

# Roadmap for cooperation on research and higher education with South Korea 2019

This roadmap summarises the status of cooperation on research and higher education with South Korea and identifies which thematic areas are particularly relevant as a basis for cooperation in the years ahead.



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- > Over the past decade, South Korea has established itself as an important research and technology centre in the world.
- > South Korea has the highest ratio of R&D spending to GDP in the world, with an intensity rate of 4.55% in 2017.
- > The private sector plays an important role in financing R&D activities, with corporations accounting for 79.4% of total R&D investment in 2017.
- > Over the last decade, South Korea has seen sustained growth in research output in terms of the world share of publications.
- > The number of co-publications between South Korea and Norway has increased significantly in the last decade. The number of collaborative papers was almost eight times as high in 2015 as it was in 2005.



South Korea is one of the OECD countries with the highest number of researchers per 1,000 employed, 15,32 in 2018.



South Korea has ranked top of the Bloomberg Global Innovation Index 2019 for six years in a row.



The number of collaborative papers, between South Korea and Norway, was almost eight times as high in 2015 as it was in 2005.

## Thematic areas for research collaboration



Digital technologies



Smart cities



Smart manufacturing



Smart health care



Nanotechnology



Environment-friendly energy



Hydrogen technology

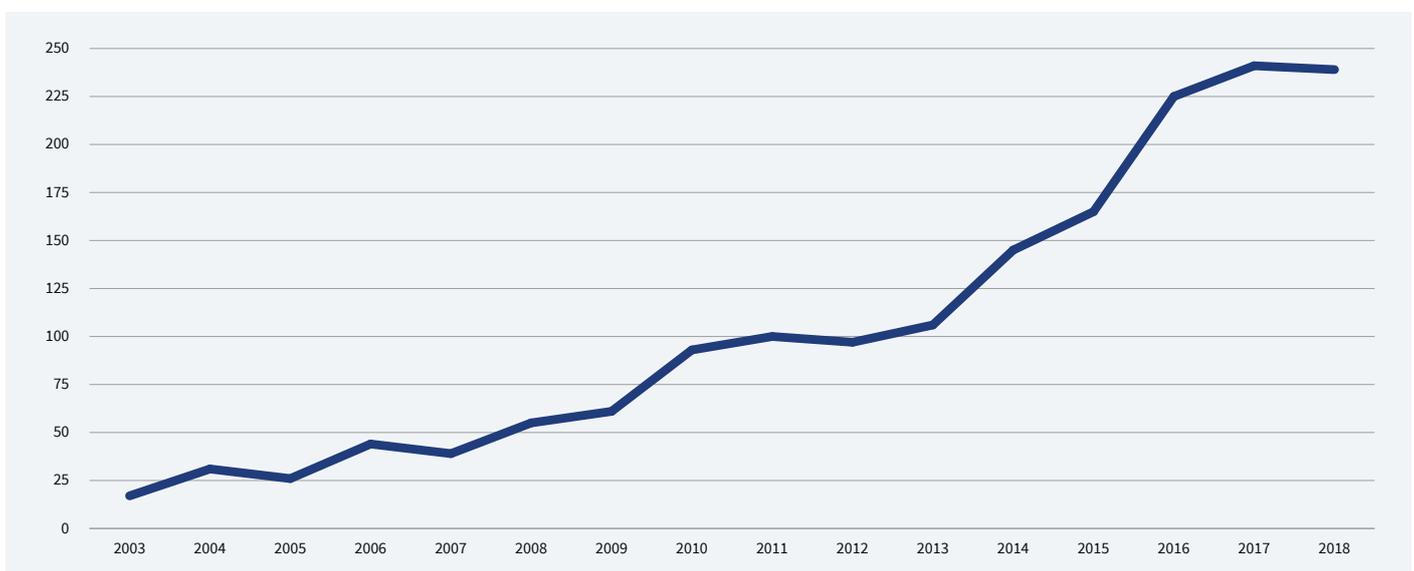


Carbon capture and storage (CSS)

## Why South Korea?

- > South Korea has achieved tremendous economic growth to become a high-tech industrialised economy.
- > Over the past 20 years, South Korean R&D spending as a share of GDP has doubled to exceed 4% in 2018.
- > South Korea's R&D investment has put the country at the forefront of cutting-edge technology.
- > R&D in South Korea is almost entirely performed and funded by the business sector. Nearly two-thirds of all R&D is directly targeted at developing specific new or improved applications.
- > 32% of tertiary graduates in South Korea are in natural sciences and engineering disciplines.
- > Data on PCT patent applications based on OECD classification show that South Korea specialises more than EU28 on ICT and nanotechnology-related patents.
- > South Korea is Norway's second biggest trade partner in Asia and an important market for Norwegian business.
- > Joint research between Norway and South Korea has continuously increased since 2003.
- > Norway and South Korea collaborate increasingly closely within the European framework programme.

## Collaborative papers Republic of Korea and Norway, 2003 – 2018



# South Korea as a knowledge nation

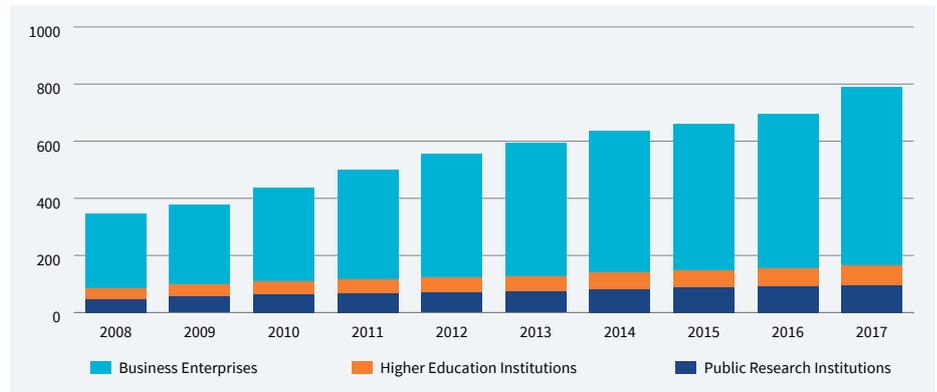
South Korea is one of the countries in the world that invests most heavily in research and innovation.

South Korea is one of the countries in the world that invests most heavily in research and innovation. Since the 1970s, the country has invested heavily in education, science and technology, expanding its higher education system, developing state-funded research institutes in the areas of science and technology and focusing its attention on high technology and knowledge-intensive industries. The Korean government has increased its R&D expenditure by an annual average of around 10% over the past ten years, becoming fifth in the world in investment and first in investment as a percentage of GDP.<sup>1</sup>

The R&D system in South Korea is characterised by the strong involvement of the private sector. In fact, R&D in the country is predominantly funded and performed by the business sector. In 2017, corporate R&D expenses accounted for almost 80% of total R&D spending and slightly more than 70% of all researchers were employed by business enterprises. In addition to business enterprises and universities, public research institutes play an important role in the Korean R&D system.

Continued high R&D investments have led to an impressive advancement of S&T in South Korea. This has raised the international indicators of the nation's science and technology competitiveness, such as in publications of papers and number of patents. However, the level of international collaboration is relatively low, and South Korea has yet to achieve the standing it seeks in international rankings and citation indexes.

R&D Expenditure in 100,000



Source: Ministry of Science and ICT, Survey of Research and Development Report

Total number of publications: Republic of Korea and Norway (2003-2019)

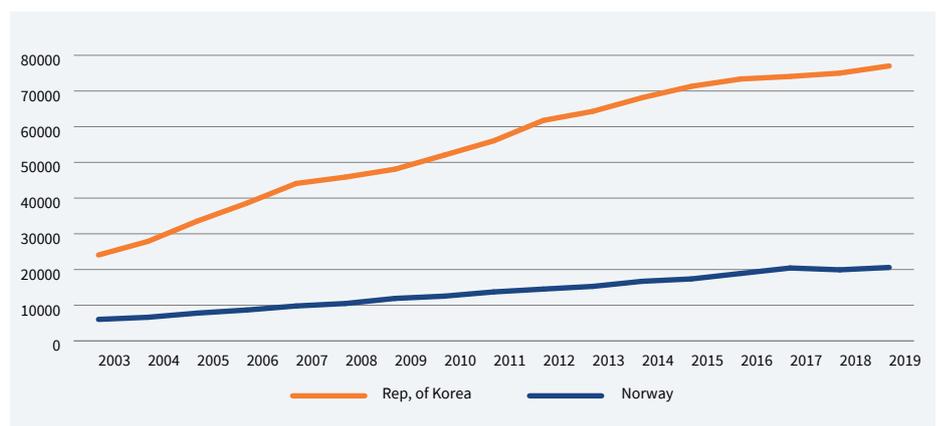


Photo: Shutterstock

Scientist trying to fix a machine parts.

<sup>1</sup> Unesco Institute for Statistics.

# Higher education

A strong focus on education has been an important pillar of South Korea's extraordinary economic rise. Strategic investments in human capital development, research and technological innovation since the 1980s have made South Korea one of the most highly educated and technologically advanced countries in the world.

South Korea has the highest share of tertiary-educated adults of all OECD countries. Almost 70% of 25- to 34-year-olds in the country have completed some form of tertiary education.<sup>2</sup> The Economist Intelligence Unit recently ranked Korea 16th of 50 countries in its 2018 Worldwide Educating for the Future Index.<sup>3</sup>

The Korean education system is extremely competitive and competition on admission to top universities is particularly fierce. Graduates of Korea's top universities dominate the country and occupy the majority of high-ranking government posts and management positions in Korea's powerful business conglomerates. Efforts have been made in recent years to reform the education system with the objective of reducing competition between institutions as well as competition in university admission, reducing university admission fees and making access to education and employment more socially equitable.

## Higher Education Institutions

As of 2017, there were 442 Higher Education Institutions (HEIs) in Korea compared with only 265 in 1990. These include 138 junior colleges and 201 universities. Increasing demand for university education over the past decades has led to the rapid growth of private providers. More than 80% of HEIs are now privately owned, and around 80% of tertiary students are enrolled in private institutions. In spite of the fact that private HEIs are relatively tightly regulated by the government and required to operate under similar rules as public institutions, there

is great variation in terms of size, quality and funding levels, resulting in a stratified university system.

## Student mobility

Korea is one of the top sending countries of international students worldwide after China, India and Germany. The number of Koreans enrolled in degree programmes abroad doubled from 1997 to 2011, but has decreased slightly in recent years.

Korea pursues an internationalisation strategy that seeks to increase the number of international students in the country

to 200,000 by 2023. Attracting more international students is considered necessary to strengthen the international competitiveness of Korea's education system. The majority of international students in Korea come from other Asian countries.

## Cooperation with Norway

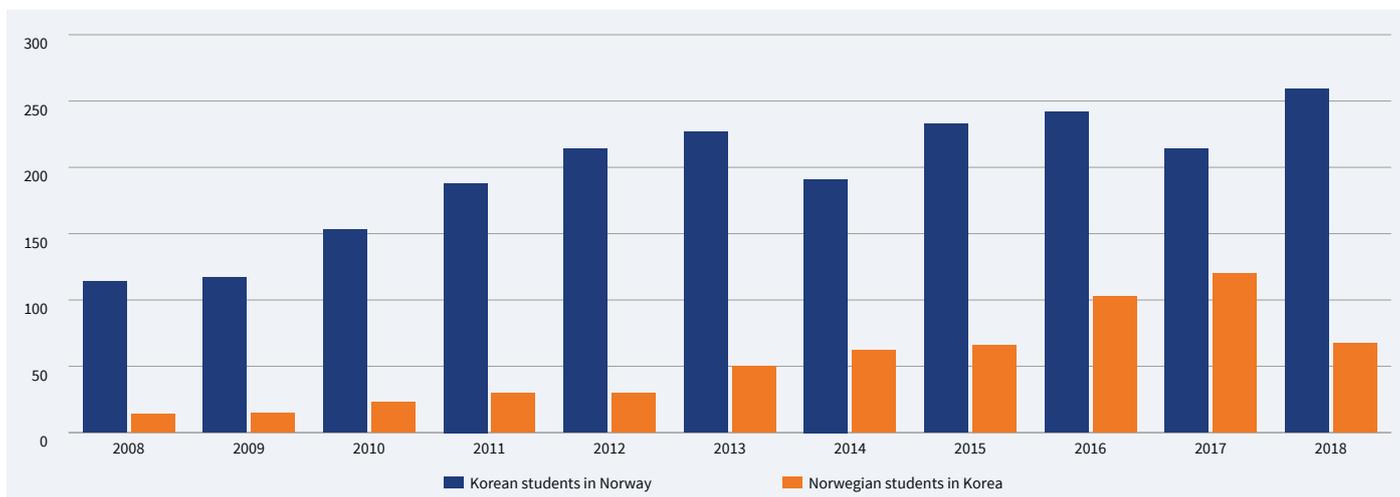
Student mobility between South Korea and Norway has increased steadily since 2008. The number of Korean students coming to Norway is much higher than the number of Norwegian students traveling to South Korea.



Photo: Norwegian Research Council

In 2019, South Korea and Norway signed an agreement on Money-Follows-Cooperation. Here is the Norwegian delegation meeting its Korean counterparts in Seoul, November 2019.

## Exchange of students between Korea and Norway 2008-2018.



<sup>2</sup> <http://gpseducation.oecd.org/Home>

<sup>3</sup> <https://educatingforthefuture.economist.com/>

# Research and innovation

The high level of R&D spending in South Korea illustrates the great importance attached to the role of research, innovation and technology as key drivers of economic development.

Two governmental ministries manage and control most of the national R&D policies and planning in South Korea: The Ministry of Science and ICT (MSIT) coordinates Korea's science and technology policy and plays a key role in directing R&D projects in basic science, while the Ministry of Trade, Industry and Energy (MOTIE) is responsible for industrial and energy policy and foreign trade and investment. Both ministries rely on underlying public organisations for the planning and implementation of R&D policies as well as for selecting, monitoring and reviewing R&D projects. MSI relies on the Korea Institute of S&T Evaluation and Planning (KISTEP) for the planning, coordi-

nation and evaluation of the government's R&D programmes and investments. It has charged the National Research Foundation of Korea (NRF) with the funding and performance management of research projects in all academic disciplines, including basic and applied science and engineering, as well as humanities and social sciences.

MOTIE relies on the Korea Institute for Advancement of Technology (KIAT) for developing industrial technology policy. KIAT's functions include, among other things, supporting and developing international innovation cooperation. The Korea Evaluation Institute of Industrial Technology (KEIT),

is responsible for planning, evaluation and management of R&D projects in industrial technology, while the Korea Institute of Energy Technology Evaluation and Planning (KETEP) is in charge of funding and managing innovative energy R&D.

The Science and Technology Policy Institute (STEP) is a think tank specialising in research science, technology and innovation that provides ministries and public organisations with policy ideas and suggestions for the promotion of T&I.

## A highly competitive university system

Traditionally, the top three universities in South Korea have been Seoul National University (SNU), Korea University and Yonsei University, known as the SKY league. Whilst these three universities are still among the most prestigious and top-ranking higher education institutions in South Korea, several other newer institutions are climbing international rankings. These include Sungkyunkwan University (SKKU), the Korea Advanced Institute of Science and Technology (KAIST) and Pohang University of Science and Technology (POSTECH).

Two Korean universities are ranked among the top 100 in the current 2019 Times Higher Education World University Rankings: SNU (ranked 63rd) and SKKU (ranked 82nd). In the QS World University Rankings, Korean universities have advanced markedly in recent years – five Korean universities now feature among the top 100 compared with only three in 2016.

The Korean government is currently seeking to strengthen industrial-academic cooperation and restructure several universities

**Table 1 - Norwegian and South Korean Universities among the top 500 in the world Times Higher Education Ranking 2019**

	South Korea	Norway
63	Seoul National University (SNU)	
83	Sungkyunkwan University (SKKU)	
102	Korea Advanced Institute of Science and Technology (KIAT)	
121		University of Oslo
142	Pohang University of Science and Technology (POSTECH)	
197		University of Bergen
198	Korea University	
201-250	Ulsan National Institute of Science and Technology Yonsei University	
351-400	Hanyang University Kyung Hee University	Norwegian University of Science and Technology (NTNU)
401-500	Gwangju Institute of Science and Technology	UiT The Arctic University of Norway



Korean University campus with cherry trees are in full blooms

Photo: Shutterstock

into smaller, more specialised and more research-oriented institutions that have greater autonomy with the aim of boosting the research output and international competitiveness of Korean universities.

## Public research institutes

In addition to universities and conglomerates, government-funded research institutes play an important role in the Korean R&D system, engaging industry in collaborative research projects relevant to national economic development. The public research institutes derive roughly half of their budget from government core grants, with the remainder coming from contract research for industry, government ministries and local governments.

## A leading innovation nation

In 2019, South Korea ranked top of the Bloomberg Global Innovation Index for the sixth time in a row. It ranked particularly high on R&D spending, manufacturing value-added and high-tech density. Another ranking in which South Korea has come out top for several years is the ICT Development Index (IDI) published by the UN International Telecommunications Union, where Korea came second in 2017 and was first in 2016.

According to data released in 2018,<sup>4</sup> South Korea ranks fifth globally in PCT (Patent Cooperation Treaty) applications following the US, China, Japan and Germany. Applicants from South Korea filed most intensively for patents related to digital communication. The Korean-based companies Samsung Electronics and LG Electronics were among the top filers of patent applications in 2018 worldwide, ranking sixth and eighth respectively.

## The Fourth Industrial Revolution

There is no doubt that South Korea is pushing to become a global technology powerhouse. The Korean government has had a strong focus on the Fourth Industrial

Revolution, a revolution of intelligence based on the hyperconnectivity triggered by digital technologies such as artificial intelligence and big data.

In its latest industrial technology innovation plan, published in March 2019, the Korean Ministry of Trade, Industry and Energy commits to investing around 16 trillion won in research and development for 100 key technologies over the next five years. The government has selected five investment areas, including future transportation, smart health care, smart living, a pleasant environment and smart manufacturing.

The Presidential Committee on the Fourth Industrial Revolution (PCFIR) has been charged with coordinating policies and creating consensus pertaining to the development and acquisition of new science and technology, including artificial intelligence (AI) and data technology, as well as new industries and services necessary for Korean society's adaptation to the Fourth Industrial Revolution.

The Moon administration has emphasised the importance of not only focusing on innovation, but also creating a 'fair and people-centred' economy, producing more technology rooted in social needs, and not just on economic potential.

## Fostering start-ups and SMEs

R&D activities in South Korea have traditionally been concentrated in big companies and government-funded research institutes. Efforts have been made in recent years to reform the R&D ecosystem to place greater emphasis on SMEs.

The former Park administration started reforms by, among other things, allocating a greater percentage of R&D funding to SMEs, easing SME access to non-debt financing, creating innovation hubs and providing tax incentives to companies that provide financing to start-ups.

It opened 19 Centres for Creative Economy and Innovation (CCEIs) throughout Korea, which support R&D in the areas of Internet of Things (IoT), biotech, 5G, cloud and fog computing, big data and artificial intelligence (AI). One of the main functions of the CCEIs is to promote the R&D activities of SMEs and start-ups using the business ideas and technology resources of the cooperating research institutes, universities or conglomerates.

The importance attached to the development of small and medium enterprises was highlighted by the establishment of the Ministry of SMEs and Startups in 2017.

## Memorandum of Understanding from 2017

In 2017, the Research Council of Norway signed a Memorandum of Understanding with the National Research Foundation of Korea (NRF) with the objective of providing additional opportunities to support cooperative activities in the fields of Science and Technology, Engineering, Social Sciences, Humanities and Innovation between the two countries.

In 2019, RCN and the Korea Institute for Advancement of Technology (KIAT) signed a Letter of Intent with the objective to establish a cooperation framework in the areas of industrial technology R&D. In the same year, RCN and the Korea Institute of Energy Technology Evaluation and Planning (KETEP) signed a Money Follows Cooperation Agreement, which provides for the reciprocal funding of researcher organisations from the partner country in the fields of Energy Efficiency, Renewable Energy, Smartgrid and Energy Storage Systems.

In November 2019, the Norwegian Ministry of Education and Research and the South Korean Ministry of Science and ICT signed an MoU to facilitate science and technology cooperation.

## Important public research institutes

The Korea Institute of Science and Technology (KIST) was established in 1966 as the first government-funded research institute in Korea and is now one of Korea's foremost science and technology institutions.

The Korea Electronics Technology Institute (KETI) is a leading government-funded R&D institute, specialising in the development of new technologies in electronics, telecommunications and information technology. It provides support to SMEs in the high-tech industry.

The Electronics and Telecommunications Research Institute (ETRI) is a global ICT research institute. Having traditionally played a central role in the development of the Korean semiconductor industry, it now focuses on developing 'smart', creative and innovative technologies.

The Korea Institute of Machinery and Materials (KIMM) is a government-funded machinery technology research institute that develops key technologies in the area of mechanical engineering and conducts reliability tests.

The Korea Research Institute for Chemical Technology (KRICT) is a government-supported research institute for chemical technology, focusing on, among other things, the development of eco-friendly chemical process technology and green convergence chemical technology.

The Korea Electrotechnology Research Institute (KERI) is a government-funded research institute specialising in electrotechnology and electric power.

The Korea Institute of Industrial Technology (KITECH) is a government-funded R&D institute that focuses on the development and management of manufacturing technologies for SMEs. It receives both government and private funding and distributes most of its research grants to private companies.

<sup>4</sup> <https://www.wipo.int/edocs/infogdocs/en/ipfactsandfigures2018/>

## Norwegian instruments for research and education collaboration

The Research Council of Norway encourages Norwegian institutions to include international partners in all applications for funding. South Korean research actors can obtain funding from Norwegian national programmes if they apply together with a Norwegian main applicant. This opportunity has been used increasingly over the last years. In 2018, there were 29 nationally funded projects with a South-Korean cooperation partner.

The programmes in which there is most cooperation are those targeted at industry-oriented research and innovation, such as BIA (User-driven Research-based Innovation) and NANO2021 (Nanotechnology and Advanced Materials) as well as programmes for energy research, such as ENERGIX and RENERGI. FRINATEK, the programme funding independent basic research projects in the areas of mathematics, physical science and technology has also been attractive to Korean partners.

## EU programmes for research and education collaboration

South Korea is an active participant in EU cooperation programmes involving both research and education. Knowledge communities in Norway and South Korea are encouraged to work together on applications to these programmes.

The EU has its own Agreement on scientific and technological cooperation and a roadmap for science and technology collaboration with South Korea. ICT, nanotechnology, health, climate, energy and mobility have been among the most important areas of cooperation.

At the most recent bilateral summit between the EU and South Korea in October 2018, the substantial progress made in EU-South Korea cooperation in research and innovation was welcomed and it was agreed to continue close cooperation in these areas.

The number of joint applications to Horizon2020 has been increasing since the start of the framework programme but remains modest, with a total of 20 joint

applications having been submitted by October 2018. The success rates are, however, relatively high. There is particularly active collaboration in the area of ICT Leadership in Enabling and Industrial Technologies.

South Korea is a partner-country of the EUREKA Network and a participant in the Eurostars programme, an international cooperation programme comprising 36 countries that supports research and development performing SMEs. Eurostars projects can address any technological area for any market but must be aimed at the development of a new product, process or service. Any type of organisation can be part of a Eurostars project consortium, although the main partner must be an R&D performing SME.

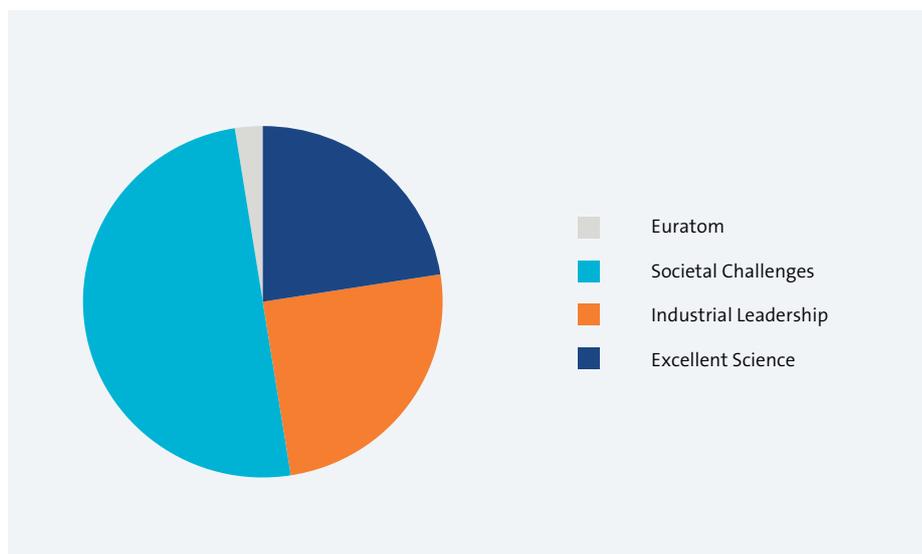
Support for cooperation with South Korea can also be provided through ERASMUS+, the EU programme for education, youth and sport. The ERASMUS+ International Credit Mobility programme gives Norwegian higher education institutions the opportunity to send and receive students and employees on exchanges outside Europe, including South Korea.

Photo: Norwegian Research Council

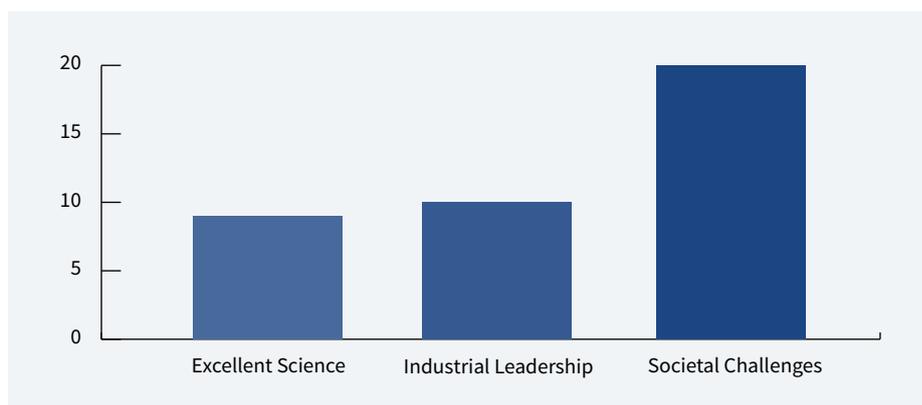


In 2019, South Korea and Norway signed three agreements on cooperation. Here is the Norwegian delegation meeting its counterparts in Seoul, November 2019.

Norway - South Korea applications to H2020 by May 2020



Norway - South Korea applications to H2020 by May 2020



# Topics for research cooperation

Certain thematic areas are particularly suitable for cooperation and mobility with South Korea.

**Digital technologies** including network (IoT, 5G), big data (Cloud), and AI software (machine learning, algorithms) are among the most important areas of R&D funding and activity in both Norway and South Korea. The need for applications where IoT works together with AI is constantly growing, creating new markets and opportunities. South Korea has placed itself at the forefront of the development of digital technologies in recent years and Norway is among the leading IoT-connected countries worldwide.

**Smart cities** are a vital area for South Korea due to the challenges related to its high density population. With the rise of innovative ICT technology, such as cloud, Big Data and IoT, innovative use of technology creates opportunities for more accessible, green and cost-effective infrastructure and transportation. Norway is far ahead in the development of e-vehicle and smart grid systems and there is great potential for cooperation with Korea in developing smart city solutions.

**Smart manufacturing:** Advanced manufacturing technology is essential to increasing productivity in manufacturing operations and improving economic competitiveness in both South Korea and Norway. The Korean government is investing heavily in R&D focused on developing technologies related to smart factories.

**Smart health care**, including digital health care and customised bio-treatment technologies, is another promising area for research cooperation. There is great potential in medical technology and eHealth, given demographic trends in both Norway and South Korea. Norway has good health-related data and high-quality health care services, while the health care system in South Korea is known as being one of the most efficient in the world.

**Nanoscience and nanotechnology** are important research areas in both countries, as they constitute the basis for the devel-

opment of new technologies and new value creation that is not related to raw material production. South Korea will invest heavily in the research and development of nanotechnology in the years to come, focusing on areas with the largest commercial impact, such as nanomaterials that can be used for AI, big data and IoT. Nanoscience and nanotechnology are still at an early stage of development with great potential for development, patenting and commercialisation resulting from research cooperation.

**Environment-friendly energy** is high on the agenda in both countries. Both South Korea and Norway are putting considerable resources and emphasis on research in this field. The South Korean government aims to increase its share of renewable energy from 6 to 20% by 2030. There is great potential for cooperation in several areas, including offshore wind, but also onshore wind, solar power and energy storage. Norwegian expertise from offshore oilfield and maritime operations can be used in connection with future offshore wind power development in both countries.

**Hydrogen technology** and hydrogen-friendly transport is another promising area for cooperation. Norway has been producing hydrogen for 90 years. With abundant renewable power and the highest penetration of electricity mobility in the world, Norway has several initiatives in developing hydrogen technology, electric mobility and grid energy storage. South Korea has plans to develop the technology and infrastructure needed for a hydrogen-based economy. This includes support for research in hydrogen power, in particular hydrogen fuel cell electric vehicles (FCEVs).

**Carbon capture and storage (CSS)** is an important measure for addressing climate challenges. Norway is a world leader in CCS technology while South Korea has committed significant funding to the development of CSS technology with the objective of achieving a reduction in domestic Co2 emissions, as well as becoming a leading actor in the global CSS technology market.

Number of collaborative papers Republic of Korea and Norway. By thematic field, total 2003–2018

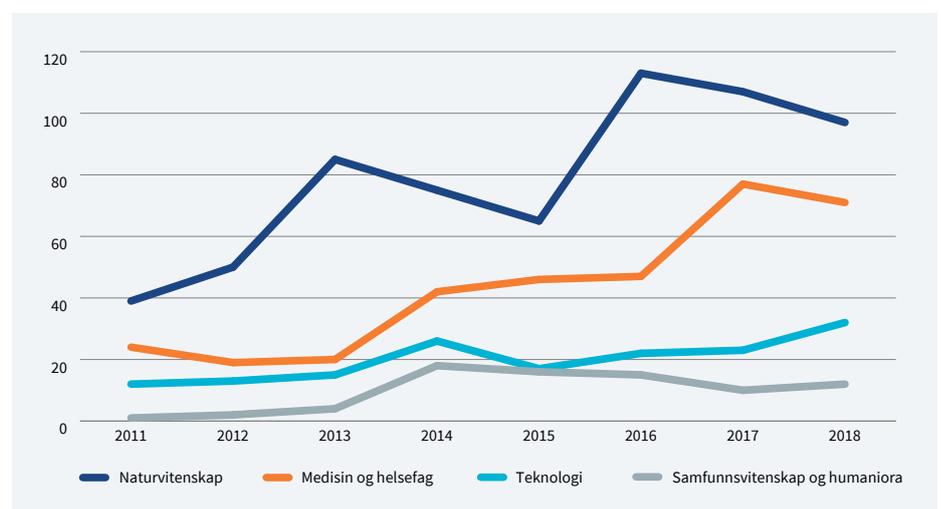


Photo: Yeo Khee, Unsplash