Roadmap for bilateral research cooperation

The Research Council of Norway

Rectors of Norwegian universities signed new research agreements with the University of Tokyo in 2013 in connection with the 10th anniversary of their bilateral cooperation agreement.

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Research cooperation with **Japan**

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 data and summary of conclusions

KEY FIGURES		
Population in 2012	Inhabitants (mill.)	127.6
Gross Domestic Product (GDP) per capita in 2012	USD (thousand)	50.0
Growth in Gross Domestic Product (GDP) in 2012	Per cent	1.9

R&D EXPENDITURES		
R&D expenditures as a percentage of GDP in 2009	Per cent	3.39
Change in R&D expenditures 2002–2011	Per cent	35.5

INTERNATIONAL COOPERATION		
Grant proposals submitted to FP7, total	Number	442
Joint grant proposals with Norway submitted to FP7	Number	48
Joint projects with Norway awarded funding	Number	20
Success rate Japan in FP7	Per cent	4138
Success rate of joint grant proposals with Norway in FP7	Per cent	41,7

TRADE AND INDUSTRY		
Import of goods and services as a percentage of GDP	Per cent	16
Norwegian goods exports to Japan in 2012	NOK mill.	8 790
Norwegian goods imports from Japan in 2012	NOK mill.	11 906
Norwegian direct capital investments in Japan in 2011	NOK mill.	311
Ranking in the Global Innovation Index	2014	22

Japan is a leading research nation and technology supplier. It is the third largest research nation in terms of share of global scientific production and is near the top in trade and industry R&D expenditures. Trade and industry account for 75 per cent of all Japanese R&D expenditures. Transport, ICT and pharmaceuticals are Japanese sectors that incorporate very high levels of R&D activity.

Japan's research policy is now becoming oriented towards solving economic and social challenges. The country's research and education system is characterised by a low degree of internationalisation, which is a major challenge for Japan. The government is focusing a great deal of attention on measures to increase internationalisation.

Increasing focus is being directed towards renewable energy and other environment-friendly energy technology in the wake of the Fukushima accident. The application of nanotechnology in areas such as energy, environmental and climate impacts, health and medical technology, and the utilisation of natural resources within a framework of responsible technology development are priorities that both countries share. Ecosystem management of marine resources is important for value creation in both countries. Norway's technology deliveries and marine industries make the country an attractive partner. A common proximity to the sea facilitates joint interests in climate research. The two countries share a long history of cooperation on polar and space research in both the Arctic and the Antarctic. Japan has the world's fastest-ageing population, and the "Life Innovation" initiative for medical care, nursing care and health may provide opportunities for more cooperation, including for Norwegian and Japanese companies in the areas of medical and welfare technology.

Norwegian-Japanese cooperation has been expanding in recent years. The first Japan-Norway Science Week was held in 2013 in Tokyo. A central challenge ahead will be to secure more funding for research projects. An important objective is thus to enhance cooperation with research funding institutions in Japan. It will also be vital to strengthen long-term institutional cooperation between the two countries and to view research and educational cooperation in a broader overall context. The establishment of a shared office for activities between the Research Council, Innovation Norway and the Norwegian Centre for International Cooperation in Education (SIU) at the Norwegian Embassy is a key measure for achieving this.

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

Japan boasts the world's third-largest economy and among the worlds largest producers of scientific papers and research. Japan's Gross Domestic Expenditure on Research and Development (GERD) in 2013 was 3.7 per cent, and the Japanese authorities have a long-term goal to bring this up to four per cent.

In 2010 the Japanese government launched its New Growth Strategy, which entails targeting science and technology priorities towards major societal challenges. The main priorities of research and innovation policy were health and welfare, green innovation, and rebuilding and reconstruction after the earthquake, tsunami and nuclear accident that hit Japan in 2011. These priorities have been continued in a new strategy launched in June 2013 by the Council for Science, Technology and Innovation (CSTI), which replaced the Council for Science and Technology Policy (CSTP).

Japan's population is highly educated; 46 per cent of those aged 25–64 have higher education, which is well above the OECD average. The proportion of young people (aged 25–34) with higher education is on the rise and is currently 59 per cent, second only to South Korea among OECD countries. In 2013 the Japanese authorities implemented an educational reform with the aim of making Japan one of the world's most innovation-friendly countries. The government considers it essential to enhance internationalisation in the research and educational system to enable Japan to adapt to current global thinking and economy, both to promote growth and to help to solve common global challenges.

The research and innovation system

According to *The Science Citation Index,* Japan's share of global scientific production has decreased in recent years, from 10 per cent of scientific articles produced globally in 2002 to 7.6 per cent in 2007, largely a result of China's rapid growth in scientific production.

Japan remains a leading nation when it comes to innovation and R&D in industry. The Japanese research and innovation system is thus largely funded by the private sector, as fully 75 per cent of the country's total R&D expenditures comes from business. As to distribution of R&D activity type in the private sector, 6.9 per cent of funding goes towards basic research, 18.3 per cent towards applied research, and 73.8 per cent towards development. Transport, ICT and pharmaceuticals are the sectors with the highest R&D activity in Japan. Compared to Europe and the USA, research activity in the service-related sectors is low, representing 11 per cent of Business Expenditure on Research and Experimental Development (BERD).

Public funding for R&D has remained relatively stable since 2000 with the exception of two larger-scale supplementary allocations: in 2009, in response to the financial crisis, and in 2013, with the accession of the new Shinzo Abe government.

Public funding for research for 2013 was EUR 38.5 billion, according to ERAWATCH, the EU Platform on Research and Innovation policies and systems. The education sector received 41 per cent of this total, while the remainder was allocated via research institutes. Traditionally, public funding for R&D has been allocated as transfers to the institutions, but in recent years these transfers have been reduced by one per cent annually as part of a strategy to increase the proportion of competitive funding. Funding through calls for proposals has gained importance the past decade.

Japan has five universities on the top-200 list in the *Times Higher Education* World University Ranking 2013/14. The University of Tokyo, at 23rd, was the highest-ranking university in Asia. Japanese authorities have ambitious targets for education policy. One goal is for more than ten Japanese universities to figure on the world's top-100 list within ten years. (See SIU report 06/2014 *Cooperation with Japan in higher education* (in Norwegian only) for a more detailed description of Japan's education policy.)


Photo: Tony van Eyken

The Council for Science, Technology and Innovation (CSTI) was established by the Office of the Prime Minister in 2001 for planning and coordination of Japanese science and technology policy at the overall level. The CSTI is headed by the Prime Minister and is comprised of relevant ministers and experts from academia, the research councils, and the business sector. The CSTI generally meets once a month.

The Science and Technology Basic Plan, which has a duration of four years, is the authorities' principal steering document for research policy. The plan sets out overall priorities and a long-term perspective for research policy. The 4th Science and Technology Basic Plan was approved in 2011 and runs through 2015. The CSTI is responsible for developing and following up the Science and Technology Basic Plan. The 5th S&T Basic Plan will run from 2016-2020.

The Japanese *Ministry of Education, Culture, Sports, Science and Technology* (MEXT) and *Ministry of Economy, Trade and Industry* (METI) are the main research-funding ministries, accounting for 64.8 and 14.3 per cent, respectively, of public allocations for research. Japan's other main research-funding ministries are the *Ministry of Agriculture, Forestry and Fisheries* (MAFF), the *Ministry of Health, Labour and Welfare* (with funding primarily for the fields of medicine and pharmaceuticals), and the *Ministry of Internal Affairs and Communications* (MIC).

The Japanese government established Japan Agency for Medical Research and Development (AMED) in April 2015.

Research funding institutions

Japan has three main research funding institutions. *The New Energy and Industrial Technology Development Organization* (NEDO) is an independent administrative institution affiliated with the Ministry of Economy, Trade and Industry (METI). *The Japan Science and Technology Agency* (JST) and the *Japan Society for the Promotion of Science* (JSPS) are both under the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

The New Energy and Industrial Technology Development Organization (NEDO)
NEDO was established in 1980 as an independent, publicly financed organisation to promote the development and implementation of new energy and environmental technologies to address Japan's energy vulnerability in the wake of the 1970s oil crisis. Today the organisation encompasses the development of new energy solutions, raising energy efficiency, and implementing new technologies. In addition to R&D on industrial technology, NEDO also encompasses the commercialisation of new technology. NEDO projects incorporate a strong component of collaboration between industry, academia and the authorities.

Japan Society for the Promotion of Science (JSPS)
The role of the JSPS is to coordinate and develop a range of exchange programmes for scientific institutions, both nationally and internationally. The JSPS awards individual researcher grants to young scientists, and provides funding for international research cooperation and cooperation between academic institutions and industry. One function of the JSPS is to collect and disseminate information about different scientific research activities.

The Japan Science and Technology Agency (JST)
The JST seeks to strengthen Japan as a creative and innovative research and technology nation and plays an important role in implementing national policy for research and technology in keeping with the objectives of the Science and Technology Basic Plan. The JST provides funding for basic research, R&D and commercialisation, placing particular emphasis on basic research with major potential for value creation. The JST also has responsibility for upgrading research infrastructure and helping with dissemination activities related to research and technology development.

Independent Administrative Institutions (IAIs):
During a large-scale reform process in 1998, *Independent Administrative Institutions* were established, providing a more autonomous institute structure for the larger national research institutes. The IAIs implement and carry out research policies and plans drawn up by the various ministries. The IAIs receive funding from different ministries but remain largely autonomous in carrying out their tasks. Examples of key research institutes with IAI status are:

- (*RIKEN* (research institute for natural sciences), affiliated with MEXT
- *National Institute of Advanced Industrial Science and Technology* (AIST), affiliated with METI
- *Research Institute of Economy, Trade and Industry* (RIETI), affiliated with METI
- *National Institute for Materials Science* (NIMS), affiliated with MEXT.

Research policy
In 2011, EUR 141 billion was allocated to R&D, according to statistics of the Ministry of Internal Affairs and Communications. This corresponds to roughly 3.7 per cent of GDP. In addition, research policy has been substantially revised, shifting from a discipline-oriented to a thematic-area approach oriented towards addressing societal and economical issues. Promoting green innovation, innovation in the health and welfare sectors, reconstruction after the earthquake and tsunami of 2011 are the strategic priorities of the 4th *Science and Technology Basic Plan for 2011–2015*. ICT and nanotechnology and materials is highly prioritised as common science and technology bases.


Photo: Horizon Magasin

In 2013 the government put forth new strategies to revitalise the economy: the *Japan Revitalisation Strategy* and a new *Comprehensive Strategy on Science, Technology and Innovation*. This new policy retains the main priorities of the 4th Science and Technology Basic Plan, with the ambition of making Japan the world's most innovative nation.

The central research policy objectives for Japan in coming years are to:

- increase R&D expenditures to four per cent of GDP by 2020;
- promote R&D in health and welfare, energy and the environment;
- enhance the national research infrastructure;
- help to revitalise regional economies through e.g. a focus on resource-based industries;
- expand research activities on natural and environmental disasters, as a response to the 2011 earthquake and tsunami;
- strengthen basic research and human capital, emphasising recruitment of more female and young scientists;
- reinforce the link between research and society through increased activity in areas such as communication and dissemination, and by involving users more in policy development.

3. Japan's strengths and weaknesses within research and innovation and the country's international standing

Strengths

Japan is internationally strong in the fields of chemistry, materials science, physics and space research. In the bibliometric analysis commissioned by the Research Council of Norway and carried out by Science-Metrix, nanotechnology and new materials is highlighted as a research area in which Japan excels, with a high degree of specialisation but with somewhat lower citation rate than other countries that publish at a comparable level. Within the sphere of energy research, Japan's citation rate is roughly at the global average. The bibliometric analysis points to biotechnology as a potentially attractive area for cooperation with Japan, based on the country's significant proportion of global publications in this field.

A strong point of the Japanese research system is in the application of R&D and commercialisation of scientific findings.

Weaknesses

Japan is the world's fifth largest research nation in terms of number of publications, but faces special challenges when it comes to citation rates and scientific output. Japan is below the OECD average in citation rate in a number of disciplines.

Japan's share of "mobile" researchers is also low, making Japan the least internationalised OECD country. Fewer than 30 per cent of large companies and fewer than 10 per cent of small and medium-sized enterprises in Japan cooperate internationally. This low degree of internationalisation within the Japanese research system poses an obstacle, and affects mobility, co-publications, institutional cooperation and international cooperation in the business sector.

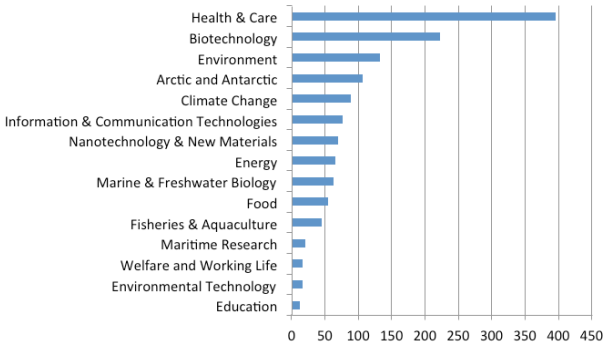
An education reform launched in 2013 with the aim of raising the quality of education prescribes internationalisation as a highly important measure for enabling Japan to adapt to current global realities and for addressing the country's economic challenges. (See section 4 on internationalisation of the education sector in SIU report 06/2014 *Cooperation with Japan in higher education* (in Norwegian only).

4. Existing cooperation with Japan

Bilateral cooperation

The bibliometric analysis indicates a slight increase in the number of publications involving collaboration between Norwegian and Japanese researchers. Health is the topic with the most Norwegian-Japanese co-publications, followed by polar research, the environment, climate and ICT. Norwegian and Japanese researchers also collaborate in the fields of advanced materials and nanotechnology and energy.

NUMBER OF CO-AUTHORED ARTICLES BETWEEN NORWAY AND JAPAN, BY TOPIC, TOTAL FOR 2008–2012



Source: Science-Metrix 2014

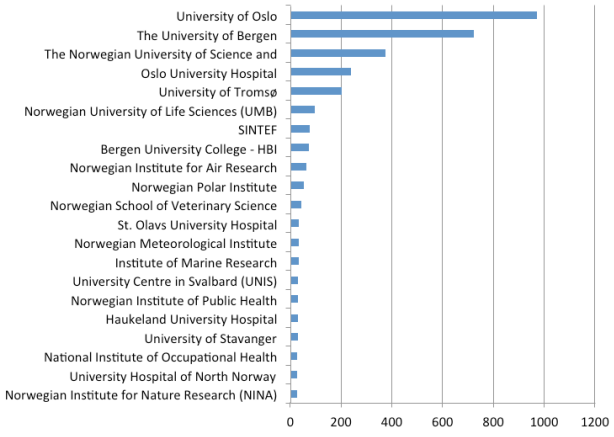
The Research Council provides funding for a total of 36 technology projects with a component of Japanese cooperation in ICT, biotechnology and environmental technology. Historically, Norway's *Institute for Energy Technology* (IFE), which hosts the Halden Reactor Project, has been a spearhead for cooperation between Norwegian and Japanese nuclear research institutions.

Since 2003 the bilateral research and technology agreement signed by Norway and Japan has provided a framework for cooperation within the high-priority areas of energy and the environment, food safety, advanced materials and nanotechnology, polar research and space research, including activities related to research infrastructure in the Arctic. In light of the agreement, the post of Counsellor for Science and Technology at Innovation Norway in Tokyo was established. This position is co-financed by Innovation Norway and the Research Council of Norway, and has played a valuable role in following up the agreement. From 2015, the Norwegian Centre for International Cooperation in Education is represented in Tokyo and the Counsellor will cover higher education, in addition to Science and Technology.

Polar research

There is a long history of polar research cooperation in both the Arctic and the Antarctic. Japan's *National Institute of Polar Research* (NIPR) has established a research station in Ny-Ålesund and has an office in the Svalbard Research Park in Longyearbyen. The NIPR represents the Ny-Ålesund Science Managers Committee (NySMAC) and the Ny-Ålesund research stations in the Svalbard Science Forum. Japan also has a research station in Dronning Maud Land, as does the Norwegian Polar Institute. The Norwegian Polar Institute and the NIPR signed a new Memorandum of Understanding (MOU) during the Norwegian Prime Minister's official visit to Japan in 2012 to renew the two institutes' longstanding cooperation. Among other things the MOU encompasses cooperation on glaciology, pollution in the Arctic and atmospheric research.

NUMBER OF NORWEGIAN-JAPANESE CO-AUTHORED ARTICLES, BY NORWEGIAN INSTITUTION, TOTAL FOR 2008–2012



Source: Science-Metrix 2014

Japan also participates in the *Svalbard Integrated Earth Observing System* (SIOS), an international research infrastructure project with 28 partners from Europe and Asia. The SIOS project coordinates and further develops existing and new research infrastructure in Svalbard.

Space research

Cooperation on space research is carried out in a number of fields:

- Japan has been a member of *The European Incoherent Scatter* (EISCAT) *Scientific Association's* radar systems located in Tromsø, Kiruna, Sodankylä and Svalbard since 1996. Japan provided funding for the establishment of the *EISCAT Svalbard Radar* with two antennae in Longyearbyen. The EISCAT_3D project will establish a new EISCAT radar system in northern Scandinavia. Sounding rockets for atmospheric studies to be launched from Andøya and Svalbard are encompassed under a 2007 agreement between the *Japan Aerospace Exploration Agency* (JAXA) and the Norwegian Space Centre. In 2010 the agreement was expanded into a general agreement on space research cooperation. In 2011 the Research Council of Norway's Programme for Space Research reported Japanese-Norwegian cooperation on four projects related to rocket research and solar physics.
- *Hinode* is a JAXA solar physics satellite, a cooperative effort with the *European Space Agency* (ESA). Researchers at the University of Oslo's Institute of Theoretical Astrophysics (ITA) have participated in the development of *Hinode* instruments and are very active in analysing the data.

Energy and the environment

Several Norwegian institutions (the Norwegian University of Science and Technology (NTNU), SINTEF, IFE, the University of Oslo (UiO)) have cooperated with Japan's *National Institute of Advanced Industrial Science and Technology* (AIST) on materials research and environment-friendly energy solutions. This cooperation consists of project collaboration and the mutual exchange of researchers. Main topics include energy systems, renewable energy, hydrogen technology and power electronics.

- Kyoto International Forum for Environment and Energy (KIFEE)

KIFEE was established in 2004 by several universities in the Kyoto area and NTNU as an international arena for multidisciplinary, strategic cooperation on developing a sustainable society, inspired by the Kyoto Protocol. KIFEE has a number of partner institutions: Doshisha University, Kyoto University, Osaka University, Shiga University, the AIST and Tohoku University. Participants from Norway are NTNU, SINTEF, UiO, the University of Bergen (UiB) and IFE. Key multidisciplinary areas of cooperation are process engineering, electrochemistry and advanced inorganic materials, advanced biological materials, and educational cooperation within energy and the environment. The Research Council has provided funding for this cooperation. KIFEE has become a collaborative platform to facilitate coordinated efforts to enhance cooperation between Norwegian and Japanese actors in academia as well as the business sector.

Safe seafood

The earthquake disaster in Japan in March 2011 led to a greater focus on safe seafood as a thematic area. In the marine bio-based industries, there are several projects with Norwegian-Japanese cooperation, including topics such as traceability, food safety and fish health. SINTEF Fisheries and Aquaculture, the Norwegian National Institute of Nutrition and Seafood Research (NIFES), Nofima and the UiB have or have had cooperation with Japanese institutions in this field.

Nanotechnology and new materials

Cooperation on nanotechnology is reflected in national programmes and in the EU framework programme, under which collaborative Norwegian-Japanese research projects have received funding. Much of the cooperation on materials research is associated with technology development in the energy sphere. Japan is a priority partner country under the NANO2021 programme.

Mobility agreement with the JSPS

The Research Council of Norway cooperates with the *Japan Society for the Promotion of Science* (JSPS) on a bilateral mobility programme to exchange visiting researchers and post-doctoral research fellows. Each year the Research Council sponsors two Norwegian post-doctoral fellows in Japan in the form of Personal Post-doctoral Research Fellowships, as well as two Norwegian researchers who receive Personal Visiting Researcher Grants. The JSPS, in turn, sponsors two Japanese post-doctoral fellowships in Norway along with researcher grants to two Japanese researchers.

Cooperation in higher education

So far there has been little cooperation in higher education between Norway and Japan beyond the cooperation practised by language and cultural study groups at UiB, UiO, NTNU and the Norwegian School of Economics (NHH). The Norwegian

Government has set up two programs in order to strengthen the long term, institutional cooperation between Norway and countries outside Europe. The UTFORSK- program has as a specific goal to strengthen the linkage between higher education and research international collaboration.

Multilateral cooperation

Japan actively participates and contributes to a number of multilateral organisations such as the *International Institute for Applied Systems Analysis* (IIASA), the *Global Research Council*, the *Global Change Programmes*, the *IPCC* and the *Belmont Forum*. Japan renewed its bilateral *Science and Technology* (S&T) *Cooperation Agreement* with the EU in 2011. The MEXT, JST and JSPS are all partners in the *ERA-NET CONCERT-Japan* project, established in 2011. As noted previously, Japan participates in the EISCAT and SIOS projects.

Of the eight non-EU priority countries, Japan has the fewest joint projects with Norway under FP7. This under-representation is also reflected in the Research Council's overall portfolio, where Japan ranks seventh among the eight priority countries.

Statistics from FP7 indicate that the quality of joint Norwegian-Japanese applications is very high, with a success rate of 42 per cent, the highest for Norwegian cooperation with any of the eight priority countries. Applications to FP7 for Norwegian-Japanese collaborative projects are distributed evenly across several programmes. The highest number of these joint projects are in ICT and in the programme for infrastructures. Other FP7 programmes with Norwegian-Japanese cooperation are Health, Environment, Socio-economic Sciences and the Humanities, Energy, and Nanosciences, Nanotechnologies, Materials & New Production Technologies.

Some 18 per cent of Japan's FP7 project portfolio involves cooperation with Norway.

FP7: CONCERT-Japan

CONCERT-Japan «Connecting and Coordination European Research and Technology Development with Japan» was an ERA-NET initiative under the 7th Framework Programme to promote research and technology cooperation between Japan and European countries. The initiative ran from 2011-2014 as a consortium formed by 13 organizations from eight European countries and Japan. JST, JSPS and MEXT were Japanese partners of the project. Both JST and RCN participated in the 2012 call for proposals for the topics *Efficient Energy Storage and Distribution and Resilience against Disasters*. Two of the nine approved projects feature Norwegian participation and a Norwegian coordinator. A new network to promote cooperation between Japan and European countries, European Interest Group for Japan, is set up from 2015.

5. Grounds for considering cooperating with Japan

Japan is one of the leading nations the fields of scientific research, technology, machinery, and medical research with the world's third largest budget for research and development and over 677,731 researchers. Japan has received the most science Nobel prizes in Asia.

Japan and Norway have common research interests, both in energy research, important technology areas such as nano-technology and materials and in developing future fisheries and aquaculture sectors. Both countries have a long history of polar research and have a fruitful collaboration within space research. Japan was accepted as a permanent observer in the Arctic Council in 2013 and has had a research station in Ny-Ålesund since 1990.

Japan actively participates and contributes in a number of multilateral organisations (the IIASA, the Global Research Council, the Global Change Programmes, the IPCC and the Belmont Forum) and cooperates actively with the EU. Japan renewed its bilateral Science and Technology (S&T) Cooperation Agreement with the EU in 2011. The MEXT, JST and JSPS were all partners in ERA-NET CONCERT-Japan, which was established in 2011.

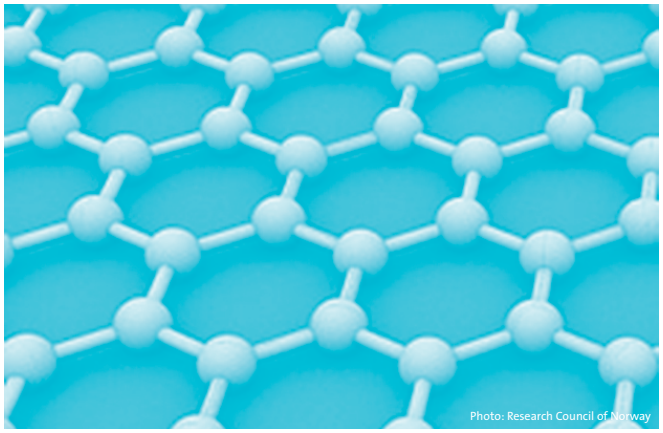
Cooperation with Japan contributes to meeting the various objectives of the Research Council's Strategy on International Cooperation as follows:

Address global challenges to society

Sustainability science is an important common denominator for many Norwegian-Japanese collaborative projects and for relations between the two countries. Sustainability is a main objective for research on environment-friendly energy, safe seafood, and marine technology. Global challenges related to climate and the environment are an important part of the basis for cooperation on polar and space research in both the Arctic and the Antarctic.

Help to enhance the quality and capacity of Norwegian research

Japan has dynamic basic research groups in the fields of theoretical and applied physics, astrophysics, biotechnology, neuroscience and nanoscience. Given Japan's strength in a range of generic technology areas, increased cooperation may help to strengthen Norwegian technology development.



Graphene

Boost the competitiveness of Norwegian trade and industry

An important motivation for the Norwegian authorities' cooperation with Japan has been to promote innovation and industrial development. Japan is a driver of technology in many areas and attracts Norwegian industrial actors in several of these. Renewable energy, including energy-related materials and energy systems, is emerging as more and more interesting to Norwegian technology developers and suppliers. This is an area receiving even greater focus in Japan since the Fukushima accident, with special instruments targeting Japanese research and industrial development.

Offshore wind power, solar/photovoltaic power, geothermal energy and hydrogen/fuel cells are complementary areas where Norwegian technology actors are active in partnerships with Japanese counterparts. As two major seafood nations dealing with vital issues concerning the future fisheries and aquaculture industries, Norway and Japan have the potential for extensive academic and industrial cooperation. Norway's technology deliveries and solid experience base in industrial development make it an attractive partner, while Japan's status as an important market for Norwegian seafood makes it a highly interesting partner for cooperation.

Japan and Norway each have complete maritime clusters. Japanese shipbuilding is undergoing a shift and the country is looking abroad more than before. This opens up opportunities for Norwegian technology suppliers for the construction of advanced and specialised vessels and for R&D cooperation on green shipbuilding technology. Increased goods transport between Europe and Asia via the Northeast Passage may provide a basis for cooperation not only within the maritime sector but also in areas such as ice conditions, infrastructure, safety/security, environmental impacts of increased transport, monitoring needs, and preparedness.

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

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

The fundamental building blocks of research cooperation with Japan are individual researchers and research institutions and their networks and relationships with colleagues and partners. The authorities do their part by facilitating cooperation through following up the bilateral research and technology agreement signed by Norway and Japan and by discussing priority areas for cooperation every two years.

Cooperation under the bilateral research and technology agreement is based on quality and relevance, common research interests, and a mutual anticipation of scientific benefit of cooperation. The parties to the agreement meet in the Joint Committee. The Ministry of Education and Research and the Ministry of Trade, Industry and Fisheries share the responsibility for coordination from Norway. From the Japanese side, the responsibility lies with the Japanese Ministry of Foreign Affairs of Japan (MOFA), which coordinates efforts with several other ministries as well as research funding institutions such as the JST and JSPS. The purpose of the meetings is to exchange information, report on activities and results, and set priorities and guidelines for activities under the agreement.

The 5th Japan-Norway Joint Committee Meeting took place in February 2015. Priority areas for cooperation are energy and the environment, marine research, advanced materials and nanotechnology, polar research and space research.

Japan-Norway Science Week was organized for the third time in Tokyo, May 2015, devoted to the topic «Sustainable energy solutions». The first Japan-Norway Science Week was organised in 2013 in Tokyo by the Research Council and Innovation Norway in cooperation with the Royal Norwegian Embassy in Tokyo. Norway-Japan Marine Science Week was held in Tokyo in June 2014.

7. Follow-up and implications

Introduction

In the bibliometric analysis, nanotechnology and new materials is highlighted as a research area in which Japan excels, with a high degree of specialisation but a somewhat lower citation rate than other countries that publish at a comparable level. Within the sphere of energy research, Japan's citation rate is roughly at the global average. The analysis also points to biotechnology as a potentially attractive area for cooperation with Japan, based on the country's significant proportion

of global publications in this field. According to the analysis, the greatest amount of Norwegian-Japanese co-publication in terms of volume is in health research.

The strong point of the Japanese research and innovation system lies in carrying out R&D and commercialising scientific findings. There is a good amount of knowledge exchange between the scientific system and innovation system.

Relevant areas for cooperation with Japan

Energy
Both Norway and Japan has high electricity production and shared interests within a broad range of energy related research fields. Renewable energy is a high priority in both countries. Offshore wind power, solar/photovoltaic power, geothermal energy, hydrogen/fuel cells, energy systems, and carbon capture and storage are highly relevant areas for cooperation with Japan.

Materials and nanotechnology
Knowledge development in this technology area as a basis for innovation is given high priority in both Japan and Norway. Both place priority on applying nanotechnology to areas such as energy, environmental and climate impacts, health and medical technology, and natural resources within a framework of responsible technology development.

Safe seafood – marine research
Research to achieve a deeper understanding of the marine environment is of great intrinsic value to knowledge nations such as Norway and Japan, while also providing an essential foundation for the long-term management of marine eco-systems and for value creation based on marine resources, both nationally and internationally. Norway's technology deliveries and solid experience base in industrial development make it an attractive partner, while Japan's status as an important market for Norwegian seafood makes it a highly interesting partner for cooperation.

Polar research and space research
Norway and Japan share a long history of polar research cooperation, particularly in the Arctic. Cooperation on glacio-logy, pollution in the Arctic, and atmospheric research have the highest priority. This includes *in situ* measurements, utilisation of research flights, and the use of advanced technology for ice-core drilling. Cooperation with Japan is given high priority in the SIOS infrastructure project, the Svalbard Science Forum and in Ny-Ålesund. Cooperation involving infrastructure for space research in North Norway and Svalbard has been extensive since Japan joined EISCAT in 1996.

Health and welfare research
Japan has the world's fastest-ageing population. By 2060 its total population will be reduced by one-third, with nearly 40 per cent of the population aged 65 years or older. The Research Council's priority area *"Healthy and active for many years"* and Japan's substantial *"Life Innovation"* initiative for research on medical care, nursing care and health may provide common ground for cooperation.

Innovation, industrial development and commercialisation of R&D
Japan's technological and industrial base may provide a basis for innovation, market introduction and commercialisation of research in several areas: seafood, maritime industry (green shipbuilding technology, also in connection with the Arctic and the Northeast Passage), energy (renewable energy and other environment-friendly energy technology, energy-related materials and energy systems), materials and nanotechnology (multiple energy areas, environmental and climate impacts, health and medical technology, and natural resources) and welfare technology.

Instruments for cooperation

National research funding
Relevant programmes are encouraged to promote cooperation with Japan by giving priority to projects with international collaboration. Efforts to implement cooperation related to funding announcements/project funding should be given priority, primarily with the Japan Science and Technology Agency (JST).

Mobility
The Research Council, in conjunction with the Japan Society for the Promotion of Science (JSPS), offers grants to Norwegian Ph.D. students and post-doctoral researchers who want to conduct research at Japanese research institutions. Japanese researchers may apply for funding for research stays in Norway through the same scheme.Research ties between institutions can be further developed through the exchange of students between professors or senior researchers. The introduction of Norway's UTFORSK Partnership Programme has fostered such exchange.

The SIU's High North Programme, under which Japan is one of the priority countries, also provides opportunities to link educational cooperation to existing research cooperation on topics relevant for the Arctic and northern areas.

Institutional cooperation between universities in Japan and Norway may be able to enhance the connection between research and education. In this context, the Programme for International Partnerships for Excellent Education and Research (INTPART) may be an important instrument.

EU cooperation
Japan is one of the partner nations for the new EU Framework Programme for Research and Innovation (Horizon 2020). Recommended priority areas for cooperation with Japan under EU programmes are aviation and transport, ICT, nanotechno-logy and materials, space research, security research, health and nuclear power. Cooperation between Norwegian and Japanese researchers should also be promoted through Horizon 2020.

Experience with the ERA-NET CONCERT-Japan has been very positive, and many Norwegian actors have submitted applications. Collaboration with other European partners and Japan is a gateway to further cooperation activities.

Academic networks

Academic networks and arenas such as those established by NTNU and other Norwegian institutions through the Kyoto International Forum for Environment and Energy (KIFEE), with funding from the Research Council, are important meeting places for generating knowledge which are also open to participation from the business sector. The INTPART programme may serve as an instrument for supporting the establishment and continuation of such academic networks. The Research Council's Industrial Ph.D. (NAERINGSPHD) scheme, which promotes research targeting a market that a company seeks to develop, is an effective instrument for creating closer ties between industry and the knowledge networks of academia.

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This position has proven particularly valuable in light of the linguistic and cultural challenges involved in cooperation with Japan and the need to engage constructively with various central and local actors and networks in the country.

National hubs

Larger-scale national R&D initiatives with participation from industry are often reserved for Japanese actors ("Japan Inc.") and international actors with a local presence. One possibility of achieving a strong link between industry and R&D may be to establish Norwegian national hubs – with the participation of key stakeholders from trade and industry, research and the public agencies within the research and innovation system – focused on particularly strategic areas. This would follow the example of the Norwegian Environment Technology Center (NETC) and its cooperation activities on floating offshore wind power.

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