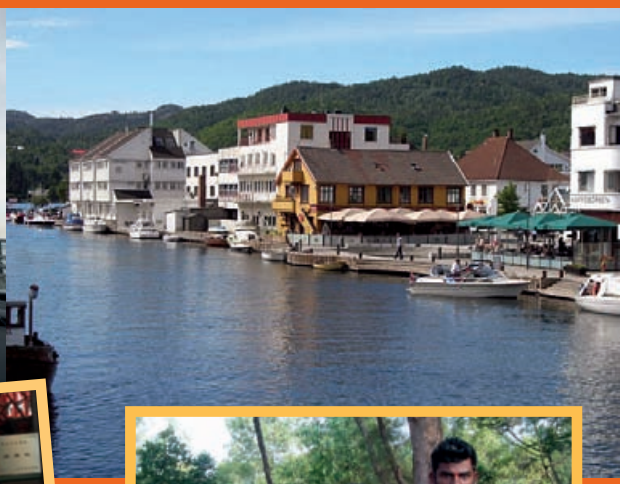

Asia NORIA-net

Future prospects for Nordic-Asian cooperation

NORIA

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Future prospects for Nordic-Asian cooperation

REPORT

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Preface

The *'Nordic-Asian research funding cooperation NORIA-net (Asia NORIA-net)'*[1] is a Nordic-Asian research funding cooperation project between the Academy of Finland, which also acts as project coordinator, the Research Council of Norway RCN, the Swedish Council for Working Life and Social Research FAS, the Icelandic Centre for Research RANNIS and the Danish Agency of Science, Technology and Innovation DASTI. These partners form the *Asia NORIA-net* project group. The *Asia NORIA-net* is funded by NordForsk, which also acts as an observer.

The aim of the *Asia NORIA-net* is to identify the needs and prepare a model for joint research funding activities to be implemented together with the Nordic countries and their Asian counterparts, focusing on China and India. The ultimate goal is to establish long-lasting funding instruments and funding mechanisms coordinated and funded by NordForsk and the national research councils together.

At the moment, both China and India are investing heavily in science and technology and developing their innovation systems. As a consequence, it is considered very important to create clearly structural and active relationships with these countries. The *Asia NORIA-net* project aims at enhancing the visibility and attractiveness of Nordic research cooperation. As a Nordic consortium, the Nordic countries and Nordic research will be more visible and attractive from an Asian point of view. Competition for Asian partnerships is expected to increase, and in that competition the Nordic countries can benefit from the power of regional cooperation.

Research cooperation between China and the Nordic countries has existing established forms and actors. Many of the Nordic research funding organisations have permanent contacts and long-term agreements with their Chinese counterparts. Forms of cooperation have been tested in practice. There is, however, a need to develop new forms of cooperation on a large scale and using strengths of the Nordic research community.

Cooperation with Indian research funding organisations is a relatively new phenomenon, at least for most of the Nordic partners. India is now investing heavily in research and technology and developing its innovation system. Among the partners, there is a need for more in-depth understanding of the Indian innovation system and driving forces to develop it. *Asia NORIA-net* is contributing to answering to this need by identifying potential research funding organisations and mapping existing bilateral cooperation.

It follows from the above that *Asia NORIA-net* has two tasks. First, *Asia NORIA-net identifies the Nordic actors* for research funding cooperation with Chinese and Indian funding bodies. Additionally, the project identifies *current practices, needs and potential participants* for multilateral and multicultural cooperation. In doing that, the project benchmarks and disseminates good practices among the Nordic partners, and reinforces Nordic joint research activities with China and India.

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[1] Asia NORIA-net: http://www.aka.fi/en-gb/A/Academy-of-Finland/International/Nordic-countries/Asia-NORIA-net/

Second, *Asia NORIA-net* identifies the *needs* of the Nordic funding organisations and NordForsk with regard to Asia cooperation. Special emphasis is placed on *future efforts*. The existing bilateral exercises are used for multilateral model development.

This report, *Future Prospects for Nordic-Asian cooperation*, serves as a final report introducing the results of the work done by the *Asia NORIA-net* project group and is a joint effort by the partners. Its purpose is to identify the partners' existing cooperation with Chinese and Indian counterparts as well as the strengths, weaknesses, opportunities and threats to Nordic-Asian collaboration. It also describes the main characteristics of the S&T systems of China and India. Finally, the *Asia NORIA-net* project group makes suggestions for future collaboration. The content of the report is produced, approved and owned by the project group. NordForsk's role in this work is to provide funding for the project.

Executive Summary

The ultimate goal of the *'Nordic-Asian research funding cooperation NORIA-net (Asia NORIA-net)'* is to establish long-term funding instruments and funding mechanisms jointly coordinated and funded by NordForsk and the national research councils. This report describes existing cooperation of the *Asia NORIA-net* partners with China and India, and prospects for strengthening Nordic-Asian collaboration in the future.

Many/most of the Nordic countries have government-level S&T agreements with either China or India or both. In addition, national research funding organisations have signed cooperation agreements with their Chinese and/or Indian counterparts. In some cases this cooperation is relatively long-standing and well-established, while other organisations are just starting to build up their relations with Asian funding organisations or have only started their collaboration quite recently. Some organisations even have policies or specific strategies for R&D&I collaboration with India and China. Forms of existing research collaboration vary from researcher mobility to jointly funded thematic programmes and innovation centres. Funding can also be earmarked for research collaboration with China or India or it can be open to all international partners.

The volume of research collaboration and researcher mobility between the Nordic countries and China is reasonably big and still growing in many fields. In some cases, cooperation between the funding organisations has begun as early as the 1980s. MOST and the NSFC are the main partners, but there is also some smaller-scale cooperation with CAS, CASS and the MSTI. On the other hand, cooperation between the Nordic research funding organisations and their Indian counterparts is either in the planning phase, or the existing bilateral agreements are relatively new. The main cooperation organisations are the Department of Biotechnology (DBT) and the Department of Science and Technology (DST). There are also other partners such as sectoral ministries (e.g. IMNRE). The DBT has on several occasions expressed its willingness to arrange a call for proposals jointly with two or more Nordic organisations. The volume of research activities between Nordic and Indian researchers is still modest in several fields. The interest in researcher mobility, especially from the Nordic countries to India, is limited but increasing.

Research funding cooperation between the Nordic countries and China and India focuses on biosciences and natural sciences, and all Nordic funding organisations seem to be interested in building up and strengthening relations with their Asian partners.

A SWOT analysis of Nordic-Indo/Chinese collaboration indicates that the main strengths of this collaboration are the relative absence of political tension between the Nordic countries and India/China, and certain themes of common interest invite further exploration. On the other hand, the main weaknesses of Nordic-Indo/Chinese collaboration are the absence of a common profile among the Nordic countries towards India and China and limited resources and/or funding. The absence of a common profile might act as an obstacle in creating trust between the partners and also in the communication process, since it might lead to confusion about to whom to talk to/work/cooperate with. The main opportunities of Nordic-Indo/Chinese collaboration are the scientific strength of the Nordic countries, especially in view of with their size, and the research potential created in the process of collaboration. The main threat to Nordic-Indo/Chinese collaboration is a high risk of miscommunication, linguistically, culturally and on other levels. A lack of bilateral and equal benefits for the partners is also a threat.

It is unambiguous that Nordic cooperation brings critical mass to potential funding cooperation with India and China, something which the Nordic countries could not obtain individually. The *'Nordic-Asian research funding cooperation NORIA-net (Asia NORIA-net)' project* suggests the launching of a multilateral research programme on selected themes in clearly defined research fields.

The *Asia NORIA-net* sees that in order to achieve such an effective Nordic-Asian cooperation it is necessary to define the themes for collaboration. The research council system in the Nordic countries, as well as India and China, have all placed their focus on cer-

tain research themes. These themes differ, as does the geography, demography, economy and political environment in each country. In spite of the national differences, transnational research programme cooperation and coordination is both desirable and attainable. However, when many stakeholders are involved the themes must be chosen carefully and in accordance with each partner's emphasis.

Additionally, the *Asia NORIA-net* suggests that the themes for collaboration should be selected on political grounds, at least in part, as cooperation in the form suggested here must be agreed on a political level. The project group further suggest that the themes for collaboration should be based on the strengths of the partners, even though that will mean that some of the themes are suitable only for some of the Nordic partners. For its own part, *Asia NORIA-net* proposes two themes as focal points for future cooperation: *Environment and energy,* and *Life sciences and biotechnology*. For the research council systems in the Nordic countries, as well as for India and China, the environment, energy, life sciences and biotechnology are research topics of high priority. That is also evident in current international cooperation in which the Nordic countries participate. More defined topics may vary according to the strengths of individual participants. On the basis of established cooperation projects between individual Nordic countries and India and China, topics that are likely to succeed include clean and renewable energy, earthquake research, environmental ecology, public health, climate research and technology. Naturally, some topics are not of interest to all Nordic countries but there are also topics that are of high interest to all the Nordic countries.

1 Nordic Partners and their cooperation with China and India

1.1 Description of Partners

The Danish Agency for Science, Technology and Innovation

The Danish Agency for Science, Technology and Innovation[2] is an institution under the Danish Ministry of Science, Technology and Innovation. The Agency's activities deal with, among other things:

- Public research funding
- Researcher mobility
- Dialogue on priorities in research and technology initiatives
- Regionalisation of research and innovation
- Commercialisation of research
- Interaction between knowledge institutions and the business community
- Innovation policy
- EU research policy
- International cooperation on research and innovation
- Research dissemination, etc.

The Agency also functions as secretariat to the Danish Research Coordination Committee, the Danish Council for Independent Research, the Danish Council for Strategic Research, the Danish Council for Technology and Innovation, the Danish Research Policy Council and the Danish Committees on Scientific Dishonesty.

The Academy of Finland

The Academy of Finland[3] is the prime funding agency for basic research in Finland. Other key agencies funding science and technology in Finland are Tekes, the Finnish Funding Agency for Technology and Innovation, and Sitra, the Finnish Innovation Fund. The Academy operates within the administrative sector of the Ministry of Education.

The Academy of Finland's mission is to advance scientific research and its application, support international scientific cooperation, act as an expert organ in science policy issues and allocate funding to research and other advancement of science. The Academy works to promote the progress of science by allocating funding to the highest-quality and the scientifically most innovative research.

The Academy is committed to raising the productivity and strengthening the impact of research funding and science policy by:

- emphasising interdisciplinarity and innovativeness in its reviews and assessments of scientific quality
- granting funding to research projects rated as excellent
- promoting the interaction and collaboration between researchers and knowledge end-users.

The Academy supports the research career at all its stages and encourages the mobility of researchers within the research system, business and industry, and the public administration as well as internationally. Universities are the Academy's most important partner in its mission to advance scientific research. Internationally, the Academy cooperates with a number of other countries as well as with international funding organisations.

The Academy takes actively part in the public debate on science policy, the goals of science, its impacts and ethics. The Academy also promotes good scientific practices and strengthens the ethical sustainability of the research it finances. The Academy's key goals and means are defined in its strategies. The most important one, '*Academy of Finland Strategy*', is from 2006. Another important document is the '*Academy of Finland International Strategy 2007–2015*'. The Academy's operations are particularly influenced by the strategies of the Science and Technology Policy Council of Finland (renamed the Research and Innovation Council as of 1 January 2009), the latest of which, '*Science, Technology, Innovation*', was published in 2006.

[2] The Danish Agency for Science, Technology and Innovation: www.fi.dk
[3] The Academy of Finland: www.aka.fi

RANNIS – The Icelandic Centre for Research

The Icelandic Centre for Research[4] (RANNIS) supports research, research studies, technical development and innovation in Iceland. RANNIS cooperates closely with the Icelandic Science and Technology Policy Council and provides professional assistance to the preparation and implementation of science and technology policy in Iceland. RANNIS administers competitive funds and strategic research programmes, coordinates and promotes Icelandic participation in collaborative international projects in science and technology. This includes participation in joint international research programmes and funding schemes. For this purpose RANNIS provides support for those seeking international funding, i.e. from FP7 programmes, Jules Verne, COST, ESF, EMBO, EMBL and various ERA-Nets. Furthermore, RANNIS monitors resources and performance in R&D and promotes public awareness of research and innovation in Iceland.

The Research Council of Norway

The Research Council[5] is Norway's official body for the development and implementation of national research strategy. The Council is responsible for enhancing Norway's knowledge base and for promoting basic and applied research and innovation in order to help meet research needs within society. The Research Council also works actively to encourage international research cooperation.

Three central areas of focus:

- The Research Council serves as an advisory body on research policy issues, identifies research needs and recommends national priorities.
- Through the establishment and implementation of targeted funding schemes the Research Council facilitates the translation of national research policy objectives into action.
- The Research Council serves as a meeting place for researchers, funding bodies and end-users of research findings, as well as for the different sectors and subject fields that are affiliated with the world of research.

Five main goals:

- **Enhanced quality and capacity:** The Research Council will work to enhance the capacity and quality of and promote the diversity in Norwegian research.
- **Thematic priorities:** The Research Council will work to strengthen research in areas of particular importance for research, trade and industry.
- **Structure:** The Research Council will promote constructive cooperation, distribution of responsibility and structures in the research system.
- **Learning:** The Research Council will help to translate research results into action.
- **Organisation:** The Research Council will work towards becoming an even more competent and strategic organisation.

The Swedish Council for Working Life and Social Research, FAS

The Swedish Council for Working Life and Social Research[6] (FAS) is tasked with supporting and initiating primary and needs-driven research in the fields of employment, work organisation, work and health, public health, welfare, caring services, and social relations. The Council was established in 2001 through a merger of the Swedish Council for Social Research and the Swedish Council for Work Life Research.

The main tasks of FAS include evaluating research in its own fields of responsibility, identifying fields for new ventures and drawing up research programmes in consultation with other research funding agencies, working for greater national and international cooperation and exchange in the research community, promoting multi- and interdisciplinary research, promoting scientific publishing, knowledge transmission, and dialogue, and furthering gender equality in research.

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[4] The Icelandic Centre for Research: www.rannis.is
[5] The Research Council of Norway: www.forskningsradet.no
[6] The Swedish Council for Working Life and Social Research: www.fas.se

Mission and objectives

To promote the accumulation of knowledge in matters relating to working life and the understanding of social conditions and processes through:

- Promotion and support of basic and applied research
- Identification of important research needs
- Dialogue, dissemination of information and transfer of knowledge
- Promotion of cooperation between researchers both nationally and internationally, particularly in EU programmes
- Research funding

The Council's support for research takes various forms. The main one is **grants for projects**. Proposals are submitted by researchers and their scientific merit and societal relevance are assessed through a peer review process. To stimulate research within specific areas the Council may award longer period **grants to research programmes** at academic departments of excellence. The Council also creates **research positions** at Swedish universities and provides grants for visiting researchers, **national and international postdoc positions**, as well as **scholarships for studies** abroad.

The research funded by the Council covers the following areas:

- Chemical and physical hazards at work including electromagnetic fields
- Stress, work and health
- Work organisation
- Labour market issues
- Public health and health services
- International migration and ethnic relations
- Social policy and social insurance
- Social welfare
- Family and children
- The elderly
- Disability
- Drug abuse

FAS has a special responsibility to coordinate research relating to older persons, disability, international migration and ethnic relations, and social science research concerning alcohol and narcotics. Of particular interest is multidisciplinary research and research that addresses topics relating to equality between the sexes.

NordForsk

NordForsk[7] is a Nordic research board with responsibility for cooperation on research and researcher training in the Nordic region. The organisation focuses on research areas in which the Nordic countries are international leaders, and promotes research and researcher training of high international calibre.

NordForsk has three main functions – coordination, funding and policy advice:

- The objective of NordForsk's coordination activity is to develop the Nordic Research and Innovation Area (NORIA) into an attractive, cutting-edge region for research and innovation.
- NordForsk's research funding instruments seek to create synergies that supplement existing national investments in research.
- NordForsk is the Nordic Council of Minister's advisory body in the area of research. NordForsk uses its policy, analysis and communication activities to build a platform from which the Nordic countries can take full advantage of their shares opportunities.

NordForsk was established on 1 January 2005 following a consolidation of the activities of the former Nordic Research Policy Council and the Nordic Research Training Academy. The Board of NordForsk is comprised of representatives from the five Nordic research councils, the Nordic University Association, and trade and industry.

[7] NordForsk: www.nordforsk.org

1.2 DENMARK

1.2.1 China and Denmark

Knowledge-based cooperation between Danish research funding agencies and partners in China

Denmark–China

Strategy:	China Strategy (2008)
Partners:	MOST (MoU 2007) NSFC (MoU 2008) ITC–Hong Kong (MoU 2009)
Forms:	Innovation Centre Support for network activities (workshops, symposia) Globalisation fund PPP Sino-Danish Center for Advanced Education and Research Danida fellowship Support for research projects
Areas:	Biotechnology and -medicine Agricultural and food technology Clean and renewable energy Nanoscience and -technology Health and traditional medicine application ICT Natural sciences
Funding:	(volume is not easy to sum up)
Priorities:	Industrial PhD programme Support for strong R&I environments (collaboration, joint professorship, networking) Joint projects

MSTI (Denmark) and MOST (China)

Collaboration between the Danish Ministry for Science, Technology and Innovation, the Ministry of Science and Technology of the People's Republic of China and other Chinese partners

In September 2007, a Memorandum of Understanding (MoU) was signed between the Danish Ministry for Science, Technology and Innovation (MSTI) and the Ministry of Science and Technology of the People's Republic of China (MOST) on scientific and technological cooperation. The principal objective of the MoU is to facilitate broad opportunities for scientific and technological cooperation between the two countries, thereby promoting areas of research of mutual benefit. More specifically, priority is given to collaboration that can advance science and technology,

notably within the research areas of mutual interest, such as a) biotechnology and -medicine, b) agricultural and food technology, c) clean and renewable energy, d) nanoscience and -technology, e) health and traditional Chinese medicine application and f) information and communication technology.

In September 2007, the Danish Ministry for Science, Technology and Innovation and the Danish Ministry for Foreign Affairs also opened the *Innovation Center Denmark* in Shanghai. As is the case of the Innovation Center Denmark in Silicon Valley and in Munich, the Innovation Center Denmark in Shanghai is one of the direct results of the globalization strategy designed by the Danish Government in 2006 to help achieve the ambitious objective of becoming one of the leading knowledge-based nations in the world by 2015. The mission of the Center is to build bridges between research institutions and companies in Denmark and in China and thereby to strengthen the access to a foreign knowledge centre of a high quality. The Innovation Center Denmark in Shanghai is furthermore appointed to the task of assisting in filling out the framework of the bilateral agreement on science and technology between China and Denmark.

In February 2008, the Danish Ministry for Science, Technology and Innovation published a strategy for knowledge-based collaboration between Denmark and China. With the launch of the strategy, Denmark intends to facilitate Sino-Danish collaboration and to encourage individual universities and companies in Denmark and China to use the framework of the bilateral agreement to conclude concrete agreements on projects and talent exchange. In addition to targeting the existing lines of action and block grants, the Danish Ministry for Science, Technology and Innovation aims to contribute to a number of new initiatives to support cooperation within the prioritised areas.

In May 2009, DASTI and the Innovation and Technology Commission, Hong Kong signed a Memorandum of Understanding. The focus is primarily on natural science disciplines and public-private cooperation. The MoU is a result of the activities at the Danish Innovation Center in Shanghai. It aims at strengthening the strategy for China and existing contacts with universities and science parks by increased focus on China's southern provinces.

Forms of collaboration

In order to secure the optimal implementation and the progress of cooperation activities within the framework of the MoU, the parties have agreed to set up a *Joint Coordinating Committee* (JCC) consisting of an equal number of representatives from each country. The responsibility of the JCC is to promote, develop and review cooperative activities within the framework of the MoU, and to advise the MSTI and MOST on ways to enhance scientific cooperation between China and Denmark – also as regards scientific and technological collaboration between Denmark and China. As for the Danish part of the JCC, the representatives will also be responsible for the promotion, development and monitoring of cooperation activities within the framework of the China strategy. The following forms of collaboration are accordingly initiated:

Open call for the cultivation of new research collaboration initiatives between Denmark and China

The Ministry of Science, Technology and Innovation will focus on the cultivation and support of new opportunities for bilateral collaboration. Thus it is intended to support smaller-scale initiatives seeking to establish contact and to identify the potential for collaboration between public and private researchers in Denmark and China. Through a call open to Danish scientists wishing to establish or enhance their collaboration with Chinese partners, financial support will be granted specifically to thematic workshops, symposia, conferences etc. that facilitate the interaction between researchers in Denmark and China.

The Innovation Center Denmark as a promoter of Sino-Danish knowledge-based collaboration between companies and research institutes

The mission of the Innovation Center Denmark in Shanghai is to build bridges between research institutes and companies in Denmark and China and thereby to strengthen the access to a foreign knowledge centre of a high quality. Limited funding is accordingly provided to network activities.

Establishment of a Sino-Danish Center for Advanced Education and Research in China

In order to enhance the visibility of Danish research-based advanced education in China, the Ministry of Science, Technology and Innovation is, in collaboration with Danish universities, exploring the possibilities for establishing a Sino-Danish Center for Advanced Education and Research in China. The center could function as a visible and accessible platform for interaction with Chinese knowledge institutions and authorities. The center could be organised, for

instance, as a joint venture between the eight Danish universities, a Chinese university and a number of research institutions and approved technological service institutes. Such collaboration would generate the necessary critical mass while combining the positions of strength of the various institutions. In addition to the actors mentioned, Danish and Chinese industry could make contributions to the center in the form of funding and offer internships and collaboration with regard to the content of the programme.

Funding

The MoU is a framework agreement encouraging individual research institutions in China and Denmark to develop scientific collaboration. Within the framework of the MoU, earmarked funding has not been set aside by the MSTI and MOST. Rather, expenses related to the activities undertaken within the framework will be borne by the individual participating research institutions. It is, however, the aim of the Danish Ministry for Science, Technology and Innovation to increase the amount of earmarked funding for international and bilateral cooperation, hereunder the collaboration with China.

In 2008, in order to facilitate and support the initiatives for strengthened collaboration between Danish and Chinese research institutions, the Danish side expects to initiate initiatives that can be financed through funds earmarked for international collaboration as part of the block grant for globalisation. The relatively modest means will be targeted at network activities organised in cooperation with the Innovation Center Denmark in Shanghai and the Joint Coordinating Committee. In 2009–2012, the lines of action of the China strategy are expected to be financed through the establishment of a fund earmarked for bilateral cooperation. Following negotiations with the parties in the Danish Parliament, this appropriation is expected to come out of the unallocated reserve of the globalisation fund for 2009–2012.

Danish priorities for further strengthening Sino-Danish research collaboration in 2008–2010

In addition to above mentioned ongoing initiatives and based on the MoU and the China strategy, the Danish side of the JCC wishes to emphasise the following priorities and activities to be carried out in 2008–2010:

Priorities:

- *Block grants for Danish universities offering Industrial PhD programmes for China for the purpose of financing the stay of Chinese researchers in companies related to Denmark.* The purposes of the new PhD programme for China is to further develop the Danish knowledge-intensive business community by strengthening the relationships between Danish and Chinese science and technology communities. The programme promotes mutual interchange of knowledge between Denmark and China by educating scientists with an insight into the commercial aspects of research and development in both countries, and by promoting personal networks in which relationships between companies and universities can be strengthened. An industrial PhD project is a 3-year PhD project conducted in cooperation with a private company, a university and an industrial PhD student. The student is employed by the company and enrolled at the university and divides his or her time between the two workplaces. The programme includes subsidies to cover the student's salary, travel expenses and tuition. The programme is intended for top-grade applicants with a Master's degree or similar from an institution of higher education in China. The project must be based in a company with branches in both Denmark and China. The application deadline is 1 February 2010.
- *Block grants to promote joint research collaboration between strong research and innovation environments in Denmark and China.* Strong relationships between researchers constitute another cornerstone of increased knowledge-driven collaboration between Denmark and China. Research collaboration creates a critical mass of infrastructure and talents, and lays the foundation for exchange of knowledge and know-how.

The Ministry of Science, Technology and Innovation will seek to provide earmarked subsidies for collaboration, joint professorships and networking between powerful public and private research environments in Denmark and China within prioritised fields. These subsidies will be allocated as block grants to existing researcher groups and innovation networks in the two countries that are already subsidised as far as the domestic part of their activities is concerned. Thus the funds will be targeted at the costs of the groups' mutual cooperation only, and this will create a good basis for concrete results that can be achieved quickly from their collaboration.

MFA (Denmark), MSTI (Denmark) and MOST (China)

Collaboration between the Danish Ministry for Foreign Affairs, the Danish Ministry for Science, Technology and Innovation and the Ministry of Science and Technology of the People's Republic of China

The Sino-Danish Committee on Scientific and Technological Cooperation (CSTC) was established in 1985. The Committee was appointed to the task of discussing the Sino-Danish scientific and technological cooperation and of assessing project proposals for Sino-Danish collaborative projects. From the perspective of Danish international development assistance, inclusion on the Committee's list of approved collaborative projects enables application to be made to the *Danida Fellowship Programme* under the Danish Ministry of Foreign Affairs (MFA). From the Danish side, three representatives from prominent research and innovation environments appointed members of the CSTC, and on the Chinese side, the members of the Committee are representatives from the Ministry of Science and Technology of the People's Republic of China (MOST). The Danida Fellowship Programme is managed and implemented by the Danida Fellowship Centre, and a Danida Fellowship finances a Chinese researcher for a ten-month stay in Denmark. Its value is DKK 7,500 per month (EUR 1,000, conversion rate 2008). A maximum of ten fellowships may be granted by Danida per calendar year.

DNRF (Denmark) and NSFC (China)

Collaboration between the Danish National Research Foundation and the National Natural Science Foundation of China

In January 2008, a Memorandum of Understanding (MoU) was signed between the Danish National Research Foundation (DNRF) and the National Natural Science Foundation of China (NSFC) on scientific cooperation within the fields of life sciences, natural sciences and engineering. The guiding principal of the MoU is to promote cooperation in the area of joint research where this seems desirable and where the available resources permit.

Within the framework of the MoU, the DRNF and the NSFC establish joint calls for research projects between Danish and Chinese partners within thematically and jointly prioritised scientific fields. The aim is to launch a call each year. Within each call (the first call on *Nano Research Collaboration* was published in spring 2008), the two foundations will support 1–3 project proposals for a three-year period with the possibility of extension up to three years. The DNRF will fund the Danish groups and the NSFC will fund the Chinese groups. The DNRF is willing to grant the selected projects DKK 10–15 million each (EUR 1.3–2.0 million, conversion rate 2008), including overhead. Furthermore and prior to the joint call, the two foundations arrange a symposium on a thematically and jointly prioritised scientific field.

1.2.2 India and Denmark

Knowledge-based cooperation between Danish research funding agencies and partners in India

Denmark–India

Strategy:	-
Partners:	DBT (MoU 2004, extended 2009)
Forms:	Support for network activities Industry delegations
Areas:	Biotechnology ICT
Funding:	EUR 1.1 million
Priorities:	PPP Joint research projects Exchange of researchers

MSTI (Denmark) and DBT (India)

Collaboration between the Danish Ministry for Science, Technology and Innovation and the Department of Biotechnology, the Indian Ministry of Science and Technology

In 2004, a Memorandum of Understanding (MoU) was signed between the Danish Ministry for Science, Technology and Innovation (MSTI) and the Department of Biotechnology (DBT), the Indian Ministry of Science and Technology, on scientific and techno-

logical cooperation within the field of biotechnology. The principal objective of the MoU is to facilitate broad opportunities for scientific and technological cooperation between the two countries, thereby promoting areas of research of mutual benefit. The MoU was extended by five years in autumn 2009.

In order to secure the optimal implementation and the progress of cooperation activities within the framework of the MoU, the parties have agreed to set up *a Joint Coordinating Committee* (JCC) consisting of a number of representatives from each country. The responsibility of the JCC is to promote, develop and review cooperation activities within the framework of the MoU and furthermore to advise the MSTI and the DBT on ways to enhance scientific cooperation between Indian and Denmark within the field of biotechnology. From the Danish side, five representatives from prominent research and innovation environments within the area of biotechnology are – by the Minister – appointed members of the JCC, whereas the Indian representatives are from the DBT.

The MoU is a bilateral framework agreement encouraging individual research institutions in India and Denmark to develop scientific collaboration. The forms of collaboration and the extent to which research collaboration between Indian and Danish research institutions is implemented is not included in this account of research collaboration between research funding agencies. In order to facilitate and support the initiatives for joint research collaboration between the individual research institutions, the Danish side of the JCC has developed a systematic approach to their responsibility of promoting, developing and reviewing cooperative activities within the framework of the MoU. Within the framework of the MoU, earmarked funding has not been set aside by the MSTI and the DBT. Rather, expenses related to the activities undertaken within the framework will be borne by the individual participating research institutions.

Joint call within the area of Biotechnology

Consistent with the overall area of collaboration – a joint biotechnology – a theme of joint Indian and Danish interest and priority is selected. Besides the exchange of knowledge within the thematically selected area, the purpose of the joint call is to facilitate the contact between Indian and Danish private and public partners.

Network programme

In the wake of the workshop, the Danish side of the network programme committee publishes a call for network programme scholarships. Within the network programme scientists can apply for funding, which gives a number of Danish and Indian scientists an opportunity to go to India or Denmark to find future partners and form a basis for collaboration projects within biotechnology and ICT. The idea of the grant is therefore to motivate Indo-Danish scientific collaboration and to serve as a catalyst for growing Indo-Danish research and development collaboration. The call is established and administered by a network programme board where there is a representative from the Danish side of the JCC.

Industry delegations

Parallel to the call for network programme scholarships the JCC wishes to promote private-public partnerships within scientific biotechnological collaboration. This is done by the arrangement of visits by industry delegations within a thematically selected area.

Danish priorities for strengthening Indo-Danish research collaboration within the area of biotechnology in 2008–2010

Based on the positive outcome of the cooperation activities within the framework of the MoU and the potential for further collaboration between India and Denmark within the area of biotechnology, the Danish side of the JCC wishes to emphasise the following priorities and suggestions for activities to be carried out in 2008–2010:

Priorities:

- The Danish Steering Group will through the network programme work to provide focus on joint research projects between powerful research environments in Denmark and India within the area of biotechnology and ICT. Regarding joint calls within biotechnology, it is a condition that the joint initiative is based on the principle of 'matching funding'.
- The Danish Steering Group will look into the possibility of developing visiting grants programmes in order to promote the exchange of researchers between Denmark and India.

1.3 FINLAND

According to the International Strategy 2007–2015 of the Academy of Finland there are seven key strategic cooperation countries. India and China are two of them.

1.3.1 China and Finland

Knowledge-based cooperation between the Finnish research funding agency and partners in China

Finland–China

Strategy:	International Strategy 2007–2015
Partners:	NSFC (MoU 1999, 2004) CAS (MoU 1981, 2004) CASS (MoU 1989, 2004)
Forms:	Researcher mobility Thematic research programmes Joint seminars and research projects CoE cooperation
Areas:	Environment and energy Environmental ecology Ubiquitous computing Signal processing Cross-cultural communication Neuroscience
Funding:	EUR 3.3 million
Priorities:	Priorities of the Research Councils Combination with the thematic research programmes

The aim is to carry out cooperation in competitive, public research funding in different fields of research. Project cooperation is implemented in the priority areas jointly defined by the Academy of Finland Research Councils and the Chinese funding organisations. In addition to joint research projects, funding is also granted for the mobility of researchers together with the partners. The Academy also promotes the networking of Finnish universities and institutions of higher education with Chinese research institutions.

The Academy of Finland and NSFC (China)

Collaboration between the Academy of Finland and the National Natural Science Foundation of China

The National Natural Science Foundation of China (NSFC) operates directly under the State Council (like MOST) and is the prime funding organisation of basic research in China. The NSFC is the Academy's key funding partner in China, as it operates on national level and its research funding is based on competition and peer review.

In the Memorandum of Understanding signed between the Academy of Finland and the NSFC possible forms of cooperation are:

- Joint research projects
- Thematic research programmes

- Researcher mobility
- Joint seminars
- Centre of Excellence cooperation

The Academy and the NSFC agreed in January 2007 to annually organise a targeted joint call for research proposals in the fields of life sciences, natural sciences and engineering. The aim is to support long-term genuine research collaboration of the highest standard. However, the first joint call was organised as early as 2002 and was targeted at Finnish Centres of Excellence in research and Chinese State Key Laboratories. Funding was granted to four three-year joint projects. This cooperation was evaluated in November 2006, and though the programme was found to be successful, it was decided that future cooperation would not be limited to Centres of Excellence. The next initiative was the Research Programme on *Neuroscience* (NEURO) that is a jointly funded research programme between Finland, China and Canada running from 2006 to 2009. Within the NEURO programme, funding is provided to four Finnish-Chinese research projects.

Since 2007, three joint calls have been organised:

- In January 2007, the themes of the call were environment and energy, and environmental ecology. A total of 14 applications were received of which four three-year projects were granted funding (Academy funding about EUR 0.96 million).
- In March 2008, a call was launched in connection with the Academy's Research programme on *Ubiquitous Computing and Diversity of Communication* (MOTIVE).
  As a result of the call, three projects out of eleven applications were funded (Academy funding about EUR 1 million).
- In April 2009, a joint call was opened within the theme Signal Processing. Four projects were funded (Academy funding about EUR 1.6 million).

The theme of the call has to be agreed separately every year at least three months before opening the call. The call is open in both countries at the same time. The Finnish research team sends its application to the Academy and their Chinese partner to the NSFC respectively, but the teams need to attach a jointly drafted research plan to their applications. Both the Academy and NSFC evaluate and rank the proposals according to their own rules and practices. The funding decisions are made on the basis of the consensus discussion where the funding partners match their ranking lists and look for a mutually satisfactory solution. However, the most important criterion guiding the decision-making is always scientific excellence.

In cooperation with the NSFC, as well as CAS and CASS, the Academy also grants funding for the *mobility of researchers* (annual quota: 12 months) and for arranging *joint seminars*. The annual call is open in January. The applicant is required to have an invitation from the Chinese receiving university department or institution where he/she is going to conduct research, and the minimum duration of the visit is one week. The Academy's grant covers a researcher's round trip from the place of residence in Finland to the destination in China, and the Chinese funding agency provides for his/her accommodation and daily allowance and vice versa in the case of a Chinese researcher coming to Finland.

Table 1. Mobility of researchers: NSFC

	Finnish researchers		Chinese researchers	
2008	5 persons	117 days	6 persons	360 days
2007	2 persons	38 days	6 persons	365 days
2006	13 persons	365 days	3 persons	270 days

The Academy, together with the NSFC, is also a partner in the CO-REACH ERA-NET whose goal is to promote research cooperation between Europe and China.

The Academy of Finland and CAS (China)

Collaboration between the Academy of Finland and the Chinese Academy of Sciences

The Chinese Academy of Sciences (CAS) is primarily a research organisation and funds only research that is conducted at its own institutions. However, the research institutions (about 100) under the CAS represent cutting-edge research in China. These research institutions receive one third of their funding from CAS, one third from the NSFC and the rest from external sources, such as private companies. The Academy and CAS have not organised any joint calls for research projects, but the mobility of researchers that is funded within the framework of the Memorandum of Understanding has been active (annual quota: 12 months) since the 1980s.

The Academy is working to find ways to boost and support cooperation between Finnish and Chinese

Table 2. Mobility of researchers: CAS

	Finnish researchers		Chinese researchers	
2008	8 persons	236 days	5 persons	300 days
2007	4 persons	180 days	6 persons	300 days
2006	2 persons	30 days	8 persons	268 days

graduate schools (doctoral programmes) in cooperation with the CAS graduate university GUCAS. The Academy and GUCAS organised a joint seminar for Finnish and Chinese graduate schools within the areas of physics, chemistry, natural resources and environmental sciences in Beijing on 20–22 May 2009 to promote networking. A total of 21 participants from 12 Finnish graduate schools attended the seminar. The intention is to organise a similar seminar in Helsinki in 2010. The Academy does not provide any additional funding for graduate schools to boost their cooperation with Chinese partners but considers its role merely as facilitator and matchmaker.

CAS has sought to identify and support Nordic-Chinese joint projects through the CAS Nordic Foundation, but the Nordic funding organisations were not active in the two CAS-Nordic Forums that were organised in 2007 and 2008.

The Academy of Finland and CASS (China)

Collaboration between the Academy of Finland and the Chinese Academy of Social Sciences

The Chinese Academy of Social Sciences (CASS) is a research organisation that is the counterpart of the CAS in the social sciences. In December 2005, the Academy arranged a joint seminar with the CASS in Helsinki with the theme *'Cross-Cultural Communication'*, and in October 2006, a call for joint projects was launched in this thematic area. Five applications were submitted, of which one was granted funding. A joint seminar in the field of *Comparative Law* was arranged in October 2009 in Beijing to facilitate networking of Finnish and Chinese researchers.

Table 3. Mobility grants annually awarded for research at research institutes of the CAS (quota: 3 months).

	Finnish researchers		Chinese researchers	
2008	1 person	30 days	2 persons	47 days
2007	1 person	90 days	2 persons	59 days
2006	1 person	15 days	3 persons	56 days

1.3.2 India and Finland

Knowledge-based cooperation between Finnish research funding agencies and partners in India

Finland–India

Strategy: International Strategy 2007-2015
Partners: DBT (MoU 2005)
DST (MoU 2005)
Tooltech Ltd. (MoU 2003)
Forms: Researcher mobility
Thematic research programmes
Joint seminars and research projects
CoE cooperation
Areas: Biotechnology
Funding: EUR 2.7 million
Priorities: Priorities of the Research Councils
Combination with the thematic research programmes

The Academy of Finland and DBT (India)

Collaboration between the Academy of Finland and the Department of Biotechnology in India

The Academy of Finland and the Department of Biotechnology (DBT), a research funding organisation in biotechnology under the Indian Ministry of Science and Technology, signed a Memorandum of Understanding on 14 July 2005. Cooperation between the Academy and the DBT can be carried out in the following fields of biotechnology: advanced biotechnology (e.g. gene therapy, structural and functional biology with relation to genomics and proteomics), medical biotechnology (e.g. drug development incl. vaccines and diagnostics), food biotechnology, agricultural and environmental biotechnology (e.g. bioremediation). In addition, researcher mobility is funded bilaterally. Both the Academy and the DBT are very pleased with their mutual cooperation and with the results it has generated.

The cooperation between the Academy of Finland and the DBT includes funding of Finnish-Indian *joint research projects* and *researcher mobility* in the field of biotechnology. Cooperation is carried out in priority fields that have been jointly agreed on and are partly based on existing researcher contacts. The theme for each call for joint projects is defined and specified in a workshop that is attended by researchers from Finland and India presenting the thematic area in question. The Academy and the DBT have arranged four researcher seminars and four calls for joint research projects with the following themes: plant, food and environmental biotechnology and medical biotechnol-

ogy. The amount of funding granted to the Finnish partners within the three-year research projects totals some EUR 2.5 million. The DBT provides funding for the Indian researchers in the projects. In 2009, the Academy of Finland, Tekes and the DBT arranged a call between the three partners in the field of medical diagnostics. In this call, it was also possible to apply for funding for corporate cooperation.

The Academy and the DBT have arranged four Indo-Finnish *researcher seminars* to map out potential fields of cooperation. The seminars also provided researchers with an opportunity to establish contacts. The seminars were held in:

1) Delhi in October 2005 in the field of medical biotechnology: diagnostics and intervention of infectious diseases, systems biology and drug development.
2) Helsinki in April 2006 in the field of plant and food biotechnology.
3) Helsinki in May 2007 with the theme *Environmental biotechnology research and Management of bioresources*.
4) Gurgaon on 23 January 2008 with the theme *Biomarkers and Diagnostics*. In this connection, an interim evaluation of the five projects that received funding in the 2006 call was carried out.

As a result of the seminars, *four calls for joint research projects* were launched:

1) in 2006, a call for joint research projects together with the DBT in the field of medical biotechnology (vaccine development and related technologies, development of new innovative diagnostics using different technologies and computational biology related to drug development). The Academy granted a total of EUR 1 million to the Finnish partners within the five three-year (2006–2008) Indo-Finnish research projects. The funding provided by the DBT to Indian researchers is equal to that amount.
2) in 2007: a call for joint research projects in the field of plant and crop biotechnology research; of the sixteen applications that were submitted, five three-year projects were granted a total of some EUR 1 million.
3) in 2007: thirteen applications were submitted to the call launched in October 2007. Two three-year projects were granted funding (total: about EUR 0.5 million).
4) in 2009: the joint call, arranged in cooperation with Tekes, the Finnish Funding Agency for Technology and Innovation, was launched in January 2009 with the theme *Medical diagnostics*. Within this call, it was also possible to apply for funding for corporate cooperation.

The seminar arranged in Gurgaon in January 2008 also assessed the progress of the five joint projects in medical biotechnology that were granted funding in the 2006 call. The seminar demonstrated that collaboration within all five projects has started successfully and generates added value for both parties. Forms of cooperation include exchange of information and knowledge, mobility of researchers and PhD students, preparation of joint publications and establishment of one joint laboratory.

The Academy of Finland and DST (India)

Collaboration between the Academy of Finland and the Department of Science and Technology in India

A Memorandum of Understanding was signed with the Department of Science and Technology (DST), operating under the Indian Ministry of Science and Technology, on 18 May 2005. The first joint call was launched in January 2010 with the theme Green Chemistry.

The Academy of Finland and Tooltech Ltd. (India)

Collaboration between the Academy of Finland and Tooltech Software Private Limited in India

Since 2003 the Academy of Finland has a Memorandum of Understanding with Tooltech Software Private Limited to support researcher mobility in the field of bioinformatics.

New INDIGO ERA-net

The Academy participates as an observer in the New INDIGO ERA-net that is aimed at strengthening and promoting cooperation with India on a European level.

1.4 ICELAND

1.4.1 China and Iceland

Knowledge-based cooperation between Icelandic research funding agencies and partners in China

Iceland–China

Strategy:	
Partners:	Rannis has no direct MoUs China Earthquake administration
Forms:	Exchange of scholars
Areas:	Earthquake research
Funding:	
Priorities:	

Iceland and China have an ongoing cultural agreement that was signed 1994 and there are several university-level programmes regarding student or teacher exchange. Formal collaboration between Icelandic and Chinese ministries, governmental institutes and other public institutes in the fields of joint research, science and innovation projects/programmes are otherwise scarce. The three collaborative efforts described below are at the moment the only formal collaboration between Icelandic research funding agencies and partners in China. In general there is no budget set for the collaborations.

The Ministry for the Environment (Iceland) and the Environmental Protection Administration (China)

Collaboration between the Ministry for the Environment of Iceland and the Environmental Protection Administration of the People's Republic China

In 2005, a Memorandum of Understanding (MoU) was signed between the Ministry for the Environment of Iceland and the Environmental Protection Administration of the People's Republic of China on environmental protection cooperation. The principal objective of the MoU is to promote cooperation between the two countries in the field of environmental protection, on the basis of equality and mutual benefit. The following areas are identified in the MoU as mutually high priority areas of cooperation:

- Nature conservation and combating soil erosion
- Solid waste management
- Environmental protection technology including renewable energy and environmental protection industry
- Promotion of environmental education and improving the public awareness of environment
- Other areas as mutually agreed upon

In order to implement the MoU the countries encourage environmental protection organisations, enterprises and municipalities as well as research institutions in both countries to establish and develop direct contacts with each other in the fields of environmental protection and sustainable development. Both countries designate a coordinator at director general level. No budget has been set. Travel and similar expenses are borne by the sending country but local expenses are borne by the hosting country. Future priorities for the MoU have not been decided upon.

The Ministry for the Environment (Iceland) and the Earthquake Administration (China)

Collaboration between the Ministry for the Environment of Iceland and China Earthquake Administration of the People's Republic of China

In 2005, a Memorandum of Understanding (MoU) in the field of earthquake studies was signed between the Ministry for the Environment of Iceland and China Earthquake Administration of the People's Republic of China. The principal objective of the MoU is to develop cooperation and exchange in the fields of seismology, volcanology, geophysics, earthquake engineering and countermeasure for seismic hazard reduction as well as to develop scientific and technological cooperation and exchange on the basis of equality, mutual benefit and reciprocity. The countries agreed that cooperation and exchange should include topics of mutual interest such as:

- Seismology using digital techniques
- Earthquake trend analysis and assessment at large earthquake sites; earthquake engineering and engineering seismology
- Seismic hazard reduction measures
- Basic seismology and geophysics
- Physics of the earth's interior
- Volcanological study
- Public awareness campaign
- Other topics as may be mutually determined

The countries agreed that cooperation and exchange might be carried out in the following manners:

- Exchange of scholars, specialists and delegations or teams for field investigations
- Collaborative research on the relevant topics
- Exchanges of seismological and volcanological information and data, earthquake catalogues and relevant publications

- Joint organisation of symposia, workshops and lectures
- Other forms of cooperation, as mutually agreed between the countries

Both countries designate a coordinator at director general level. No budget has been set. Travel and similar expenses are borne by the sending country but local expenses are borne by the hosting country. Future priorities for the MoU have not been decided upon but will remain in force until 2010.

The Ministry of Education, Science and Culture (Iceland) and the Minister of Education of the People's Republic of China (China)

Collaboration between the Ministry of Education, Science and Culture of Iceland and the Minister of Education of the People's Republic of China

In September 2006, the Icelandic Minister of Education, Science and Culture paid an official visit to China with the aim of strengthening relations between the countries in the field of education, science, innovation and culture. During the visit, the Minister had a meeting with the Minister of Education of the People's Republic of China. That same month the Minister of Education, Science and Culture and the China's State Councillor signed a common letter of intent to establish a joint programme of a *Confucius Centre* in Reykjavík. It was established in autumn 2008. Collaboration is implemented mainly in the form of encouraging collaboration between academic institutions. The funding of Confucius Centre is in the hands of the Minister of Education of the People's Republic of China while the University of Iceland collaborates by providing personnel and the necessary facilities for the institution. Future priorities for the collaboration have not been decided upon.

1.4.2 India and Iceland

Knowledge-based cooperation between Icelandic research funding agencies and relevant partners in India

Iceland–India

Strategy:	-
Partners:	Ministry of Science and Education (MoU 2007) Ministry of New and Renewable Energy (MoU 2007)
Forms:	Development of new technologies
Areas:	Earthquake research Geothermal energy
Funding:	ISK 209 million (EUR 1.2 million)
Priorities:	-

Iceland and India have an ongoing cultural agreement. Otherwise formal collaboration between Icelandic and Indian ministries, governmental institutes and other public institutes in the fields of joint research, science and innovation projects/programmes is scarce. The two collaborations described below are at the moment the only formal collaboration between Icelandic research funding agencies and partners in India. In addition, the governments of Iceland and India have signed a draft MoU regarding sustainable fisheries development.

The Ministry for Education and Science (Iceland) and the Ministry of Science and Education (India)

Collaboration between the Icelandic Ministry for Education, Science and Culture and the Indian Ministry of Science and Education

In 2007, the Icelandic Ambassador to India and the Secretary of the Indian Ministry of Science and Education signed a Memorandum of Understanding (MoU) on earthquake prediction research between Iceland and India. The Memorandum foresees increased cooperation between Icelandic and Indian scientists with the aim of predicting earthquakes more accurately. This MoU follows the Agreement on Science and Technology between Iceland and India, signed by Iceland's Minister of Education, Science and Culture and the Indian Minister for Science and Technology in Reykjavik on 19 October 2005. In recent years, Icelandic geologists have developed a seismic system for the study of anomalies prior to earthquakes. The Indo-Icelandic earthquake prediction research is intended to strengthen this capability for the mutual benefit of both countries.

The signing of the MoU paves the way for the first phase of cooperation. This will include a visit of two Indian geologists to Iceland and a reciprocal visit of Icelandic scientists to India in order to draft a project proposal. The first phase will be led by two Partnership Coordinators; one nominated by the Icelandic Meteorological Office, the other by India's Department of

Science and Technology. Other partners include the University of Iceland, the University of Akureyri and the Icelandic Ministry for Foreign Affairs, the India Meteorological Department, the Wadia Institute of Himalayan Geology, the National Geophysical Research Institute (NGRI) and the Ministry of External Affairs. The collaborative efforts are expected to begin in 2010.

The budget was set at a total of ISK 209 million (EUR 1.2 million), distributed over a three-year period. The Icelandic Government will pay salary and other travel expenses for three Icelandic specialists working in India and local expenses for visiting specialists from India. The Indian Government will pay salary and other travel expenses for 15 Indian specialists working in Iceland and local expenses for visiting specialists from India. The Indian Government also pay for research equipment. There have been some elaborations concerning further funding from EU or similar institutions but nothing has been decided. Future priorities for the MoU have not been decided upon.

The Ministry of Industry Energy and Tourism (Iceland) and the Ministry for New and Renewable Energy (India)

Collaboration between The Icelandic Ministry of Industry Energy and Tourism and the Secretary of the Indian Ministry for new and renewable energy

In 2007, the Icelandic Ambassador to India and the Secretary of the Indian Ministry for New and Renewable Energy signed a Memorandum of Understanding (MoU) between Iceland and India on renewable energy cooperation.

The MoU envisages cooperation for development of:

- Systems
- Sub-systems
- Devices
- Components
- Monitor and evaluation of cooperation activities

The countries declared their mutual cooperation on the development of new technology for renewable resources in the areas of:

- Geothermal
- Hydrogen
- Fuel cells
- Wind energy

In addition, both governments will monitor and evaluate their cooperation activities together. Cooperation on hydrogen and fuel cells was agreed upon as part of the International Partnership for Hydrogen Economy (IPHE). Active forms of collaboration have not been decided upon. There is no defined budget. Future priorities for the MoU have not been decided upon.

Sustainable fisheries development and the United Nations University Fisheries Training Programme

The United Nations University Fisheries Training Programme is funded and operated by the Government of Iceland. Three Indian students are expected to take part in the training programmes of the University starting later this year. A draft Memorandum of Understanding on sustainable fisheries development between India and Iceland has been approved by the Governments of both countries.

Forms of collaboration are implemented particularly through the student training programmes at the United Nations University Fisheries Training Programme. The programme is funded and operated by the Government of Iceland and it receives annual funding from the Government. There is no specific budget earmarked for collaboration in fisheries between India and Iceland. Future priorities for the collaboration will probably be mainly in the form of student training programmes at the United Nations University Fisheries Training Programme.

1.5 NORWAY

1.5.1 China and Norway

Knowledge-based cooperation between Norwegian research funding agencies and partners in China

Norway–China

Strategy:	Governmental level strategy (2008)
Partners:	MOST (AoC 2008) NSFC (MoU 1992)
Forms:	Joint projects Scholarships Researcher mobility
Areas:	Natural sciences Climate change and technology Public services Environment
Funding:	NOK 34 million/year (EUR 4.1 million/year, conversion rate 2008)
Priorities:	Sino-Norwegian cooperation programme: expansion of the themes (agriculture, energy etc.)

The cooperation between Norwegian and Chinese research partners is broad and covers a number of fields and topics. Areas that are subject to particular strategic effort are described in the following.

The Ministry of Education and Research (Norway) and MOST (China)

Collaboration between the Norwegian Ministry of Education and Research and the Ministry of Science and Technology of the People's Republic of China

In November 2008, an Agreement of Cooperation[8] (AoC) was signed between the Norwegian Ministry of Education and Research and the Ministry of Science and Technology of the People's Republic of China (MOST) on scientific and technological cooperation. The AoC serves as a replacement for a MoU between MOST and the Research Council of Norway; the MoU was terminated as the AoC entered into force. The principal objective of the AoC is to facilitate broad opportunities for scientific and technological cooperation between the two countries. A joint committee shall meet alternately in the Kingdom of Norway and the People's Republic of China at mutually agreed times.

[8] The AoC is published at: http://www.regjeringen.no/nb/dep/kd/tema/forskning/forskningsavtaler.html?id=495515

RCN (Norway) and NSFC (China)

Collaboration between the Research Council of Norway (RCN) and the National Natural Science Foundation of China (NSFC)

The cooperation, based on a MoU signed in 1992 between the Research Council of Norway (RCN) and the National Natural Science Foundation of China (NSFC), have three aims:

- To strengthen contacts between Chinese and Norwegian researchers, including mutual research policy information exchange between the partners.
- Provide funding for Sino-Norwegian basic research projects in natural sciences.
- Support to network activities.

Support is given primarily in the form of individual scholarships and mobility support. Applications for funding are sent to both parties. The sending party covers the travel expenses and the receiving party covers the running expenses during the stay. Both parties have to accept an application for the project to be funded.

Norwegian Programme for Research Cooperation with China (CHINOR)

A China cooperation programme CHINOR[9] (2009–2017) amounting to NOK 20 million a year (EUR 2.4 million, conversion rate 2008) has been established in the Research Council. The cooperation programme will work through thematic research programmes, and aims at opening calls for funding of Sino-Norwegian cooperation. The calls, project evaluation and project follow-up will be organised and managed by thematic research programmes on the Norwegian side. In addition, the cooperation programme may participate in Sino-Nordic and Sino-European cooperation. Both *bilateral joint calls* with research funding counterparts in China, and *inclusion of third countries* from the Nordic countries or the EU are part of the programme mandate, and the RCN and CAS will engage in a joint project scheme. In the field of welfare and social sciences, CASS is an important partner for the CHINOR programme.

Thematic scope

In the starting phase, the priorities of the Sino-Norwegian programme are:

- Climate change
- Climate technology
- Public services and welfare
- Environment

In the future, provided there is substantial funding, the set of priority themes could be widened. Based on an analysis of common research priorities and interest from China, the following four additional topics could be included:

- Energy
- Nanoscience and material science
- ICT
- Biotechnology

In addition, China has expressed interest for cooperation in the field of Traditional Chinese Medicine. Traditional Chinese Medicine may have relevance for health, medicine, pharmacy, biotechnology and bioprospecting. China has also expressed interest in strengthening the existing strong cooperation in Polar research.

Based on common interest in business and industry, governance and nature management, another set of future topics for cooperation could be raised: China and Norway are both large in fisheries as well as aquaculture, and there is potential for cooperation in the field of aquaculture and fisheries, as well as fishery management. Furthermore, offshore oil and gas and maritime technology are fields of common interest. Some of China's greatest challenges are linked to food. Food production capacity, food safety and environmental issues in agriculture constitute themes of common interest and could be areas of collaborative research in the future.

[9] Chinor: http://www.forskningsradet.no/servlet/Satellite?c=Page&cid=1253952407004&p=1253952407004&pagename=chinor%2FHovedsidemal

Calls in 2008 in climate research and public service research

To pave the way for a China-Norway programme, two calls were implemented at the end of 2008 aimed at increasing Sino-Norwegian research cooperation. The topics were climate change and public services, respectively. The calls resulted in six large research projects on climate change with a total funding contribution of about EUR 5 million from both countries for over three years. Of this, EUR 3 million was provided by the RCN. In addition, a number of network projects were established in the area of public services and welfare research.

1.5.2 India and Norway

Knowledge-based cooperation between Norwegian research funding agencies and partners in India

Norway–India

Strategy:	Governmental level strategy (August 2009)
Partners:	DST (MoU 2006, PoC 2009) DBT
Forms:	Cooperation projects Joint projects Scholarships Researcher mobility
Areas:	Climate Clean energy Geotechnology Marine Nanoscience and -technology Vaccines International political issues Environment Social development
Funding:	NOK 30 million/year from 2010 (EUR 3.7 million/year, conversion rate 2010)
Priorities:	Indian-Norwegian cooperation programme

Ministry of Education and Research (Norway) and MST (India)

Collaboration between the Norwegian Ministry of Education and Research and the Indian Ministry for Science and Technology

A Memorandum of Understanding was signed between the two parties in 2006, and a more detailed Programme of Cooperation (PoC) was signed in May 2009, in Oslo. A joint minister-level working group has been established and the groups meet about every second year.

The PoC has the following prioritised topics:

- Climate research including ocean, arctic and polar research
- Clean energy
- Geotechnology and early warning systems for geohazards
- Marine research – bioprospecting and polar research
- Nanoscience/-technology primarily related to clean energy and solar energy and medical issues
- Vaccines – human and fish/animal, including vaccination programmes and biotechnology of new vaccine development

RCN (Norway) and DBT (India)

Collaboration between the Research Council of Norway and the Department of Biotechnology, Indian Ministry for Science and Technology

The Department of Biotechnology (DBT), Ministry of Science & Technology, Govt. of India and The Research Council of Norway (RCN), Programme for Global Health and Vaccination Research (GLOBVAC) have established collaborative efforts between India and Norway in the field of human vaccination research, including joint calls for proposals and joint research projects between Indian and Norwegian scientists, and with the intention of matched funding.

Following joint calls in 2006, 2007, 2008, there are now three projects ongoing (totalling NOK 40 million (EUR 4.9 million) from the RCN, conversion rate 2008), and three projects are under contract negotiations (NOK 11 million (EUR 1.3 million) from the RCN, conversion rate 2008). Hence, approximately 25% of GLOBVAC funding for vaccination research has so far been allocated to Indo-Norwegian collaborative projects. Proposals from the joint call in 2009 are under evaluation. Further, following an invitation from the DBT and PATH, work is ongoing towards a Norwegian engagement in and co-funding of a phase III trial of an oral rotavirus vaccine in India.

A new Indian-Norwegian cooperation programme in the RCN (INDNOR)

The RCN has established an India programme (5+5 years 2010–2020) amounting to NOK 20 million a year (EUR 2.4 million a year, conversion rate 2009), which will cooperate closely with other programmes at the RCN or other funding bodies. This is in accordance with, and an integral part of, the Government's new strategy on India, which was launched in August 2009. Topics for research calls will be international political issues, climate, the environment, clean energy and social development. The funding of the first projects will be granted in 2010.

1.6 SWEDEN

1.6.1 China and Sweden

Knowledge-based cooperation between Swedish research funding agencies and partners in China and India

Sweden–China

Strategy:	-
Partners:	MOST
Forms:	VINNOVA Joint research projects in telecommunication Joint centre as node for projects in material science
Areas:	VINNOVA Telecommunication Material science Biotechnology FAS Public health Demographics Health care systems
Funding:	VINNOVA Telecommunications SEK 27 million (EUR 2.9 million, conversion rate 2007) for 2008–2011 from VINNOVA. Material science center approx. SEK 1 million a year (EUR 108,000 a year, conversion rate 2007).
Priorities:	FAS Public health – Ageing Reproductive health Demographics VINNOVA Biotechnology Telecommunication Material science

Governmental agreements on cooperation in science and technology have been in place between Sweden and China since 1978 but were then part of a larger general cooperation agreement. Since this implied that it would never come to concrete discussions on S&T cooperation under this agreement, it was decided to make a separate agreement and a subgroup for S&T cooperation in 2004. In this agreement, three areas were identified as particularly important for research collaboration: telecommunication, material science and biotechnology. In 2007, a new meeting was held in Beijing where the areas of energy and environment, and medicine and health were added. All these agreements were signed by the Ministry of Science and Technology of the People's Republic of

China (MOST) and the Ministry of Education in Sweden.

The Swedish Governmental Agency for Innovation Systems, VINNOVA[10], has been the governmental agency in Sweden that has so far implemented practical collaboration within the three areas defined in the first agreement. Other governmental agencies such as the Swedish Council for Working Life and Social Research, FAS[11], and the Swedish Energy Agency[12] are working on implementing collaboration under the new sectors added to the first ones.

VINNOVA (Sweden) and MOST (China)

Collaboration between the Swedish Governmental Agency for Innovation Systems and the Ministry of Science and Technology of the People's Republic of China

Telecommunications

IMT Advanced and Beyond is the first joint initiative on mobile communication research between Sweden and China in *the Sino-Swedish Strategic Cooperative Programme on Next Generation Networks*. The programme is funded by VINNOVA in Sweden and the Ministry of Science and Technology of the People's Republic of China (MOST). Seven projects started in 2008 and are funded with SEK 27 million (EUR 2.9 million, conversion rate 2007) by VINNOVA and RMB 20 million (EUR 1.9 million, conversion rate 2007) by MOST. The projects will run for three years, covering a broad range of topics from protocols and coding to transmission and antennas to enhance the capabilities of future mobile communication systems. Biannual workshops are held to give the researchers an opportunity to meet and exchange results.

Material science

In 2002, the Sino-Swedish Advanced Materials Exchange Centre on both sides was established and sponsored by Swedish VINNOVA and Chinese MOST, respectively. The Chinese office is located at Central Iron & Steel Research Institute (CISRI), Beijing, and the office in Sweden was set up at Chalmers University of Technology, Gothenburg. One important purpose is to act as a node for Sino-Swedish scientific cooperation in materials technology and thus provide a platform for various research institutes, universities, industries and technical service organisations in both countries. The centre aims to be a main initiator for forefront cooperation in materials science. Project areas are initiated, grown and moved into mature conditions. New topics are identified and channelled for the future. The centre is a dynamic contact node and vehicle for emerging and growth of scientific cooperation rather than an organisation for keeping the same research ongoing.

Biotechnology

In this area VINNOVA has not supported any programme collaboration or centre activities in the way that has been done in the other areas. Instead, a few projects have been supported that are more on an ad hoc basis and not as a result of a call for proposals. One such project is presently supported in food technology.

FAS (Sweden) and China

Collaboration between the Swedish Council for Working Life and Social Research and China

The Swedish Government and the Riksdag put great emphasis on a policy of global development (PGU), which "in an effective way will contribute to fair and sustainable global development enabling poor people to more successfully benefit from globalisation". In a number of different bills the Government has reiterated both the need for and measures of globalising Swedish research policy to cover countries outside the EU and the USA. The priority fields of the PGU are:

- Human rights and actions against oppression
- Social and economic exclusion
- Migration
- Climate change and environments
- Conflicts and vulnerable situations
- Infectious diseases and other threats to health

The Government's emphasis on a policy for global development means that global issues are more strongly linked with their respective ministries and authorities. Over the last year, the Government has given greater prominence to the global perspective in a number of bills concerning research. FAS has participated in research contacts with India and China, both of which Sweden has special agreements with. Involvement in EU research also has consequences on global issues. Furthermore, FAS is a member of *the Swedish Unesco Council for Scientific Cooperation* and chair of *the*

[10] VINNOVA: www.vinnova.se
[11] FAS: www.fas.se
[12] The Swedish Energy Agency: www.energimyndigheten.se

MOST Committee, which opens new windows for action in global issues. In addition, FAS works together with Sida and the Swedish Research Council within the framework of *Research Links* (see below).

The 2nd Sino-Swedish Science Week was held in Beijing in September 2007 within the framework of the research policy exchange between Sweden and China. FAS took part in the Swedish delegation and organised a workshop on public health, demographics and health care systems in collaboration with *Vårdal Foundation* and *the Knowledge Foundation*. The work has continued during 2008 and 2009 with visits of several delegations within these research areas.

1.6.2 India and Sweden

Sweden–India

Strategy:	-
Partners:	Ministry of Science & Technology (DST, DBT), Ministry of Communications & Information Technology (DIT), Ministry of Health
Forms:	VINNOVA Joint research projects
Areas:	VINNOVA e-Health/Visualization Biology, diagnostics and treatment of tuberculosis FAS Alcohol policy Medicines (research) Antibiotic resistance Sexual and reproductive health Maternity welfare Innovations in the healthcare sector
Funding:	VINNOVA-DBT SEK 16 million (EUR 1.7 million, conversion rate 2008) for three years 2009–2012 by VINNOVA VINNOVA-DIT SEK 5.3 million (EUR 0.6 million, conversion rate 2008) for three years 2009–2012 by VINNOVA
Priorities:	FAS Public Health – Reproductive health, Maternity welfare, Addiction VINNOVA Biotechnology and ICT

The governments of India and Sweden signed in 2005 a cooperation agreement in the field of science and technology. This agreement was signed by the Ministry of Science and Technology (MoST) in India and the Ministry of Education and Research in Sweden. The Swedish Governmental Agency for Innovation Systems, VINNOVA, has been the governmental agency in Sweden that has so far implemented practical collaborations within the two areas defined in the first agreement. Under this agreement VINNOVA has signed two agreements, one with the Department of Science & Technology and one with the Department of Biotechnology. VINNOVA has also agreed to fund joint projects with the Department of IT, Ministry of Communications and IT.

VINNOVA (Sweden) and India

Collaboration between the Swedish Governmental Agency for Innovation Systems and India

Biotechnology

VINNOVA and the Department of Biotechnology (DBT), Ministry of Science and Technology, India, have agreed to support top-level research cooperation between Indian and Swedish scientists in the field of biology, diagnosis and treatment of tuberculosis. The programme is the first bilateral co-operation, based on joint funding, between the two funding organisations and is a result of the signing of a collaborative agreement in May 2007. VINNOVA will fund the Swedish research teams and the DBT the Indian teams. VINNOVA has committed to contribute around SEK 16 million (EUR 1.7 million, conversion rate 2008) for three years (2009–2012).

Information technology

VINNOVA and the Department of Information Technology, Ministry of Communications and Information Technology, India, have agreed to support joint research projects in the field of *e-Health and Visualization of medical data*. VINNOVA will fund the Swedish research teams and DIT the Indian teams. VINNOVA has committed to contribute around SEK 5.3 million (EUR 0.5 million, conversion rate 2008) for three years (2009–2012).

Environmental technology

In 2008, VINNOVA co-funded four workshops organised by the Swedish network 'Centre for Indian-Swedish Cooperation on Technical Research and Education (INSTEC)' in collaboration with the Indian counterparts. VINNOVA funding came to around SEK 0.3 million (EUR 31,000, conversion rate 2008).

FAS (Sweden) and India

Collaboration between the Swedish Council for Working Life and Social Research and India

In 2008, in discussions on closer cooperation in the public health sector between Sweden and India, FAS

was represented in the Swedish governmental delegation including the Swedish National Institute of Public Health[13] and the Vårdal Foundation[14]. In February 2009, the Ministries of Health in Sweden and India signed a Memorandum of Understanding in the area of health, which identifies several priority fields, of which the most relevant are:

- Alcohol policy
- Medicines, research
- Antibiotic resistance
- Sexual and reproductive health
- Maternity welfare
- Innovations in the healthcare sector

In February 2010, an Indo-Swedish Health week will be arranged in India with a view to further developing collaboration between the stakeholders involved.

1.6.3 The Swedish Research Links programme

The Swedish Research Links Programme seeks to foster research ties between researchers in Sweden and researchers in Asia, the Middle East, South Africa and North Africa. The programme is funded by the Swedish International Development Cooperation Agency (Sida) and administered by the Swedish Research Council. The programme offers two forms of grants for international collaboration: International Research Grant (normally awarded for three years) and International Planning Grant (one year). The funding can be used for joint activities such as exchange research visits between the partners, seminars, workshops and joint publishing. It is awarded for both basic and applied research.

Criteria

- Scientific quality, in relation to the research standards currently applicable within the field or discipline
- Relevance, in relation to the objectives established for this programme
- Competence of the applicants in relation to the proposed research assignment, and their respective academic standing and track record
- Balanced cooperation, both research partners should contribute equally to the project.
- Budget, in relation to the project plan and funds available (please note that salaries are not funded); basic project funding must come from other sources.

Grant amount

- SEK 0.3 million (EUR 31,200, conversion rate 2008) a year for three years, i.e. a total of SEK 0.9 million (EUR 93,600, conversion rate 2008).
- International Planning Grant, for one year, amounts to SEK 75,000 (EUR 7,800, conversion rate 2008).

1.7 Summary of National Activities

1.7.1 Current status

Many/most of the Nordic countries have government-level S&T agreements with either China or India or both. In addition, national research funding organisations have signed cooperation agreements with their Chinese and/or Indian counterparts.

In some cases this cooperation is relatively long-standing and well-established, while other organisations are just starting to build up their relations with Asian funding organisations or have only started their collaboration quite recently. Some organisations even have policies or specific strategies for R&D&I collaboration with India and China. However, all Nordic funding organisations seem to be interested in building up and strengthening relations with their Asian partners.

Forms of existing research collaboration vary from researcher mobility to jointly funded thematic programmes and innovation centres. Funding can also be earmarked for research collaboration with China or India or it can be open to all international partners.

It is also worth pointing out that existing funding cooperation is focused on biosciences and natural sciences.

1.7.2 China

The volume of research collaboration and researcher mobility between the Nordic countries and China is reasonably big and still growing in many fields. In some cases, cooperation between the funding organisations has begun as early as the 1980s. MOST and the NSFC are the main partners, but there is also some smaller-scale cooperation with CAS, CASS and MSTI.

[13] Swedish National Institute of Public Health: www.fhi.se
[14] Vårdal Foundation: www.vardal.se

Areas of interest:

- MOST: biotechnology, biomedicine, agricultural and food technology, clean and renewable energy, nanoscience and -technology, health and traditional Chinese medicine application, public health, ageing, ICT
- NSFC: neuroscience, environment and energy, environmental ecology, ubiquitous computing, cross-cultural communication, climate research and technology, public services, environment
- Current forms of cooperation: innovation centre in Shanghai, funds for networks (seminars, conferences etc.), PhD programmes (for staying in Denmark), support for strong R&I environments (joint professorship), calls for joint research projects, collaboration between Centres of Excellence, joint thematic programmes, researcher mobility, joint seminars

1.7.3 India

The volume of research activity between Nordic and Indian researchers is still modest in several fields. The interest in researcher mobility, especially from the Nordic countries to India, is limited but increasing. One should bear in mind that the quality of research varies greatly from one university or research institution to another in India.

Cooperation between the Nordic research funding organisations and their Indian counterparts is either in the planning phase, or the existing bilateral agreements are relatively new. The main cooperation organisations are the Department of Biotechnology (DBT) and the Department of Science and Technology (DST). There are also other partners such as sectoral ministries (e.g. IMNRE). The DBT has in several occasions expressed its willingness to arrange a call for proposals jointly with two (or more) Nordic organisations.

Areas of interest:

- DBT: e.g. advanced biotechnology, structural and medical biotechnology, food biotechnology, agricultural and environmental biotechnology
- DST: earthquake research
- Ministry of Health: public health (sexual and reproductive health)
- Current forms of cooperation: support for networks and PPP, joint professorships, calls for joint research projects, researcher mobility, summer schools

1.7.4 Nordic-Asian cooperation: Strengths, weaknesses, opportunities and threats

SWOT analysis

Table 4.

Strengths
- No political tension between countries involved
- Some common interests
- Increased funding in India and China
- Good reputation of the Nordic countries
- Social security (in the Nordic countries)
- Strong educational system
- Research environment
- Critical mass together
- Nordic part of high-tech societies

Weaknesses
- Lack of resources/Limited funds
- Absence of a common profile among the Nordic countries
- No thematic issues shared by all Nordic countries
- Inefficiency
- Small size
- Organisational problems

Opportunities
- Common scientific strength
- Research potential
- Large-scale cooperation
- Cooperational increase
- Increase regional cooperation
- 'Hot topics' in common
- Good reputation
- More resources
- Increase of flexibility
- Food topics are high importance topics
- Political gains

Threats
- Miscommunication
- Lack of bilateral and equal benefits
- Lack of instruments to mandate
- Unclear goals

STRENGTHS

The SWOT analysis of the Nordic-Indo/Chinese collaboration indicates that the main strengths of this collaboration are that there is no, or at least *very little, political tension* between the Nordic countries and India/China – especially if compared to the big players on the global political arena. Another strength of the Nordic-Indo/Chinese collaboration is that there are certain *themes of common interest* that invite further exploration.

WEAKNESSES

According to the SWOT analysis, the main weaknesses of the Nordic-Indo/Chinese collaboration are the *absence of a common profile* among the Nordic countries towards India and China and the *lack of resources/limited funds*. The absence of a common profile might act as an obstacle in creating trust between the partners and also in the communication process, since it might lead to confusion about to whom to talk to/work/cooperate with.

OPPORTUNITIES

According to the SWOT analysis, the main opportunities of the Nordic-Indo/Chinese collaboration are the *scientific strength* of the Nordic countries, especially in view of their size and the *research potential* created in the process of collaboration.

THREATS

According to the SWOT analysis, the main threat of the Nordic-Indo/Chinese collaboration is a high *risk of miscommunication*, linguistically, culturally and on other levels. A *lack of bilateral and equal benefits* for the partners is also a threat.

2 S&T System in China and India

2.1 CHINA'S S&T&I SYSTEM

This section of the report is an English translation of parts of the Danish strategy for knowledge-based collaboration between Denmark and China.[15]

China's current innovation system can be traced back to early 1980, where the ongoing economic reform also led to a thorough review of the scientific and technological system. The process of change was related to a break with the hierarchical system dominated by large public research institutions established after the Soviet model. The key objectives were a better link between research and production and a major increase in public and especially private investment in research and development (R&D).The reforms have been driven by five big technology programmes and thorough restructuring, where hundreds of institutions have been merged, shut down or transformed to units operating on market conditions.

Simultaneously investments in a large number of science and incubator initiatives for technology companies have promoted public-private interaction and the creation of high-tech enterprises in China. Also, the process has been supported by greater openness to the contributions of international actors and a strong growth in production of engineers and scientists. Finally, the National Plan for R&D development (2006–2020) has emerged which is a management tool for China's ambitious research strategy of the first 20 years of the 21st century.

2.1.1 Public and private R&D investments in China

Today, China is among the world's leading countries in terms of investments in R&D and hence a strong player in the global knowledge economy. In 2007, China invested 1.49% of GDP in R&D, which represents public and private investments at US$ 102.3 billion. By comparison, the total investment in Sweden was US$ 12.1 billion (3.6% of GDP), in Finland US$ 6.4 billion (3.48% of GDP), in Denmark US$ 5 billion (2.55% of GDP), in Norway US$ 4.1 billion (1.64% of GDP) and in Iceland US$ 0.3 billion (2.75% of GDP) (OECD 2009/1).

Unlike countries such as Germany, USA and Japan that have traditionally been seen as global leaders when it comes to research and technology, China's R & D investments increased dramatically. Between 1999 and 2005, China's total R&D investment prolif-

Table 5. Overview of the major science and technology programmes in China. (Source: OECD 2007)

R&D programme for core technologies (1982)	Development of core technologies in support of China's industrial production. Priority given to public-private partnerships and operation-driven processes for boosting effectiveness.
Spark programme (1986)	R&D with a focus on improving the efficiency of the agricultural sector and creating incentives for technology transfer to rural regions in China.
R&D programme for high technology – 863 (1987)	Improvement of China's innovation capacity in high-tech sectors. Focus on IT, biotechnology, agriculture, environment, energy, new materials and robotics.
Torch programme (1988)	Support for high-tech sectors through the establishment of science parks and business incubators.
National basic research programme – 973 (1997)	Promotion of research that creates a platform for future development and/or generates pioneering new research knowledge.

[15] Ministeriet for Videnskap, Teknologi og Udvikling 2000.

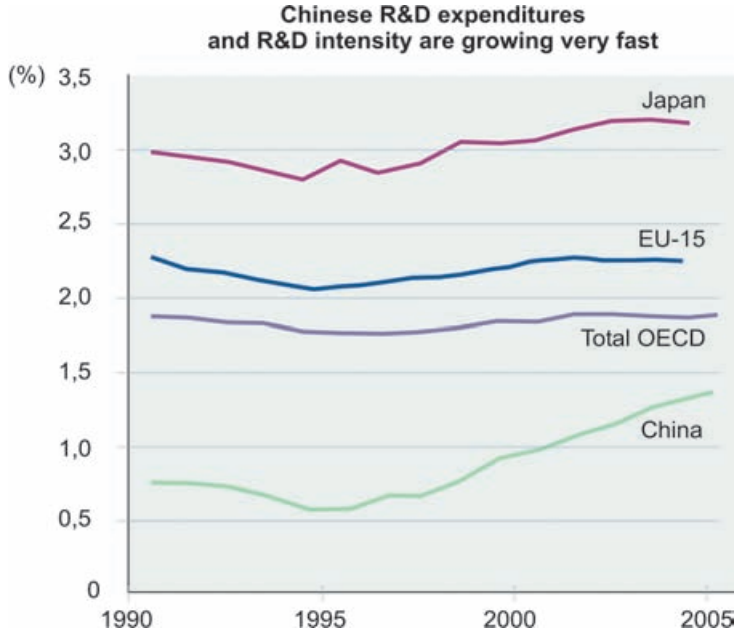

Figure 1. Chinese R&D expenditures and R&D intensity. (Source: OECD 2007)

erated by an average of 21% a year and in 2006 China achieved a position as the second leading country in the world only surpassed by the United States who invests even more in research and development.

The impressive growth of China's R&D investment has mainly been driven by industry. In the early 1990s, companies funded about 40% of total R&D activities; this share has grown to over two thirds. The implemented reforms have managed to change the balance in the Chinese innovation system promoting research related to production. It is especially in the private sector China has experienced an explosive growth in the number of persons engaged in research and development, while there has been a more moderate and stable growth in university scientific staff. Consistent with the Government's desire to promote research in the private sector, there has been a decline in the number R&D staff in governmental research institutions.

An unintended consequence has been that China currently invests relatively little in development of new knowledge. Today, only respectively 6% and 24% of China's total R&D investments is allocated to basic and applied research, while more than two thirds targeting practical development work. In the past few years, economic growth has been concentrated in most of the Chinese R&D investments in the country's eastern provinces. Especially in areas around Beijing, Shanghai and in the southern Guangdong province near the delta of the Pearl River accounts for a very large proportion of the total R&D activities. China's 22 provinces are also characterized by large differences in specialization and growth potentials.

In the area around Beijing a large number of China's public research institutions are focusing on basic research, while R&D activities in the areas near Shanghai to a greater extent have a commercial focus. Therefore the regional dimension is of crucial importance – local differences have to be taken into consideration when researchers and companies are trying to establish partnerships in China.

2.1.2 Central organisations in China's research and innovation system

China's innovation system consists of approximately 5,400 governmental research organizations, 3,400 university-related research institutions, 13,000 research institutions operated by state enterprises and 41,000 private companies with R&D activities. Of the 5,400 governmental research institutions nearly 5,000 institutions are in the area of science and technology while 400 institutions are in the area of social science. Approximately 1,000 of the technological and scientific institutions is controlled by the central government, including the various ministries and the Chinese Academy of Sciences (CAS). The remaining research institutions are administered by regional and local authorities.

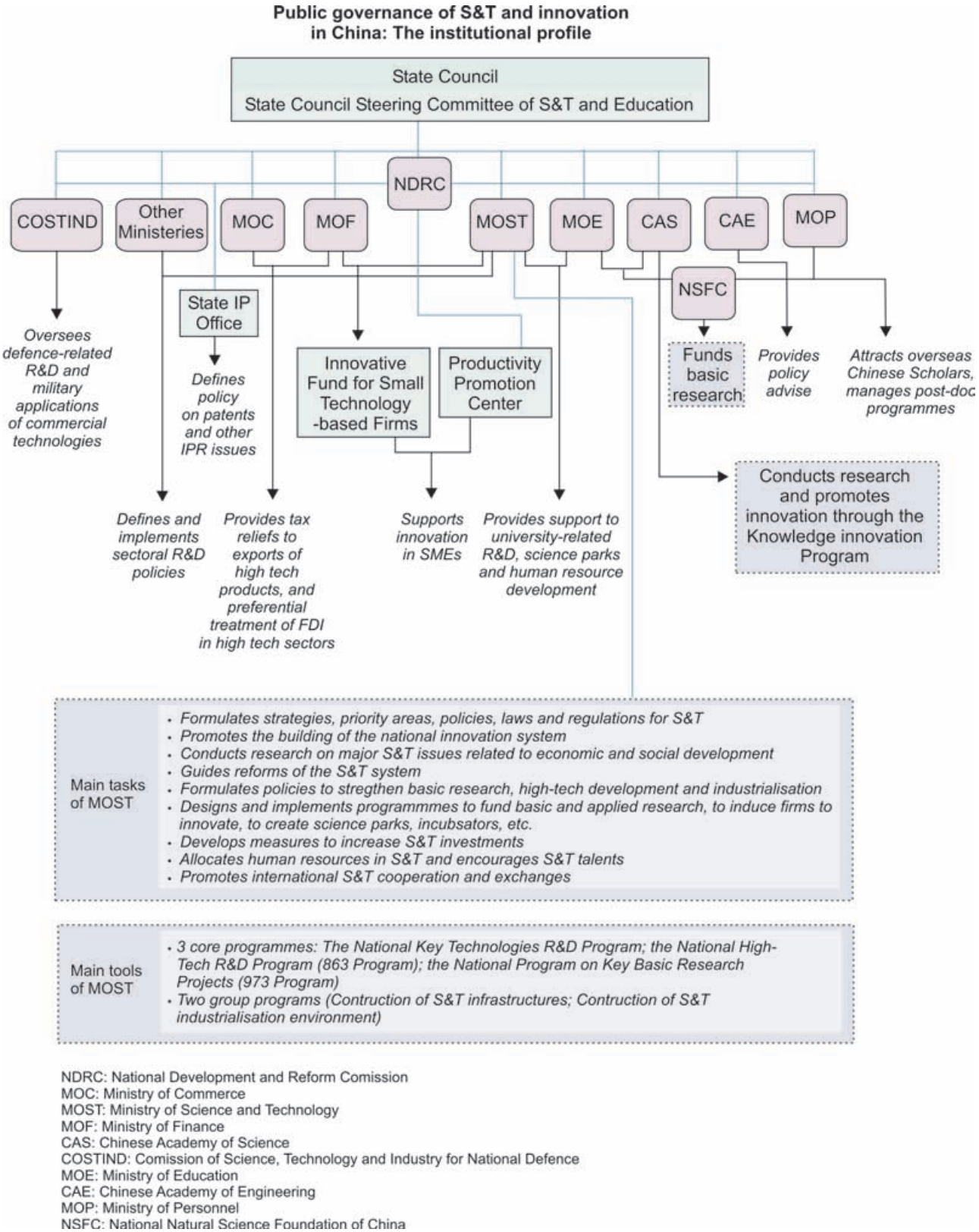

Figure 2. Overview of key institutions in the Chinese innovation system. (Source: OECD 2007)

The Ministry of Science and Technology of the People's Republic of China (MOST) has overall responsibility for the formulation and implementation of China's R&D policy. This is done with reference to the State Council for Science, Technology and Education, a council represented by the President, Science Minister, and the Minister for Education and other relevant actors. MOST's tasks include, among other things, drafting and implementation of strategic and long-term strategies for China's research and development and planning of basic research and scientific and technological programmes. These matters are solved by MOST often in cooperation with other organizations within the government, the higher education sector and the private sector.

The Commission of National Development Reform (NDRC) is also an important player in the Chinese innovation system. The NDRC is responsible for China's economic and regional development and has a large share of the governmental R&D budget. The NDRC is predominantly responsible for the formulation of China's development strategy in renewable energy and high-tech industry.

The Ministry of Education of the People's Republic of China (MOE) oversees the State Key Laboratories and research institutions within the universities and is responsible for research scholarships which are administrated by the China Council for International Scholarships (CSC). Each year the CSC awards about 5,000 abroad scholarships to promising Chinese doctoral students.

The Chinese Academy of Sciences (CAS) is China's leading scientific institution in natural science, technology and science and technology innovation. The Academy has more than 50,000 employees spread over 92 research institutions.

The Chinese Academy of Social Sciences (CASS) is the leading academic research centre in the fields of the humanities and social sciences in China. CASS has more than 3,000 researchers in its 32 research institutes.

The National Science Fund of China (NSFC) funds basic research provided on the basis of competition and conducted by universities and research institutions. NSFC's budget is expected to increase by 20% a year over the next three years. Budget in 2008: EUR 630 million.

Local government research and development committees. Most of China's provinces have independent research funding, including funds to finance R&D activities at regional universities.

2.1.3 Research schools

Along with a strong investment in R&D, China has invested in targeted research. The number of registered doctoral students in China reached 55,000 students in 2005, which is almost three times more than in 2000. A very large proportion of China's PhD students are enrolled in the engineering sciences (42%) and 17% is enrolled in the natural sciences. However, in recent years there has been a trend towards increased diversification inter alia medicine, agriculture and social sciences.

China has a long tradition of sending young researchers abroad. 12% of all Chinese students enrolled at a Masters or PhD education at a university went in 2005 abroad. Studies show that over 90% of the Chinese, who obtained a doctoral degree in the U.S. in 1996, was still in the country five years later. Consequently there is a large recruitment potential associated with the Chinese to conduct research in the Nordic countries.

Increasing investment and production of scientists can be seen in the number of Chinese working with R&D. Since 1995, the number of researchers has increased with 6% a year and amounted in 2007 to 1.4 million full-time researchers. Statistics shows that not only has the number of researchers who hold a university degree increased but there has been significant quantitative improvements too. In comparison, Sweden had 48,000 full-time researchers in 2007, Finland 39,000, Denmark 30,000 and Norway 25,000. (OECD, 2009/1.)

2.1.4 Research efforts and strengths

In 2006, China launched the National Plan for R&D (2006–2020) that sets the direction for public R&D investment in the near future. Through ambitious focus on research and innovation China tries to cut its dependence on foreign knowledge and know-how and increasingly placing Chinese companies in the high end of value chain.

The 15-year plan focuses on a number of areas considered to be of strategic importance for China's economic and social development. It relates to energy sector, water and environmental protection. Moreover, emphasis is on innovation within information technology, innovation of new materials and advanced manufacturing technology to upgrade China's industrial level. Biotechnology and health science is also considered crucial in attempt to reduce the threat from serious diseases and improve the general public health. In total there are 11 research areas, 16 programmes, 27 technical spearheads, 16 basic programmes and four research plans which set the agenda of the Chinese research.

Publications

By analysing Chinese publications and citations it is possible to obtain an idea of the extent to which the 15-year plan's efforts are reflected in China's existing research strengths. Since 1995 there has been a massive growth in the production of Chinese scientific articles. China now produces more than 6% of the world's scientific articles and is a key global player in terms of development of new knowledge.

Table 6. Chinese publications by scientific disciplines, 2001–2008. (Source: Thomson Reuters 2009)

Chinese publications by scientific disciplines				
Scientific area	**2001–2005 Publications**	**2004–2008 Publications**	**2001–2005 Citations / publication**	**2004–2008 Citations / publication**
Chemistry	63,333	98,863	2.44	3.49
Physics	41,390	63,277	2.51	3.11
Engineering	25,437	42,524	1.37	1.8
Material Sciences	30,322	47,177	1.54	2.18
Clinical Medicine	17,035	29,039	4.24	4.25
Biology and Biochemistry	9,648	15,953	2.94	4.06
Mathematics	9,334	15,857	0.99	1.24
Geosciences	8,186	13,123	2.25	3.09
Earth sciences*	7,655*		2.5*	
Plant and Animal Science	8,443	14,639	1.98	2.6
Environment/Ecology	4,903	9,012	2.08	2.88
Energy and Environment*	4,835*		2.3*	
Pharmacology & Toxicology	3,256	6,530	2.39	3.41
Pharmacology*	3,633*		2.5*	

* Source: National Science Indicators (updated data unavailable for Asia NORIA-net report).

The largest producer of Chinese scientific articles is *the Chinese Academy of Sciences* (CAS). A number of Chinese universities are also increasingly productive with a high publication rate. In 2005, Tsinghua, Beijing and Zheijiang universities all had a production of more than 2,500 publications in recognized international journals.

Bibliometric analyses give a clear indication that Chinese research strengths are to be found within the natural science and technically oriented disciplines in general. Most of China's publications are in chemistry, physics and engineering science. Looking at the impact of the Chinese knowledge, which to some extent reflects the quality of publications and usability, China is especially strong within space science, clinical medicine and biotechnology.

Within the listed strengths, there are particularly two areas of innovative research, where China is doing very well and attracts many foreign investments. These are nanotechnology and stem cell biology. Both fields are important, according to their medical and technological potential, but these areas have also gained attention due to the economic support, the areas has been given from both investors and key decision makers. China is currently the 9th highest investor in the world in nanotechnology, and the Chinese Academy of Sciences (CAS) is ranked number 4 after UC Berkeley, MIT and IBM in terms of achieved citations within nanoscience.

2.1.5 Innovation

Companies in China have traditionally been characterized by a very limited ability to innovate and absorb knowledge. However, there has been a change in recent years in which high-tech companies have begun to prioritize R&D activities. One example is the telecommunications company Huawei, which has R&D branches in India, USA, Netherlands, Sweden and Russia and more than 10,000 research workers in China. 10% of the company's turnover is allocated to R&D activities and Huawei is included in the UN organization for intellectual rights' (WIPO) list of world's 50 most innovative companies.

Despite several good examples, there are still relatively few Chinese knowledge companies that are visible and competing on the global market. China is e.g.

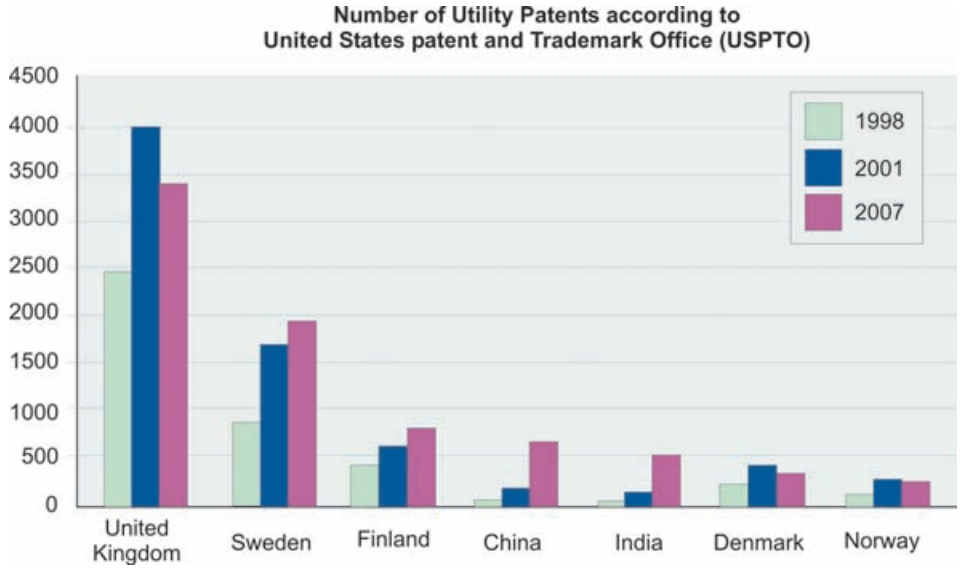

Figure 3. Increase of Chinese Patents in America. (Source: USPTO 2009)

still scoring very low in international comparisons on the number of applications of patents. As a consequence, the 15-year plan for R&D has a strong emphasis on strengthening the ability of enterprises to be innovative and use new knowledge. Notably small and medium enterprises (SMEs) will be considered as market players who can help to change the innovation landscape in China. It is therefore expected that in the coming years, there will be opportunities for foreign businesses to find commercial R&D partners in China.

Science parks

Science parks have been a central element in China's efforts in innovation. The building of science parks began in late 1980, and there are currently 53 national parks spread across China's provinces. The parks operate largely as incubator schemes for high-tech SMEs. The most successful science parks are located at prestigious universities and governmental research institutions. An example the Zhongguancun Science Park in Beijing, which is affiliated the universities of Beijing and Tsinghua, and the Chinese Academy of Science (CAS).

In 2000, around 21,000 businesses were situated in a science park. These companies had recruited scientific staff, equivalent to 560,000 full-time equivalent (FTE), including almost 10,000 PhDs and more than 5,000 returned to the companies after an exchange at a foreign university. The science parks had high-tech exports in 2000 by approx. US$ 100 billion (EUR 99 billion, conversion rate 1999).

Table 7. Foreign firms in China R&D departments, 2006. (Source: Wilsdon and Keeley 2007, OECD 2007)

	Numbers (estimated)
Foreign direct investments	DKK 300 billion (EUR 40 billion, conversion rate 2006)
Multinational R&D centres in China	750 centres

2.1.6 Foreign firms

Since 2000, the establishments of foreign R&D centres have really taken off especially around the three main hubs of economic development Beijing, Shanghai and Hong Kong. Development is driven by companies' desire for a closer relationship between development and production, but in particular also a strategic consideration of that China is developing into a major international player in the R&D area.

2.1.7 Research and innovation cooperation between China and the EU

In 1998, China and EU signed a bilateral agreement on scientific and technological cooperation. The agreement was later confirmed and expanded on an EU-China Summit November 2007. During the bilateral cooperation agreement, China has been given the opportunity to cooperate with one or more European countries within the *European Union's Framework for research and development*.

In relation to EU's 6th Framework Program (2002–2006) China had approx. 400 participants in 229

projects – one of the most active countries. China's ambition is to expand this cooperation under the 7th Framework Program (2007–2013). In 2007, there was Chinese participation in more than 450 applications for CIP with emphasis in the fields of environment, health and ICT. In addition to the collaboration through the FP with EU, China and EU are planning a separate lookup in the fields of health, biotechnology, energy, environment and climate. It is therefore expected that Nordic researchers and companies in the coming years will have good opportunities to develop cooperation with partners in China through participation in EU funded projects.

2.2 INDIA'S S&T SYSTEM

The text for this section is an extract from the CREST OMC Working Group document *Country Report India: An Analysis of EU-Indian Cooperation in S&T* by Jan Peter Wogart[16] (except for figures and conversion rates).

2.2.1 India moves: Results and limitations of recent reforms

Since the independence of the country in the late 1940s, Indian policy makers have followed a two-pronged approach towards development in general and science, technology development and innovation in particular. While attempting to catch up with the fully industrialized countries by getting foreign companies to transfer technology – first to public later to private enterprises – many policies and programs have aimed at developing technologies endogenously by public sector research organizations to support the small and medium sized enterprises in agriculture and industry.

Those policies were part and parcel of a development strategy, which was following a statistic approach towards economic development, in which a series of 5-year plan determined the allocation of resources by the central government and in which public enterprises dominated the industrial development of the country. High barriers to imports and disincentives for exports led to an inward directed development process, which resulted in low growth of output and employment and with it a continuation of wide-scale poverty within the country.

The role of technology-intensive sectors in that extraordinary rapid expansion of the Indian economy is evident from the rising shares of services in the economy in general and the ICT services in particular, as is the predominance of those industries in output and exports which have undergone the most intense technological innovations, of which pharmaceuticals and chemicals and to a lesser extent automobiles and electrical and electronic equipment manufacturers are leading examples. The latter ones have – similar to the ICT industries and services – benefited from a more responsive technological infrastructure and innovative policy schemes.

2.2.2 R&D institutions and their knowledge inputs & outputs

By international standards, India's research strengths include mathematics, theoretical physics, engineering sciences, chemistry, molecular biology and biotechnology, nanotechnology, information technology and space research. [...] Moreover, the public R&D system is fragmented, with too many government agencies, organizations and structures aiming to tackle the var-

[16] Wogart 2008.

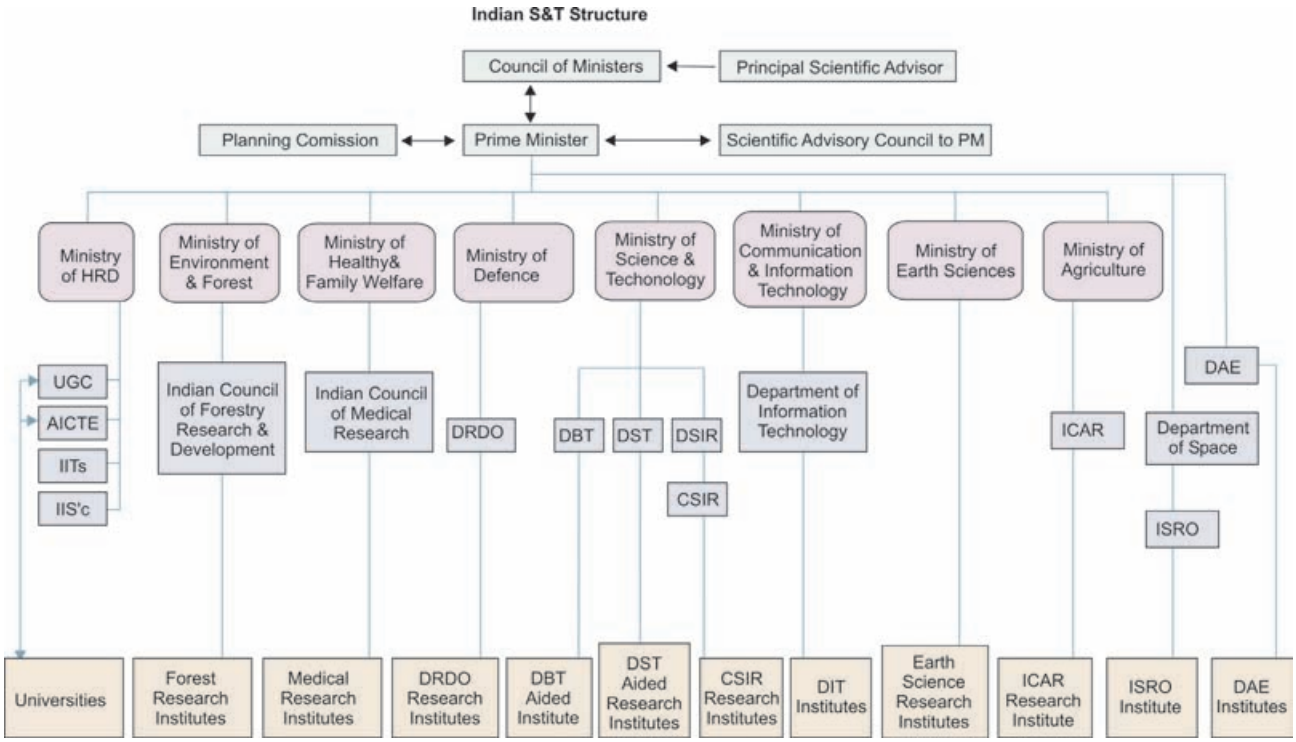

Figure 4. Indian S&T Structure. (Source: New Indico ERA-net 2010)

ious challenges simultaneously with little or no coordination with processes which are "slow, bureaucratic and hierarchical." [...] While the Planning Commission has been actively engaged in budgeting and outlining major guidelines of R&D as well as advising on technology matters, a single plan on innovation or a precise approach on innovation is missing.

The main responsibility for organizing, coordinating and promoting S&T activities as well as international cooperation lies within one Ministry, the Ministry of Science and Technology (MOST) (http://www.mst.nic.in). Almost all of the organisations dealing with innovation in India are under the aegis of this Ministry. MOST is in charge of the Department of Science and Technology (DST), the Department of Scientific and Industrial Research (DSIR), the Department of Atomic Energy (DAE), the Department of Space (DoS), the Department of Biotechnology (DBT), and the Department of Ocean Development (DOD). MOST's objective is to promote new areas of Science & Technology and to play the role of a nodal department for the governance of S&T activities in the country. Under MOST, the newly established National Innovation Foundation is the only governmental institution whose sole purpose is the promotion of innovation in the country.

As pointed out above, the public sector in 2002–2003 has accounted for 67% of the total national R&D expenditure. In fact, major scientific agencies accounted for a share of 84% of the total government R&D expenditure including public sector in-house R&D units. Five major scientific agencies, the Defence Research and Development Organisation (DRDO), the Department of Space (DOS), the Indian Council of Agricultural Research (ICAR), the Department of Atomic Energy (DAE), and the Council of Scientific Industrial Research (CSIR) account for close to 90% of total R&D expenditure under the central government major scientific agencies, with the DRDO alone accounting for a share of just over 30%.

The DST is primarily entrusted with the responsibility of formulation of S&T policies and their implementation, identification and promotion of thrust areas of research in different sectors of S&T; technology information, forecasting and assessment; international collaboration, promotion of science & society programmes and coordination of S&T activities in the country.

The major organisation under DSIR is the Council of Scientific and Industrial Research (CSIR), with its 40 institutes dedicated to research and development in well-defined areas and around 100 field stations.

Among the other programmes of DSIR are: support to R&D by industry, programmes aimed at technological self-reliance, schemes to enhance efficacy of transfer of technology and a National Information System for Science and Technology (NISSAT).

Traditionally, research in science and technology in India has been government-led. Currently, two thirds of gross domestic expenditure on R&D (GERD) is directly funded by the central government, with an additional 9% coming from state governments, and 5% being funded by the higher education sector. Only 20% are financed by the private sector. In 2004, GERD amounted to US$ 5.9 billion. Between 1995 and 2004, the average nominal growth of Indian GERD was more than 13% per year. Thus, according to the size of the country, India ranks on 8th position among national R&D expenditures in the world. However, India's R&D intensity, measured by GERD as a percentage of GDP is below 1%, and it declined slightly after 2000 since strong economic growth outpaced R&D expenditure advances. As consequence, the R&D intensity stayed at a relatively modest level of only 0.8 %.

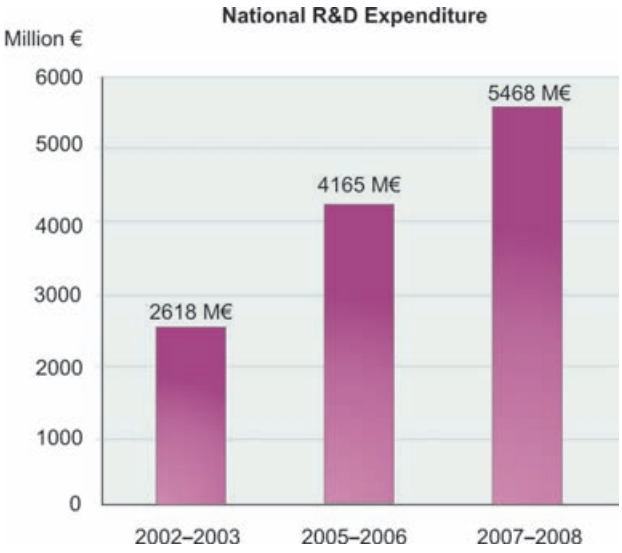

Figure 5. National R&D Expenditure. (Source: DST 2008)

2.2.3 Publications and patents

The common and still very rough indicators for outputs in the S&T field are patent applications granted by the EU and US Patent Offices and scientific and technical journal articles. During 2003/4 Indian scientists and engineer published close to 13 thousand articles, which was half of Chinese output, but was accomplished at greater efficiency, if measured by US$ costs per article published.

With India policy-makers demanding greater emphasis on measurable results from S&T institutions in the last 20 years, scientific publications have risen rapidly. While India has a strong institutional base for S&T research, the majority of the institutions were found to be of medium or low productivity, i.e. still not very actively pursuing publications, or publishing in no impact journals. Chemistry, Physics and Engineering were characterized as highly productive areas of research, while surprisingly Mathematics and Computer Science were less productive. Indian scientists also

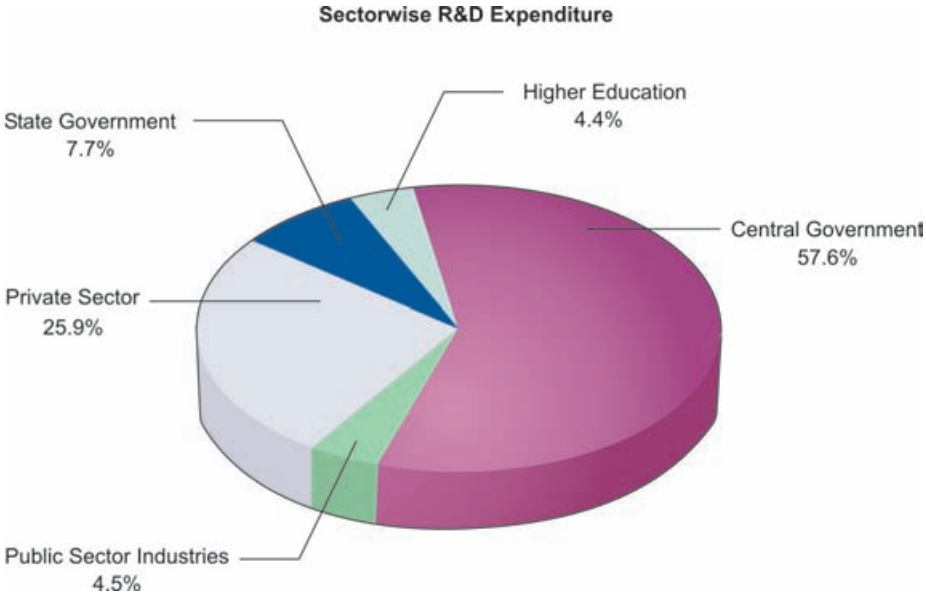

Figure 6. Sectorwise R&D Expenditure. (Source: DST 2008)

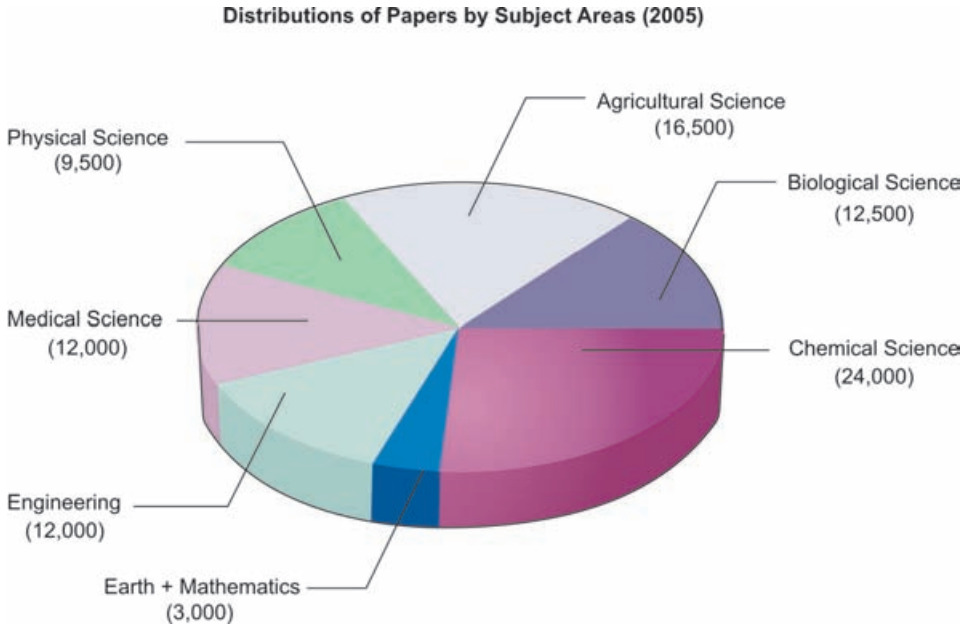

Figure 7. Indian publications. (Source: DST 2008)

proved to be increasingly present at the frontier and emerging sciences, such as biotechnology, drugs and pharmaceutical research, material sciences and medical sciences. Last but not least, India's collaborative research output has grown faster than the overall expansion of scientific publications.

In the case of patents received by the major two patent offices in Europe and the US, India started on a very small level, but increased its applications rapidly leading to a substantial rise in official patents granted, which past the 600 mark by 2006. While China passed the 1,000 mark, similarly to the earlier observation considering costs of achieving those goals, India again was ahead by spending only one third per patent granted.

2.2.4 Innovation industries and their impact on S&T development

India's ICT capabilities and its presence in the world market for ICT software and services are well documented. The IT software and service sector has sustained an annual compound growth rate of over 45% during the last decade, which has been unprecedented in any of the other sectors of the Indian economy. As a result the ICT sector contributed about 22% of total export earnings and provided employment to over one million people in 2004. India exports ICT software and services to about 133 countries, and over 300 Fortune companies outsource ICT services to Indian companies.

A high proportion of Indian software companies are engaged in developing software applications for the banking, manufacturing, communications, retail and distribution, and government sectors. Emerging areas of software applications development include hotels, insurance, and transportation. More important for the development of the science and technology field, the national ICT related system of innovation in India has evolved over time and has been instrumental in the creation of an extensive infrastructure base for the development of other innovative skill-intensive activities. This includes one of the largest and most expanding mass of technically trained manpower, a network of centres of international reputation in natural sciences such as the Indian Institute of Science, the Indian Institute of Technologies (IITs), national laboratories and a number of Software Technology Parks to facilitate the export of ICT software and services.

A second field of rising importance in S&T development is the health sector. Pharmaceutical companies from India produce generic drugs and the enactment of the Indian Patent Act of 1970 allowed Indian companies to take new drugs developed abroad, use the 'reverse engineering' process and develop generic drugs until 2005. This has resulted in an enormous growth in the number of pharmaceutical manufacturing companies, accompanied by an increase in investment in the pharmaceutical sector from US$ 250 million in 1973 to about US$ 1 billion in 2002–03.With

competitive pricing of the generic drugs Indian pharmaceutical companies export those to about 200 countries and have become a major source of supply for critical drugs in the national and global markets.

Today, India pharmaceutical ventures account for more than 20% of the world's generic drug production. Local companies control about 75% of the Indian market, up from 30% in 1972. Up until recently, however, the Indian pharmaceutical companies did not worry about developing new drugs through internal R&D. The lack of scientific knowledge, personnel and copyright law required for successful new drug discovery did not become a priority until India became a signatory to the World Trade Organization (WTO) in 1995 and the obligation to implement a product patent regime in 2005. That meant a paradigm shift from process to product innovation. Larger Indian pharmaceutical companies began investing in new drug discovery by pursuing and realizing research alliances with global firms.

In addition to the private pharmaceutical companies, there are public institutions organized by the Council of Scientific and Industrial Research (CSIR) and the Indian Council of Medical Research, which are also involved in the discovery of new drugs. As a result, both the private run and public companies increasingly contribute to the global patent applications. In the time period between 1995 and 1999, public and private enterprises filed 56 patent applications that increased to 246 patent applications between 2000 and 2004. Despite that increase, Indian companies still spend a relatively small fraction of their revenue on R&D, that is, Indian companies invest 2% on R&D compared with an average of 18% by the TNCs.

There is now a major shift from chemistry-driven drug development to biology-based drug development. The so-called biopharmaceuticals are medicines derived from living cells and include end products such as insulin and human growth hormones. The Indian biopharmaceutical market is growing at about 30% a year and the government support for the medical biotechnology industry has increased by 69% between 2001 and 2005. According to the National Biotechnology Development Strategy, the entry of biotechnology into the pharmaceutical industry will enhance the innovative ability of the generics producing Indian drug industry and contribute to the transformation of the sector.

2.2.5 Long-term plans and policies for S&T development

Unlike China, India's policy-makers have not produced a grandiose long-term plan for S&T. However, India's Planning Commission has been responsible to issue consecutive 5-year plans since Independence, all of which contain an important section on S&T. [...] Two other major visions and policy proposals, which have been elaborated with the support of Department of Science and Technology (DST) regarding science, technology and innovation in India, are Technology Vision 2020 and Science and Technology Policy 2003.

Technology Vision 2020 is the umbrella strategy initially prepared by TIFAC, The Technology Information, Forecasting and Assessment Council of DST under the chairmanship of Dr. Abdul Kalam, India's most famous nuclear scientist and former President. The document lays out the objectives and actions for India to undertake in order to become a fully developed country by the year 2020. [...] Five areas were identified based on India's core competence, natural resource endowments, and talented manpower. They include:

- Agriculture and food processing – with a target of doubling the present production of food and agricultural products by 2020. Agro food processing industry would lead to the prosperity of rural people, food security and speed up the economic growth;
- Infrastructure with reliable and quality electric power including solar farming for all parts of the country, providing urban amenities in rural areas and interlinking of rivers;
- Education and Healthcare: To provide social security and eradication of illiteracy and achieve health for all;
- Information and Communication Technology: Considered a core competence and wealth generator. ICT can be used for tele-education, tele-medicine and e-governance to promote education in remote areas, healthcare and also transparency in the administration;
- Critical technologies and strategic industries witnessed the growth in nuclear technology, space technology and defence technology.

The Science & Technology Policy 2003, developed by the Department of Science and Technology, also provides a road map for integrating science and technology directly with societal concerns. Keeping in view these broad objectives, the document spells out an implementation strategy that will enable identification of specific plans, programmes and projects, with clearly defined tasks, estimates of necessary resources, and time targets. The broad objectives of the Indian Science and Technology Policy include the same areas as the Vision 2020 and add more general objectives ranging from using S&T more effectively to alleviate poverty, ensure nutritional, environmental, water, health energy security, promote the empowerment of women, establish intellectual property rights to making sure "that the message of science reaches every citizen of India and to make it possible for all people to participate fully in the development of science and technology and its application for human welfare. Science and technology will be fully integrated with all spheres of national activity.[17]"

2.2.6 Private sector interactions and FDI

India has had its share of restricting the flow of foreign capital, and although reforms since the mid-1980s have liberalized India's FDI regime, India was still far below the amounts and GDP shares of its major competitors earlier in this decade. However, the latest official data indicate that FDI which mainly went into electrical equipment, telecommunications, real estate and construction, and particularly the IT service sector, have substantially increased between 1999 and 2007 from US$ 2.2 billion (EUR 2.2 billion, conversion rate 1999) to close to US$ 20 billion (EUR 14.6 billion, conversion rate 2007).

In the last few years, over 300 transnational corporations (TNCs) have been setting up R&D and technical centres in India. They employ 80,000 plus scientists and engineers. Current spending is about US$4 billion a year and further investment plans have come close to US$ 5 billion. The United States accounts for more than half the number of companies and 72% of the investments. Others key countries include South Korea, Germany, Denmark, and the United Kingdom. According to the 2005 TIFAC Report on Foreign Direct Investment in R&D, companies from EU member and associate countries had established close to 30 R&D centres in India by 2003, which was less than the 53 US centres, but clearly ahead of the 12 East Asian ones. Almost half of the centres have been installed in Bangalore, followed by Delhi and Mumbai. Most work is concentrated on IT, R&D software, engineer-

[17] DST 2003.

ing design (automotive, consumer durables, aerospace), chemical design (molecules, chemical structures), and agriculture and biotechnology (seeds, food, enzymes). Between 2000 and 2005, some 415 patents from India have been filed by these firms with the U.S. Patent Office.

2.2.7 International S&T strategies: Objectives and instruments

While India's policy-makers have pursued international cooperation in the S & T field for decades, it is interesting to note that until recently there is scant mentioning of those efforts in India's major policy and strategy documents concerning scientific and technological development. Though spending over 30 pages on Indian S&T development of the past and following planning period, 10th 5 Year Plan (2002–2007) has but a terse paragraph on the role of international cooperation in the S&T field. Similar scant treatment to that issue is devoted in the Vision 2020 paper and the Government's S&T Policies 2003 document, although the latter one acknowledges the importance of international cooperation more explicitly, especially in elevating S&T policies into the political sphere of India's international relations policies.

With the 10th 5 Year Plan (2002–2007), the attention to international cooperation in the S&T field has been specified more explicitly. It is now put into the forefront and is mentioned together with several other priorities in the 'renamed' Chapter on 'Innovation and Technology'. A whole section is devoted to 'Leveraging International Collaborative Inputs', which exposes the major rationale behind that endeavour, i.e. "providing first-hand acquaintance with scientific and technological developments and work cultures in other countries and access to sophisticated research facilities abroad."

2.2.8 Furthering and attracting human resources

Today India's rise to a global player is not attributed to its education system, including its university system, but to its special S&T institutions. Seven Indian Institutes of Technology (IIT) and six Indian Institutes of Management (IIM) as well the Indian Institute of Science (IISc) and the newly established Institutes of Information Technology (IIIT) and the All India Institute of Medical Sciences (AIIMS) are the leading centres of scientific, technical and engineering excellence in India. Those elite institutions are known to have rigorous entrance examinations to select 1% from close to 400 thousand applicants, and they offer demanding course work. As a result, over 60% of doctorates in sciences and engineering are granted by just about two dozen of those top institutions of learning.

At the turn of the century, the seven IITs turned out about 3,000 graduates per year. That is woefully inadequate for fulfilling worldwide and Indian demands. Similar to the two-tier character of India's economy, dualism seems also be typical for the education system in general and the higher education institutions in particular. Many of the universities and colleges which supply today India's high tech and modernizing industries lack qualified staff to teach and resources to keep pace with the need of industry to get qualified personnel. As a consequence, engineering industries and software firms are forced to increasingly foster in-house training. In addition to several efforts from industry, the government's Mission REACH program is in the process of creating Centres of Relevance and Excellence in a network of universities. Another initiative of the Ministry of Science and Development to have graduates make the jump from academia to applied research and development is a scheme involving universities helping 'techno-entreneurs' identify appropriate networks and academic institutions with appropriate R&D, which can then provide guidance in developing prototypes, filing IPRs, and even finding appropriate sources of finance for commercialization of the final products or services.

Like other developing countries with elite universities and research institutions, India has to deal with the brain drain problem. Although there are no exact data to calculate the loss to India's economy by students staying and working abroad after graduation, the costs have become more significant since India's firms and institutions require an increasing number

of highly skilled personnel. Surveys undertaken on Indian PhD graduates in science and technology, who have stayed abroad, show that close to 80% of 1990–91 doctoral recipients were still working in the United States in 1995. While an even higher share of Chinese students stayed on, only 11% of Koreans with science and engineering doctorates from US universities in 1990–91 were working in the United States in 1995.

While that problem has led countries such as India to think of policies to reverse the brain drain. Earlier proposal to establish a compensatory fund for OECD countries returning some of the investment in education to the poorer nations went nowhere, mainly because of multilateral jurisdiction issues. On the other hand, India has developed a number of programmes, which were to encourage return migration. The Council for Scientific and Industrial Research (CSIR) was involved in both, a scheme to temporarily and permanently attract Indian scientists and engineers.

2.2.9 Encouraging public-private partnerships in R&D

India's policy makers' inclination to support endogenous technological development was strengthened when it became necessary to move from reverse engineering to serious R&D activities once the country joined the WTO. As a consequence a number of programmes have been implemented, which went beyond traditional fiscal and monetary incentives. Quite a number of public-private partnerships have formed, which have fostered the linkage between research institutions and industry. Among the more promising undertakings are the Technology Development and Demonstration Programme, the New Millennium India Technology Leadership Initiative and the Drug Development Program.

One of the early external programmes was initiated in the late 1980s with the World Bank's Technology Development Project, which – besides providing funds for imports of embodied technology and venture capital – supported a research and development fund (R&D SPREAD Fund) promoting industry-sponsored research at public R&D institutions and the IITs. The Fund was managed by a technology oriented unit of ICICI, at that time still India's mostly public premier Development Bank.

Since 1994 SPREAD has funded 120 projects of which close to 50 were completed by 2008; of these two thirds were successful in being commercialized, a significant number for a programme which attempted to bring India's public and private sector closer together. Three sectors (pharmaceuticals/bio-technology, electrical/electronics and chemicals and petrochemicals) counted for three quarters of all projects. An evaluation has been undertaken and came to very positive results, especially since over 80% of the companies involved in the programme had no previous involvement with the R&D institutions. As a consequence, a follow-up programme was implemented, which disbursed over US$ 15 million (EUR 14.9 million, conversion rate 1999) between 1994 and 2002.

Since 1992, bilateral aid (mostly from the U.S. and Germany) supplied US$70million (EUR 69 million, conversion rate 1999) to support SPREAD and more importantly helped to modernize and update facilities, equipment, and organizational structure of India's major research institutes. Out of those, CSIR laboratories succeeded to receive funds for 11 projects, with central educational institutes receiving eight and other government institutions receiving funds for 16 projects. The SREAD Program was not only made possible by government's decision to gradually liberalize the economy, but also by the expressed wish and financial pressure to have the technological institutes forge links with industry.

The recently inaugurated Indo-German Science and Technology Centre (IGSTC) has taken up the idea to actively further the interaction and collaboration of the S&T institutions and industry. Named '2 + 2 Research and Development Projects', a foursome of a research institute from each country and two enterprises from India and Germany will attempt to forge closer links between applied R&D and innovation in such areas as biotechnology and health research, production technologies as well as energy and environmental technologies. Since the signing of the Agreement in 2007, six partnerships have been approved and supported. Germany and India have allocated up to EUR 10 million each for the coming five years.

3 Future prospects for Nordic-Asian cooperation

3.1 General discussion

As stated in the project description *"the ultimate goal of the 'Nordic-Asian research funding cooperation NORIA-net (AsiaNORIA-net)' is to establish long-lasting funding instruments and funding mechanisms coordinated and funded by NordForsk and the national research council's together".*

To be able to reach that aspiration it is necessary to define the themes of cooperation. The research council system in the Nordic countries, as well as India and China, have all set their focus on certain research themes. Those themes differ as the geography, demography, economy and political environment are different in each country. In spite of this national difference, transnational research programme cooperation and coordination between the Nordic countries, India and China is both desirable and reachable.

Research programme cooperation and coordination between the Nordic countries, India and China can put emphasis both on broad areas and comprehensively defined themes that are of great interest to all partners involved. Possible thematic advantages of Nordic-Chinese/Indian research programme cooperation and coordination are various; politically, scientifically and socioeconomically. It is also unambiguous whether Nordic cooperation adds a critical mass into potential funding cooperation with India and China, which the Nordic countries could not obtain individually. However, as always when many stakeholders are involved, the themes have to be chosen carefully and in accordance to each partner's emphasis.

3.2 Suggestions

The 'Nordic-Asian research funding cooperation NORIA-net (Asia NORIA-net)' suggests an initiation of a multilateral research programme on selected themes within well-defined research fields.

The fields and themes for cooperation were identified by a proactive approach. The proactive approach envisages research programme cooperation and coordination on specific themes based on current emphasis of national research council systems both in the Nordic countries and in India and China. It also looks as what the Nordic countries have in common regarding cooperation with China and India.

Chinese and Indian wishes for collaborative themes have also to be taken into account. But as neither formal nor informal dialogue has started with Chinese and Indian counter partners their wishes have not been stated within the *Asia NORIA-net*. However, while choosing themes for cooperation, emphases of the Chinese/Indian research council system have been taken into consideration.

The Nordic-Asian research funding cooperation NORIA-net suggests that:

- Themes for collaboration should be partly politically selected as cooperation such as suggested here has to be agreed on the political level.
- Themes for collaboration should be based on the strengths of the partners, even though that will mean that some themes are suitable for some Nordic partners only.

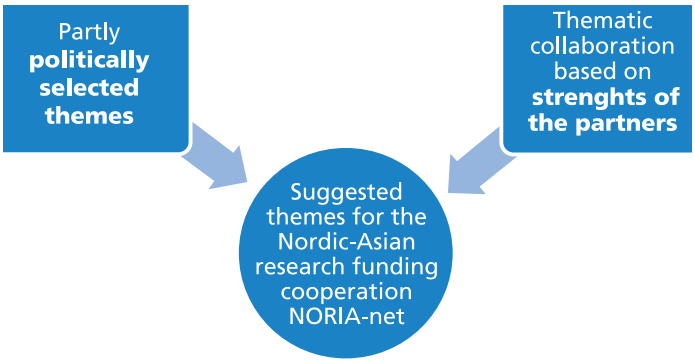

Figure 8. The methodological focal points of topic designation.

Having stated that the themes should be partly politically selected and they should be based on the strengths of the partners and with consideration to the defined themes of each national research council system, the *Nordic-Asian research funding cooperation NORIA-net* suggests the following these themes of co-operation as focal points:

According to the research council systems in the Nordic countries, India and China, the environment, energy, life sciences and biotechnology are research topics of a high priority. That is also evident in current international cooperation in which the Nordic countries participate.

More defined topics may vary based on individual participants' strengths. Based on existing established co-operational projects between individual Nordic countries with India and China topics likely to succeed are: clean and renewable energy, earthquake research, environmental ecology, public health, climate research and technology. It is also clear that some topics are not of interest to all Nordic countries; as an example could be earthquake research that evidently is a high interest theme for Iceland but not so much for the other Nordic countries. On the other hand, there are topics that are of high interest for all countries such as renewable energy.

3.3 Forms, procedures and funding

This section introduces some potential schemes for a joint Nordic effort to increase scientific cooperation with India or China.

3.3.1 Joint call – (The NORFACE ERA-Net model)

One of the partners (e.g. the Academy of Finland) acts as a coordinator of the joint call and attends to administrative and financial issues. Funding can be provided by the partner councils themselves – based on the size

Table 8. Suggested themes of cooperation.

Environmental and Energy
Which might include current co-operational topics such as:

- Clean and renemable energy
- Earthquake research
- Environmental ecology
- Climate research and technology

Life sciences and biotechnology
Which might include current co-operational topics such as:

- Biotechnology
  - *advanced biotechnology*
  - *structural and medical biotechnology*
  - *food biotechnology*
  - *agricultural and environmental biotechnology*
- Biomedicine
- Agricultural and food technology (including fisheries)
- Health and traditional chinese medicine application, eHealth
- Public health (ageing, reproductive health)
- Neuroscience

of the country (GDP and population) plus additional funding from NordForsk or the Nordic Council of Ministers. An ERA-Net model like this may involve a Network Board (NB) consisting of one representative of high standing from each partner council. Additionally one could have a Management Team (MT) with officers who take care of the day-today activities of the call: planning, launching the call, organising peer review, evaluation and monitoring.

This model is laborious and time consuming and quite a large amount of funding would be needed – if the time and resources devoted to the project shall be worth while. Another question is what one should do with China and/or India. If one managed to attract the relevant partner institutions they should also have representatives in the MT and NB, and with the geographical distance this might be difficult to arrange. The NB should decide a theme for a call based on suggestions from the MT. It seems perhaps not so realistic to organise the funding using a common pot procedure like NORFACE has done on two occasions. But a distributive pot – where all partners fund the researchers from their country who are deemed worthy of funding following peer review and evaluation – is a more likely model to consider. The research consortiums in such a call should have as a minimum one Asian partner and one Nordic partner, or even two from the Nordic countries.

3.3.2 Trilateral call using existing schemes

A less time-consuming and not so ambitious scheme could be a trilateral or multilateral call like the one the Academy of Finland has recently proposed for DASTI, and later for the RCN. This scheme would imply that one country/partner council uses their existing mechanisms (bilateral cooperation with a particular partner abroad – for example DBT in India) and simply invites a third council to join in. When regards funding such a call can involve EUR 1–2 million from each of the partners per year in 3–4 years and be launched within a field which is relevant for several or all countries, for example ICT, biotechnology, nanomaterials or even social sciences. Administratively such a scheme does not necessarily demand very much more work than a bilateral call. Of course, at least 1–2 representatives of the different partners who join in will have to devote some time to make preparations internally and to meet the other partners for planning and strategic purposes.

3.3.3 Coordinated calls in the Nordic countries and Asia

A last option is to simply coordinate the time frame for relevant calls in the Nordic countries as well as in China and India, respectively, in order to promote the idea of Asian-Nordic collaboration. Applicants from all these countries should as part of the call be encouraged to consider creating consortiums which include both Asian and Nordic expertise in the field. One could envisage a close coordination with relevant institutions in China and/or India to ensure that a small part of major thematic calls could be earmarked for Asian-Nordic collaborative projects. This way of going forward would place emphasis on networking activities and dialogue in order to achieve closer research cooperation within selected themes.

3.3.4 Networking activities

Seminar series and workshops

An idea that also is inspired by ERA-nets, and NORFACE in particular, is to organise a series of seminars in different countries. One would need a limited amount of funding that might be made available through an open competition arena. The successful applicants (research institutes or networks) would then get the responsibility to arrange workshops and seminars engaging participants from China/India and the Nordic countries. There might be for instance one major topic for each year in a three-year period. The purpose would be threefold:

a) to showcase the most promising research in a particular field – which is of importance in all the countries involved;
b) create an arena for researchers from different countries which would facilitate the exchange of ideas and practices;
c) make policy makers, research administrators and researchers come together to explore the opportunities for research collaboration and joint programming.

Exchanges and mobility

A short-term exchange programme might be interesting to develop through the Asia NORIA-net network. The exchanges might involve both research administrators and researchers. One could envisage that both China and India in addition to the Nordic countries could take part so that a 'triangle' of exchange hosts

can offer visits. In such a scheme a Chinese researcher could choose to travel either to India or to one of the five Nordic countries. Accordingly, a researcher from any of the Nordic countries would get two alternatives: India or China. For research administrators a stay of 1–2 weeks might be realistic. For researchers a duration of 2–4 months might be suitable for a visit so that – if a defined topic and area of research is specified – participation in a concrete research project is made possible. A scheme like described above would of course mean that research councils are willing to host visitors for a short stay – and more importantly that universities or research institutes volunteer to both send and host researchers.

Nordic centres and contact points

A third possible networking activity that is worth considering is to create common Nordic centres in India and/or China. These should exclusively focus on R&D cooperation and act as an information point for Nordic research and technology. The objectives should be to inform the relevant Chinese and Indian stakeholders about Nordic research; its strengths and opportunities for bilateral and multilateral cooperation. Like an embassy or a trade and industry office abroad it would function as a broker in order to find common ground for a strengthened cooperation in the R&D field between top-quality institutions in Asia and the Nordic countries. If a closer cooperation is established with and amongst the different individual Nordic permanent actors (embassies, companies, chambers of commerce) that are already present in China and India – the establishment of a new Nordic centre or information point for R&D might be of mutual benefit. The idea is based on an assumption that Chinese and Indian policy-makers and research groups will find it both easier and more attractive to consider Nordic research in their search for relevant international partners – if they can approach the five countries by the use of only one communication channel.

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The *'Nordic-Asian research funding cooperation NORIA-net (Asia NORIA-net)'* is a Nordic-Asian research funding cooperation project between the Academy of Finland, which also acts as project coordinator, the Research Council of Norway RCN, the Swedish Council for Working Life and Social Research FAS, the Icelandic Centre for Research RANNIS and the Danish Agency of Science, Technology and Innovation DASTI. These partners form the Asia NORIA-net project group. The Asia NORIA-net is funded by NordForsk, which also acts as an observer.

The aim of the Asia NORIA-net is to identify the needs and prepare a model for joint research funding activities to be implemented together with the Nordic countries and their Asian counterparts, focusing on China and India.

The ultimate goal is to establish long-lasting funding instruments and funding mechanisms coordinated and funded by NordForsk and the national research councils together.

This report, *Future Prospects for Nordic-Asian cooperation*, serves as a final report introducing the results of the work done by the Asia NORIA-net project group and is a joint effort by the partners. Its purpose is to identify the partners' existing cooperation with Chinese and Indian counterparts as well as the strengths, weaknesses, opportunities and threats to Nordic-Asian collaboration. It also describes the main characteristics of the S&T systems of China and India. Finally, the Asia NORIA-net project group makes suggestions for future collaboration.

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