Roadmap for bilateral research cooperation

The Research Council of Norway

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Research cooperation with **India**

The Research Council has drawn up roadmaps for cooperation with eight priority countries outside of the EU/EEU: Brazil, Canada, China, India, Japan, Russia, South Africa and the US.

The roadmaps contain background information about the research policy and the research and innovation systems in the priority countries, Norway's cooperation with these countries, and an assessment of areas of and opportunities for cooperation. The roadmaps are intended to provide a basis for setting priorities and encourage more targeted cooperation with the selected countries.

The roadmaps are a follow-up of the white paper on research, Meld. St. 18 (2012–2013) *Long-term perspectives – knowledge provides opportunity*, which identifies these eight priority countries.

The roadmaps for international cooperation were approved by the Executive Board of the Research Council on 28 September 2014. More information about the Research Council's international cooperation is available at www.forskningsradet.no/internasjonalt

1. Key figures and summary of conclusions

KEY FIGURES		
Population in 2012	Inhabitants (mill.)	1 236.7
Gross Domestic Product (GDP) per capita in 2012	USD (thousands)	1.5
Growth in Gross Domestic Product (GDP) in 2012	Per cent	3.2

R&D EXPENDITURES		
R&D expenditures as a percentage of GDP in 2011	Per cent	0.76
Change in R&D expenditures 2002–2011	Per cent	86.4

INTERNATIONAL COOPERATION		
Grant proposals submitted to FP7, total	Number	1 038
Joint grant proposals with Norway submitted to FP7	Number	83
Projects awarded funding, total	Number	18
Joint projects with Norway awarded funding	Number	174
Success rate India in FP7	Per cent	16,8
Success rate of joint grant proposals with Norway in FP7	Per cent	21,7

TRADE AND INDUSTRY		
Import of goods and services as a percentage of GDP	Per cent	30
Norwegian goods exports to India in 2012	NOK mill.	2 076
Norwegian goods imports from India in 2012	NOK mill.	3 355
Norwegian direct capital investments in India in 2011	NOK mill.	630
Ranking in the Global Innovation Index in 2013		66

India has a rapidly growing economy and is investing systematically in knowledge production. The Indian authorities are aiming to increase R&D expenditures from roughly one per cent of GDP to two per cent in 2018. India has been very successful in service innovation, particularly in ICT. Outsourcing of knowledge-based services to India has helped to make the Indian service sector the largest contributor to the country's GDP. The presence of international research institutions has advanced the country's integration into the global research system. Business expenditure on research and experimental development (BERD) in India is roughly 54 per cent and growing.

India's strengthened international position is an important point of departure for research cooperation with the country on global challenges relating to climate, the environment and energy, among others. India is also home to world-leading research groups in several areas, particularly ICT and pharmacology.

Important areas for research cooperation between Norway and India are ICT, health, bioeconomy, marine research and aquaculture, polar research, and energy. Service development is also a potential area for cooperation with Norwegian trade and industry or for innovation-oriented research. India is currently strengthening R&D production in materials science and nanotechnology, so this may also be a potential area for cooperation. Relevant social science topics include democratic development, poverty, the caste system and social structures, industrialisation and rapid economic growth, international governance, international negotiations, and peace and conflict resolution.

The Programme for Research Cooperation with India (India programme) at the Research Council of Norway is a key instrument for following up cooperation with India. In light of the innovation aspects of several of the prioritised research areas, there is a strong argument for defining innovation as a separate focus area. It is therefore important to lay a foundation for more long-term institutional cooperation between Norwegian and Indian R&D institutions.

2. Brief description of India's research policy and research and innovation system

Norway's bilateral research cooperation with India (see section 4) is primarily targeted towards mathematics, natural science and technology disciplines. Therefore this roadmap mainly refers to the parts of the research and innovation system that apply to these disciplines. However, as there are aspirations to expand the scope of cooperation to include other subject areas, the research systems for the social sciences and the humanities should also be mapped in future.

Research and innovation system

The *Ministry of Science and Technology* (MST) is the responsible ministry for science and technology research at the overall level in the Indian Government. The following departments under the MST have responsibility for specific research fields:

- Department of Science and Technology (DST)
- Department of Biotechnology (DBT)
- Department of Scientific and Industrial Research (DSIR)

In addition, several other entities in the central government and state administration, trade and industry, and NGOs also conduct independent research activities. The DST website provides an overview of the science and technology research system. There are 486 government or state-run universities,

as well as 173 private universities. There are no Indian institutions ranked among the world's top 200 universities, but the *Indian Institute of Science* (IIS), the 16 *Indian Institutes of Technology* (IIT) and the 13 *Indian Institutes of Management* (IIM) hold a high standard. Fifteen to 20 of India's universities are considered research universities; the remainder are primarily educational institutions. Most research is therefore conducted at institutes that are not affiliated with universities.

Research-funding institutions

The DST, which is the MST's main funding body for science and technology research, is the Research Council's main partner for cooperation on research funding under the Agreement between the Government of the Republic of India and the Government of the Kingdom of Norway on Cooperation in the Fields of Science and Technology. The other departments under the MST also provide research funding within their spheres of responsibility, and there has been extensive collaboration with the *Department of Biotechnology* (DBT) on funding of vaccine research as part of Gavi, the Global Alliance for Vaccines and Immunisation.

The DST is responsible for designing and implementing research policy, identifying and promoting focus areas for research in various sectors, providing information about technology, forecasts and scientific review, international cooperation, and promoting research programmes and coordinating various activities at the national level. Creating links with innovation and trade and industry has become an increasingly important task for the DST. In 2011, the DST and the *Confederation of Indian Industry* (CII) together established the non-profit organisation *Global Innovation & Technology Alliance* (GITA) with the aim of increasing private sector investment in research.

The DBT is responsible for facilitating biotechnological development and establishing guidelines for the usage of biotechnological products.

In addition to its established cooperation with the above-mentioned partners, the Research Council is engaged in dialogue with the *Indian Council of Medical Research* (ICMR) on research on antibiotic resistance. Through its dialogue with the DST, the Research Council is also in contact with the *Ministry of Earth Sciences* regarding geoscience and glaciology research. Social science and humanities research is the responsibility of the *Ministry of Human Resource Development* (MHRD) and is organised under the *Indian Council of Historical Research* (ICHR), the *Indian Council of Social Science Research* (ICSSR) and the *Indian Council of Philosophical Research* (ICPR). The evaluations of these three institutions contained some criticism, and there are plans to replace them with a single body consolidating all social science and humanities research. Several European countries have issued joint funding announcements with the ICSSR. Norway has had preliminary contact with the ICSSR via the Research Council and the Royal Norwegian Embassy in New Delhi, but knowledge about the


Photo: PhotoDisc

research system, research policy and research priorities for the social sciences and humanities is currently limited.

Research and innovation policy

With economic growth of six to seven per cent in recent years, due in part to major growth in the service sector, India needs more expertise and highly educated personnel to advance development and innovation. The country's young and expanding population is exerting major pressure on the entire education system. The efforts under India's two most recent five-year plans have paid off, and today the country is not far from achieving its goal of universal education, although the quality varies. The Eleventh Five Year Plan for 2008–12 focused particularly on enhancing quality in the education and research system.

In 2013, the MST launched the *Science, Technology and Innovation Policy 2013*. The vision of the policy is "to accelerate the pace of discovery and delivery of science-led solutions for faster, sustainable and inclusive growth". The policy places greater weight on innovation than previous STI policy, in keeping with the priority in the Twelfth Five Year Plan for 2012–17 of promoting discovery-led innovation in the private sector.

India seeks to chart its own course, and points out that its strength lies in what the country has dubbed "frugal innovation" – a means of circumventing the limitations in resources and purchasing power. India has declared 2010–2020 as the "Decade of Innovation". This entails greater participation in research on the part of the private sector, as well as a focus on integrating science, technology and innovation and encouraging research that helps to provide solutions needed by society. One of the policy's aspirations is to "position India among the top five global scientific powers by 2020".

According to the policy, gross expenditure in research and development (GERD) is less than one per cent of GDP; the goal is to increase this figure to two per cent. According to the MST, achieving this goal by 2018 is feasible, provided that the private sector contributes more funding. Most research activity in India is publicly funded: 66 per cent according to OECD figures. This figure is decreasing, while the private sector's share is rising. New schemes will make it easier and more

attractive for industry to carry out research activities. These will include permitting companies to compete for public funding, facilitating access to investment capital and strengthening companies' rights in connection with the commercialisation of research results.

According to the policy, India ranks ninth globally in the number of scientific publications and 12th in the number of patent applications. Scientific publication has tripled in the 2003–2012 period, and India, together with China, has experienced the greatest increase in publication output worldwide during this period. Nevertheless, only 2.5 per cent of Indian publications are published in the top one per cent of scientific journals. The aim is to quadruple this figure by 2020.

In general, Indian publications are cited less frequently than would be expected, given the number of scientific publications produced. Although the citation rate of Indian publications in the energy field is on a par with the world average, the citation rate in other areas is much lower.

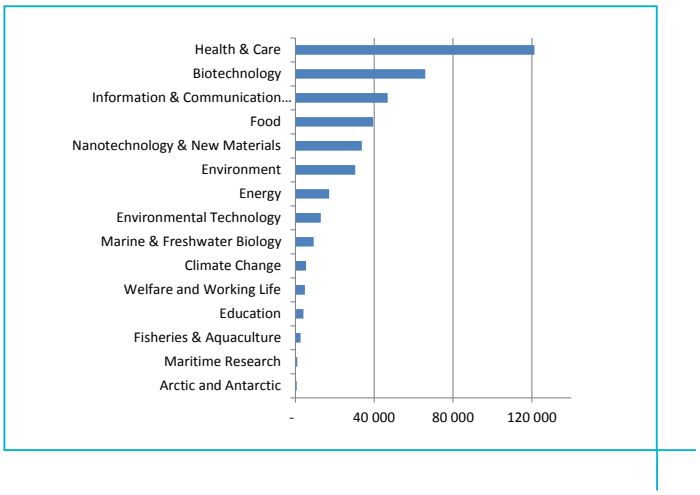
Innovation in the private sector is dominated by international companies. Although Bangalore is often referred to as the "Silicon Valley of India", in all likelihood it will take many years before truly innovative, global, Indian-born companies will emerge. Other important innovation hubs are found in the National Capital Region in the north (Noida/New Delhi/ Gurgaon), in Mumbai/Pune in the west, and in Bangalore/ Hyderabad/Chennai in the south.

Favourable regulations and strong educational institutions are helping to drive the positive development in these regions.

The policy recommends entering into bilateral and multilateral strategic partnerships with other countries to achieve policy aims. At the same time, there is reluctance and scepticism to foreign investment and international cooperation in certain political circles, which will slow down this process. Nevertheless, more than 100 of the world's leading multinational corporations have established development departments in India, including *Intel, Microsoft, General Electric* and *IBM*. A growing number of research institutes and companies around the globe are seeking to draw upon the competencies built up in India, particularly at the 16 renowned Indian Institutes of Technology (IIT) but also at world-leading institutes in other fields. Despite this, India has a low percentage of international co-publication of scientific papers.

Figure 2 shows the number of publications with at least one author from India, by theme, for the period 2008–2012. Nearly one-half (47 per cent) of the papers were published in the *Health & Care* and *Biotechnology* themes, which is likely a result of India's extensive investment in pharmaceutical production. Publications in the themes of *Information & Communication Technologies, Food Sciences, Nanotechnology & New Materials*, and *Environment* accounted for an additional 38 per cent. The other themes together accounted for the remaining 15 per cent.

FIGURE 2. NUMBER OF PUBLICATIONS WITH AT LEAST ONE AUTHOR FROM INDIA, BY THEME. TOTAL FOR 2008–2012.



All in all, India can be said to have set out clear scientific and innovation-related ambitions that are backed by budget allocations. In so far as Figure 2 can be seen as an indicator of India's priority research areas, there is good correspondence with Norway's competencies in the highest priority areas. The focus areas of cooperation between the EU and India in water, energy and health are also in alignment with Norwegian competencies.

3. India's strengths and weaknesses in research and innovation, and the country's international standing

Strengths

- Political focus on research and innovation as set out in the Science, Technology and Innovation Policy 2013.
- A large population with an increasingly high level of education.
- Cheap labour.
- Growing purchasing power in segments of the population, creating an expanding market for consumer goods.
- Extensive expertise in basic research in fields such as chemistry, physics, pharmacology and toxicology. Great strides are being made in space research and ICT research.
- India has enjoyed particular success in research-based innovation in ICT and pharmacology. Research efforts and industry involvement in these fields have led to tremendous growth in ICT service production and a large pharmaceutical production industry. Medicine production in India accounts for 10 per cent of global production, putting the country in third place after the US and Japan.
- India is one of the world's largest producers of wheat, rice, fruit, vegetables and freshwater fish. It is also among the world's largest exporters of rice, spices and cashews. Agricultural research is one of the largest research fields.

Weaknesses

- The quality of the educational institutions varies widely.
- There is no world-class research infrastructure.
- The Indian population has a much shorter average educational career than the populations in other emerging economies, such as the other BRICS countries.
- In practice, the number of individuals with a very high standard of living and high level of education who are actors in the private and research sectors and who are achieving world-leading results in their fields is small. The majority of the population is not taking part in this development and a large segment within this group is for all practical purposes illiterate. Researcher density (percentage of researchers in the population) in India is therefore low.
- India produces highly talented researchers, but the best have tended to emigrate to other countries, where they enjoy success at top universities. This trend, however, appears to have reversed somewhat.
- There are relatively few entrepreneurs in India to transform knowledge into commercial products or services.
- It is difficult to obtain access to capital early in the commercialisation process.
- Higher education is only research-based to a small degree, and therefore does not play a substantial enough role in providing adequate researcher training.

4. Existing cooperation with India

Bilateral cooperation

Cooperation in research between Norway and India is based on a bilateral agreement from 2006, and is primarily concentrated in the mathematics, natural science and technology disciplines. However, there is also a good deal of research cooperation taking place outside this framework and in other subject areas. A Joint Working Group (JWG) on research and technology has been created under the agreement and meets every other year to discuss progress and tools for implementing the agreement. The *Department of Science and Technology* (DST) represents India in the JWG, while the Ministry of Education and Research represents Norway. The Research Council is the coordinating institution for the agreement for Norway, and has established a Programme for Research Cooperation with India (India programme), which consists of the following components:

- The Research Council has taken over the responsibility for administering seven projects (NOK 44 million for the 2011–2015 period) from the Royal Norwegian Embassy in New Delhi.
- A programme funded by the Norwegian Ministry of Foreign Affairs via the embassy in New Delhi (NOK 125 million for the 2012–2016 period). Topics for the funding announcements are determined on the basis of current priorities and in consultation with the embassy.
- A programme funded by the Norwegian Ministry of Foreign Affairs via Norad – the Norwegian Agency for Development Cooperation (NOK 200 million for the 2010–2019 period). Topics for the funding announcements are determined on the basis of current priorities.

Until now, cooperation has focused on climate, the environment, energy, gender equality, health, social science and the humanities. The projects have at least one partner from each country. Funding announcements are issued in collaboration with the Indian authorities to the greatest extent possible, but the India programme can also issue funding announcements unilaterally in Norway.

Cooperation is administered in dialogue with Norad, the embassy in New Delhi and relevant Indian authorities. Funding is administered in collaboration with relevant programmes at the Research Council. An Expert Advisory Group comprising representatives of research institutions and industry organisations has been appointed, with the mandate of providing advice to the Research Council on the administration and planning of activities targeting India.

There are also Norwegian-Indian JWGs in an array of other areas under the auspices of various ministries (the name of the responsible Norwegian ministry is in parentheses). The JWGs on the environment (Ministry of Climate and Environment), higher education (Ministry of Education and Research), maritime activities (Ministry of Trade, Industry and Fisheries) and marine activities (Ministry of Trade, Industry and Fisheries) all have potential links to the JWG on research and technology.

India has a permanent research station in Ny-Ålesund, Svalbard. This reflects the high priority India gives to polar research, and as a result the country has been granted observer status in the Arctic Council. India's National Centre for Antarctic and Ocean Research (NCAOR) is an associated partner in the project Svalbard Integrated Arctic Earth Observing System (SIOS-Preparatory Phase).

Encouraging India to become a partner in the SIOS project has been a priority. SIOS is an international project to upgrade and coordinate research infrastructure in Svalbard and the adjacent maritime areas. The objective is to strengthen the position of Svalbard as an international arena for climate and environmental research.


Photo: Morten Ryen

Further developing cooperation on economic issues with India is a key objective of the Norwegian Government's strategy for cooperation between Norway and India, *Opportunities in diversity*. The Government seeks to expand private sector cooperation, trade and investments and to establish the best possible framework and ensure predictability for the Norwegian business sector. Innovation Norway has an office in New Delhi and works to promote private sector cooperation between Norway and India. Both countries have active chambers of commerce: Norway India Chamber of Commerce and Industry (NICCI) in Norway and the Norwegian Business Association (India) (NBAI) in India. Some 85 Norwegian companies have established a presence in India. Private sector cooperation has developed particularly successfully in the maritime, oil and gas, new and renewable energy, and ICT/telecommunications sectors.

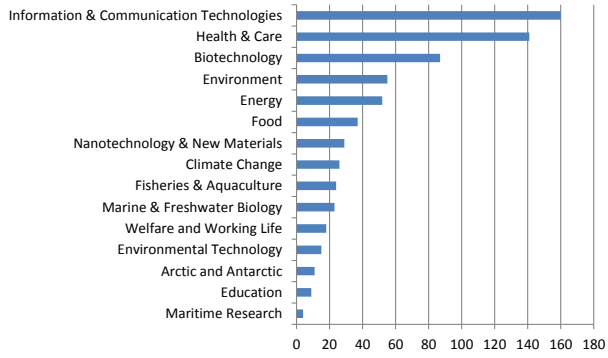
A new position as Science and Technology Counsellor was created for India in 2012. The position is co-financed by Innovation Norway and the Research Council and is integrated into the Royal Norwegian Embassy in New Delhi. The counsellor's remit is to strengthen bilateral cooperation in research, innovation in trade and industry, and higher education.

According to the bibliometric study conducted by Science-Metrix for the Research Council (2014), there were 904 scientific papers co-authored by India and Norway in the 2003–2012 period, primarily involving cooperation with the University of Bergen, University of Oslo and Norwegian University of Science and Technology (NTNU). Although there was an increase in cooperation during the period, Norway does not appear to be a key partner for India. In all likelihood, the increase reflects India's generally strong increase in publication output during the period. However, it is important to note that the citation rate for co-publications with Norway is higher than for Indian publications in general. This is particularly true in the themes of *Health & Care, ICT, Biotechnology*, and *Environment*.

Figure 3 shows the number of co-publications between Norway and India in the 2008–2012 period, by theme. The themes with the most co-publications have the highest citation rate for co-publications as well. The themes with the most co-publications also mainly correspond to the themes in which Indian researchers publish the most. It therefore appears that


Photo: Shutterstock

FIGURE 3. NUMBER OF CO-PUBLICATIONS BETWEEN NORWAY AND INDIA, BY THEME. TOTAL FOR 2008–2012.



Norwegian-Indian collaboration generally holds a high scientific standard and reflects India's priorities.

On the whole, cooperation on education between Norwegian and Indian institutions is limited. The link between education cooperation and research cooperation is also generally weak. Cooperation on higher education is coordinated by a bilateral group administered by the *Indian Ministry of Human Resources Development* (MHRD) and the Norwegian Ministry of Education and Research on behalf of their respective countries. The two ministries signed an agreement in 2014 to strengthen education cooperation.

The number of Norwegian exchange students in India has grown in recent years, from 131 in 2009/10 to 182 in 2011/12, but many of these are on work experience at institutions such as hospitals and are not affiliated with Indian educational institutions. During the 2011/12 academic year, Oslo and Akershus University College of Applied Science and Sør-Trondelag University College sent the most students – 43 and 24, respectively. (*Source: Norwegian State Educational Loan Fund.*) One of the challenges to education cooperation with India is that there is a wide array of institutions of highly variable quality and a rudimentary framework for receiving international students. The Nordic Centre in India (NCI) works to facilitate academic exchange for Nordic students in India. In collaboration with Indian institutions, the NCI organises semester programmes and summer programmes tailored to students from the Nordic member universities. The University of Oslo and University of Bergen are members of the NCI and have made use of their programmes.

The number of Indian exchange students in Norway has also grown, from 83 in 2009 to 176 in 2012. Many have been recruited through cooperation that has its roots in development assistance. This cooperation encompasses both research and education, but as a rule there is little involvement of Norwegian students. Approval of academic credits from institutions abroad is problematic in India; thus the majority of Indian students abroad are graduate students, also in Norway.

Most are registered at BI Norwegian Business School or the Faculty of Engineering Science and Technology at NTNU.

Multilateral cooperation
India has participated in the EU Seventh Framework Programme (FP7), and has submitted 83 joint grant proposals with Norway. Eighteen of these projects were awarded funding, giving a higher success rate for joint proposals with Norway (21.7 per cent) than India's overall success rate in FP7 (16.8 per cent). Nevertheless, the success rate of Norway's joint proposals with India is lower than the success rate of Norway's joint proposals with other third countries.

Within the framework of the India programme, the Research Council has participated in multilateral calls under the EU's *New INDIGO* project, which involve cooperation between institutions in two European countries and an Indian institution. Four projects featuring Norwegian participants have received funding thus far under two calls on human health and clean energy, respectively.

Norway also participates in the working group on India under the EU's *Strategic Forum for International Science and Technology Cooperation* (SFIC). The DST represents India in both these forums.

Both India and Norway participate in other forums such as the *International Institute for Applied Systems Analysis* (IIASA) and the *Belmont Forum* under the *International Group of Funding Agencies for Global Change Research* (IGFA).

5. Grounds for considering cooperation with India

India is one of 10 priority countries for international research cooperation designated by the Norwegian Ministry of Education and Research. India's rapidly growing economy and systematic investment in knowledge production makes it an interesting market for Norwegian knowledge-based industry and an attractive scientific partner in many research fields. Cooperation with India will advance the objectives (in bold) of the Research Council of Norway's Strategy for International Cooperation 2010–2020 in the following manner:

Help to address global challenges to society
Although the India programmes work programme does not explicitly name this objective as grounds for cooperation, it does cite India's increasingly significant role as a global actor as a point of departure for the programme. The Norwegian Government's strategy for cooperation between Norway and India describes India as a country with global ambitions that can have global consequences. Against this background, research cooperation with India is important for promoting Norwegian interests vis-à-via a major global actor. At the same time, cooperation thus far has been targeted towards priority research areas that the Research Council's Strategy for

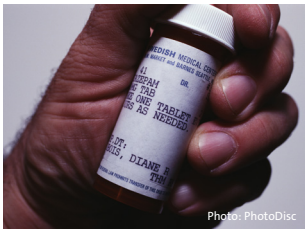


Photo: PhotoDisc

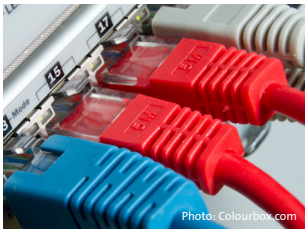


Photo: Colourbox.com

International Cooperation identifies as important for dealing with global challenges, i.e. climate, energy and the environment. Cooperation towards research-based solutions in these areas will help to solve these global challenges. Research cooperation will enhance research capacity in both countries in general. It will be just as important for Norway to help to expand research capacity in India, as it is to strengthen Norwegian researchers' knowledge and understanding of India.

Enhance the quality and capacity of Norwegian research
According to the work programme, the India programme is designed to serve as a catalyst and facilitator for research cooperation between India and Norway, with participation of researchers from both countries and a quality-oriented focus on collaboration.

Secure Norway access to international knowledge production
India has world-leading research groups in several fields, particularly ICT and pharmacology, and these areas should be of interest to Norwegian research groups for cooperation. The India programme will help Norwegian researchers to gain access to their counterparts in India. This in turn will expand Norway's knowledge base on India. Collaborative efforts include joint funding announcements with India issued in cooperation with the DST.

Boost the competitiveness of Norwegian trade and industry
India has large markets for many goods and services due to its vast population and growing purchasing power in certain population segments. One of the aims of the India programme is to ensure the involvement of trade and industry actors to facilitate access to markets and research environments.

Promote Norway as a leading research and innovation nation in selected research areas
As mentioned above, the India programme is targeted towards strengthening the ability of Norwegian trade and industry and research institutions to seek out international partners and to support long-term cooperation between Norwegian and Indian institutions. The Royal Norwegian Embassy and Innovation Norway's office in New Delhi play an important role in these efforts. The *Centres of Excellence scheme* (SFF), the *Centres for Research-based Innovation scheme* (SFI) and the *Centres for Environment-friendly Energy Research Scheme* (FME) are funding instruments where the Research Council has employed concentrated investment to help to build outstanding research environments and develop the potential for innovation

and value creation. In addition, there are the cluster programmes run by Innovation Norway and Siva in cooperation with the Research Council: the Arena Programme, the Norwegian Centres of Expertise Programme (NCE) and the Global Centres of Expertise Programme (GCE). These centres can serve as a "spearhead" to promote Norway as an actor in relevant areas.

6. Current priorities for Norway's activities vis-à-vis India

The white paper on research, *Meld. St. 18 (2012–2013) Long-term perspectives – knowledge provides opportunity,* specifies India as one of Norway's priority countries for cooperation.

The Research Council's India programme builds on the *Norwegian Government's strategy for cooperation between Norway and India* of 2009, in which research is named as a key tool for achieving results in the following thematic priority areas:

- International political issues;
- Climate, environment and clean energy for the promotion of sustainable development;
- Societal development, knowledge and culture;
- Economic issues with focus on private sector cooperation, trade and investments.

The objectives of the India programme as set out in the work programme are:

- To strengthen bilateral research cooperation with India;
- To establish binding cooperation on research funding with the Indian governmental research funding bodies in collaboration with relevant thematic research programmes and scientific activities at the Research Council;
- To continue to foster relations with India through cooperation with EU and Nordic countries as well as multilateral organisations in which India and Norway are partners;
- To implement capacity-building and promote the establishment of new research cooperation between India and Norway;
- To lay the foundation for cooperation with India in all thematic areas and scientific fields, and encompassing basic research, applied research and innovation. Efforts will be made to ensure the involvement of trade and industry, universities and university colleges, and independent research institutes in both countries.

Cooperation between the Research Council and the DST is based on a work programme under the bilateral agreement between the Norwegian Ministry of Education and Research and the DST, and its thematic priorities. After the most recent renegotiation of the work programme at a bilateral meeting in 2012, the list of priorities is as follows:

- Climate research including ocean and Arctic/polar research
- Clean energy
- Geotechnology and geohazards
- Marine research – bioprospecting and polar research
- Nanoscience and technology primarily related to clean energy, solar energy and medical issues
- Vaccines – human and fish/animal, including vaccination programmes and biotechnology of new vaccine development
- Information and communication technology
- Glaciology
- Medical research (cancer, diabetes, infectious diseases, etc.)
- Social aspects of climate change-related issues

As a follow-up to the dialogue with the DST on thematic priorities, Memorandums of Understanding (MoUs) will be signed with other Indian institutions with responsibility for research. MoUs are in the process of being drawn up with the *Ministry of Earth Sciences,* the *Indian Council of Medical Research* and the *Indian Council of Social Science Research*. The need for additional MoUs will be assessed on an ongoing basis.

7. Follow-up and implications

Introduction

According to the above-mentioned bibliometric study, India is one of the countries in which the share of co-publications with other countries is growing faster than the world average. The study recommends that Norway considers strengthening its collaboration with India with regard to co-publication. India has the highest output in the fields of biomedicine and medical research. Although the score in the citation index for these fields is not particularly good, the research underlying the medical industry is of high quality. There is already extensive Norwegian-Indian collaboration in these areas, and the co-publications achieve the highest score in the citation index in the study. In addition, India has a sizeable and growing output in *Information & Communication Technologies*, which is also the theme in which there is the highest output of co-publications between India and Norway. While the quality of Indian publications varies in general, the co-publications with Norway have a very good impact score.

Relevant areas for research cooperation

A variety of assessment criteria could have been used in determining relevant areas for future research cooperation with India. High scientific merit was the most important assessment criterion when selecting the areas below, but existing collaborative relationships and national priorities in both countries were also taken into consideration. Funding announcements in the areas of polar/climate research, geohazards and antimicrobial resistance are under planning.

Energy

Energy is already a thematic priority area under the Norwegian Government's strategy for cooperation between Norway and

India and the bilateral agreement on research cooperation. Innovation Norway also gives priority to energy in its collaborative activities with India. In addition, the Ministry of Petroleum and Energy prioritises cooperation with India in its allocation letter to the Research Council, and the Ministry of Climate and Environment's JWG addresses clean energy, among other topics. The EU gives priority to energy research in its cooperation with India as well.

Indian institutions have the highest international impact scores in the field of energy research, making it the highest-quality research field in India. The country is one of the world's largest producers of publications in the field, and output is growing rapidly. There is not much co-publication between Norway and India; thus there is untapped potential for cooperation between Norwegian and Indian institutions in a field in which India is developing high-powered research groups. Innovation-oriented research can also be conducted in the field, particularly in the areas of hydropower and infrastructure. Solar energy and smart grids are priorities in India, and are suitable for innovation-oriented research as well. Sustainable energy development is also a relevant topic.

ICT

ICT is already a thematic priority area under the bilateral agreement on research cooperation, and Innovation Norway reports that many ICT-related companies are seeking cooperation with India. The bibliometric study shows that existing collaboration in the ICT field is successful and there is potential for expansion. The field is also suitable for innovation-oriented research, particularly given India's success in service development. ICT-based health services are another relevant topic.

Nanotechnology

Nanotechnology is already a thematic priority area under the bilateral agreement on research cooperation. India's output in the field is high and growing rapidly, with a fairly good citation frequency. There is little collaboration with Norway in this field; thus there is potential for increased collaboration in a field in which India is developing high-powered research groups. Relevant research topics include nanotechnology related to clean energy and medical issues, which are specific priorities under the bilateral agreement.

Biotechnology in medical research

Biotechnology in medical research is already given priority under the bilateral agreement on research cooperation. As mentioned above, the bibliometric study shows that there is good potential for increased collaboration based on existing, highly successful collaboration. Relevant research topics include pharmacology, toxicology and development of both human and animal medicines, particularly vaccines. This field is also relevant for innovation-oriented research in connection with the pharmaceutical industry.

Social science and humanities perspectives of the scientific, technological and innovation-oriented research areas

While these perspectives are not mentioned directly in any of the underlying documents for the India programme, they should be given priority in keeping with the programme objective of facilitating cooperation in all thematic areas. Opportunities for expanding the perspectives to encompass other research areas should be considered.

Further efforts in connection with research priorities in the Government's strategy for cooperation with India: international political issues, societal development and economic issues

These thematic priority areas are not encompassed by the bilateral agreement on research cooperation or the bibliometric study. Further consideration must be given to how these priority areas can be optimally addressed. Relevant research questions may be related to international governance, international negotiations, peace and conflict resolution, the environment and climate.

The India programme should be open to incorporating other research topics than those mentioned above in response to new priorities put forward by the DST and the embassy in New Delhi. The Indian authorities are very eager to issue joint funding announcements with Norway, and effort should be made to realise this. However, there should still be room to issue unilateral funding announcements in certain cases.

Innovation, industrial development and commercialisation of R&D

Innovation-oriented research

Private sector cooperation is an objective of the Norwegian Government's strategy for cooperation between Norway and India, but it is not addressed in the bilateral agreement on research cooperation. Given the clear innovation aspects of all the above-mentioned thematic priority areas, all of which are incorporated into the bilateral agreement on research cooperation, there are good arguments for prioritising innovation as a designated area on its own. This argument is bolstered by the strong focus on innovation in the Indian Government's new STI policy. In India, Innovation Norway's activities target the areas below, and these, together with the above-mentioned research areas, should form the basis for innovation-oriented efforts:

- Maritime sector
- Oil and gas
- Marine sector
- Energy (renewable) and the environment

In addition, food production/bioeconomy should be a priority area for innovation-oriented research. Although this is not an area in which India stands out in terms of scientific merit, the country has a high publication output and scores well in the citation index for Norwegian-Indian co-publications. GITA is also very interested in entering into collaboration with Norway on food. The Ministry of Trade, Industry and Fisheries and the

Ministry of Agriculture and Food both name India as a priority partner country for aquaculture and agriculture, respectively. It may also be possible to incorporate aquaculture research efforts into the JWG on marine activities, for which the Ministry of Trade, Industry and Fisheries is responsible.

ICT
Innovation-oriented research in ICT may be a relevant area for cooperation, particularly given India's success in service development. ICT-based health services are another relevant topic. According to Innovation Norway, many ICT-related companies are seeking cooperation with India.

Instruments

National research funding
Research funding is the main instrument employed under the Research Council's India programme, at least for the duration of the current programme period (2010–2019). The programme has a relatively sizeable budget for financing research cooperation. Unlike other programmes at the Research Council, the India programmes funds are primarily administered by other research programmes with which the India programme must collaborate on joint funding announcements. Programmes collaborating with the India programme are required to provide co-funding.

The priorities described below apply to the use of funding under the India programme, and it will always be possible to apply for funding for Norwegian-Indian collaborative projects under other Research Council programmes. In these cases, the priorities of the programme in question will apply for grant applications.

The activities under the India programme are steered in part by the priorities set out in the work programme for the bilateral agreement between India and Norway. For the most part, these priorities lie within the scope of the DST's sphere of responsibility – mathematics, natural science and technology – and cooperation thus far has mainly been in these fields, although a larger-scale funding announcement for social science and humanities research was issued in 2012. Activities are also determined in part by the priorities of the embassy in New Delhi. These are the priorities that are being followed up by the India programme in the short term.

Mobility
The India programme facilitates a certain degree of mobility, as will the **International Partnerships for Excellent Education and Research (INTPART)** scheme.

EU cooperation
Despite the fact that there has been little cooperation with India under the EU framework programme thus far, priority should be given to encouraging cooperation in this arena. This may help to establish networks, which in turn can be drawn upon for cooperation within and outside the framework programme.

The ERA-NET for cooperation with India, *INNO INDIGO*, is an excellent tool in this context and should be used actively.

Other multilateral fora
The working group on India under the Strategic Forum for International Science and Technology Cooperation (SFIC) should be actively used to promote Norwegian priorities with regard to the EU's India-related activities at all levels.

Multilateral fora such as the IIASA and Belmont should also be actively used to promote Norwegian-Indian research cooperation in relevant areas.

International Partnerships for Excellent Education and Research (INTPART)
A new scheme, INTPART, funds partnerships between Norwegian higher education and research institutions and world-class partners in prioritised counties. Special attention is attached to integrating higher education and research, as well as cooperation with the business and public sectors. The programme is administered jointly by the Research Council and SIU.

The India programme faces a challenge in that it has many thematic priorities and has as its objective to create a framework for cooperation in all thematic areas. This means that, in practice, only one funding announcement will be issued within most of the thematic areas. There is a need to achieve more long-term cooperation than this affords, and the INTPART scheme can be of use here by providing a platform for developing cooperation, which can then form the basis for applying for funding under the Research Council's general calls for proposals.

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