**Nanotechnology activities in Eastern Europe and Central Asia (EECA)**

Countries of ex-Soviet Union have rapidly recognized the potential of nanotechnology to contribute to the scientific and socio-economic development and have identified nanotechnology as one of the priority areas of state science and technology (S&T) and innovation policies. Currently, governments are working towards requalification of specialists and attracting private sector’s attention to science and innovation as demonstrated by the growing number of innovative science exhibitions, fairs, annual forums on nanotechnology and by the multiplication of technological parks. At the national level, nanotechnology laboratories and centres of excellence are being created and educational courses on nanotechnology are being developed. Nanotechnology networks, partnerships and joint ventures are being progressively put in place by both state and non-state actors. At the regional level, inter-state and bilateral innovation programmes and projects mentioning nanotechnologies are also being agreed upon.

Below is a general picture of activities undertaken in the field of nanotechnologies in Eastern Europe and Central Asia. It highlights existing nanotechnology programmes and initiatives, nanotechnology centres, and major institutions and organisations involved in nanotechnology R&D. Challenges that these countries are facing with regard to development and oversight of nanotechnologies are also addressed.

**I. Regional Cooperation in development and realisation of Innovative activities**

Although since the early 1990s the linkages between the former Soviet Republics have somewhat weakened, there are long-standing educational and professional ties in the region, providing potential ground for a revival of close economic and scientific cooperation.[[1]](#footnote-1) Inter-state cooperation in the field of innovative technologies is built today upon a complex institutional structure of two entities: the Eurasian Economic Community (EurAsEC) and the [Commonwealth of Independent States](http://www.cis.minsk.by/) (CIS). While the [CIS](http://www.cis.minsk.by/) promotes general cooperation among nine former Soviet Republics, five countries of the CIS space committed themselves to a deeper integrated economic area via the establishment of the Eurasian Economic Community (EurAsEC[[2]](#footnote-2)). Objectives of the EurAsEC comprise the establishment of a common customs area, common external economic policy, tariffs, prices, and other components of a common market. Both entities recognize nanotechnology as an important factor of future international competitiveness and have already agreed upon joint innovative S&T activities and increasing cooperation in this area.

**EurAsEC “Centre for High Technologies”**

The EurAsEC **“**Centre for High Technologies” was established in 2009 and includes Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan and Armenia. The Centre’s activities aim at the creation of the EurAsEC common research area through development of infrastructures for scientific, technological and innovative activities, development of joint scientific and technical programmes, analysis and harmonisation of normative legal frameworks, establishment of financial mechanisms to support innovative activities, and strengthening scientific and educative potential of the EurAsEC states. Special attention is given to the creation of favourable conditions to attract investment, establishment of venture funds and cooperation with the Eurasian Development Bank. The centre considers nanotechnologies to be one of its focus areas together with bio, IT and energy-saving technologies. Creation of the joint “Innovation Fund of the Centre of High Technologies” is under discussion.[[3]](#footnote-3)

**Inter-State Programme on Innovation Cooperation in the CIS**

The CIS has set an ambitious “Inter-State Programme on Cooperation in Innovation for the period up to 2020”, designed to boost global competitiveness of the CIS economy and to transform it into a socially-oriented knowledge-based economy. The main objective of the Programme is the establishment of the inter-state innovative space that combines opportunities of national innovation systems and promotes international authority of the CIS as a global centre of technological leadership. Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan and Ukraine are actively participating in its development but the programme is open to other CIS countries. Developers are trying to avoid creating new bodies and build on entities already existing in the CIS, the EurAsEC and the Customs Union. It also provides opportunities to establish connections with the Framework Programme of the European Union and similar activities in Asia and the Pacific. As such, the Programme may be regarded as an attempt to move towards more integrated innovation cooperation as opposed to a cluster of single or targeted measures.[[4]](#footnote-4)

Within the framework of the Programme, the CIS countries signed an agreement in 2009 to set up an “International Innovation Centre of Nanotechnologies” that will play a role of a "locomotive" for the formation of a regional market of nanoindustry in the CIS space.[[5]](#footnote-5) In 2011 CIS countries also discussed a joint programme for development of science**[[6]](#footnote-6)** (including nanoscience) aimed as re-establishment of links between scientific communities that were lost in the past.

**Inter-State Framework for Cooperation in Innovative Technologies**

|  |  |
| --- | --- |
| **Eurasian Economic Community (EurAsEC) 2001** | [**Commonwealth of Independent States**](http://www.cis.minsk.by/) **(CIS) 1991** |
| **Legal nature** | International Economic Organisation (elements of supranationality) | Regional Organisation (intergovernmental) |
| **Scope and objectives** | Deeper integration in economic area, common market, common customs area, common external economic policy, tariffs, prices, etc.  | Inter-state cooperation in political, economic, environmental, humanitarian, cultural, S&T, R&D, innovation and other fields |
| **Membership** | Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan | Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Uzbekistan |
| **Unofficial members** | Armenia, Moldova, Ukraine[[7]](#footnote-7) | Turkmenistan, Ukraine |
| **Nanotechnology** | One of the priority areas, socio-economic development and competiveness  | One of the priority areas, socio-economic development and competiveness  |
| **Centres** | EurAsEC Centre for High Technologies  | CIS International Innovation Centre of Nanotechnologies  |

The CIS and the EurAsEC are the main integration and cooperation platforms in the region although other organisations are involved in innovative technologies cooperation.

**ECO Nanotechnology Network**

The Economic Cooperation Organisation (ECO) is an intergovernmental regional organisation initially comprising Iran, Pakistan and Turkey for the purpose of promoting economic, technical and cultural cooperation among its member states. The Organisation was expanded to include Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The ECO Nanotechnology Network (ECO-NAN)[[8]](#footnote-8) was created in 2009 with the aim to promote nanotechnology, strengthen research capacity through connecting national nanotechnology institutes, researchers, scientists, engineers, and policy-makers, and facilitate exchange of technical experiences. The website of the network will establish a nanotechnology database listing institutions, scientists and their respective capabilities, and research programmes. In cooperation with the ECO Transfer of Technology Centre, the ECO Science Foundation, as well as the standing Committee on Scientific and Technological Cooperation of the Organisation of Islamic Conference, ECO-NAN intends to promote nanotechnology applications for tackling poverty and achieving the UN's Millennium Development Goals (e.g. cheap sustainable energy, enhanced disease diagnosis and treatment methods, water or soil clean up applications etc.).[[9]](#footnote-9)

**Shanghai Cooperation Organisation**

In 2006 member states of the Shanghai Cooperation Organisation (SCO) (China, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Uzbekistan) established the University of Shanghai Cooperation Organisation (SCO University). The SCO University should operate as a network of already existing universities in member states, and observer states (Mongolia, India, Iran, and Pakistan) in order to make full use of competitive institutions in joint training programmes. Nanotechnology is one of the five priorities of the SCO University.

**Cooperation with the European Union**

Organisations from EECA are involved in a number of S&T projects with countries of the European Union through the multi-annual Framework Programmes for Research and Technological Development. The 7th Framework Programme (FP7 2007 – 2013) research topics cover Nanotechnologies, Materials and Production Technologies with a total budget of €3,475 million.[[10]](#footnote-10) Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan are International Cooperation Partner Countries of the EU[[11]](#footnote-11). They are targeted by the European Commission to increase research cooperation. Organisations from these countries can participate and receive funding under the FP7. The most active countries of this region are Russia, Ukraine and Belarus.

**Network of cooperation in the field of nanotechnology[[12]](#footnote-12)**



The ICPCNanoNet project funded by the European Commission under the FP7 aims to provide wider access to published N&N research and opportunities for collaboration between organisations and scientists in the EU and International Cooperation Partner Countries (ICPC). The S&T International Cooperation Network for Eastern European and Central Asian countries (IncoNet EECA)[[13]](#footnote-13) envisaged several activities to increase policy dialogue and cooperation between EECA countries and the EU in science and technology. It also aims at increasing participation of researchers from these countries in FP7 projects.[[14]](#footnote-14)The web portal “incrEAST“[[15]](#footnote-15) was designed to link the research structures of the EU, Eastern Europe and Central Asia. It focuses on information about scientific and research policy cooperation between EU Member States and associated states in Eastern Europe and Central Asia.[[16]](#footnote-16)

**International Science and Technology Centre (ISTC)[[17]](#footnote-17)**

The International Science and Technology Centre (ISTC) was established in 1992 as a non-proliferation programme.[[18]](#footnote-18) Its larger goals include reinforcing the CIS transition to a market-based economy responsive to civilian needs, and supporting basic and applied research and technology development. The ISTC approved a number of projects for activities in Russia, Armenia, Belarus, Georgia, Kazakhstan, and the Kyrgyz Republic including the development of nanostructured materials.[[19]](#footnote-19)

**II. Nanotechnology activities implemented at the national level**

Although there are a number of attempts to coordinate development of high technologies and innovation policies at the regional level, most nano-related activities are carried out at the national level.

**Armenia**

In order to develop its innovation system the government of Armenia issued the “Law of the Republic of Armenia on Scientific and Technological Activities” and the “Law on the State Support to Innovation Activity”, elaborated the “Strategy on the Development of Science in Armenia 2011- 2020”, established the “Science Development Action Plan 2011-2015” and identified “Science and Technology Development Priorities for 2010-2014”. In order to improve policy-making and promote the coordination in the field of S&T, in October 2007 the government decided to establish the State Committee of Science empowered to carry out integrated S&T and innovation policy in the country. Advanced technologies (such as biotechnology and nanotechnology) and new materials have been identified among the priority areas.

The Armenian National Academy of Sciences of the Republic of Armenia[[20]](#footnote-20) with around 35 affiliated institutions and centres has been traditionally the leader of S&T research in the country and is recognized as the official consultant to the highest governing bodies on R&D. In 2002 the Academy initiated the “Targeted Programme for Nanotechnology Development” which was aimed at development of nanoelectronics and semiconductor electronics.[[21]](#footnote-21) The NAS RA maintains close collaboration and supports development of scientific studies carried out with Yerevan State University and other establishments.

The Department of Physics of Semiconductors and Microelectronics (DPS&M) of the Yerevan State University (YSU) incorporates R&D Centre of Semiconductor Devices & Nanotechnologies (CSD&N).[[22]](#footnote-22) Apart from R&D activities, the Centre works on valorisation of research results. A Scientific Innovation Centre of Advanced Technologies was established at the Yerevan Physics Institute. The institute plans to develop nanotechnologies on the basis of the Centre.[[23]](#footnote-23) The Academy and the Yerevan State University organise the “International Conference on Semiconductor Micro & Nanoelectronics” (ICSMN). It brings together scientists, engineers and students from universities, research institutes and companies to present and discuss the latest results in the general field of semiconductor materials and devices and micro and nanoelectronics.

State Policy and strategy documents related to S&T and innovation in Armenia, stress the importance of the development of international cooperation in the field of sciences and technology. Initiatives have been established to promote cooperation in the area of nanotechnologies between Armenia, Russia and Belarus. For example, Russian-Armenian Innovation Cooperation Centre opened in 2010 in Yerevan with the intention to join innovative potential and to create additional conditions for promotion of joint development in the field of high technologies, including nanotechnologies.[[24]](#footnote-24) In January 2013 the Academy and the Joint Institute for Nuclear Research (JINR) signed a deal to cooperate in science, innovations and education. The sides intend to conduct research in physics, nuclear power, nanotechnology, and energy as well as information technologies and will form joint science groups.[[25]](#footnote-25)

It is also worth mentioning that Armenia will participate in the UNITAR pilot project aimed at developing and strengthening capacities to address nanotechnology and manufactured nanomaterials.

Very limited governmental funding as well as private investment in the area of advanced technologies, insufficient infrastructure, lack of adequate facilities and aging scientific personnel significantly impede on the development of new programmes and project implementation in priority areas as well as generation of practical returns in the field of nanotechnologies. Moreover, publicly available sources provide only very limited information on nanotechnology R&D undertaken in the country.

**Azerbaijan**

The first Nano Research Centre[[26]](#footnote-26) was created in 2005 at the Baku State University (BSU)[[27]](#footnote-27). The University hosts the Chemical Physics of Nanomaterials Department and the Nanostructured Materials Synthesis Laboratory. Works carried out by the BSU include investigation of new photo-electro thermo-luminescent polymer nanocomposite materials, application of nanotechnology in the prevention of suppurative inflammatory processes in postsurgical complications, influence of interphase interactions on physico-chemical properties of polymeric magnetic nanocomposites, interactions of nanoparticles with membrane systems of cells of higher water plants, etc. In 2010 the State Baku University signed a memorandum of cooperation with the CIS Nanotechnology Centre.[[28]](#footnote-28) Nanotechnology investigations also take place at the Aviation Academy and the Azerbaijan Technical University.

The Azerbaijan National Academy of Sciences is the central research organisation encompassing 34 research institutes and 3 regional research centres. It coordinates national S&T activities and performs policy-making functions by developing new policies, implementing and monitoring national S&T programmes.[[29]](#footnote-29) The Academy investigates nanomaterials for various applications. Researches in the field of nanotechnologies are conducted at the Institute of Physics, Institute of Radiation Problems, Institute of Chemical Problems, Institute of Geology and Institute of Petrochemical Processes.[[30]](#footnote-30) In 2009 The High-Tech Research Centre (HTRC) was formed at the Institute of Physics. HTRC carries out research work in the field of carbon and bio-nanotechnology.[[31]](#footnote-31)

The scientists of the Joint Institute of Informatics Problems (JIIP) under the National Academy of Sciences of Belarus and the Institute of Physics of the National Academy of Sciences of Azerbaijan agreed to implement a series of joint-projects in the area of nanotechnologies. Under the cooperation agreement, the Belarusian and Azerbaijani scientists intend to work on the creation of new methods, algorithms and software for modelling nanostructures, new elements for helioenergetics and will carry out joint research of output performance of polyatomic and condensed systems.[[32]](#footnote-32)

Since 2011 Azerbaijan participates in the PRIMA-ERA project, which is designed to reinforce research collaboration between the Azerbaijani Institute of Physics and research centres in the European Research Area. The project will facilitate Institute’s collaboration with EU research centres and will reinforce its engagement in the EU Framework Programme in research topics covered by such thematic priorities as energy and nanotechnologies.[[33]](#footnote-33)

The oil sector - the locomotive of economy in Azerbaijan became the pioneer for nanotechnology application. Successful applications of nanotechnologies have been found in oil industry through results of joint research conducted by the BSU and the State Oil Company of Azerbaijan (SOCAR)[[34]](#footnote-34). It’s Nanotechnologies Research and Development Centre works towards increasing oil and gas production through application of nanotechnologies.[[35]](#footnote-35) The State Oil Company launched a Programme "NANONEFT" for 2010-2015 that plans to apply nanotechnology in oil extraction, well drilling and petro-chemistry. Furthermore, the company has signed a Memorandum of Understanding with the Economic Development Agency of the Federal State of North Rhine-Westphalia (NRW.İNWEST GmbH) and German Nano-technologies cluster of new materials (NanoMikro+Werkstoffe.NRW). The Memorandum envisages establishment of joint projects and identification of areas for production of nano-technological systems. The cooperation will focus on sale of nanotechnologies systems to the EU and other countries.[[36]](#footnote-36)

It must be noted that even though in 2007 the “Nanotechnology Development Programme of Azerbaijan Republic” was drafted it is unclear whether it has been officially adopted. Nanotechnology initiative is gaining momentum in the oil sector. However, even if the this sector of Azerbaijan has been flourishing, little has trickled into the state funding of science and technology. The national innovation system of Azerbaijan, in general, is at a relatively early stage of development.

**Belarus**

The legal basis of S&T and innovation policy in Belarus is formed by a number of legal acts and state programmes dedicated to science, technology and innovation. Nanotechnologies are included into the list of the critical technologies of Belarus. One of the key programmes under implementation is the “State Programme of Innovative Development of the Republic of Belarus”. A sub-programme of the “State Programme of Scientific Research 2011-2015” is specifically dedicated to “Nanomaterials and Nanotechnologies”.[[37]](#footnote-37) The “National Strategy for Sustainable Development 2001-2020 of the Republic of Belarus”[[38]](#footnote-38) as well as the Programme “Socio-Economic Development of the Republic of Belarus 2011-2015”[[39]](#footnote-39) also list nanotechnologies among priority areas.

Policy-making and coordination in science, technology and innovation are carried out by a triangle composed of the State Committee on Science and Technology, National Academy of Sciences and Higher Certifying Commission.

Funding bodies integrated into the state S&T system are Belarusian Republican Foundation for Fundamental Research under the NAS, Belarusian Innovation Fund and Branch Innovative Funds under different Ministries.[[40]](#footnote-40)

**Institutional framework for policy-making and coordination in science, technology and innovation[[41]](#footnote-41)**

|  |  |
| --- | --- |
| **State Committee on Science and Technology (SCST)** | Coordinates S&T and innovation policy (application of the research results in the economy, legislation, budget distribution, intellectual property rights, international cooperation, scientific training) |
| **National Academy of Sciences (NAS)** | Organizes, conducts and coordinates basic and applied research |
| **Higher Certifying Commission (HCC)** | Certifies highly qualified scientific personnel and implements state regulation |

The National Academy of Sciences is the leading research player in the country comprising institutions with the highest concentration of qualified researchers. The Academy is not only a leading R&D organisation, it also coordinates basic and applied research, as well as state programmes throughout the national territory.[[42]](#footnote-42) Its research activity is largely oriented towards enterprises.[[43]](#footnote-43) In 2011, in line with the innovation strategy, the Ministry of Education and the Academy created a project “Concept for Development and Use of Nanotechnologies and Nanomaterials in the Republic of Belarus”. It suggested the creation of a coordination body dedicated to nanotechnologies and development of nanotechnology platforms on the basis of existing educational and industrial establishments.[[44]](#footnote-44)

Several universities and institutes implement the state innovation policy and carry out R&D activities focused on, or including nanotechnologies and nanomaterials. For example, a “Laboratory of Nanoprocesses and Nanotechnology” was established at the [A.V. Luikov Heat and Mass Transfer Institute](http://itmo.by/). Specific research areas include study of mechanical and thermal processes at micrometre and nanometre scale, development of nanotechnological methods and tools, as well as study of micro-mechanics of biological objects and nano-tomography of cell structures. In 2007, the "nanodrilling" method, developed by the laboratory, was awarded as the best R&D achievement by NAS of Belarus. International projects and scientific contacts are established with Russia, South Korea, Poland, the U.S., UK, Vietnam, Ukraine and other countries.[[45]](#footnote-45)

The Belarusian State University (BSU) is the largest University in Belarus and is one of the main executors of relevant state programmes on scientific research and fundamental investigation.

The Faculty of Radio engineering and Electronics of the Department of Micro and Nanoelectronics offers first-degree programmes on micro and nanoelectronics technologies and systems as well as nanotechnologies and nanomaterials in electronics.[[46]](#footnote-46) The faculty of Extra-Mural Training offers programmes in micro and nanoelectronic technologies and systems.[[47]](#footnote-47) The Centre of Nanoelectronics and Novel Materials of the Belarusian State University of Informatics and Radio electronics (BSUIR) carries out research in the areas of quantum computing, scanning probe nanotechnology, silicon-based optoelectronics, silicon quantum well devices, and silicon and germanium structures.[[48]](#footnote-48) Scientists from BSUIR organise regular "Nanomeetings" aimed at gathering together specialists working on nanostructures.[[49]](#footnote-49)

State universities and other leading institutes of higher education in Belarus provide specialist trainings in a number of technological spheres including bio and nanotechnology*.* It is planned that in 2012-2015 in the Republic of Belarus 1,650 students will be admitted on the specialties in the sphere on nanotechnology.[[50]](#footnote-50)

Business development in the field of new technologies is also encouraged by the national government. In 2005 the President of Belarus opened a Hi-Tech Park in Minks. Currently 118 companies are registered as Park's residents (half of which are foreign companies and joint ventures).[[51]](#footnote-51) The scope will further be extended to other perspective future-oriented industries. Belarus is currently implementing a project aimed at creating the National Scientific Technological Park called “BelBioGrad” as part of the Programme “Socio-Economic Development of the Republic of Belarus 2011-2015”.[[52]](#footnote-52)

Cooperation agreements and arrangements in the frame of innovation policy are being concluded between Belarus, border-states and other countries. Belarus has very intensive research collaboration with Russia. The National Academies of the two countries have organised a number of collaborative calls. Cooperation and closer integration with Russia spans many areas (science, R&D, innovation and new technologies).[[53]](#footnote-53) Scientists of Belarus and Russia also plan to set up a database of nanotechnologies. The “databank” will contain information on the cutting-edge Belarusian and Russian innovations in nanotechnologies.[[54]](#footnote-54) Within the frame of established scientific and technical cooperation many projects presented by Belarus have received support from RUSNANO.[[55]](#footnote-55)

Belarus also collaborates with the EU. Since the beginning of the FP6, Belarusian partners were involved in 22 projects with financial contribution from the European Commission in information technologies, nanosciences and materials, environment and energy.[[56]](#footnote-56) For FP7 Belarus teams also participated in the projects in the field of nanotechnologies.[[57]](#footnote-57) Belarus takes part in the EU-Belarus-Russia Network in Nanomaterials-Driven Anti-Cancer Gene Therapy. The main objective of NANOGENE project is to provide the tight collaboration of five institutions from the European Union, Russia and Belarus in the field of nanomaterials-driven delivery of anti-cancer siRNA into cancer cells.[[58]](#footnote-58)

Recently, the Nanotechnology Industries Association has been set up in Belarus with the purpose to coordinate academic, innovative and commercial activities in the field of nanotechnologies.[[59]](#footnote-59)

**GEORGIA**

Georgia's research system has gone through major restructuring. Changes include the optimisation of the number and activities of research institutes and their integration into the university system, elaboration of new funding models for S&T and programmes for young scientists.[[60]](#footnote-60) The first “International Conference on Nanochemistry and Nanotechnologies 2010-NANO” took place in March 2010 in Tbilisi. During the conference participants proposed to consolidate joint efforts and intellectual resources of all scientists working in nanotechnology sphere in Georgia.

Several institutes of higher education carry out research in nanotechnology and propose Masters and Doctoral programmes in this field.

In June 2008 Ministers of Education of Armenia and Georgia signed an agreement on cooperation in the field of education 2008-2011. The cooperation is focusing among other topics on nanotechnologies.[[61]](#footnote-61)

Georgia has carried out a number of reforms in its S&T system in the last years. Nanotechnology activities take place at major educational establishments and research institutions. However, it seems that up to date there is no clear coordinated action in the area of nanotechnologies.

**Kazakhstan**

Main branches of the Kazakh economy are oil-and-gas, mining-metallurgical complexes, and

agriculture. However, the country is focusing on expanding research in other S&T areas. Nanotechnologies have been chosen by the State as one of its priority fields for development. The main national S&T strategy document was the “State Science Development Programme in Kazakhstan for 2007-2012” Within this framework, scientists implemented scientific and technology programmes and fundamental research programmes. One of the S&T programmes was specifically dedicated to “Nanotechnologies and New materials”. The programme targeted the creation of new structural materials for solid-state electronics, machine building, power-intensive industries, the space industry and medicine.[[62]](#footnote-62)

The "National Agency for Technological Development" Joint Stock Company is the successor of "National Innovation Fund JSC (NIF JSC), which was established to support innovation activity in Kazakhstan, creating venture funds, attracting foreign investments, increasing technological competitiveness, promoting high technologies and science absorbing industries and financing innovative projects that meet national priorities.[[63]](#footnote-63) It contributed to the establishments of regional techno parks, which are the main bases of the innovation infrastructure in Kazakhstan.

In 2008 a State Company National Nanotechnology Laboratory of Open Type[[64]](#footnote-64) was established at the Al-Farabi National University. The objective of the Laboratory is to establish scientific-technological and educational infrastructure for development of nanoscience, nanotechnologies and nanoengineering and to bring applied nanoscience closer to manufacturing and business. For example, the laboratory is working on creation of DLS (diamond-like carbon) coating.[[65]](#footnote-65)

Institute of Physics and Technology (IPT)[[66]](#footnote-66) situated in Almaty provides technological infrastructure for the implementation of programmes and projects in the scientific direction of nanotechnologies and new materials. Activities of the Institute include development of instrumental basis for the synthesis of nanoscale structures, analytical tools for analysing the properties of nanoscale objects, nanostructures and clusters, and semiconductor materials for use in micro-nanoelectronics. It has established scientific and educational partnerships with domestic and Russian centres and universities and the National Innovation Fund. Scientific co-operation is also established with laboratories and universities in the U.S., Japan and Europe.

Laboratory for Nanoengineered Methods of Research was created at Taraz State University. It carries out research activities for the development of a new generation of nano-enabled foods and creation of new types of construction materials based on local raw materials and industrial wastes and organizes scientific seminars, round tables and training courses in the field of nanotechnology, nanomaterials and biotechnology.[[67]](#footnote-67)

Engineering Regional Laboratory IRGETAS was created in 2007 at the D.Serikbayev East Kazakhstan State Technical University (EKSTU). The laboratory is a multi-access test centre specializing in nanotechnology development for manufacturing of advanced materials for atomic industry, mechanical engineering, building industry and other industries. EKSTU signed a contract with a Japanese company JEOL Ltd establishing Kazakhstan-Japanese educational research service centre in the field of nanotechnologies and electronic microscopy. Contracts for joint-research in the field of physical material science, nanotechnologies and new materials production were also concluded with R&D centres of Russian Federation (Tomsk, Barnaul) and Germany (Magdeburg).[[68]](#footnote-68)

The Institute of Hi-Technology and Sustainable Development was created in 2010 at the Kazakh National Technical University K.I. Satpaev (KazNTU). The University offers courses in nanotechnology[[69]](#footnote-69) and hosts a laboratory of engineering profile that carries out research on synthesis of bio- and nanomaterials.[[70]](#footnote-70) KazNTU has created a department responsible for introduction and realisation of the international educational programs of the SCO University in such directions as “Nanotechnology”, “Ecology” and “IT-Technology”.[[71]](#footnote-71) Together with the International Postgraduate Institute “Excellence PolyTech” and the Institute of Industrial Engineering after A. Burkitbayev the Institute of High Technology and Sustainable Development organized a series of lectures in “Nanotechnology” (visiting lectures programme, KazNTU). [[72]](#footnote-72) A technological park[[73]](#footnote-73) is situated on the premises of the University. It is composed of laboratories that carry out projects, which are financed by National Innovation Fund, as well as university research projects in engineering, materials and technologies of polymers, nanomaterials and nanotechnology, oil, and biotechnology.

Traditional links contribute Kazakhstan’s close cooperation with EECA countries, especially with Russia. In 2011, Kazakhstan and Russia have signed an agreement with the aim to organize the scientific-educational innovation partnership. RUSNANO, Kazyna Capital Management, VTB Capital and I2BF Holdings have set up a Russian-Kazakhstan Nanotechnology Venture Fund. The Fund will operate for 10 years and its target size is $100 million.[[74]](#footnote-74) Focus of the Fund will be on transferring cutting-edge technology, creating new forms of international collaboration, and stimulating development of financial infrastructure for nanotechnology markets.[[75]](#footnote-75)

A number of international conferences, exhibitions are organized in Kazakhstan including International Kazakh-Russian-Japan science conference “Advanced Technologies, equipment and Analytic Systems for Materials Science and Nanomaterials”, International exhibition  “Nanoindustry:  Equipment - Advanced Industrial Processes - Production”, annual courses in professional development and personnel training as well as regional science work-shops in nanotechnologies.[[76]](#footnote-76)

A public initiative was launched by NANOLIFE.KZ - an electronic journal dedicated to nanotechnologies in general.

Despite a numerous amount of nano-related activities that have been initiated in Kazakhstan, ,it appears that development of nanotechnologies in the country, from a practical perspective, is currently at the experimental stage.[[77]](#footnote-77)

**Kyrgyzstan**

The State Programme on “Science Development and Innovative Activities in Kyrgyz Republic for the period up to 2015” targets creation of an innovative economics, on the basis of native and foreign scientific, technical and intellectual potentials.[[78]](#footnote-78) National science and technology priority research areas include new technologies and materials together with IT, water and energy resources, biotechnology and other fields.[[79]](#footnote-79)

In 2007 the Prime Minister of the Kyrgyz Republic signed a Decree on Nanotechnology Development in Kyrgyzstan establishing the National Nanotechnology Development Council designed as a coordination platform of relevant ministries, state committees and administrative bodies. The Council was entrusted with a task to develop a National Nanotechnology Initiative.[[80]](#footnote-80) Recently, the government revisited the Decree of 2007 with the aim to enhance efficiency of national nanotechnology development.[[81]](#footnote-81)

With regard to R&D activities in Kyrgyzstan, a nanotechnology laboratory was created at the Institute of Chemistry and Chemical Technology of the National Academy of Sciences of the Kyrgyz Republic. The institute developed machines with electric motors and machines, which save fuel using the nanosupplements that enhance the efficiency of combustion of such fuel. Nanosupplements are also used in machine parts, so the machine parts serve longer. Kyrgyz-Russian Slavic University (KRSU) also carries out research in the area of nanotechnology.[[82]](#footnote-82)

Despite the difficult situation of science in Kyrgyzstan, there are several exclusive developments - domestic scientists patented seven inventions in the field of nanotechnology.[[83]](#footnote-83) These include method of obtaining titanium dioxide - a catalyser for the decomposition of water to hydrogen fuel and fullerenes, carbon nanostructures that can be used to obtain qualitatively new types of drugs, alternative energy, electronics and minimisation of computer chips and parts.[[84]](#footnote-84)

The National Academy of Sciences of the Kyrgyz Republic[[85]](#footnote-85) plays an important role in promoting S&T activities. It carries out research in various scientific fields, forms scientists in all fields of knowledge, advises the government on S&T policy, coordinates basic research funded by the state, participates in international cooperation initiatives on S&T, and organises symposiums and conferences.[[86]](#footnote-86) In 2010 the National Academy of Sciences joined the CIS International Innovation Centre for Nanotechnology. In 2007 the Techno-park of the National Academy of Science[[87]](#footnote-87) was established with the intention to develop and support effectively small innovative businesses to commercialize scientific knowledge, inventions, know-how and high technologies.[[88]](#footnote-88)

Kyrgyzstan is a member of the Shanghai Cooperation Organisation and the Economic Cooperation Organisation. It has a bilateral agreement with the Islamic Republic of Iran. Two countries established a Commission on Trade, Economic, Scientific, Technical and Cultural Cooperation. Countries agreed to establish connections between governmental authorities in the field of scientific and technical information and nanotechnologies. [[89]](#footnote-89)

Despite the will to develop innovative technologies scientists of Kyrgyz Republic work in difficult conditions. Kyrgyzstan is one of the poorest countries in Central Asia. Lack of state resources, very limited budgetary funding for research organisations and scarce investment from private sector significantly impede proper implementation of the innovation activities. Because a small share of funding is dedicated for buying new and modern scientific equipment, scientists carry out research on self-made devices in ill-equipped laboratories.[[90]](#footnote-90) Furthermore, remuneration of scientists of the National Academy is low. Another problem is the attraction of youth to science. Finally, the national science policy in general suffers significantly from weak legislative basis, insufficient coordination framework and largely undeveloped conditions for technology transfer and international co-operation.

**MOLDOVA**

The major reforms in the S&T system of Moldova have taken place since 2004[[91]](#footnote-91)when the Parliament adopted the “Code of the Republic of Moldova on Science and Innovations”. [[92]](#footnote-92) The Code changed the role of the Academy of Sciences of Moldova. It now has the central role in developing and implementing the national S&T policy and provides scientific advice to the public authorities. Several institutions were established within the ASM structure: the Agency on Innovation and Technology Transfer[[93]](#footnote-93) and the Centre for International Projects.[[94]](#footnote-94) The programme “Nanotechnologies and Nanomaterials” is one of the state programmes established in priority areas. The Academy of Sciences implements this programme.

A number of scientific teams work in the field of nanotechnology. For example, the Institute of Electronic Engineering and Industrial Technologies (Nanotechnology) carries fundamental and applied scientific research in the area of solid state electronics, engineering of materials and electronic devices and hosts a Nanotechnology Laboratory.[[95]](#footnote-95) The Technical University of Moldova has a National Centre for Materials Study and Testing that carries out nanotechnology R&D activities in several directions including advanced technologies of semiconductor nanomatrices, optic and photoelectric properties of nanostructured semiconductor materials, nanocomposite materials, nanoelectronic devices, nanolasers, radiation nanosensors, etc.[[96]](#footnote-96) The Institute of Applied Physics carries out research in semiconductor materials, including nanomaterials and studies optical phenomenon and particles transfer in nano-structures and molecular systems.[[97]](#footnote-97) Researchers in Moldova have already obtained results in this area and some of their achievements may be ready for commercialisation.[[98]](#footnote-98)

**A selection of nanotechnology players in Moldova[[99]](#footnote-99)**

|  |  |
| --- | --- |
| **Nanoelectronics Nanooptics** | Institute of Applied Physics of the ASM |
| Institute of Electronic Engineering and Industrial Technologies |
| Technical University of Moldova |
| **Nanochemistry** | State University of Moldova, |
| Institute of Chemistry of the ASM |
| **Nanobiology** | State University of Moldova |
| State University of Medicine and Pharmaceutics “N. Testemitanu” |
| Institute of Microbiology and Biotechnology of the ASM |
| “Ficotehfarm” |

The Summer School in nanotechnology and biomedical engineering "Nano-Bioengineering-2012" is organized within the framework of the FP7 project MOLD-ERA with the objective to develop creative skills for the national economy.

Having been a deeply agrarian country for a long time, Moldova has the research excellence in the related fields, such as agricultural biotechnologies, soil fertility and food security. Results have also been achieved in biomedicine, pharmacy, health maintenance and protection. Besides, physics, nanotechnologies and new materials are the fields of international collaboration.[[100]](#footnote-100) However, funding for innovation activities remains modest. Cooperation between research and business and qualified human resources remain a major challenge in Moldova.[[101]](#footnote-101)

**Russian Federation**

Despite it’s excellent technical and scientific potential, Russia’s economy has been for a long time largely dependent on mineral resources. However, the country leadership recognized the need to shift its economic focus to a high technology and innovation driven society and nanoindustry development has become one of the strategic national priorities of Russian Federation. Nanotechnologies are part of the major competitive Federal Targeted Programme "Research and Development in Priority Fields of S&T Complex of Russia” which is modelled on the example of the EU’s Framework Programme. The “Development Programme of Nanoindustry in the Russian Federation for the period until 2015”[[102]](#footnote-102) was established in 2008. The programme has a coordinating character and defines specific tools and activities for the implementation of the presidential initiative "Development Strategy for Nanoindustry” announced in 2007. Another important instrument for nanotechnology development is the Federal Target Programme “Development of the Infrastructure of Nanoindustry in the Russian Federation for 2008–2010” which was renewed for the year 2011. A special plan of priority actions aimed at implementing the programme was adopted by the Federal Consumer Rights and Human Well-Being Department (Rospotrebnadzor) in 2009. This plan covers different environment, health and safety (EHS) aspects of manufactured nanomaterials.

To fuel innovation, the Russian government has established government-funded initiatives.[[103]](#footnote-103) “RUSNANO” - state-run Corporation of Nanotechnologies was set up in 2007 to drive economic modernisation through development of national nanotechnology industry. In March 2011 RUSNANO was reorganized into a $10 billion global joint-stock company with 100% shares owned by the Russian government. RUSNANO carries out its charge through commercial mechanisms, by co-investing in nanotechnology projects with substantial economic potential and social benefit.[[104]](#footnote-104) The company focuses on commercialisation of nanotechnologies, attracting private investment to nano-industry, developing partnerships with the leading nanotechnology centres in the world, and promoting Russian nanoproducts on the world market.[[105]](#footnote-105) It is designed to bridge the gap between mature and tested R&D results and market ready high-tech products. Foreign research organisations and companies can apply for support, provided they set up business and production in Russia.

All RUSNANO projects can be grouped into 6 clusters: solar energy and energy saving, nanostructured materials, medicine and biotech, mechanical engineering and metalworking, optoelectronics and nanoelectronics. As of September 2012, RUSNANO has co-invested $6.6 billion in 105 investment projects with a total budget of $15.5 billion, of which the majority is invested in Russian companies[[106]](#footnote-106).

While RUSNANO is a business entity, it collaborates with the non-commercial Fund for Infrastructure and Educational Programmes, also established during the reorganisation of the Russian Corporation of Nanotechnologies. The mission of the Fund is to develop nanotechnology infrastructure, initiate professional training programmes on demand of RUSNANO portfolio companies, develop human resources for the nanoindustry, address standardisation, certification and safety of nano-enabled products and carry out activities focused on education and popularisation.**[[107]](#footnote-107)**

**Russian Corporation of Nanotechnologies (2007)[[108]](#footnote-108)**

|  |  |
| --- | --- |
| **Open Joint-Stock Company** **RUSNANO** | **Fund for Infrastructure and Educational Programmes** |
| Business entity | Non-commercial organisation |
| Investment projects:* Stimulation
* Selection
* Business structuring
* Co-financing
* Implementation
 | Innovative infrastructure:* Infrastructure projects and programmes
* Foresight, road maps
* Standardisation, certification, metrology
* Education, popularisation
* Nanotechnology International Forum
 |
| Cooperation and synergies with other institutions, joint projects at the regional level and partnerships at the international level  |

Both RUSNANO and the Fund are state instruments dedicated to implement the state policy in the field of nanotechnologies. They join forces with other Russian institutions, such as Russian Venture Company (RVC)[[109]](#footnote-109) and the Skolkovo Foundation.[[110]](#footnote-110) These institutions are key sponsors for Russian Innovation Week and are also members of the Russian Innovation Centre.[[111]](#footnote-111)

Special attention is given to cooperation at the regional level. In 2010 Eurasian Development Bank and RUSNANO signed a memorandum of cooperation for joint financing of nanotechnology projects. The parties agreed to coordinate their efforts in accomplishing mid-sized and long-term investment projects in order to strengthen integration of economic processes among countries of the Eurasian Economic Community as well as to increase their production of innovative nano-enabled goods and to create new workplaces in industry, medicine, transportation, and other areas in the EurAsEC countries.

Besides, international cooperation is seen as an important element of the Russia’s innovation policy. In 2012 RUSNANO invested in 20 projects involving partnerships with American companies representing 16 per cent of RUSNANO’s investments, followed by European and Asian companies.[[112]](#footnote-112) RUSNANO has established a subsidiary RUSNANO USA, Inc. The company's primary tasks include cooperating with American and Canadian high-tech companies, venture capital and private equity funds and implementing preliminary due diligence of potential portfolio companies as well as facilitating the marketing of Russian nanotechnology products.[[113]](#footnote-113) [Skolkovo](http://www.ewdn.com/category/regions-and-cities/skokovo/) innovation hub has also opened an American beachhead in Silicon Valley. Similarly, RUSNANO Israel Ltd. represents the interests of Corporation, its portfolio companies, and the Fund in Israel. RUSNANO Israel Ltd. and MATIMOP (the Israeli Industry Centre for R&D) jointly operate the intergovernmental Russia-Israel Bilateral R&D Programme.

Bilateral R&D cooperation is also established via Russian funding share in the German research infrastructure XFEL (X-Ray Free Electron Laser), which amounts to € 250 million for the period 2009-2016.[[114]](#footnote-114) In addition, Russian scientists take part in a number of projects with the EU. Under FP7 at least 15 Russian teams are active in projects in the field of “Nanosciences, Nanotechnologies, Materials and New Production Technologies”.[[115]](#footnote-115)

Although the strategy of Russian Federation is focused on the development of national nanoindustry, it is recognized that an appropriate regulatory oversight is needed to control manufacturing and placing on the market of nano-enabled products. However, despite the fact that several legislative acts may be indirectly related to nanosafety,[[116]](#footnote-116) there is no federal legislation specifically dedicated to this matter. Instead, the issue of nanosafety is currently covered by means of normative technical acts, in the form of resolutions, methodical instructions and methodical recommendations, approved by the Main Sanitarian Inspector of Russian Federation.[[117]](#footnote-117)

One of the main documents in this area is the “Concept of Toxicological Researches, Methodology of Risk Assessment, Methods of Quantitative Identification of Nanomaterials” of 2007. Another important document is the methodical recommendation “Safety Assessment of Nanomaterials” also issued by Rospotrebnadzor in 2007. It contains an algorithm for identification of potentially dangerous nanomaterials, study methods for their physical, chemical and molecular-biological characteristics, experimentation schemes and nanotoxicity research guidelines. Besides these documents, more than 30 methodical acts, which are compulsory at the department level, have been issued by Rospotrebnadzor in the area of nanosafety regulation.[[118]](#footnote-118)

In line with the existing framework, a number of accredited laboratories are responsible for testing the safety of nanomaterials in Moscow, Perm, Yekaterinburg, Tyumen and Novosibirsk. In addition to that a special working group is currently developing a set of subordinate and methodical documents on nanosafety and risk assessment according to the 2009 Order of the Ministry of Public Health of the Russian Federation.

With regard to information about nanotechnology developments in Russia, there are a few publicly available sources that provide useful data on R&D and commercialization activities. For example, “NanoNewsNet.ru”[[119]](#footnote-119) was created in 2004. Its task is to raise awareness about nanotechnologies in Russia and to provide analytical information about nanoindustry. It also provides useful information about nanotechnology activities in other CIS countries.

As part of the Targeted Programme "Development of Infrastructure for Nano-Industry in the Russian Federation” (initiated in 2008), Russian Government announced in 2010 the creation of the National Nanotechnology Network. A great number of research centres (such as the Kurchatov Institute) and universities (including Moscow State University and the Moscow Institute of Physics and Technology) were to become members of the network.[[120]](#footnote-120) The website of the National Nanotechnology Network[[121]](#footnote-121) is intended to coordinate the work of the largest participants in the innovative process and to provide updated information about various aspects of nanoindustry development in Russia including a catalogue of nano-enabled products and equipment.

Nanotechnological Society of Russia (NtSR) was founded in 2008 in Moscow as a non-profitable organisation.[[122]](#footnote-122) The NtSR brings together representatives from research, education, business, administration, and other areas. Its aims comprise promotion of creativeness, cooperation, and progress in the Russian nanosociety, assistance in commercialisation of the research results, education, information support, international collaboration, public contacts and propagation of innovation progress.[[123]](#footnote-123) The NtSR has active contacts and formal agreements with the state corporation "RUSNANO", NT- MTD Co, Nuclear Society of Russia, and other organisations. “Nanometer”[[124]](#footnote-124) is a non-commercial website, dedicated to the popularisation of scientific knowledge and interaction between scientific groups involved in nanotechnology development in Russia.

Nanoeducation is an important part of the Nanotechnology Programme. Its core element is the installation of equipment in educational establishments and organisation of nanotechnology laboratories.[[125]](#footnote-125) In 2010, the RUSNANO School League project took place in 20 schools in 10 regions of the Russian Federation. The annual all-Russia Olympiad, jointly conducted with Moscow State University entitled “Nanotechnology - Breakthrough to the Future” plays a high-profile role in educating young people. Russian Government also collaborated with NT-MDT Co producing nanotech devices. The company provides special training tools “NANOEDUCATOR” with a set of learning aids, accessories for introducing students to nanotechnology and giving them a basic understanding of how to work with objects at the nanoscale level.

The above-mentioned activities indicate that Russia emerges as an important player in the race for nanotechnologies. The Russian Federation is definitely a leader in nanotechnology funding, R&D and commercialisation in the EECA region. Russia has chosen a centralized approach to developing nanotechnologies, and progress has been made in formulating the strategy, developing the regulatory base, and providing resources in this area. However, despite a significant amount of achievements, Russia’s nanotechnology sector has yet to tackle a number of challenges.

First, both public and private spending did not manage to reach their full potential. In 2011 RUSNANO announced its intention to sell 10% of its shares by the end of 2012 as part of a plan to progressively privatize 40% of the company. In March 2012, RUSNANO announced it was closing 16 investment projects estimated at $600 billion. The official reason for the decision was the rejection of the co-investors. Earlier, in September 2011, RUSNANO has already closed down another 6 investment projects of $300 million. In addition, RUSNANO’s “monopoly” is currently under a lot of criticism from media, deputies and scientists with regards to transparency and efficiency of its intended mission. Second, although cooperation with the CIS countries is identified as one of the priorities, it is argued that the overall tendency of RUSNANO’s cooperation puts more emphasis on signing numerous framework agreements instead of engaging in practical technology development. Third, building the bridge between science and innovation as well as creating a better infrastructure for the commercialisation of research remains a challenging task.[[126]](#footnote-126) Although Russia is investing heavily in nanotechnology development, it is lagging behind international leaders in terms of producing real-world products.[[127]](#footnote-127) Last but not least, the existing regulatory framework for nanotechnologies consists of a fragmented set of methodical and guidance documents, which are merely compulsory at the department level. Hence, one of the most dynamic fields of innovative activities in the Russian Federation is not covered by specific and compulsory legislation dedicated to the EHS oversight of nanomaterials.[[128]](#footnote-128) According to Rospotrebnadzor producers of nanoproducts have to undergo a state level registration and to label their products accordingly. Yet, a number of products on the Russian market are advertised as nano but mention no state registration. This situation leads to serious concerns about the capacity of the existing framework to properly regulate risks associated with nanomaterials.

**Tajikistan**

Tajikistan S&T system is governed mainly by the National Academy of Sciences, which concentrates the majority of research organisations. The first structure aimed at the development of nanotechnologies was established in Tajikistan in 2007. [S.U. Umarov](http://www.phti.tj/html/Temp.htm) Physical-Technical[[129]](#footnote-129) Institute of [Academy of Sciences Of Republic of Tajikistan](http://www.ant.tj/) has been active in solving a number of basic research and applied problems of nuclear physic, solid-state physic and semiconductors. The Institute has a department of nanomaterials. According to the Academy of Sciences, Tajikistan started cooperation in the field of nanotechnologies with Russia, in particular with the Shubnikov Institute of Crystallography and the United Institute for Nuclear Research[[130]](#footnote-130).

Due to the difficult situation of the country there is an urgent need to build and modernise R&D infrastructures. The S&T system is mainly funded from the limited state budget with scarce foreign and private investment. There is also lack of highly educated scientific personnel. Although nanotechnology research takes place, it is still at a very early stage.

**Turkmenistan**

The "National Programme of Socio-Economic Development of Turkmenistan for 2011-2030” provides for a gradual transition to innovative, resource-saving technologies that will ensure sustainable development.[[131]](#footnote-131) It is considered that the most important role belongs to fundamental science and research directed to form new technological aspects of industrial branches based on the wide implementation of high technologies: nanotechnologies, know-how, latest achievements of fundamental sciences and improvement solutions.[[132]](#footnote-132)

The Academy of Sciences of Turkmenistan[[133]](#footnote-133) is responsible for coordination of scientific and research activities. The Turkmen State Power Engineering Institute decided to launch a special course entitled "Fundamentals of Nanotechnology". The new discipline is to be introduced into the training of specialists such as mechanical, electrical, automation and chemical engineers. The main objective is to study ways to create nanoparticles and nanomaterials, their structure and properties, methods to manipulate nano-objects and application of these nano-objects in different systems.[[134]](#footnote-134)

According to the institute of Strategic Planning and Economic Development a technological park will be established in Turkmenistan. The park will create opportunities for research in the field of alternative energy and nanotechnologies.[[135]](#footnote-135)

Several priority fields for Turkmen-Russian cooperation were identified. These included advanced materials, nanotechnologies, power engineering and energy efficiency, telecommunications, biotechnology and pharmaceutics[[136]](#footnote-136).

It should be noted that, although a few steps have been undertaken with a view of promoting nanotechnologies in Turkmenistan basic infrastructure for their development is yet to be created.

**UKRAINE**

Since 2003 Nanotechnologies have been identified as one of the strategic priority areas for innovation development. More recently, the Law “On Priorities in Innovation Activities in Ukraine” defines strategic innovation priorities for the period 2011-2021. One of them directly concerns assimilation of the new technologies of materials production, their processing and interconnection, creation of the nano-materials and nanotechnologies industry.[[137]](#footnote-137) The State Target Scientific and Technical Programme “Nanotechnology and Nanomaterials” for the period 2010-2014 was approved in 2009. The Programme consists of several research areas and development directions : physics of nanostructures, technologies of semiconducting nanostructures, diagnostics of nanosystems, nanomaterials, nanobiotechnology, nanochemistry, nanoelectronics and nanophotonics, and development of national nanoindustry.[[138]](#footnote-138)

The aim of the national nanotechnology initiative is to develop industry which would be environmentally friendly, automated, secure, capable to partially substitute the conventional production and old “dirty” industry, to increase GRP through enlargement of “high tech” sector of economy, and to develop and commercialise nanotechnologies in biomedicine, agriculture, security and environmental protection. The main feature of the strategic plan for nanotechnologies is to respond to the global priorities in this area.

1. The Scientific and Industrial Concern (SIC) "Nauka" is a significant player in the realisation of the Ukraine’s innovative development policy. SIC “Nauka” unites a number of organisations that carry out fundamental and applied research, develop and commercialize technology and have at their disposal solid scientific production basis. “Nauka” is a management body of the scientific-technical programme “Nanotechnologies and Nanomaterials”. The first SIC “Nauka” production site opened in 2011 in Lvov. It is dedicated to industrial production of nanoheterostructures for various purposes, in particular for high-brightness LEDs, concentrator solar cells and high-power SHF transistors. Such products are expected to increase energy efficiency of many companies. According to the business plan, the company intends to produce about 20 million LEDs annually in Ukraine. At the stage of scientific research and experimental tests “Nauka” has reached an agreement and signed the first contract to supply nanoheterostructures to the European Union. Similar sites were to open in Kiev.[[139]](#footnote-139)

The National Academy of Sciences of Ukraine has been conducting fundamental research and implementing targeted projects in the area of nanostructure systems, nanomaterials and nanotechnologies. A business portal “Nanotechnologies and nanomaterials” was developed by the NASU Nanotechnologies Transfer Joint Office (NTTJO).[[140]](#footnote-140) The portal joins and coordinates activity of specialists from technology transfer departments of different institutions of the Academy, presents information on research and novel developments in the field of nanotechnologies and nanomaterials and facilitates the transformation of the knowledge-intensive developments of researches from NASU into innovations.

Lashkaryov Institute of Semiconductor Physics is the leading institution in nanotechnology and nanoscience research. It focuses on micro and nanoelectronics[[141]](#footnote-141) and carries out research in three national Programmes (NASU programme, Targeted Applied Research Programme, Programmes of Departments of Physics and Astronomy) and one bilateral collaborative Programme with Russia (Russian Fund of Fundamental Research and NASU Bilateral Programme).[[142]](#footnote-142)

Russia and other CIS countries are important partners of the Ukrainian scientific cooperation. Special attention is paid to joint Ukrainian-Russian scientific and technological projects. For example, Ukraine's first Scientific and Educational Centre “Nanoelectronics and Nanotechnology” opened in Kiev in 2011. The Centre is a result of cooperation between SIC “Nauka”, National Technical University of Ukraine “Kiev Polytechnic Institute”, and Russian company NT-MDT within the framework of Russian-Ukrainian scientific-research programme “Nanophysics and Nanoelectronics”. The Centre will focus on R&D activities in the field of nanophysics and nanoelectronics, implement competitive scientific and applied projects, promote international S&T and educational cooperation with partner universities, companies and foundations[[143]](#footnote-143) and will provide conditions for in-depth specialists training for nanoindustry. The material and technical base of the Centre is created within the nanotechnology complex NANOFAB[[144]](#footnote-144) designed and created by the SIC “Nauka”. Activities of the Centre will be carried out under the guidance of Russian and Ukrainian academics.[[145]](#footnote-145)

In recent years, Ukraine has been pursuing a policy of European integration.[[146]](#footnote-146) Ukrainian teams took part in the EU’s FP6.[[147]](#footnote-147) Under FP7 EU and Ukrainian researchers collaborate in three N&N areas: impact of engineered nanoparticles on health and the environment, characterisation of nanostructured materials and nanostructured coatings and thin films.[[148]](#footnote-148) “Nanotwinning” project consists of a number of events, which are focused on stimulation of cooperation between Ukrainian scientists and European representatives of science, education and business.[[149]](#footnote-149)

Ukraine also developed other scientific collaboration. In this respect, the development of relations with Japan in the area of science and technology has an important place in the Ukraine-Japan relations. Both sides showed interest in the realisation of joint projects and expressed commitment to cooperation by organizing workshops, information exchanges and implementation of research projects in priority areas, which list nanotechnologies. In 2010 the two countries signed the "Memorandum on Commitment for Realisation the Joint Project on Engineering and Exploitation of Micro/Nano Satellites".[[150]](#footnote-150)

1. In line with the objective to promote innovative development, Ukraine organizes international innovation forums and the specialized trade fairs in nanotechnologies.[[151]](#footnote-151) Ukraine also hosts the International Summer School “Nanotechnology: From fundamental Research to Innovations”[[152]](#footnote-152) and the International research and practice conference "Nanotechnology and Nanomaterials".[[153]](#footnote-153)

With regard to information sharing, a Ukrainian website for nanotechnologies[[154]](#footnote-154) provides fundamental data on nanotechnologies, advances, application and their commercialisation in the country.

A particular feature of Ukrainian S&T system is its orientation towards industrial research and high share of applied research. A number of universities and research institutes have participated in various international and regional research programmes. One of the prevailing thematic fields of collaboration with Ukrainian research institutes is nanotechnology alongside physics, new materials, energy, space and sustainable development.[[155]](#footnote-155) However, the whole Ukrainian innovation and business support infrastructure lacks funding, up-graded equipment and methodologies to provide state of the art services. One of the key challenges is to link Ukrainian innovation and business support infrastructure to international and European best practice.

**Uzbekistan**

Modernisation and application of new technologies falls within the framework of the major economic reforms undertaken by the government of Uzbekistan.[[156]](#footnote-156) The Committee for Coordination of Science and Technology Development (CCSTD) under the Cabinet of Ministers is responsible for the implementation of innovative projects in priority areas whereas the Technology Transfer Agency established under the Ministry of Economy is in charge of promoting high-tech innovation in the domestic production.[[157]](#footnote-157) Innovation programmes are financed through Innovation Fund established in the CCSTD.

The Committee for Coordination of Science and Technology Development jointly with the Academy of Sciences, concerned ministries and departments, and with participation of leading scientists and specialists of the country, identified eight priority areas of science and technology development for 2012-2020. The list includes chemical technology and nanotechnology.[[158]](#footnote-158)

The first experiments on the nanometre level were undertaken at the Heat Physics Department (HPD) of the Uzbekistan Academy of Sciences. A laboratory of perspective research was put in place to provide further research in this area.[[159]](#footnote-159) Institute of Nuclear Physics of Academy of Sciences of Republic of Uzbekistan[[160]](#footnote-160) has been involved in the international research projects (FP7 NMP) connected with the synthesis and application of nanomaterials in a number of overlapping areas, ranging from water treatment to food safety, environmental monitoring to medical devices.[[161]](#footnote-161) The Institute of Chemistry and Physics of Polymers carries out research on the basis of pluridisciplinary approach. The institute developed new substances and nanomaterials applicable in agriculture, construction and medicine. The Department of Immunopharmacology at the Tashkent University created a Centre for Molecular Medicine and Nanotechnology.[[162]](#footnote-162)

Industrial filters for cleaning process liquids and gases based on nanotechnology developed by the Institute of Energy and Automation of the Academy of Sciences of Uzbekistan have been tested by oil and gas companies. In order to expand the introduction of new devices, the Academy of Sciences and Uzbekneftegaz NHC (state-owned holding company of [Uzbekistan](http://en.wikipedia.org/wiki/Uzbekistan)'s oil and gas industry[[163]](#footnote-163)) decided to establish UzNANOneftegaz research centre on the basis of the institute.[[164]](#footnote-164)

Uzbekistan Environmental Enterprise GRINTEK is specialized in the development of technologies and equipment for purification of water and air. It has developed the technology of obtaining special combination of stable metal nanoparticles in solutions and composite materials for attainment of antimicrobial properties to different surfaces.[[165]](#footnote-165)

Despite considerable scientific potential, it is important to further develop the environment for generation of knowledge, to further integrate science industry and education, and to involve actively young people in the S&T sphere. In the industrial sector the level of susceptibility of local enterprises to innovations is low, which leads to lack of interest and demand to domestic technologies.[[166]](#footnote-166)

**CONCLUding remarks**

Competitiveness of national economies increasingly depends on the level of the high technology production. It is no surprise that nanoscience and nanotechnologies have become one of the most promising spheres of action for politicians, scientists and industrialists in the EECA region. Nanoindustry development is regarded as an important factor of socio-economic and competitive development. Many countries have a high S&T potential and have been carrying out nanotechnology R&D for a number of years. Countries’ scientific potential is mainly, but not exclusively, concentrated in the national academies of science. Nanotechnology R&D and educational activities also take place at major scientific educational establishments. Even in the conditions of very limited public funding, scientists are able to conduct high-level research. Efforts have been made in order to attract private and foreign investment and a number of innovation support systems integrating nanotechnology are under construction. However, despite the expressed political will and a number of R&D activities announced, or undertaken, a number weaknesses may be identified that hamper development and oversight of nanotechnologies in the region.

Governments have an important role to play in fostering innovation as they are in charge of creating appropriate incentives, structures and innovation-promotion instruments, in particular, where financial resources are at stake. Supportive government policies are critical for the development of nanotechnology-based industries. As it can be seen from the previous pages, nanotechnologies and nanomaterials are explicitly identified as a priority area in the vast majority of the state innovation programmes. Several countries have established nanotechnology, nanoscience and nanomaterials targeted programmes. Nonetheless, despite ambitious state strategies the governmental funding in many countries has not yet reached its peak. Neither did the private sector investment. In addition, the commercialisation of nanotechnology research in many ways presents a familiar picture of excellent research that is not being translated to the country’s development potential. Nanotechnologies seem uncertain for industry to get involved with. Furthermore, innovation policy in EECA is highly influenced by the framework conditions, including the features of the business environment. Extractive industries in countries with oil, gas and mineral resources or classic heavy industries in others currently account for the majority of industrial production, enjoy the biggest share of funding and play a critical role in the dynamics of the economy. This may not be an inductive element for the development of innovative industries.

As nanotechnology is a multidisciplinary field, knowledge-generation institutions create innovative ideas, facilitate knowledge transfer and exchanges between scientists and engineers from different fields and have the capacity to develop and adapt solutions for constantly challenging technological landscape. In this regard, imperfect infrastructure for nanotechnology research and development, the necessity to build and to strengthen the capacity of R&D institutions, to equip laboratories with basic facilities, to create incentives for transformation of nanotechnology inventions into commercialized products remain hot topics on the agenda. Lack of new generations taking up scientific careers is another serious threat to the future potential of research organisations in the EECA region.

At the same time, while the infrastructural basis for nanotechnology development is under construction, it is important to mention that potential benefits of nanotechnology are widely publicized whereas the discussion of the potential effects of their widespread use in the consumer and industrial products seem just to be beginning to emerge. The hyperbolic enthusiasm about nanotechnologies is not proportionately accompanied by a closer insight into the safety of nanomaterials. It is difficult to access the actual data on on-going nanotoxicology studies, even if such studies may be taking place. Furthermore, the situation is aggravated by the fact that regardless of efforts that have been made in filling the regulatory gaps, there is a lack of solid legislative frameworks and enforcement mechanisms in terms of EHS and ELSI (Ethical, Legal and Social Implications).

It is an uneasy task to embrace the overall picture of on-going activities in field of nanotechnologies in EECCA, which is characterized by a fragmented line of actions, varying funding opportunities and a cluster of research and development projects. Some countries have created consolidated information platforms and portals, which allow tracing innovation activities and work undertaken by governments, laboratories and business enterprises. However, transparency remains very problematic for most countries. Information available on public portals is often unsubstantial and it is very difficult to evaluate which projects have been successfully implemented, what products have been developed and put on the market and what innovative centres, laboratories and parks are in reality functional.

From the times of the USSR, EECA countries have inherited rather strong economic and scientific links that could serve as a basis for networking within the region. As it has been already discussed earlier, efforts have been made to set up coordinated regional platforms in innovation and nanotechnologies. However, practical results are yet to be seen. Discussions on coordinated approach to nanotechnology in areas ranging from normative legal frameworks to safety of nanomaterials are still at an embryonic stage.

EECA countries have the potential to apply their efforts in development of nanotechnologies to their development. The question is in which direction science and technologies of the region will move in? What R&D activities will be translated into practical results desirable for the society? To what extent political decisions are concerned in reality with societal and environmental implications of nanoindustry development? As many questions remain unanswered, effective and safe development and use of nanomaterials necessitates a fruitful dialogue between different stakeholders. Civil society groups have the capacity to effectively contribute to understanding and oversight of nanotechnologies. However, even if punctual public initiatives do exist, the civil society is yet to be included in nanotechnology discussions.

1. http://www.unece.org/fileadmin/DAM/ceci/publications/icp5.pdf [↑](#footnote-ref-1)
2. http://www.evrazes.com/en/about/ [↑](#footnote-ref-2)
3. <http://profinance.kz/news/27331-sozdaets-innovacionny-fonda-centra-vysoki.html>; <http://www.evrazes-bc.ru/news/view/8784> [↑](#footnote-ref-3)
4. <http://www.unece.org/fileadmin/DAM/ceci/publications/icp5.pdf> [↑](#footnote-ref-4)
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7. Observer status [↑](#footnote-ref-7)
8. http://www.econano.org [↑](#footnote-ref-8)
9. http://www.universityworldnews.com/article.php?story=20090409202329287 [↑](#footnote-ref-9)
10. http://www.icpc-nanonet.org/content/section/13/136/ [↑](#footnote-ref-10)
11. ftp://ftp.cordis.europa.eu/pub/fp7/docs/icpc-list.pdf [↑](#footnote-ref-11)
12. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-12)
13. <http://www.inco-eeca.net> [↑](#footnote-ref-13)
14. http://www.icbss.org/index.php?pid=461 [↑](#footnote-ref-14)
15. <http://www.increast.eu/>) [↑](#footnote-ref-15)
16. http://www.inco-eeca.net/en/271.php [↑](#footnote-ref-16)
17. www.istc.ru [↑](#footnote-ref-17)
18. Parties to ISTC are Canada, the United States, the European Union, Japan, Norway and South Korea (funding Parties), as well as Russia, Armenia, Belarus, Georgia, Kazakhstan, the Kyrgyz Republic and Tajikistan (recipient Parties). [↑](#footnote-ref-18)
19. http://www.nti.org/treaties-and-regimes/international-science-and-technology-center-istc/ [↑](#footnote-ref-19)
20. http://www.sci.am/ [↑](#footnote-ref-20)
21. http://www.nanonewsnet.ru/blog/nikst/nanotekhnologii-v-armenii-vesma-skromnye-masshtaby [↑](#footnote-ref-21)
22. http://www.semicond.ysu.am/ [↑](#footnote-ref-22)
23. http://old.express.am/15\_07/science15.html [↑](#footnote-ref-23)
24. http://ininc.jinr.ru/page.php?id=100> [↑](#footnote-ref-24)
25. http://vestnikkavkaza.net/news/culture/36268.html [↑](#footnote-ref-25)
26. http://nanomaterials.bsu.edu.az/en/ [↑](#footnote-ref-26)
27. http://bsu.edu.az/ [↑](#footnote-ref-27)
28. http://ict.az/ru/index.php?option=com\_content&task=view&id=1360&Itemid=79 [↑](#footnote-ref-28)
29. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-29)
30. http://napep.net/wp-content/uploads/2011/09/Azerbaijan.pdf [↑](#footnote-ref-30)
31. http://bakutel.az/2009/?p=news\_\_read&t=industry&q=5&l=en [↑](#footnote-ref-31)
32. http://napep.net/wp-content/uploads/2011/09/Azerbaijan.pdf [↑](#footnote-ref-32)
33. http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ\_RCN=12678687 [↑](#footnote-ref-33)
34. http://www.aze.az/news\_nanotexnoloqii\_v\_azerbayd\_53501.html [↑](#footnote-ref-34)
35. http://new.socar.az/socar/en/research-and-development/oil-and-gas-research-and-design-institute/about [↑](#footnote-ref-35)
36. http://new.azertag.com/en/node/903045 [↑](#footnote-ref-36)
37. http://www.physics.by/ [↑](#footnote-ref-37)
38. http://un.by/pdf/OON\_sMall.pdf [↑](#footnote-ref-38)
39. <http://scienceportal.org.by/en/science/> [↑](#footnote-ref-39)
40. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-40)
41. http://scienceportal.org.by/en/science/ [↑](#footnote-ref-41)
42. A list of programmes implemented by the NAS and catalogues of research and development activities may be found at: <http://nasb.gov.by/eng/activities/research/>. [↑](#footnote-ref-42)
43. http://scienceportal.org.by/en/science/ [↑](#footnote-ref-43)
44. www.bsuir.bu/m/12\_100229\_1\_68697.pdf [↑](#footnote-ref-44)
45. http://nanosciencelab.info/en/index.shtml [↑](#footnote-ref-45)
46. http://www.bsuir.by/online/showpage.jsp?PageID=80395&resID=100229&lang=en&menuItemID=102706 [↑](#footnote-ref-46)
47. http://www.bsuir.by/online/showpage.jsp?PageID=80393&resID=100229&lang=en&menuItemID=102706 [↑](#footnote-ref-47)
48. <http://www.nanowerk.com/nanotechnology/research/research_country.php?country=Belarus#ixzz2JspdNS3D> [↑](#footnote-ref-48)
49. http://www.economy.gov.by/publfiles/001514\_637291.pdf [↑](#footnote-ref-49)
50. http://israel.mfa.gov.by/eng/rb/science/ [↑](#footnote-ref-50)
51. http://www.park.by/topic-about\_htp/ [↑](#footnote-ref-51)
52. http://respublika.info/5303/innovations/article48809/ [↑](#footnote-ref-52)
53. http://www.mfa.gov.by/en/courtiers/russia/ [↑](#footnote-ref-53)
54. http://www.belisa.org.by/en/news/stnews/international/dc76c84de2e34a47.html [↑](#footnote-ref-54)
55. http://www.nanonewsnet.ru/blog/nikst/belarus-vremya-innovatsii [↑](#footnote-ref-55)
56. http://www.increast.eu/en/154.php [↑](#footnote-ref-56)
57. fp7-nip.org.by/\_NIO/FP7BelProjects\_08\_2012\_.docx [↑](#footnote-ref-57)
58. http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ\_RCN=13211739 [↑](#footnote-ref-58)
59. http://news.belta.by/en/news/society?id=707194&goback=.gde\_2245236\_member\_214820548 [↑](#footnote-ref-59)
60. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-60)
61. http://www.nanonewsnet.ru/blog/nikst/armeniya-i-gruziya-razvivayut-sotrudnichestvo-v-sfere-obrazovaniya-i-nauki [↑](#footnote-ref-61)
62. http://www.unece.org/fileadmin/DAM/ceci/publications/icp5.pdf [↑](#footnote-ref-62)
63. http://www.kazakhstan.org.sg/uploads/fckeditor/File/Information%20letter.pdf [↑](#footnote-ref-63)
64. http://www.nnlot.kz/EN/ [↑](#footnote-ref-64)
65. http://en.tengrinews.kz/science/Kazakhstan-nanotechnologists-working-on-diamond-coating-10994/ [↑](#footnote-ref-65)
66. http://www.sci.kz/?q=en/node/425 [↑](#footnote-ref-66)
67. http://www.tarsu.kz/eng/index.php?option=com\_content&view=category&layout=blog&id=79&Itemid=94 [↑](#footnote-ref-67)
68. http://www.ektu.kz/divisions/cnir/irgetas.aspx?lang=en [↑](#footnote-ref-68)
69. http://www.kazntu.kz/en/node/536 [↑](#footnote-ref-69)
70. http://kazntu.kz/en/node/528 [↑](#footnote-ref-70)
71. <http://kazntu.kz/en/about-university/institute/miop/usou> [↑](#footnote-ref-71)
72. http://kazntu.kz/en/node/5750 [↑](#footnote-ref-72)
73. (http://www.unece.org/fileadmin/DAM/ceci/publications/icp5.pdf) [↑](#footnote-ref-73)
74. RUSNANO and Kazyna Capital Management, anchor investors for the Fund, will each contribute $25 million. VTB Captial and I2BF Holdings will manage the fund’s resources. The latter are expected to attract private investments of $50 million to $100 million. [↑](#footnote-ref-74)
75. http://en.rusnano.com/press-centre/news/88509 [↑](#footnote-ref-75)
76. http://www.ektu.kz/divisions/cnir/irgetas.aspx?lang=en [↑](#footnote-ref-76)
77. <http://en.tengrinews.kz/science/Kazakhstan-nanotechnologists-working-on-diamond-coating-10994/> [↑](#footnote-ref-77)
78. http://www.increast.eu/en/168.php [↑](#footnote-ref-78)
79. http://www.increast.eu/en/168.php [↑](#footnote-ref-79)
80. Its tasks included identifying major direction of sustainable socio-economic development of the Republic through integration of nanotechnologies, coordinating work in creation of regional nanotechnology centres and promoting participation of the Republic in international programmes and projects. [↑](#footnote-ref-80)
81. <http://www.nanonewsnet.ru/blog/nikst/kirgiziya-naznachen-novyi-redsedatel-soveta-po-razvitiyu-nanotekhnologii-v-kr> [↑](#footnote-ref-81)
82. http://www.eu-casia.org/Kyrgyz-RussianSlavicUniversity [↑](#footnote-ref-82)
83. http://www.increast.eu/en/967.php [↑](#footnote-ref-83)
84. http://www.increast.eu/en/967.php> [↑](#footnote-ref-84)
85. http://www.nas.aknet.kg [↑](#footnote-ref-85)
86. http://www.increast.eu/en/168.php [↑](#footnote-ref-86)
87. http://www.tpnas.kg/ [↑](#footnote-ref-87)
88. http://www.nas.aknet.kg/eng/index.php?menu=0 [↑](#footnote-ref-88)
89. mineconom.kg/files/Иран%20Протокол.doc [↑](#footnote-ref-89)
90. <http://www.zonakz.net/blogs/user/ussr/13777.html?mode=full> [↑](#footnote-ref-90)
91. The reforms of S&T sector in Moldova have resulted in: Strategy of Industrial Development of Moldova (2006 – 2015); Strategy of Sustainable Development of Agriculture and Food Sectors (2006 – 2015); Strategy for the Development of Renewable Energy Sources; Law on Technology Parks and Business Incubators. [↑](#footnote-ref-91)
92. http://www.moldova.md/en/stiinta/ [↑](#footnote-ref-92)
93. The Agency on Innovation and Technology Transfer (AITT) serves as the centre for the organisation of the developed hi-tech industrial infrastructure in the area of innovation and technology transfer within the ASM. [↑](#footnote-ref-93)
94. With the aim of improving international S&T collaboration, the Centre for International Projects (CIP) was created by the Academy of Sciences and started its activities in January 2009. [↑](#footnote-ref-94)
95. http://www.asm.md/?go=detalii\_sectii&n=39&struct2=1&sec=12&new\_language=1 [↑](#footnote-ref-95)
96. http://www.utm.md/en/scientific-centers/national-center-of-materials-study-and-testing [↑](#footnote-ref-96)
97. http://www.phys.asm.md/data/laboccf.php [↑](#footnote-ref-97)
98. http://ru.publika.md/link\_108161.html [↑](#footnote-ref-98)
99. Adapted from <http://inincis.jinr.ru/images/prez/Tighineanu.pdf> [↑](#footnote-ref-99)
100. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-100)
101. http://ec.europa.eu/enterprise/policies/innovation/files/countryreports/moldova\_en.pdf [↑](#footnote-ref-101)
102. http://www.consultant.ru/documents:cons\_doc\_LAW\_106174/?frame=4 [↑](#footnote-ref-102)
103. <http://www.bizjournals.com/boston/blog/mass-high-tech/2012/04/russian-innovation-is-here-to-stay.html?page=all> [↑](#footnote-ref-103)
104. http://en.rusnano.com/about [↑](#footnote-ref-104)
105. http://www.rusnano.com/Document.aspx/Download/26463 [↑](#footnote-ref-105)
106. http://riw-sv.com/organizers [↑](#footnote-ref-106)
107. A list of nanocentres selected by the Fund for Infrastructure and Educational Programmes may be found at <http://en.rusnano.com/about/fiep> [↑](#footnote-ref-107)
108. http://en.rusnano.com/upload/oldnews/Document/31815\_1.pdf [↑](#footnote-ref-108)
109. The Russian Venture Company RVC is a government-sponsored fund-of-funds with a mission of promoting the development of the innovation-based economy in Russia. It was founded by the Russian government in 2006 to ensure faster development of an efficient and globally competitive innovation system and venture capital industry in Russia.   The firm is creating a self-sustained venture capital industry that nurtures Russian innovation, entrepreneurship and technology business expertise. RVC currently backs 12 venture capital funds that run a portfolio of 118 companies. [↑](#footnote-ref-109)
110. Founded in May 2010 by the Russian government, the Skolkovo Foundation is a non-profit organisation with a mission to accelerate the transformation of Russia into an innovation-based economy through strategic partnerships with leading scientists and innovators around the world. [↑](#footnote-ref-110)
111. The Skolkovo Innovation Centre, initiated in 2010, is a physical business city under construction outside of Moscow. It is designed to become a global high technology hub and to help Russian scientists and business people develop and commercialize new technologies. [↑](#footnote-ref-111)
112. <http://en.rusnano.com/press-centre/media/20130121-ft-guest-post-russia-needs-economic-reforms-to-fulfil-high-tech-potential> [↑](#footnote-ref-112)
113. http://riw-sv.com/organizers [↑](#footnote-ref-113)
114. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-114)
115. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-115)
116. The Federal Act from 30 March 1999 N 52-ФЗ “About Sanitarian and Epidemiological Well-being of Inhabitants”; the Federal Act from 26 June 2008 N 102-ФЗ “About Proving of Measurements Unity”; the Federal Act from 18 July 1999 N 183-ФЗ “About an Export Control”; the Federal Act from 27 December 2002 N 184-ФЗ “About Technical Regulation”; the Federal Act from 10 January 2002 N 7-ФЗ “About Environmental Protection”; the Federal Act from 21 November 2011 N 323-ФЗ “About Health Protection in Russian Federation”; etc. [↑](#footnote-ref-116)
117. http://iopscience.iop.org/1742-6596/429/1/012067/pdf/1742-6596\_429\_1\_012067.pdf [↑](#footnote-ref-117)
118. http://iopscience.iop.org/1742-6596/429/1/012067/pdf/1742-6596\_429\_1\_012067.pdf [↑](#footnote-ref-118)
119. http://www.nanonewsnet.ru/about/company [↑](#footnote-ref-119)
120. http://www.rusventure.ru/en/press-service/massmedia/detail.php?ID=1298 [↑](#footnote-ref-120)
121. http://www.rusnanonet.ru/ [↑](#footnote-ref-121)
122. http://www.ntsr.info/eng [↑](#footnote-ref-122)
123. The NtSR comprises around 1100 members, including 30 members of Russian Academy of Sciences (RAS), 43 associated members of RAS, 337 doctors of sciences, and 342 PD. They cover physics, math, chemistry, biology, medicine, pharmaceutics, and many other areas. NtRS is presented in 70 regions of Russia. There are members from other countries. [↑](#footnote-ref-123)
124. http://www.nanometer.ru/2007/02/05/11706959446843.html [↑](#footnote-ref-124)
125. http://www.nanowerk.com/news/newsid=15493.php [↑](#footnote-ref-125)
126. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-126)
127. http://news.bbc.co.uk/2/hi/science/nature/8658777.stm [↑](#footnote-ref-127)
128. http://iopscience.iop.org/1742-6596/429/1/012067/pdf/1742-6596\_429\_1\_012067.pdf [↑](#footnote-ref-128)
129. http://www.phti.tj/index.php?lang=en [↑](#footnote-ref-129)
130. http://www.nanonewsnet.ru/blog/nikst/v-tadzhikistane-budut-zanimatsya-razrabotkoi-nanotekhnologii [↑](#footnote-ref-130)
131. http://www.turkmenistaninfo.ru/?page\_id=6&type=article&elem\_id=page\_6/magazine\_123/1085&lang\_id=en [↑](#footnote-ref-131)
132. http://icbss.org/media/739\_original.pdf [↑](#footnote-ref-132)
133. http://science.gov.tm/en/ [↑](#footnote-ref-133)
134. http://easttime.info/news/turkmenistan/turkmen-students-study-nanotechnology [↑](#footnote-ref-134)
135. http://www.ntsr.info/nanoworld/news.php?ELEMENT\_ID=3966 [↑](#footnote-ref-135)
136. http://www.turkmenistan.gov.tm/\_en/?idr=5&id=110615a [↑](#footnote-ref-136)
137. http://www.increast.eu/en/195.php [↑](#footnote-ref-137)
138. http://www.ciemat.es/sweb/Spain-ISTC-STCU/22abril/RecentAchievements.pdf [↑](#footnote-ref-138)
139. http://nauka.kiev.ua/en/vo-lvove-otkrylos-unikalnoe-v-ukraine-proizvodstvo-nanostruktur/ [↑](#footnote-ref-139)
140. www.nas.gov.ua/programs/nano2b/EN/Pages/home.aspx [↑](#footnote-ref-140)
141. http://www.nas.gov.ua/en/Structure/dpa/isp/Pages/default.aspx [↑](#footnote-ref-141)
142. <http://www.icpc> nanonet.org/2010reports/ICPCNanonetSecondAnnualReportEECA.pdf [↑](#footnote-ref-142)
143. http://nauka.kiev.ua/en/about-nauka/dostizheniya/ [↑](#footnote-ref-143)
144. <http://nauka.s42.org.ua/en/about-nauka/materialno-texnicheskaya-baza/> [↑](#footnote-ref-144)
145. http://www.ukrainians.ca/science/61239-nanotechnology.html [↑](#footnote-ref-145)
146. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-146)
147. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-147)
148. <http://www.icpc> nanonet.org/2010reports/ICPCNanonetSecondAnnualReportEECA.pdf [↑](#footnote-ref-148)
149. <http://www.iop.kiev.ua/~nanotwinning/> [↑](#footnote-ref-149)
150. <http://japan.mfa.gov.ua/en/ukraine-japan/science> [↑](#footnote-ref-150)
151. http://www.hi-techexpo.com/en/exhibitions/index.php [↑](#footnote-ref-151)
152. http://www.iop.kiev.ua/~nanotwinning/iss2/index.html [↑](#footnote-ref-152)
153. http://www.iop.kiev.ua/~nanotwinning/conference/index.html [↑](#footnote-ref-153)
154. <http://nano.com.ua> [↑](#footnote-ref-154)
155. http://icbss.org/media/532\_original.pdf [↑](#footnote-ref-155)
156. Decree No 436 (07.08.2006) “On measures to improve the coordination and management of S&T development”; Decree No 916 (15.07.2008) “On additional measures to stimulate innovative projects and technologies into production”; Decree No 1631 (26.10.2011) “On creation of High Technologies Center in Tashkent with participation Cambridge University of Great Britain”; Decree of Cabinet of Ministers No 33 (07.02.2012) “On measures to further optimisation and improvement of activities of Academy of Sciences. [↑](#footnote-ref-156)
157. http://academy.uz/en/activities/part\_5.php [↑](#footnote-ref-157)
158. http://it.mf.uz/en/component/content/article/1067-2012-04-16-09-28-48.html [↑](#footnote-ref-158)
159. http://www.gov.uz/ru/press/society/4074 [↑](#footnote-ref-159)
160. http://www.inp.uz/khidirov [↑](#footnote-ref-160)
161. https://intranet.kpk.gov.pl/images/page.ashx?path=6997%2F6998%2F7931 [↑](#footnote-ref-161)
162. http://www.nanonewsnet.ru/blog/nikst/tsentr-molekulyarnoi-meditsiny-nanotekhnologii-sozdan-v-uzbekistane [↑](#footnote-ref-162)
163. http://www.ung.uz/ [↑](#footnote-ref-163)
164. http://www.ut.uz/eng/opinion/ahead\_with\_innovative\_progress.mgr [↑](#footnote-ref-164)
165. http://green.sk.uz/technonano2.html [↑](#footnote-ref-165)
166. <http://rp7.ffg.at/upload/medialibrary/07_Zakhidov.pdf> [↑](#footnote-ref-166)