

# NORDFORSK MAGAZINE 2017

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NordForsk



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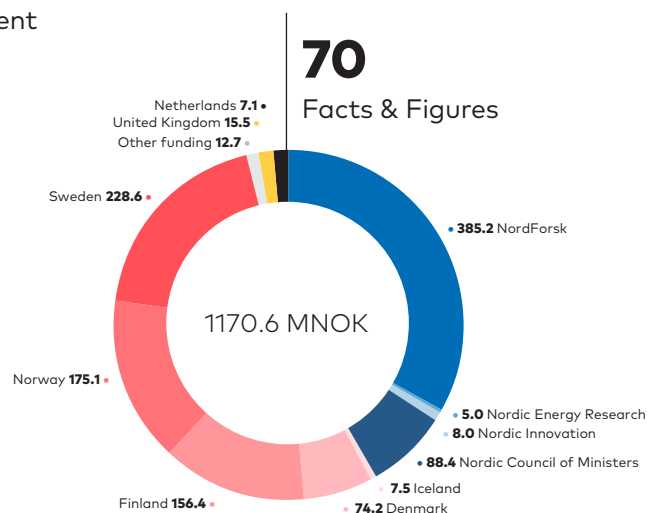


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# THE NORDIC KNOWLEDGE REGION IS GROWING STRONGER AND MORE VISIBLE

NordForsk works systematically to achieve the visions of the Nordic Ministers for Co-operation focusing on freedom of movement, innovation, visibility and international engagement. This is important because we live in a time when the challenges facing society are so great that no country in the world can deal with them on its own. Cooperation across borders is a must, in particular regarding the need for pertinent new knowledge that will make it possible to realise the UN Sustainable Development Goals.

NordForsk helps to generate important, new knowledge through its large, interdisciplinary and multidisciplinary initiatives in areas such as climate, health, education, societal security and gender equality. The initiative, "Responsible Development of the Arctic: Opportunities and Challenges - Pathways to Action" represents another key activity. Since the impact of ongoing climate change affects the Arctic region more rapidly than other parts of the world, knowledge about what is happening there is an indicator of what will be happening to everyone on Earth if we do not take steps to protect our planet.

NordForsk contributes to the knowledge region's development by creating incentives for cooperation between the countries and autonomous areas that constitute the Nordic region. The organisation also works to expand and enhance cross-sectoral cooperation. One example is the joint activity that NordForsk, Nordic Innovation and Nordic Energy Research are carrying out under the Green Growth Research and Innovation Programme, whose objective is to facilitate the transition to a society where

economic growth is based on the sustainable use of natural resources.

Cross-border Nordic cooperation has been receiving greater attention from many actors in Europe and beyond, and is increasingly being seen as a role model for others. This adds to unity and trust within the Nordic region, but it should be pointed out that, in practice, working in the Nordic arena is still far from problem-free. There were many obstacles to cooperation when NordForsk first began its activities, and even though these have gradually diminished they are still far from insignificant. This is in part due to constant and – not infrequently – rapid and unexpected changes in the research policy framework underlying our organisation's operations. The various nation states and autonomous areas making up the Nordic region do not always have parallel forms of organisation and are therefore not as similar as those looking at us from the outside sometimes think.

The context in which NordForsk works to facilitate Nordic cooperation thus entails both opportunities and challenges. It is important for actors engaged in this type of cooperation to be ready when a window of opportunity presents itself and to be able to move in another direction when the opportunities for cooperation decrease for one reason or another. Working under these conditions can be complicated.

Nevertheless, in the time it has existed, NordForsk has been able to strengthen its position by expanding Nordic research cooperation. The quality of the research being funded has improved and the project portfolio has grown to encompass more and more research areas. Funding contributions from Nordic research funding bodies have steadily increased, and now significantly exceed the allocations provided by the Nordic Council of Ministers.





The emergence of more comprehensive cooperation on research infrastructure has also broadened the scope of NordForsk's activity. The most important initiatives in this context are in the areas of digital access to quality-assured data and cooperation on the Nordic registers, which represent a real goldmine. Intensive efforts are underway to dismantle national barriers and enable full utilisation of the registers and biobanks. The Nordic e-Infrastructure Collaboration (NeIC) is making rapid advancements in collaborative solutions for the digital infrastructure that is increasingly becoming so important for researchers and other users.

NordForsk is still a young organisation. It was established in 2005 and I have had the privilege of being along for the entire ride. For the first five years I was a member of the NordForsk Board and I have been working as Director of NordForsk for close to eight years since. It has been an enriching and exciting experience and I am proud of what NordForsk has achieved thus far. It is also very satisfying to note that Nordic funding agencies appear to be ready for the

next phase with new bolstering of Nordic research cooperation. I wish my successor, Arne Flåøyen, the best of luck as he embarks on the crucial task of helping to strengthen the Nordic knowledge region and enhance its visibility.

Finally, I would like to thank my current and former colleagues in the NordForsk secretariat as well as national and Nordic partners for their fruitful cooperation. You all play an important part in the Nordic network of people that has made it possible for our daily operations to run smoothly, and for our activities to generate such excellent results.

*Gunnel Gustafsson,  
Director NordForsk*

# NORDFORSK IS A BRIDGE-BUILDER

On 1 March 2017, John-Arne Røttingen took the helm as Chief Executive of the Research Council of Norway. The physician, epidemiologist and professor believes the Nordic region is entering a time when restructuring is necessary – and that cooperation on research and innovation will be essential to success.









## NORDFORSK IS A BRIDGE-BUILDER

**I** am a strong advocate of international research cooperation in general," says Dr Røttingen, "and with the Nordic region as a research arena and NordForsk as a bridge-builder between the Nordic national research councils, I believe we can achieve an even clearer voice in Europe as well as globally. Collectively we have 26 million inhabitants and are the world's 11th largest economy. That means we are an actor others listen to, and we will take advantage of that ahead."

### **First CEPI, then Research Council of Norway**

The man who now administers nearly NOK 10 billion in research funding accepted the position in June 2016 but did not take over until nine months later. There was a good reason for the delay: he was establishing the secretariat for the Coalition for Epidemic Preparedness Innovations (CEPI) – a global coalition to develop vaccines and prevent and contain epidemics and pandemics.

It was no coincidence that Dr Røttingen was chosen to set up the CEPI secretariat. His CV includes heading the testing of the Ebola vaccine in Guinea in 2014–2015, a vaccine that proved to be 100 per cent effective. The study on this vaccine led to an article published in the prestigious journal *The Lancet*, and as the article's last author, Dr Røttingen was awarded the 2016 Fulbright Award for best research article.

"The Ebola outbreak in West Africa cost 11 000 lives," he explains, "and CEPI was founded to apply the lessons learned from that catastrophic epidemic. Setting up CEPI was an important job I felt very motivated to complete. It was always meant to be only a temporary position, but after I took the job at the Research Council of Norway, I ended up staying on for just nine months instead of a year and a half. CEPI is now established with its headquarters in Oslo and it has offices in London, New Delhi and Washington D.C."

### **Big shoes to fill**

Once the CEPI secretariat was up and running, Dr Røttingen was ready for a completely new set of tasks at the Research Council.

"I find this job very exciting and important to society. Research and knowledge have always been central to my work, and I've always been very interested in how research can be implemented in practice to make an impact. So to me, this is not a career change."

"My strongest field by far is health. I have a broad-based health science background, from basic biomedicine to

social science research, so naturally I am not as familiar yet with the other scientific and thematic priority areas under the Research Council of Norway. Also, I have some big shoes to fill. That may sound like an empty phrase but I mean it. Arvid Hallén led the Research Council for 12 years and had widespread experience in the Research Council system from before that. All that experience is not simply passed on to his successor, and I am lucky to have the help of all our in-house expertise as we continue to expand our activities."

### **Finds Nordic cooperation very worthwhile**

Dr Røttingen has worked a great deal internationally and sees many advantages in cooperation at the Nordic level. He believes that the best collaborative relationships are obtained when Nordic research cooperation comes from the bottom up and is driven by peers within the same field who establish ties across national borders. The role of the national research councils and NordForsk is to create a good framework for this cooperation.

"I benefited greatly from Nordic cooperation in my previous job as Chief Executive of the Norwegian Knowledge Centre for the Health Services, where we had a well-functioning Nordic network of knowledge centres. That was a strength when it came to developing our own activities, and we learned from one another through our joint projects. In addition I felt we were a strong constellation in the context of cooperation with the rest of Europe. We achieved the same effect with the Nordic network of communicable disease control institutes. These experiences have made me a great believer in Nordic research cooperation, both because cooperation itself has an impact and because the Nordic region as a unified community has a stronger voice in international processes."

### **National research councils should be more involved in Nordic issues**

The Research Council of Norway encourages international cooperation in its calls for proposals, and Dr Røttingen believes Nordic research cooperation has a major role to play in achieving top-notch research results.

"Is it constructive to have special mechanisms for promoting Nordic research cooperation when we have such mechanisms at the European and bilateral levels? My answer is yes. In general the Nordic countries do well within the EU framework. We are an active stakeholder but we can do even better. The key is standing together. If we approach different research areas collectively, I believe it will be easier to take a leading role. And to accomplish that, we first need an arena where we can



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establish the collaborative relationship. The Nordic national research councils and NordForsk can provide the arena."

Dr Røttingen elaborates by saying, "The national research councils should think more about how we can promote Nordic cooperation in the projects we fund – especially when it comes to creating the best foundation, for example as regards infrastructure and making changes in systems at the Nordic level, either by encouraging cooperation or dismantling barriers. By making it easier to share data across national borders, for example, or by deciding that one ethics review will suffice instead of five."

### **Must better exploit Nordic competitive advantages**

The new head of the Research Council of Norway believes the Nordic region has some advantages unlike anywhere in the world.

"From my experience in health research, we have certain comparative advantages in a number of research areas because the Nordic countries have similar systems. As an example, we have personal identity numbers and registers that enable us to carry out large-scale population-based surveys. These may be health-related or apply to other areas of society. We have an advantage there that the rest of the world does not, and we should make use of it."

### **ABOUT JOHN-ARNE RØTTINGEN**

**Born:** 27 March 1969

**Position:** Chief Executive, Research Council of Norway

**Background:** Dr Røttingen has a medical degree, with a doctorate from the University of Oslo and Master's degrees from the University of Oxford and Harvard University. He is a visiting professor of global health and population at the Harvard T.H. Chan School of Public Health.

John-Arne Røttingen formerly held the position of Director of the Division of Infection Control and Environmental Health at the Norwegian Institute of Public Health, and served as Chief Executive of the Norwegian Knowledge Centre for the Health Services. Dr Røttingen resigned as adjunct professor of health policy at the University of Oslo when he began at the Research Council. He led the testing of the Ebola vaccine in Guinea in 2014–2015.

"At the same time," he adds, "it's important to identify the challenges we face, the ways we can tackle them, and the opportunities that expanded cooperation may open up. Politicians are only as good as the counsel they receive."

### **Seeks closer dialogue**

Dr Røttingen hopes there will be closer dialogue between NordForsk and the Nordic national research councils in coming years.

"I view NordForsk as an important actor for facilitating Nordic research cooperation. That is its most vital function. The various research programmes under NordForsk are one instrument, but we need to enable NordForsk to function more widely as a common platform for dialogue on research policy, research strategy and research funding in the Nordic region. In order to do this, the Nordic national research councils must take greater part in NordForsk's activities." He explains further:

"One challenge for NordForsk is preventing it from being viewed as one of many research councils in the Nordic region. Being one of many, as well as operating alongside them, doesn't provide Nordic added value. NordForsk should be the research councils' common platform for expanding Nordic cooperation. Therefore it is important that the national research councils themselves initiate and prioritise areas for cooperation through NordForsk, and in this way encourage joint Nordic initiatives and calls for proposals. The Research Council of Norway has a number of thematic programmes, and I expect our activities to be closely aligned to corresponding initiatives under NordForsk, and that we look for ways to create a cohesive whole."

### **The Nordic region is a stabilising force**

Before Dr Røttingen rushes off to another meeting, he emphasises his unshakable faith in the Nordic region's role in these uncertain times.

"I have worked a great deal internationally in the global health sector. Many people view the Nordic region as bridge-builders between the less flexible blocks. I believe the Nordic region benefits greatly from being perceived as reliable and knowledgeable, which gives other countries confidence in our joint assessments and statements. The Nordic region is an important actor for knowledge-building and research," concludes John-Arne Røttingen, "and I believe the region will come to play an even more significant role in the international arena in the future."







Ignacio Pisso and  
Andreas Stohl.  
Photo: NordForsk/  
Terje Heiestad



# SAVING ARCTIC CLIMATE DATA

More and more climate data is being collected. While the large amounts of data certainly provide a better basis for precisely measuring changes in the global climate, it is often challenging to collect, process and store such volumes so the data can be of benefit to other researchers. The Nordic Centre of Excellence eSTICC is looking to solve this problem in a project that will enable climate scientists and computer experts to work together closely.

"This project is unique in that we have received funding for something that is essential for our research and yet never gets funding otherwise," explains centre director Andreas Stohl, a senior researcher and meteorologist at the Norwegian Institute for Air Research (NILU).

"Normally we get funding for a particular research activity, but very often we simply lack the tools we need to carry out the research. The whole purpose of the eSTICC centre is to develop tools and make them more effective. This is incredibly valuable."

## **NCoE eSTICC - eSCIENCE TOOLS FOR INVESTIGATING CLIMATE CHANGE AT HIGH NORTHERN LATITUDES**

A core activity is storing and publishing data from the former NCoEs CRAICC, DEFROST and SVALLI. The centre is funded under NordForsk's Nordic eScience Globalisation Initiative.

**Project leader:** Dr Andreas Stohl, NILU

**Project period:** 2014–2018

**Budget:** NOK 25 million

The acronym eSTICC stands for "eScience Tools for Investigating Climate Change at High Northern Latitudes". The centre specialises in different types of eScience tools, e.g. computational tools or components of larger models, for use in Arctic climate research. Specific activities at the eSTICC centre encompass data processing, inverse modelling, climate modelling, high-performance computing and training and education.

"The Arctic is warming faster than the rest of the earth," says senior researcher and mathematician Ignacio Pizzo, project coordinator of the eSTICC centre. "At the same time it is an under-researched region. We still understand too little about the processes occurring in the Arctic as a result of climate change."

There is therefore a need to take more measurements as well as develop better measurement tools and models for analysing these. Having IT specialists review some of the scientific software used by climate researchers has made it possible to optimise the Norwegian Earth System Model (NorESM), quadrupling the computational rate of some parts of the program. This has a major impact on the number of calculations that can be performed.

### **Improved models**

A core area at the eSTICC centre is improvement of models used to verify greenhouse gas emissions. One of the centre's six projects has been focusing on optimising a model for atmospheric methane concentrations. Greenhouse gas concentrations in the atmosphere are typically calculated using greenhouse gas inventories, which are based on emissions figures collected for various greenhouse gases. But there is high uncertainty around these inventories.

"It always gets more complicated when the biosphere is involved," explains Dr Stohl. "For example, how much greenhouse gas does the forest take up? This question has yet to be properly answered. We also don't know how much methane the wetlands emit."



## SAVING ARCTIC CLIMATE DATA

In cases such as these, researchers use “inverse modelling”, first measuring atmospheric methane concentrations and then calculating the emissions that would explain the measurement data. These calculations are then compared to the greenhouse gas inventories to uncover any discrepancies in the inventories. An inverse model for measuring methane gas concentrations has been reviewed by the eSTICC centre’s IT specialists, who were able to optimise the computational rate here by a factor of four as well.

### Reusing Arctic data

There is a great need to store the measurements and results already recorded from Arctic climate research in a way that makes them available for other researchers. Another project at the eSTICC centre is dealing with systematising and publishing Arctic climate data from three former Nordic Centres of Excellence (NCoEs) awarded funding under the Top-level Research Initiative: Cryosphere-Atmosphere Interactions in a Changing Arctic Climate (CRAICC), Stability and Variations of Arctic Land Ice (SVALI) and Impact of a changing cryosphere - Depicting

### TOP-LEVEL RESEARCH INITIATIVE

The Top-level Research Initiative (TRI) was the largest joint Nordic research and innovation initiative to date, with a budget of DKK 400 million. The TRI focused on climate, energy and the environment. Some projects are still active.

Three institutions under the Nordic Council of Ministers – **NordForsk, Nordic Innovation** and **Nordic Energy Research** – served as the secretariat for the TRI and were responsible for administering the six sub-programmes:

- Effect studies and adaptation to climate change
- Interaction between climate change and the cryosphere
- Energy efficiency with nanotechnology
- Integration of large-scale wind power
- Sustainable biofuels
- CO<sub>2</sub> – capture and storage

As of 2016, the TRI had resulted in more than 450 scholarly publications.

ecosystem-climate feedbacks from permafrost, snow and ice (DEFROST).

The eSTICC centre has engaged one or more people from each of those former NCoEs for the purpose of identifying and systematising the climate data collected.

“The centres produced a wealth of data,” says Dr Pisso in explaining the eSTICC centre’s work with the data compiled. “Some of these data were published directly and are thus available via articles, databases or websites. But there is also data that, without our centre’s efforts, could have wound up solely on someone’s hard drive and only known to a very few people.”

### Publicly available data

This was the case with, among other things, sets of aerosol data from the former CRAICC centre. These data will eventually be stored in NILU’s EBAS database, a world data centre for aerosol. The eSTICC centre plans to use the CRAICC data in upcoming projects. “Even more importantly,” adds Dr Stohl, “these data should in principle be publicly available, and when they are, anyone interested can use them in the years to come.”

At the same time, it is important for the eSTICC personnel that their efforts actually make it easier for researchers to navigate their way through the various data and databases. The eSTICC website recently opened a data portal providing an overview of relevant climate data.

“This is a kind of metadata that identifies datasets in the major official databases,” continues Dr Pisso. “There were people who worked to make data more accessible before the eSTICC centre, of course, so it is vital that we don’t duplicate their work. We provide links in areas where relevant and maintained data is available.”

### Face-to-face with technicians

Carrying out the eSTICC centre’s activities requires many meetings between the climate researchers and IT specialists. “Researchers typically do not meet personally with the IT people,” says Dr Stohl. “It is all done by e-mail. For this reason the IT experts never really learn about climate research and we don’t learn why the infrastructure is the way it is. But at our



The NILU observatory in Queen Maud Land, Antarctica. Photo: Are Bäcklund/NILU

centre, this is something we have all really come to understand."

One benefit resulting from this cooperation is an advanced model for how icebergs calve. The model was derived from work done at the SVALI centre, but before the eSTICC centre's time this consisted of several separate models using, among other things, different units of measurement. Making the model function required many cumbersome manual calculations and data transfer. But after meetings arranged by the eSTICC centre, the model was streamlined. "This is a good example of something that did not automatically happen simply because the researchers do not have the right expertise," says Dr Pisso.

"We researchers are usually not interested in formalising things too much because documenting and formalising require extra effort," concludes Andreas Stohl. "But sometimes it's actually worth the time."

### **NORDIC eSCIENCE GLOBALISATION INITIATIVE (NeGI)**

The NeGI under NordForsk promotes Nordic collaboration on eScience through targeted efforts on eScience research and graduate education.

Activities under the programme include three Nordic Centres of Excellence: two for research on climate change and the environment and one related to health.

Climate change and the environment:

- Ensemble-based Methods for Environmental Monitoring and Prediction (EmblA)
- eScience Tools for Investigating Climate Change at High Northern Latitudes (eSTICC)

Health:

- The Nordic Information for Action eScience Centre (NIASC)

The total budget for the programme was approximately NOK 110 million, with funding from the Nordic Council of Ministers, Research Council of Norway, Swedish Research Council, Academy of Finland and NordForsk.

# NEW NORDIC CENTRES OF EXCELLENCE FOR THE BIOECONOMY

The Nordic Bioeconomy Programme under NordForsk will generate new knowledge on how to promote and advance the transition to a bioeconomy-based society in the Nordic countries. The programme has a budget of approximately NOK 90 million, distributed among three Nordic Centres of Excellence (NCoE) that were launched in 2017.



Illustration: Magnus Voll Mathiassen

## **BIOWATER.** An Integrating Nexus of Land and Water Management for a Sustainable Nordic Bioeconomy:

Researchers from a variety of subject fields will be working with water and environmental resources management authorities and the business sector to develop future scenarios concerning "the green transition". Using existing data from Nordic catchments, the BIOWATER centre will quantify the effects of the various scenarios on water, elemental cycles such as carbon and plant nutrient dynamics, and ecosystem services.

"Along with photosynthesis, water may be the most important factor for achieving the green transition," says Per Stålnacke, Senior Scientist at the Norwegian Institute of Bioeconomy Research and co-head of the BIOWATER centre. "Our approach is to examine water's pathways in the landscape and to quantify all the services water provides from catchments to the end user," adds Jan Vermaat, Head of Department at the Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, and the centre's other co-head.

Participants in the BIOWATER centre include approximately 40 researchers from eight countries, a number of stakeholder representatives and six doctoral fellows.



**Project leader:** Senior Scientist Per Stålnacke, Norwegian Institute of Bioeconomy Research (NIBIO).  
Photo: Erling Fløistad/NIBIO



## **NordAqua.** Towards Versatility of Aquatic Production Platforms: Unlocking the Value of Nordic Bioresources:

Research on the “blue” bioeconomy – that is, on the sustainable utilisation of biological organisms that live in an aquatic environment – is rapidly expanding across the world and there is widespread interest in developing techniques for harnessing photosynthetic algae for refining carbon-neutral biological products.

The NordAqua centre is a consortium of 10 universities and research institutes, 10 industrial partners and several societal stakeholders. The virtual centre includes world-leading experts in photosynthesis, synthetic biology, industrial techniques, microbiology, medical research, water management and entrepreneurship. In all, close to 100 researchers are involved.

“Our aim is to encourage the transition to a more bio-based, sustainable Nordic region using microorganisms that are specially adapted to our harsh northern climate. We will carry out cutting-edge research on photosynthetic algae and develop technology for using this, for example, to purify sewage water and produce biomass which in turn can be exploited as a source of energy such as food or feed for animals,” says head of the centre, Eva-Mari Aro.



**Project leader:** Academy Professor Eva-Mari Aro, University of Turku. Photo: Academy of Finland/Reco

## **SUREAQUA.** Nordic Centre for Sustainable and Resilient Aquatic Production:

The SUREAQUA centre comprises a multidisciplinary group working to generate knowledge, innovation and technology to ensure sustainability and resilience in aquaculture.

“The abundance of aquatic raw materials in oceans, lakes and rivers provides the Nordic countries with unique opportunities for biomass production and refining. Aquaculture, which can be defined as the production of freshwater and ocean-based resources for human use or consumption, can provide large amounts of nutritional foodstuffs, but requires meticulous resource administration to ensure sustainable activity,” says Fiona Provan, who is heading the centre together with Senior Research Scientist Elisa Ravagnan of the International Research Institute of Stavanger.

The SUREAQUA centre is a consortium of 40 Nordic partners representing research and development, industry, public entities and environmental agencies. Together, the partners will develop new solutions to extract food for animals and humans alike from raw materials found in saltwater and freshwater. Focus areas will include fish behaviour, water quality and energy efficiency as well as better utilisation of by-products.

The centre also makes systematic efforts to ensure that the products and techniques they develop will be economically, socially and environmentally sustainable.



**Project leader:** Senior Research Scientist Fiona Provan, International Research Institute of Stavanger (IRIS). Photo: Elisabeth Tønnessen/IRIS





# NORDIC GREEN GROWTH RESEARCH AND INNOVATION PROGRAMME

**Nordic Innovation, NordForsk and Nordic Energy Research have joined forces on this research and innovation programme with the aim of accelerating the transition towards a sustainable Nordic society.**

The Nordic countries have committed themselves to ambitious climate goals towards 2050 in terms of developing energy efficient, low-carbon societies. To achieve these goals, we need extensive green transitions in all areas of the Nordic societies and economies. We need to promote green economic growth, sustainability and competitiveness in both the public and the private sectors.

The Nordic countries produce excellent research and consistently rank among the best when it comes to innovation. The region is well-positioned to develop innovative solutions and provide policy advice targeted towards the opportunities and challenges involved in reaching the Nordic climate goals.

NordForsk, Nordic Innovation and Nordic Energy Research, the main funders of Nordic cooperation in research and innovation, have launched this research and innovation programme together. The programme has a total budget of NOK 73 million.



**1**

**High-Value Products  
from Lignin**

**2**

**New Nordic Ways  
to Green Growth  
(NOWAGG)**

**3**

**CIRCit – Circular Economy  
Integration in the Nordic  
Industry for Enhanced  
Sustainability and  
Competitiveness**

**4**

**Where Does the Green  
Economy Grow? The  
Geography of Nordic  
Sustainability Transitions  
(GONST)**

**5**

**Feather2Feed**

**6**

**Low Temperature Plasma  
for Chemical Production**



## 1. High-Value Products from Lignin:

Lignin is a side-stream component that is available in large quantities from industrial wood refining processes. The objective of this project is to develop technologies to use lignin as an alternative renewable material source in selected high value applications.

The researchers will study multifunctional metal coatings, ultra-pure biogas and functional films for biomedical use or edible food packages. The aim is to reduce production costs and simultaneously improve material properties by using a material that is currently underutilised.

"Within this programme, the closest synergy for us is with the project on low temperature plasma, and we will certainly discuss our projects in more detail. The more non-technical projects are interesting for us as well," says project leader Tarja Tamminen.

### Three potential end uses are envisaged:

- Multifunctional metal coatings: Lignin-containing metal coatings aim at protection against biofouling, water frictional resistance, corrosion and icing in demanding environments, such as marine applications.
- Ultra-pure biogas: Regenerable adsorbent materials with high adsorption capacity and efficiency based on metal-lignin composites will enable the use of biogas e.g. for fuel cell power plants that have strict purity requirements.
- Functional films: Biomedical applications require materials with anti-microbial, cell friendly, biodegradable and biocompatible properties that can be produced in film form. Similar materials can be used for edible food packages. Lignin will be studied as a functional component in such applications.

**Project leader:** Tarja Tamminen, VTT Technical Research Centre of Finland

### Project partners:

VTT Technical Research Centre of Finland  
Aalto University, Finland  
Aarhus University, Denmark  
Royal Institute of Technology, Sweden

## 2. New Nordic Ways to Green Growth (NOWAGG):

How to upscale and finance innovative low-carbon and resource-efficient technologies is essential to green growth. Nordic countries are early adopters of novel environmental technologies, and as such serve as a unique laboratory.

"Our project is about understanding what green growth really is, when green growth is meant to be inclusive to improve welfare in the Nordic region," says project leader Mikael Skou Andersen, Aarhus University.

This research project will improve the basic understanding needed for policy-making related to promoting technological green growth innovations. New types of cooperation between private and public actors may play a crucial role here.

The project will aim to identify key bottlenecks and options for improvement in existing governance arrangements. The availability of venture capital is essential for investment in new technologies. Risk reduction will be illustrated by experiences from a range of case studies of recent Nordic environmental technologies.

The output from this project can be used both in the Nordic countries and globally to promote green growth. Experiences from Nordic countries are much needed to achieve timely de-carbonisation internationally.

**Project leader:** Mikael Skou Andersen, Aarhus University

### Project partners

Aarhus University, Denmark  
Lund University, Sweden  
Fridtjof Nansen Institute, Norway  
Luleå University of Technology, Sweden  
University of Eastern Finland



Tarja Tamminen, VTT Technical  
Research Centre of Finland  
Photo: NordForsk/Terje Heiestad



Mikael Skou Andersen,  
Aarhus University  
Photo: NordForsk/Terje Heiestad



Tim C. McAloone,  
Technical University of Denmark  
Photo: NordForsk/Terje Heiestad

### 3. CIRCit – Circular Economy Integration in the Nordic Industry for Enhanced Sustainability and Competitiveness:

Circular economy is a way of thinking where the main idea is to maximise value creation by utilising raw material and resources in circular systems, also known as circular models. It can be about expanding the life of a product, by repairing or remanufacturing, or providing the product as a service. In the project Circular Economy Integration in the Nordic Industry for Enhanced Sustainability and Competitiveness (CIRCit), researchers will be working in close collaboration with Nordic companies.

“We are aiming at industrial transition by developing tools and methodologies to help the Nordic industry to discover the opportunities that circular economy thinking provides. The goal is for Nordic industry to establish itself as a forerunner in the area,” says project leader Tim C. McAloone.

McAloone and the team in CIRCit will use these tools and methodologies to support industry in increasing resource productivity, enhancing energy efficiency, lowering resource consumption and decreasing waste. The tools and approaches that are developed in the CIRCit project will be freely available to Nordic industry.

“There is much beneficial learning to be gained between all the projects within this programme, even now in the beginning. Business-wise, a circular economy also means finding business opportunities for existing and new companies for enhanced value creation. For example by taking products back, providing new services, reusing parts and components and recycling materials,” says McAloone.

**Project leader:** Tim C. McAloone,  
Technical University of Denmark (DTU)

**Project partners:**  
Technical University of Denmark (DTU)  
Swerea, Sweden  
Federation of Technology Industries in Finland  
NTNU, Norway  
Innovation Center, Iceland



### 4. Where Does the Green Economy Grow? The Geography of Nordic Sustainability Transitions (GONST):

"We want to gain a better understanding of how transitions towards green growth unfold in different Nordic regions. We want to find out whether and how their respective development paths are conditioned by their pre-existing industrial, institutional and governance contexts," explains project leader Teis Hansen.

There is no one-size-fits-all approach to greening the growth path of an economy as this depends on place-based policy and institutional settings, level of development, resource endowments and particular environmental pressure points. This research project addresses the place-based, context-dependent nature of the shift to green growth in the Nordic countries by asking the question: where does the green economy grow?

The project is based on a mixed methods approach. Quantitative techniques will be applied to analyse the importance of human capital and technological specialisation for the greening of the economy. Qualitative case studies of Nordic regions will focus on the role of institutions and account for the diversity in Nordic regional green pathways.

The project in particular seeks to engage pioneering green growth regions in the case study analysis, and a full work package in the project will be focusing on the possibilities for policy-learning between participating regions by involving policy-makers. An important element here will be to distinguish between those successful practices that can be transferred between regions, and those which are context dependent.

"More thorough knowledge on these issues will benefit Nordic society as a whole, as well as the other projects in this programme," states Hansen.

**Project leader:** Teis Hansen, Lund University

**Project partners:**

Lund University, Sweden  
Aalborg University, Denmark  
University of Tampere, Finland  
NIFU, Norway  
SINTEF, Norway  
Technical University of Denmark

### 5. Feather2Feed:

"Our main aim is to bring forth a market-ready technology, where a colourless feather hydrolysate of high digestibility and nutritional value is ready for industrial scale production at the end of the project period. This will be achieved by using a new combination of technologies," says Diana Lindberg, project leader of Feather2Feed.

The challenge addressed by the project is the implementation of improved circular bioeconomy in the global chicken industry. With an increasing world population and mean income, there is a growing demand for protein.

"Today, feather is mostly destroyed, used for soil improvement, or burned for heat generation. When used as a protein feed source, an energy intensive chemical method is used for the feather meal production. In this project we will address the negative environmental issues around the conventional process and provide a radically new combination of state-of-the-art technologies," says Lindberg.

Alternative sources for feed ingredients are needed, preferably derived from by-products from local sources using mild processing conditions. Locally produced feather waste is a by-product-derived, nutritional, protein-rich feed source which is suitable for replacing fish meal and soy protein in pet food, among others.



Teis Hansen,  
Lund University  
Photo: NordForsk/Terje Heiestad



Diana Lindberg,  
Nofima  
Photo: NordForsk/Terje Heiestad



Martin Østberg,  
Haldor Topsøe  
Photo: NordForsk/Terje Heiestad

The project represents a collaboration between Nordic SMEs and a state/private research institution. Since the technology in question has applications both in the Nordic countries and globally, and given the size of the poultry industry and potential access to other protein-rich side streams, the project will be a showcase of innovative Nordic technology solving a global waste problem and satisfying a need for improved protein rich animal feeds.

"We hope that we can be one of the cases that influences the other projects in this programme, especially the ones researching policy, and we look forward to learning from their research."

**Project leader:** Diana Lindberg, Nofima, Norway

## 6. Low Temperature Plasma for Chemical Production:

Lignin is a waste material from wood processes when cellulose and hemicellulose have been extracted. In this project researchers aim to develop a process, based on low temperature plasma, that will be able to decompose lignin into valuable chemicals. This can facilitate production of bio-based chemicals at a price level that is comparable to today's cost.

The application is focusing on using a resource that is present in large quantities in the Nordic countries. If successful, the project may be able to expand the value chain for companies operating in this region – forestry, paper mills, and chemical companies that will be able to produce competitive bio-based chemicals.

The technologies involving bio-based chemicals have a strong foundation in these countries, which are in the forefront of the development of biotechnologies to replace traditional feedstocks typically based on crude oil and other fossil fuels. There is also a large export potential as lignin and bio-based chemicals are not solely related to the Nordic countries.

There is demand for these chemicals in other parts of the world and this demand is increasing as new technologies make it possible to develop alternative production routes.

"There are definitely synergies between the projects in this programme, especially between these two projects focusing on lignin. We will absolutely be able to gain new knowledge from the other project, since they have some expertise that we don't have, and it will be valuable for us to cooperate with them," says project leader Martin Østberg.

**Project leader:** Martin Østberg, Haldor Topsøe

### **Project partners:**

University of Uppsala, Sweden  
Haldor Topsøe, Denmark  
Perstrop AB, Sweden  
N2 Applied, Norway



# THREATS IN THE AIR

According to the World Health Organization, air pollution is the world's largest single environmental health risk. Each year approximately 10 000 people in the Nordic region die prematurely as a result of air pollution exposure, but the question of which pollutants are the most detrimental to health has yet to be resolved. Professor Jørgen Brandt and other participants in the NordForsk project NordicWelfAir are hunting for the answer.





## THREATS IN THE AIR

**A**ir pollution costs the Nordic countries tens of billions of kroner every single year. "It has a negative impact on human health and leads to higher mortality and greater inequality in the distribution of welfare. In order to regulate air pollution effectively, we have to find out which chemical substances are the most harmful and which population groups are affected the most," says Jørgen Brandt, professor at the Department of Environmental Science at Aarhus University and project leader of the NordicWelfAir project.

Together, the 16 partners from five Nordic countries participating in the project will map out air pollution and its various components all the way down to a 1 km x 1 km resolution for all the Nordic countries. Project activities also include development of a common air pollution modelling framework which will, for the first time, make it possible to calculate air pollution levels in the Nordic countries from 1990 to the present with the same geographical resolution for all countries.

### High costs and more disease

Although the air quality in the Nordic countries is relatively good compared with many other regions, the negative health effects of air pollution are significant. It can lead to respiratory disease,

### UNDERSTANDING THE LINK BETWEEN AIR POLLUTION AND DISTRIBUTION OF RELATED HEALTH IMPACTS AND WELFARE IN THE NORDIC COUNTRIES (NordicWelfAir)

The NordicWelfAir project is funded under NordForsk's Programme on Health and Welfare and has 16 partners from five different Nordic countries.

The NordicWelfAir project will identify which emissions are most harmful to human health and, with the aid of the Nordic registers, determine which diseases they can cause and who is most vulnerable to negative health impacts.

**Budget:** NOK 30 million.

**Duration:** 2015–2020.

**Project leader:** Professor Jørgen Brandt, Department of Environmental Science, Aarhus University.

cardiovascular disease and cancer, as well as further complications for those already suffering from other illnesses.

"We have a problem with air pollution in the Nordic region. Our air may not be as bad as in Beijing, but it nonetheless poses a very serious health and socio-economic problem on a Nordic scale. We already know quite a bit about the consequences of air pollution exposure, and in Denmark alone there are close to 4 000 premature deaths related to air pollution each year. This is 20 times higher than the annual figures for traffic fatalities," Professor Brandt states.

"Air pollution is a significant cause of disease, and it costs society an enormous amount of money. Just for Denmark the cost is DKK 30 billion each year," he continues. "This includes costs associated with premature death, sickness absence and hospital admissions, for example."

### Which substances are most harmful and who is most affected?

In the face of such a severe problem that leads to both serious illness and high societal costs, it is imperative to find the best, most effective means of mitigation. That is what the NordicWelfAir project is planning to help with.

"Air pollution consists of a combination of many different types of particles and gases that can adversely affect human health in a variety of ways. We don't really know which substances are most harmful. Therefore, the project will see whether the answer is, for instance, soot particles from oil, wood and coal-burning stoves; NO<sub>x</sub> emissions from automobiles leading to nitrate particles; or ammonium particles from agriculture," the professor says, adding: "In short, we are going to determine which sources are the most damaging pollutants and who is most vulnerable."

### Air pollution travels rapidly over great distances

Fine particles in the air are rapidly transported by wind across national borders and are deposited by rain and snow on surfaces below. Using different air pollution models, the NordicWelfAir project will identify where pollutants are coming from, and it may not necessarily be from a country close by.





Professor Jørgen Brandt and Senior Scientist Camilla Geels from the Department of Environmental Science at Aarhus University  
Photo: NordForsk/Trine Bukh

"Pollutants in the air you breathe on the streets of Oslo or Copenhagen come from numerous sources," the professor explains. "Local traffic is an obvious source, but some are coming from other cities and countries, even distant sources like China and the US or a cloud of volcanic ash from Iceland. Our model allows us to perform detailed calculations, which in turn can identify which areas are most exposed to air pollution and where it comes from. This is unprecedented at this scale in air pollution research."

#### **Nordic registers a goldmine for research**

An important element of the NordicWelfAir project is to look at air pollution in relation to various diseases to find any significant relationships. The unique Nordic health registers compiled over many decades are essential in this context. The data sets show, for example, where individuals have lived and relocated. Linking these data to the project data model makes it possible to calculate the amount of air pollution these people have been exposed to over the past 25 years, almost hour by hour.

"The Nordic registers represent unlimited potential for our project. The public's high level of trust in their respective authorities has enabled the countries to compile a wealth of information at the level

of the individual. We have selected 17 pollutants (particulates and gases) we believe to be the most harmful, and using the registers we can in principle link them to hundreds of negative health effects," Professor Brandt explains.

In addition, the NordicWelfAir project will study whether the effects of air pollution on health vary, for example between men and women, different age groups, income levels and education.

"All information about the various diseases people have, what is wrong with them and causes of death has been stored. This enables us to find out which substances and emissions are most detrimental, and which diseases they cause. We could write thousands of scientific articles based on this material, so it is safe to say that the Nordic registers are a goldmine for researchers," says Jørgen Brandt with a smile.

#### **Interdisciplinarity generates Nordic added value**

Five groups representing completely different subject fields are working together on the NordicWelfAir project. While this could easily have been problematic, it has instead become one of the project's strengths.

"The project involves researchers from environmental economics, atmospheric modelling, welfare



## THREATS IN THE AIR

research, register research and epidemiology, as well as researchers studying emissions of pollutants. With such a wide variety of scientific groups we learn a great deal from one another and probably look at things somewhat differently from how we would have done otherwise. It is both exciting and refreshing, and I'm certain that this way of working makes each of us better," Professor Brandt says. "It's also very motivating to find that the individual fields are gaining new strength from cooperating with other Nordic scientists in the same area. Everyone has different areas of expertise and experience, which they share and use to enhance each other. In this way the project generates Nordic added value by boosting each country's national research communities in the areas of emissions, register research or environmental economics."

### **Research findings as a basis for policy**

Co-coordinator of the NordicWelfAir project, Senior Scientist Camilla Geels, who is also from the Department of Environmental Science at Aarhus University, is hoping the project's findings can be used as a basis for advising authorities on which emissions should be regulated more strictly.

"If we can prove that emissions from heating stoves, for example, are particularly harmful and can cause disease x and y, which in turns costs society z amount of money, that will make it easier for politicians to take concrete decisions. There are many cars in Nordic countries and motorists are often singled out as the major culprit when it comes to air pollution. Vehicle emissions are undeniably a problem, but the automobile industry is highly regulated compared with other sources of pollution such as residential heating," she points out.

"Heating stoves are also a sensitive political subject as they represent something special to many Nordic residents. They are associated with family togetherness and good times and even though the vast majority of people have alternative heating sources, they still use their stoves," Ms Geels explains, adding: "The profile of the Nordic countries is greener than many other regions. If they stand united before the EU to advocate stricter regulation of air pollution and, in addition, can present concrete research findings from a joint Nordic activity like the NordicWelfAir project, they will have a much stronger voice than if each country tries to do it on its own."

### **Hard to rule out other causes of disease**

According to Professor Brandt, one of the most difficult aspects of the project will be proving that disease and health problems are in fact the result of air pollution as opposed to other factors.

"The epidemiological component of the project is looking at this issue. If you live near a highway it may well be noise pollution and not just emissions that cause health problems. Smoking and/or a poor diet are also potential causes of disease," he says. "It's a difficult task, but here we will draw on data from the various registers in addition to other studies. For example, the University of Copenhagen has conducted a survey over many years asking nurses what they eat and drink, if they smoke and where they live. The Danish Cancer Society Research Center maintains a similar register of cancer patients. That is, they know a great deal about their lives."

Ms Geels continues: "We can use this approach to compare information found in the national registers against other surveys, and attempt to rule out patients whose disease is rooted in other causes. We are also working together with the Department of Public Health at Aarhus University, where they have a research project where they take people into a chamber and expose them to air pollution. They measure how the subject's body reacts in a wide variety of ways. This yields a better understanding of the physiological effects of polluted air when it comes to pulmonary and cardiovascular diseases, for example."

### **Impossible without NordForsk**

Both Jørgen Brandt and Camilla Geels are clear that this project would not have been possible without Nordic Programme on Health and Welfare under NordForsk.

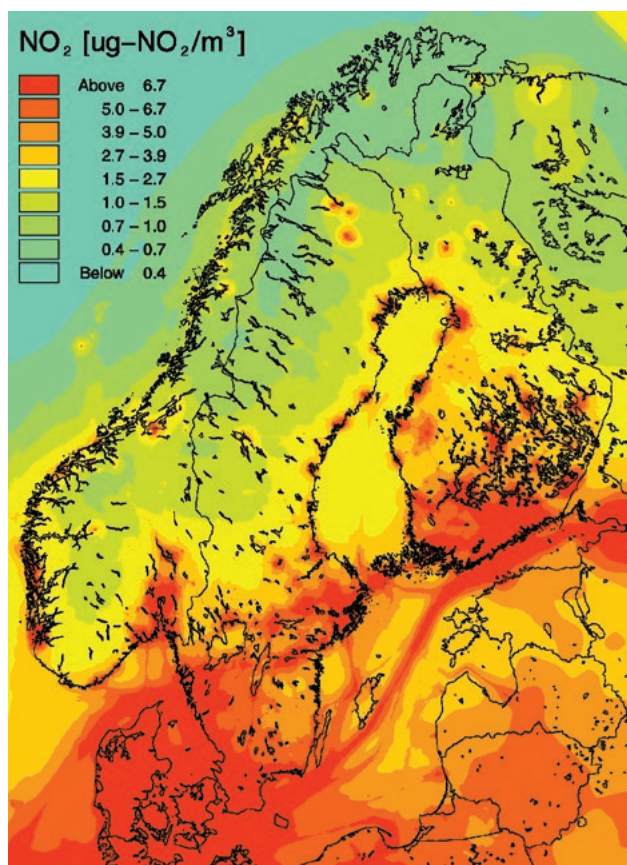
"We are certain that NordForsk is the only entity that would have funded such a large, interdisciplinary Nordic project," says Ms Geels. "This is also part of the reason why everyone is so enthusiastic. This is a unique project that can yield revolutionary results within several subject fields, and people all over the world are following these efforts with major interest," Professor Brandt concludes.

### **The road ahead**

The NordicWelfAir project is nearly halfway through its project period, and the two colleagues are eagerly anticipating the next half.

“We have completed two years of the project, and are more inspired now than ever before. The findings of the various working groups are starting to come in, and we will soon have a better picture of which sources of air pollution are the most harmful, what the negative impacts they have on health are, and what steps to take to improve Nordic air quality,” Professor Brandt says.

“We hope the outcome of our research will help to promote constructive political decisions that lower air pollution levels in the Nordic countries and lead to less disease and premature death. That would be the true measure of success for the NordicWelfAir project,” he concludes.



Nitrogen dioxide (NO<sub>2</sub>) is one of the gases shown to be detrimental to human health. The picture shows the annual average concentrations of NO<sub>2</sub>, calculated with one of the modelling systems (DEHM-UBM) used in the NordicWelfAir project. The picture shows higher concentrations in cities and in the vicinity of large point sources. Shipping is also a significant source of NO<sub>2</sub>.  
Figure: NordicWelfAir

## NORDIC PROGRAMME ON HEALTH AND WELFARE

The overall goal of the Nordic Programme on Health and Welfare is to improve health in the Nordic countries by finding solutions to societal and public health challenges through high-quality research. The programme is a cooperative effort between the Academy of Finland; Independent Research Fund Denmark | Medical Sciences; Icelandic Centre for Research (Rannís); Research Council of Norway; Swedish Research Council for Health, Working Life and Welfare (FORTE); Swedish Research Council; and NordForsk. The budget is approximately NOK 300 million.

### Denmark

- Aarhus University, Department of Environmental Science
- Aarhus University, Department of Public Health
- Aarhus University, Centre for Integrated-based Research
- Danish Cancer Society Research Center

### Finland

- Finnish Environment Institute
- Finnish Meteorological Institute
- National Institute for Health and Welfare

### Sweden

- Swedish Meteorological and Hydrological Institute
- Umeå University (UmU)
- IVL Swedish Environmental Research Institute Ltd.

### Norway

- NILU – Norwegian Institute for Air Research
- Norwegian Institute for Water Research
- Vista Analysis
- Norwegian Institute of Public Health

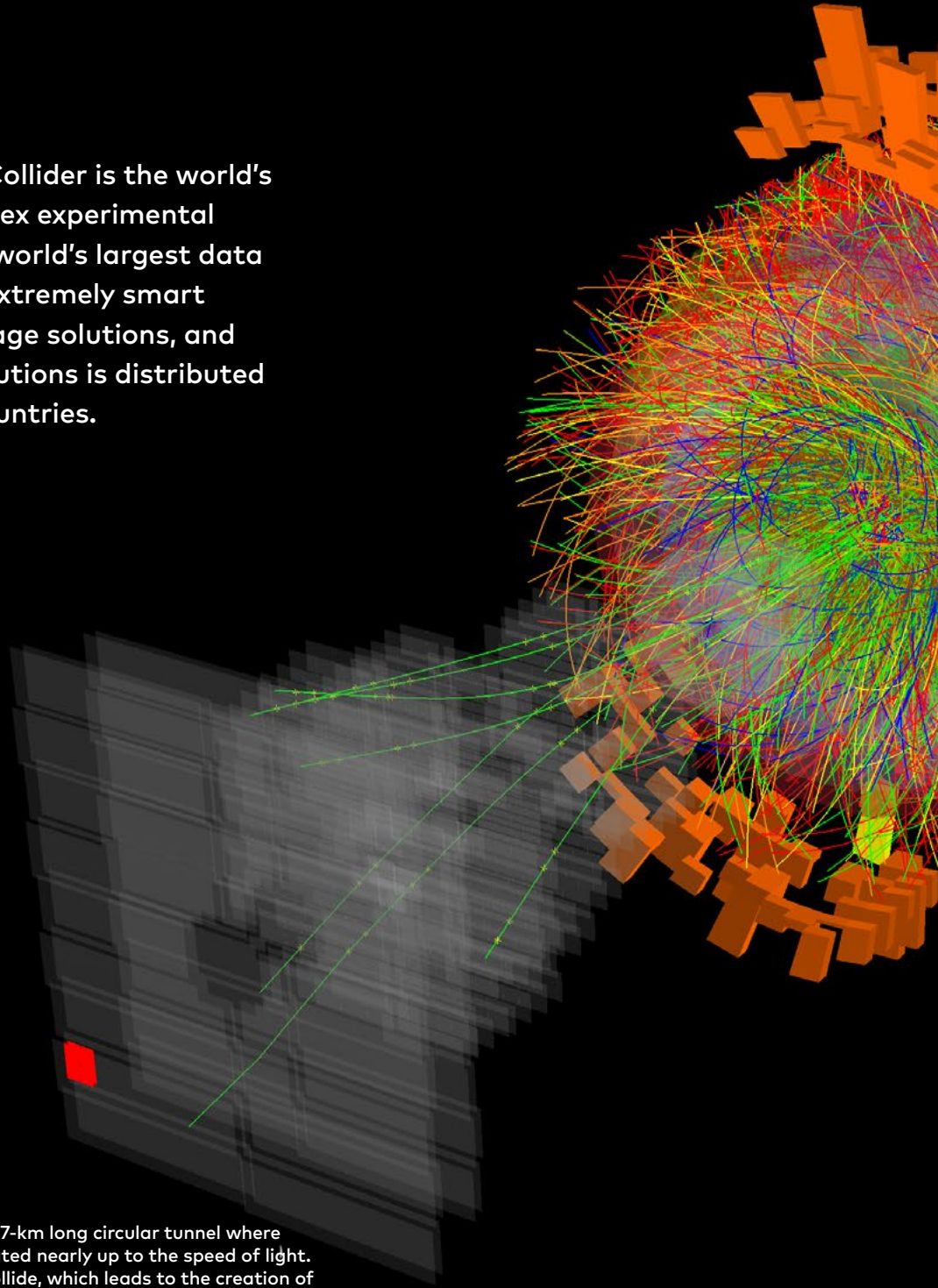
### Iceland

- Landspítali – The National University Hospital of Iceland
- University of Iceland

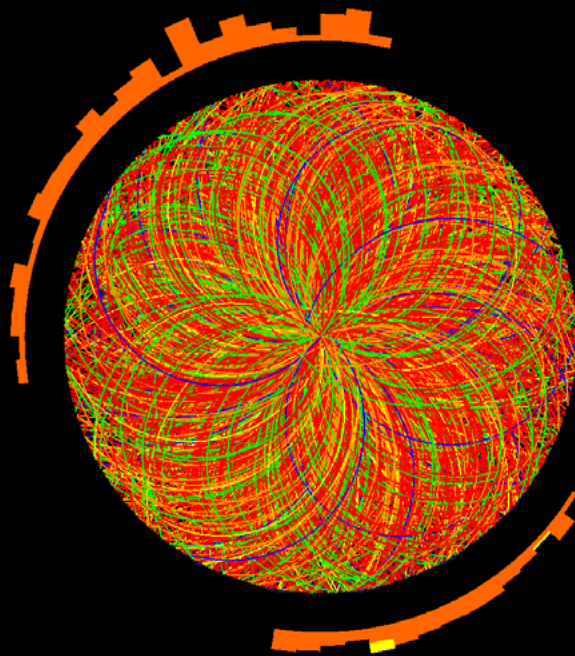
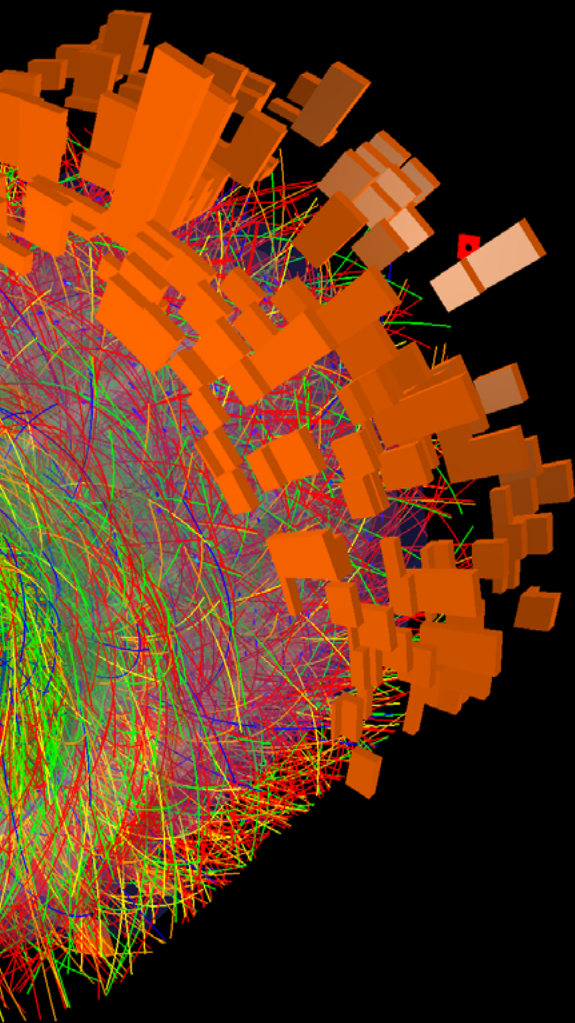


# THE SMARTEST STORAGE FOR THE WORLD'S LARGEST DATA VOLUMES

CERN's Large Hadron Collider is the world's largest and most complex experimental facility, generating the world's largest data volumes. This calls for extremely smart data handling and storage solutions, and one of the smartest solutions is distributed between four Nordic countries.



CERN's Large Hadron Collider is a 27-km long circular tunnel where protons and lead nuclei are accelerated nearly up to the speed of light. The particles are then brought to collide, which leads to the creation of new particles – and enormous amounts of data. The picture is from a collision in ALICE; one of LHC's seven detectors. Photo: CERN.



**THE NORDIC e-INFRASTRUCTURE  
COLLABORATION (NeIC)**

NeIC facilitates development and operation of high-quality e-Infrastructure solutions in areas of joint Nordic interest.

NeIC is a distributed organisation consisting of technical experts from academic high-performance computing centres across the Nordic countries.

NeIC is a joint initiative between the Nordic countries, hosted by NordForsk since 1 January 2012.

Annual budget:  
Approximately 28 million NOK.



## THE SMARTEST STORAGE FOR THE WORLD'S LARGEST DATA VOLUMES

**T**he Large Hadron Collider (LHC) outside Geneva, on the border between Switzerland and France, is the latest addition to the accelerator complex at the European Organization for Nuclear Research (CERN). The LHC allows physicists to test different theories of particle physics, mainly by accelerating beams of protons or lead nuclei up to almost the speed of light. When these particles are flying fast and carrying very high energies, researchers smash them together – in order to investigate the new and strange particles that sometimes arise.

### **An unprecedented amount of data**

The LHC is an extremely advanced and complicated research facility, and the multitude of sensors and instruments along the LHC also produce enormous amounts of data. The current production amounts to hundreds of petabytes per year, and production is expected to increase by 10 to 100 times in the near future. That is why CERN needs the Worldwide LHC Computing Grid (WLCG), which is exactly what the name implies: a global collaboration of more than 170 computing centres in 42 countries linking together national and international grid infrastructures.

“The structure of distributed computer centres was chosen because no institution alone would have been capable of receiving, storing and processing the total output of data from CERN,” explains High Performance Computing expert Mattias Wadenstein at NeLC. He is also the manager of the distributed Nordic Tier 1 site in the WLCG.

The WLCG is composed of four levels or “tiers”, of which Tier 0 is CERN’s own data centre – which is distributed between Switzerland and Hungary. All the data from the LHC passes through this central hub, but it provides less than 20 per cent of the grid’s total computing capacity.

### **A Nordic model for the future**

Tier 1, where Mattias Wadenstein is working, consists of 13 computer centres. They provide round-the-clock support for the whole grid and are responsible for storing raw and reconstructed data, as well as for performing large-scale reprocessing and storing the corresponding output. The centres are also responsible for distributing data to Tier 2 institutions, typically universities and other scientific institutes that can store sufficient data and provide adequate

computing power for specific analysis tasks. The majority of the grid’s resources are located in Europe, but there are resources in North America and East Asia as well, and centres in other parts of the world also contribute to this global effort.

One of the Tier 1 centres is located in the Nordic countries, and it functions like any other Tier 1 computer centre. But a closer inspection reveals that the Nordic Tier 1 facility, which is part of the globally distributed network, is itself a distributed network with storage facilities at the universities in Oslo and Bergen in Norway, Linköping and Umeå in Sweden, Espoo in Finland and Copenhagen in Denmark.

“The Nordic facility is in fact one of the smaller Tier 1 facilities, although it is still a massive undertaking. But the most interesting thing is perhaps that the distributed structure has worked so well that it is now being seen as a model for the future,” Mr Wadenstein explains.

According to a recent evaluation report by the Spanish expert Dr Josep Flix, the Nordic model provides a unique set of competencies and is a successful example which other data and computing centres around the world could learn from. The evaluation report states that the Nordic distributed model may even prove critical for the worldwide LHC network’s future capacity to handle large volumes of data from CERN.

### **Rising to the challenge**

One of the requirements for being one of CERN’s Tier 1 computer centres is that it should appear to be one site. Therefore, the Nordic team built a solution that hides the distributed nature effectively. “That was a challenge, and was only possible because we managed to recruit a good technical team that can maintain and evolve the setup,” Mr Wadenstein says.

“One of the advantages with the Nordic structure is the national co-funding, which offsets some of the extra costs that come with distribution. In addition, the structure brings a lot of competence closer to more universities than would otherwise have been the case,” he explains. He adds that the Nordic Tier 1 is a meta-centre under the shared control of different national organisations.

“In my opinion, this is an excellent example of Nordic collaboration rising to the challenge of receiving

Mattias Wadenstein is the Nordic area coordinator for CERN's Worldwide LHC Computing Grid (WLCG) and leads the meta-distributed Nordic part of the collaboration. Photo: NordForsk.



and storing huge data flows. The key to success is a combination of good routines, a high-quality platform, and continuous development of the open source software that we are heavily dependent on," Mr Wadenstein says.

#### **Looking for a needle in the haystack**

The LHC started up in September 2008 and achieved its greatest success so far in 2013 with the discovery of the Higgs boson, one of the most fundamental components of the fabric of our universe. Far from closing the books, this discovery opened up whole new areas of research into the stability of the universe, why it seems to hold so much more matter than antimatter, the composition and abundance of dark matter, and so on.

Mattias Wadenstein adds that the researchers at CERN and the LHC are throwing away more than 99.9 per cent of the data from the experiments because they are only interested in observing the collisions and special events. They are looking for "the needle in the haystack", so they have no use for data about the hay. But the remaining amount of data, which must be stored for future research, is still enormous.

The LHC machine is taken down for upgrading from time to time. The latest upgrade, in 2015, was so

successful that the experiments started to generate more than twice the amount of data that the facilities were prepared to accommodate. That was of course a test that the Nordic facility passed with flying colours.

According to Mr Wadenstein, one of the advantages of the distributed setup is that the system is very scalable. The future will be bringing new challenges because a planned LHC upgrade in 2022 could lead to a factor 100 increase in data volumes to be stored and processed.

"I am confident that we shall be able to rise to this challenge", says Wadenstein.



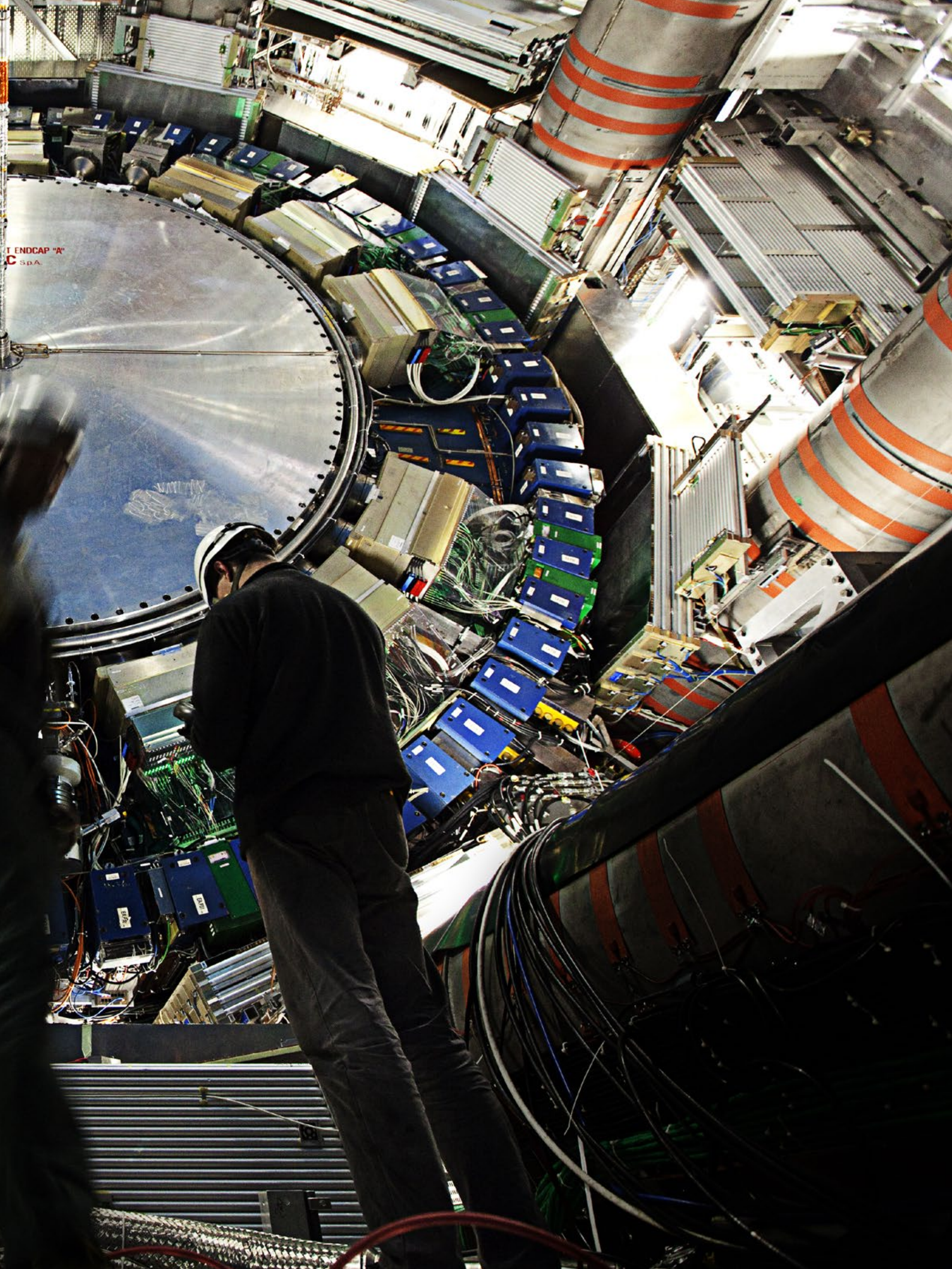
# STUDYING DARK MATTER WITH THE BEST e-INFRASTRUCTURE

Professor Farid Ould-Saada wants to solve one of the largest remaining mysteries in the natural sciences: What is the nature of dark matter? His data come from the world's largest research facility, CERN, and his tool is the world's most advanced network for distributing, analysing and storing data – which happens to be Nordic.

The ATLAS detector at the LHC weighs about 7 000 tonnes and is being used in the efforts to produce dark matter similar to that which is thought to have come from the Big Bang.  
Photo: Claudia Marcelloni, CERN.



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## STUDYING DARK MATTER WITH THE BEST E-INFRASTRUCTURE

**T**he existence of dark matter was, in principle discovered in 1932 when the Dutch astronomer Jan Oort proved that the visible matter in the Milky Way was not sufficient to hold the galaxy together because of gravity. He concluded that there must be more matter out there. But what is the nature of this matter?

Professor Farid Ould-Saada at the University of Oslo explains that dark matter is a mystery in both particle physics and astrophysics. Observations have shown that the universe must contain a type of matter that does not emit or interact with electromagnetic radiation, so it must be very different from the ordinary matter that surrounds us.

"But we still don't know what this dark matter is made of. The nature of dark matter is one of the great unsolved mysteries in the field of natural science," Professor Ould-Saada says.

### Trying to create dark matter

"We are trying to solve this mystery by looking at it from all possible angles, and one of these angles involves using the Large Hadron Collider (LHC) at CERN. We are basically trying to produce dark matter by recreating the conditions that existed in the universe shortly after the Big Bang, which occurred about 13.7 billion years ago. Because we know that dark matter – whatever it is – had to be there from the start," he explains.

Professor Ould-Saada is involved in the ATLAS experiment, which is one of the seven detectors in the 27-km-long circular tunnel that is the backbone of the LHC. ATLAS is a giant detector that weighs 7 000 tonnes, and it played a crucial role when scientists at the LHC and CERN discovered the Higgs boson in 2012. As a general purpose detector, ATLAS can be used to investigate a wide range of physics, and it is now being used in the search for the particles that could make up dark matter.

### Taking care of Big Data

"We realised already around the year 2000 that the enormous amounts of data from the LHC would become a problem. When the LHC is running, we have a collision between particles every 25 nanoseconds, and each collision generates an enormous amount of data that must be received, sorted, stored and analysed. Today, the Worldwide LHC Computing Grid

handles hundreds of petabytes ( $10^{15}$  bytes) per year, and we expect a 10-to-100-fold increase in the years to come," he says.

The scientists at CERN soon realised that they would need a system for distributed computing in order to handle all the data. After much deliberation, they settled on a system with a total of 170 computing centres at different levels or tiers in 42 countries. The uppermost level – Tier 0 – is CERN's own computing centre, which distributes data to 13 centres at a lower level called Tier 1. These centres further distribute data to a large number of centres at Tier 2, the level where Professor Ould-Saada works.

The Nordic contribution to Tier 1 is a distributed centre that links together data processing and storage facilities at six universities in Norway, Sweden, Finland and Denmark.

### The best centre in the world

Professor Ould-Saada and his colleagues in Oslo travel to CERN in Switzerland from time to time, but most of their work is done in front of their computers at the Department of Physics. Although he does not have direct access to the data coming out of CERN, it almost seems that way because the Nordic contribution to the Tier 1 network is functioning above all expectations.

"In my opinion, the Nordic Tier 1 Facility functions better than all 12 of the other Tier 1 facilities around the world. This Nordic success is due in large part to the 'middleware' that was developed via the NorduGrid collaboration and to the close cooperation between physicists, computer scientists and system administrators," says Professor Ould-Saada.

"It was necessary to have a critical mass of scientists and other experts in order to establish a Tier 1 facility, and none of the Nordic countries had the necessary resources on their own. But we reached the level of critical mass when we decided to collaborate at the Nordic level," Professor Ould-Saada concludes.

# the ATLAS Experiment

CERN

Geneva, Switzerland



Farid Ould-Saada is a professor of High Energy Physics at the University of Oslo and is trying to find out what dark matter is made of.

Photo: NordForsk/  
Terje Heiestad



# NORDIC NEUTRON SCIENCE PROGRAMME

The Nordic research community will have a front row seat when the European Spallation Source (ESS) becomes operational in 2019 and NordForsk is helping to prepare researchers to take advantage of the new opportunities.

The European Spallation Source is a DKK 20 billion research facility under construction in Lund, Sweden. The facility will house what is going to be the world's most powerful neutron source. The neutron source will essentially function as a giant microscope that will enable researchers to study the attributes of a wide range of materials and organisms down to the atomic scale. The facility will help to expand knowledge within medicine and life sciences, energy conversion and storage, and smart materials, to name a few.

In order to help prepare Nordic researchers to take maximum advantage of ESS, NordForsk has launched a research programme for neutron research, with an emphasis on building new competencies.

The programme's objectives are to provide more of the Nordic region's researchers with the skills needed to utilise neutrons in scientific analysis, as well as to enhance competency levels in neutron scattering, particularly among younger researchers.

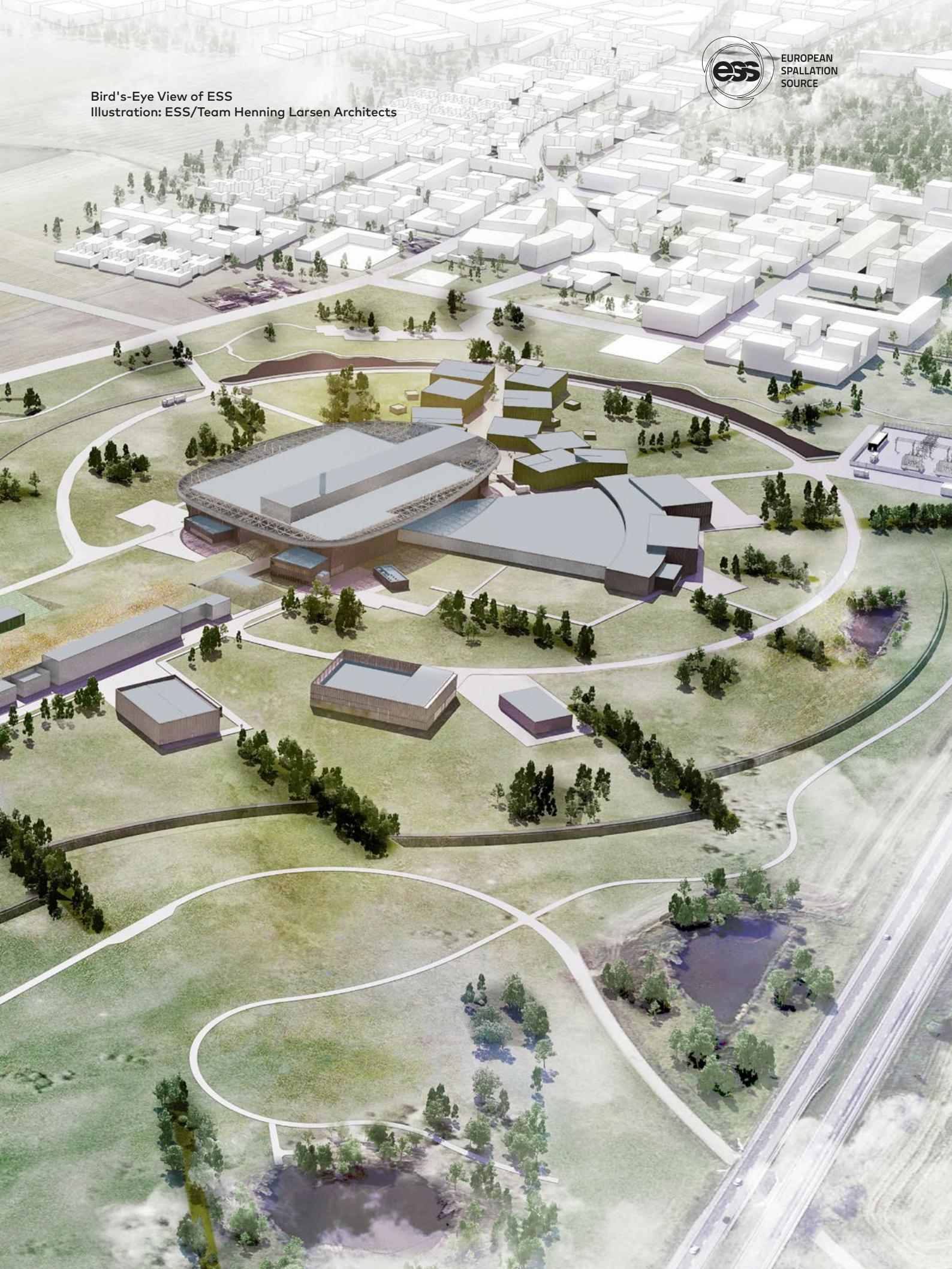
The programme has a budget of approximately NOK 65 million and is funded by the Danish Ministry of Education and Science, Research Council of Norway, Swedish Research Council, Swedish Foundation for Strategic Research and NordForsk.

A number of calls for proposals were issued during 2016 and the following activities are currently being funded:

- 1  
**Nordic Neutron School**
- 2  
**Functional Hydrides – FunHy**
- 3  
**The structure of membrane**
- 4  
**Antimicrobial peptides seen by neutrons: from basic mechanism to the next generation antibiotics**
- 5  
**Neutrons for heat storage**
- 6  
**Water selectivity of aquaporins using neutron scattering**
- 7  
**Magnetic frustration under pressure**
- +  
**Neutron science capacity-building networks**



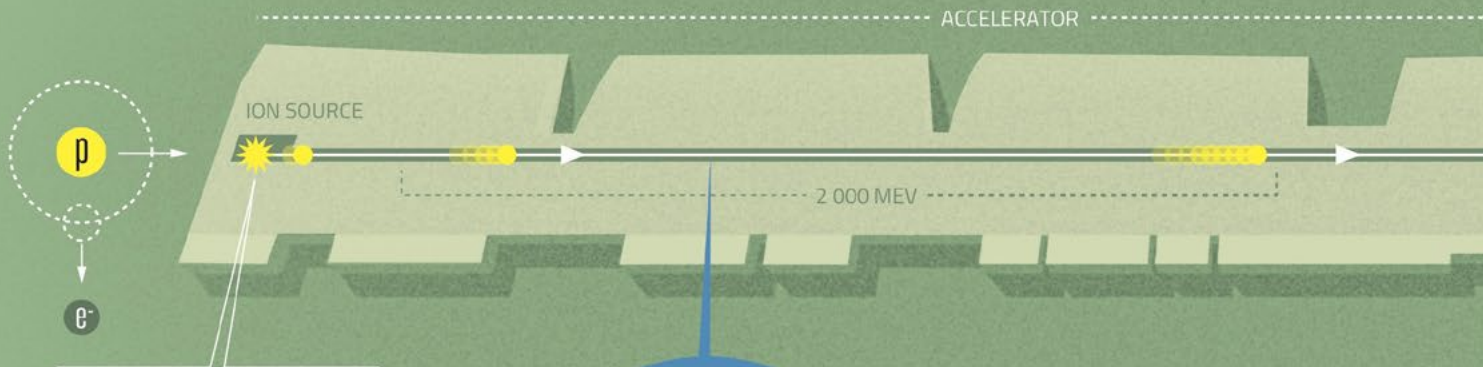
Bird's-Eye View of ESS  
Illustration: ESS/Team Henning Larsen Architects





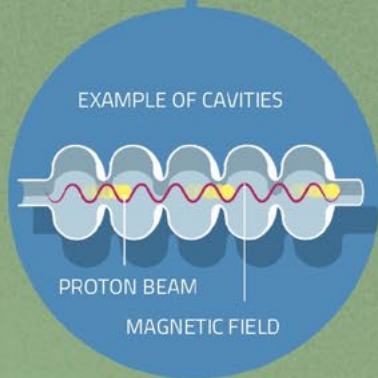
EUROPEAN SPALLATION SOURCE

The European Spallation Source (ESS) is a multi-disciplinary research centre based on the world's most powerful neutron source. ESS will give scientists new possibilities in a broad range of research, from life science to engineering materials, from heritage conservation to magnetism. ESS is a pan-European project, with Sweden and Denmark serving as host countries. The main research facility is being built in Lund, Sweden, and the Data Management and Software Centre (DMSC) is located in Copenhagen, Denmark.



PROTONS GENERATED IN AN ION SOURCE

In the ion source protons are generated and guided into the linear accelerator, the Linac. The first part of the linac is used to focus the proton beam while it accelerates.



CAVITIES ACCELERATE THE PROTONS

Electromagnetic fields are used to accelerate the protons to approximately 96% of the speed of light. The second part of the accelerator consists of superconducting cavities which are cooled to -271 °C using liquid helium. After traveling 602.5 m the protons hit the target wheel.

TOTAL BUILDING AREA 65 000 m<sup>2</sup>

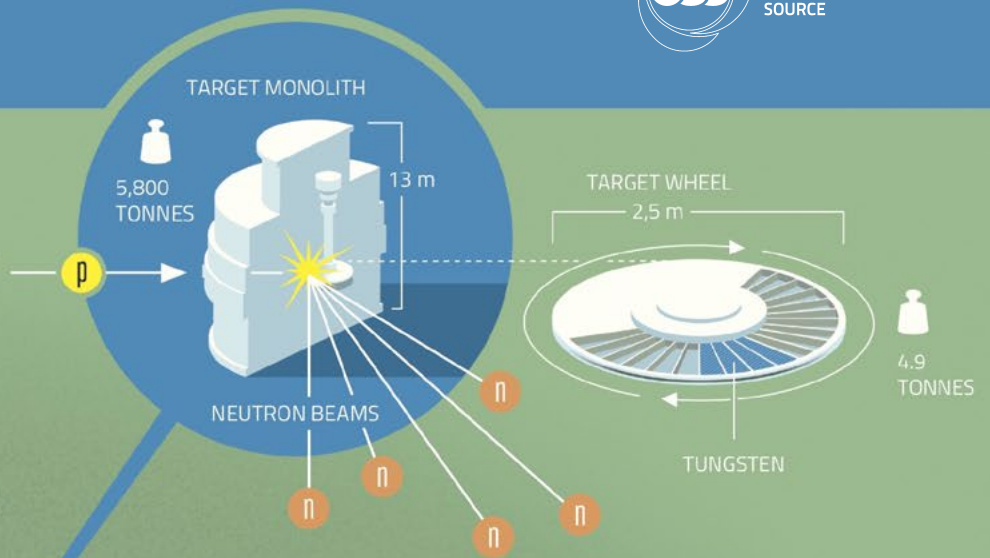
The ESS facility will be approximately 650 metres in total length. The target building will be 125 metres long, and about 30 metres high. The 537-meter-long accelerator tunnel is built underground and will be covered with soil.

- Concrete: \_\_\_\_\_ 50 000 m<sup>3</sup>
- Rebar: \_\_\_\_\_ 6 000 tonnes
- Pipes: \_\_\_\_\_ 40 km
- Cables: \_\_\_\_\_ 2,000 km
- Total volume: \_\_\_\_\_ 400,000 m<sup>3</sup>



### THE TARGET IS THE NEUTRON SOURCE

When the accelerated protons hit the rotating tungsten target wheel spallation occurs and neutrons are scattered from the tungsten nucleus. The more neutrons produced and collected in the target, the "brighter" the neutron source. The neutrons are directed through moderators and neutron guides to the scientific instruments where they are used for experiments. The Target monolith consists of the Target wheel, moderators, cooling systems and shielding and weighs approximately 5,800 tonnes.



EXPERIMENTAL HALL 1

SCIENTIFIC INSTRUMENT

LABORATORIES/OFFICES

TARGET BUILDING

LABORATORIES

EXPERIMENTAL HALL 2

NEUTRON BEAMS

EXPERIMENTAL HALL 3

SCIENTIFIC INSTRUMENT

SAMPLE



### PILES TO AVOID MOVEMENTS

The heavy Target building and experimental halls are resting on a total of 6,400 piles of different types, in order to avoid unwanted movements in the structure.

### UNIQUE CAPABILITIES OF ESS

ESS will have 22 tailor-made instruments located in three experimental halls. Neutrons are excellent for probing materials on an atomic and molecular level – everything from motors and medicine, to plastics and proteins. The neutrons hit the sample and detectors register the neutron scattering, giving precise information about the material's structure and dynamics.

TARGET MONOLITH





From the first Graduate School on Neutron Scattering  
Photo: NordForsk/Eivind Sætre

### 1. Nordic Neutron School: Theory, experiment, and e-learning.

The school will carry out a range of teaching activities to educate the future Nordic neutron scattering community and enable coming researchers to make the best possible use of ESS. The elements are:

- A core course, to be held regularly, to train Nordic PhD students in the basic techniques of neutron scattering.
- A hands-on course on diffraction and SANS to be held at the JEEP-II reactor in Norway, as well as hands-on activities to be available at international facilities.
- A series of targeted advanced courses on relevant subjects.

The school offers a new teaching concept combining a prepared set of lecture notes with e-learning modules and exercises containing analysis of real data.

The first Graduate School on Neutron Scattering took place in Tartu, Estonia, 11–21 September 2017.

**Project leader:** Kim Lefmann, University of Copenhagen

### 2. Functional Hydrides – FunHy:

FunHy is a consortium carrying out research and education at the frontier of materials science, and will utilise neutron scattering as a tool for meeting the grand energy challenges of storing and converting renewable energy.

The project seeks to design and develop novel functional materials based on advanced characterisation using neutron scattering.

The project will look especially at the potential of hydrides – that is compounds of hydrogen and other elements.

The project is a collaborative effort within a strong Nordic and international research network and offers the highest level of education in energy materials science for three directly funded PhDs, and a high number of Bachelor, Master and associated PhD students. An open Nordic research meeting will be organised with the aim of gathering Nordic experts, starting new collaborations and sharing knowledge. The project will expand the reach of the Nordic research networks and enhance collaboration in the field of neutrons for materials science.

**Project leader:** Torben Jensen, Aarhus University

### 3. The structure of membrane proteins under solution conditions:

Cell membranes and their membrane proteins hold important keys to the production of both current and future medicines. But these cellular systems are multicomponent by nature and the interactions between the protein, membrane and the surrounding water phase are still very poorly understood. More structural information about them is needed to develop medicines that can adequately target them.

This project will combine neutron and X-ray scattering to study specific examples of such systems in order to gain new insights. The central target to be investigated is the magnesium transporter A). Bacteria have always been a part of human life. The bacteria *E. coli* in our gut needs magnesium, just like humans do. To take up magnesium, *E. coli* has two separate protein systems, one functioning at high levels of magnesium and one at low levels of magnesium. The latter system is called magnesium transporter A and moves magnesium into *E.coli*. More knowledge about the structure of the protein is required to provide the molecular understanding needed to design molecules that boost or stop this protein's function.

**Project leader:** Marie Skepö, Lund University

### 4. Antimicrobial peptides seen by neutrons: from basic mechanism to the next generation antibiotics:

Antimicrobial peptides (AMPs) are found in many species, and their function is to fight pathogens such as bacteria. Human saliva and sweat contains AMPs as a part of the immune system. Some AMPs act against fungi, viruses and even tumours.

These molecules have been around for hundreds of millions of years and have largely been able to avoid bacterial resistance. Yet they are used surprisingly little in treatments, mainly because they are somewhat unstable towards enzymes and may be toxic to other cells.

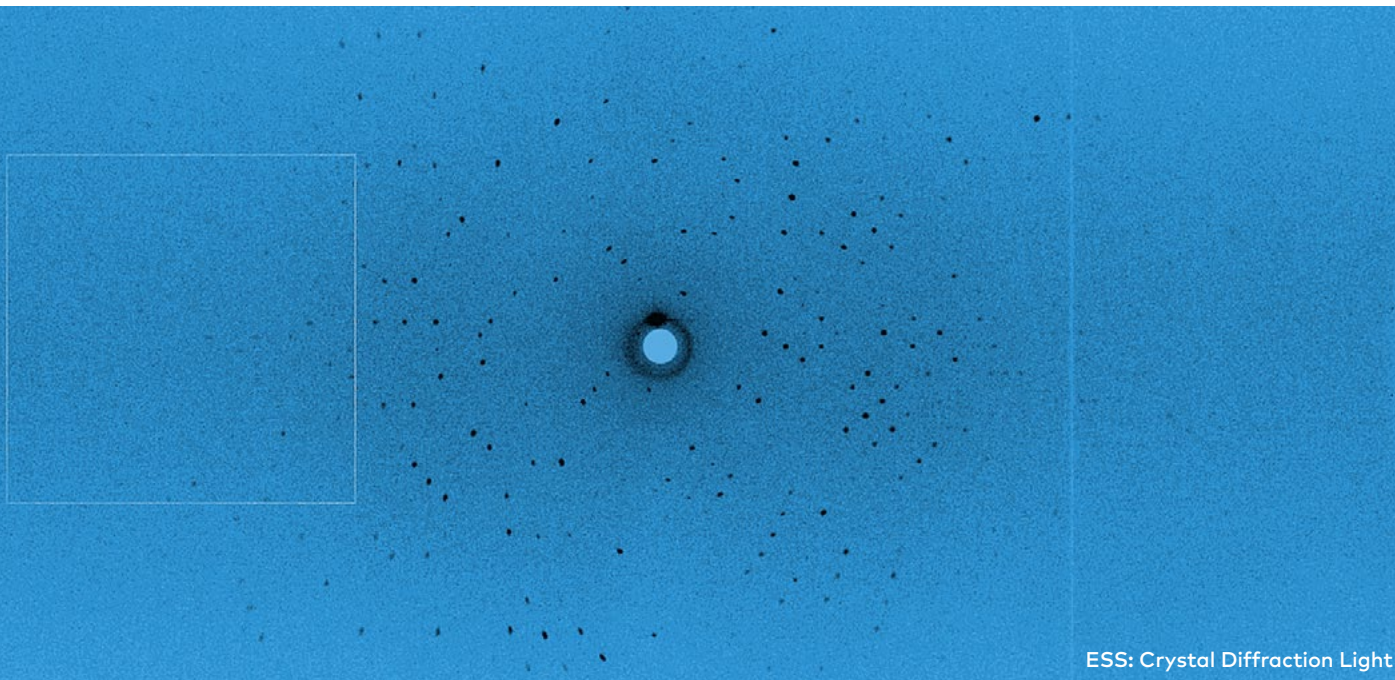
To utilise these compounds, more research is needed to understand how they work and how they can be modified to enhance stability and reduce toxicity.

This project brings together experts in synthetic chemistry of antibiotics and experts in the fields of physical chemistry and neutron scattering to learn more about how these fascinating materials work and how they can be used to combat the growing threat of multi-resistant bacteria. Neutron scattering will help to reveal on a molecular scale how the peptides act on lipid membranes, the main target of their antimicrobial action.

This insight will facilitate the design of new materials that can be used for therapeutic purposes.

**Project leader:** Reidar Lund, University of Oslo





ESS: Crystal Diffraction Light

### 5. Neutrons for heat storage

Energy storage has been identified as a strategic technology for supporting the transition to a fossil-fuel free society and economy.

Heat Storage stocks thermal energy by heating or cooling a storage medium, so the energy can be used at a later time for heating and cooling applications and power generation. Heat storage systems are particularly useful in buildings and industrial processes and can help to balance energy demand and supply on a daily, weekly and even seasonal basis. They can also reduce peak demand, energy consumption, CO<sub>2</sub> emissions and costs, while increasing the overall efficiency of energy systems. The conversion and storage of variable renewable energy in the form of thermal energy can also help increase the share of renewables in the energy mix.

This project seeks to develop new technology and build a cost-effective, compact thermochemical heat storage system based on ammonia salts.

Neutron imaging techniques are especially well suited in this context, as they can reveal information from the atomic scale up to the systemic level. The knowledge acquired will facilitate the design of highly efficient solutions with an extended lifetime.

**Project leader:** Didier Blanchard, DTU – Technical University of Denmark.

### 6. Water selectivity of aquaporins using neutron scattering

This research project will study human aquaporins of importance for health and disease, with a special focus on aquaglyceroporins.

Using an interdisciplinary approach centred on neutron protein crystallography, the project will shed light on the mechanisms of water and glycerol selectivity and transport as well as on proton exclusion.

Results from the project will increase understanding of the selectivity and transport mechanisms of human aquaglyceroporins, and provide new methods for neutron crystallography involving membrane proteins. This would represent a major contribution to basic bioscience with implications beyond physiology and biomedicine.

**Project leader:** Karin Lindkvist, Lund University

## 7. Magnetic frustration under pressure

Magnets are found everywhere, from the everyday refrigerator magnet to magnets used in wind turbines to generate power.

Magnetism in commonplace ferromagnets occurs when a magnet's atomic magnetic moments, which we can think of as tiny compass needles, all point in the same direction. However, there are different classes of magnets in which the tiny compass needles do not want to align, including some that have a built-in uncertainty regarding the direction in which the tiny compass needles will point. These are called "frustrated magnets".

Frustrated magnets exhibit unique and interesting behaviour. One of the best ways to study this behaviour is using neutrons, since the magnetic moment of the neutron makes it the perfect experimental probe of magnetic materials.

A fundamental question in physics has been whether magnetic monopoles exist. It is generally known that an ordinary bar magnet has a north pole and a south pole. If we try to isolate these two poles by cleaving the bar magnet in two parts we simply create two new bar magnets, each with a north and south pole. The question is whether it is possible to separate the magnetic north and south poles into magnets with monopoles, i.e. similar and not opposite magnetic charges. This question was, to some extent, answered in 2008 with the prediction and subsequent detection of monopole-like features inside a frustrated magnet called "spin ice".

This project deals with what happens at very low temperatures, when all monopoles have been annihilated in the spin ice material. High pressure will be applied to the systems to find out what really happens.

**Project leader:** Patrik Henelius, KTH Royal Institute of Technology.

## + Neutron science capacity-building networks

NordForsk has provided a total of NOK two million in funding for six networks in neutron scattering science. The networks will play an important role both in specialised teaching and in attracting new neutron user groups from academia and industry.

These six networks are connecting research communities across the Nordic region and will help to achieve critical mass in specialised fields and areas. Regular meetings and joint training activities in the networks will increase Nordic collaboration, which will in turn strengthen the impact of Nordic research in the international neutron scattering community.

### Networks

- Soft and biological materials
- Functional materials
- Magnetism and superconductivity
- Engineering, processes and real-space imaging
- Low-dimensional structures
- Network for Young Nordic Neutron Scatterers (NYNNeS)

**Project leader:** Martin Sahlberg, Uppsala University



# DELICATE BALANCE BETWEEN ANONYMITY AND LAW ENFORCEMENT

The ability to remain anonymous can be a matter of life and death for those involved in a fight for democracy. But it can also serve as a tool for criminals, who use the "darknet" for their activities. This poses challenges in police investigations.

Over the next four years, NordForsk will be providing SEK 13 million to the research project "Police Detectives on the TOR-network", a collaborative effort between the Norwegian Police University College, Stockholm University, Northumbria University Newcastle and the Open University in the Netherlands. The project will compare the everyday reality of law enforcement operations with both the forensic requirements for an investigation and the legal requirements for obtaining information properly in accordance with the statutory framework.





## THE NORDIC SOCIETAL SECURITY PROGRAMME

The Nordic Societal Security Programme was launched in 2013. In connection with the programme's first call for proposals, two Nordic Centres of Excellence were granted a total of NOK 45 million:

- Nordic Centre of Excellence for Security Technologies and Societal Values (NordSTEVA)
- Nordic Centre of Excellence on Resilience and Societal Security (NORDRESS)

An international call for proposals in the area of society, integrity and cyber security was completed in March 2016 in cooperation with the Economic and Social Research Council (ESRC) and the Netherlands Organisation for Scientific Research (NWO). The following four projects were awarded a total of EUR 4.2 million in funding:

- Police Detectives on the TOR-network (A Study on Tensions Between Privacy and Crime Fighting)
- Taking surveillance apart?: Accountability and Legitimacy of Internet Surveillance and Expanded Investigatory Powers
- Enablement besides Constraints: Human Security and a Cyber Multi-disciplinary Framework in the European High North (ECoHuCy)
- Governance of Health Data in Cyberspace

The Nordic Societal Security Programme is funded by the Academy of Finland, Icelandic Centre for Research – RANNÍS, Swedish Civil Contingencies Agency, Norwegian Directorate for Civil Protection, Research Council of Norway and NordForsk. The overall budget is approximately NOK 120 million.



## DELICATE BALANCE BETWEEN ANONYMITY AND LAW ENFORCEMENT

**T**OR is short for “The Onion Router”, an information-exchange protocol which prevents the tracking of users who send or receive data.

Normally, when you visit a website the data traffic between your device and the server computer takes the most direct route possible. While the contents of the communication may be encrypted, the IP addresses of the source and destination computers remain in readable format along the route. Otherwise the data would not reach their destination. It is possible to intercept the data traffic and see which device is communicating with which server. Web servers normally log the addresses of the computers that access them. By correlating the computer addresses with consumer data from internet service providers, the authorities can pinpoint the office or household of the person accessing the website.

### Like the layers of an onion

If you use the TOR software, however, the data you send on the Internet will take a random route through some of the more than 3 000 servers on the TOR network. Each time data are relayed from one stop to another, another encryption layer is added on top of the old one, almost like the layers of an onion – thus the name “The Onion Router”. The source computer will only be known by the first server, and the destination web server will log the address of the last server on the TOR network as the computer making the request, not the device where the request originated.

This makes it very difficult for authorities to find out who is posting information or accessing a website or service. No stop on the way will hold information about the source and destination of the data traffic, and even if one stop is hacked it will only be able to reveal the previous and next stop on the TOR network.

### Is anonymity a good thing?

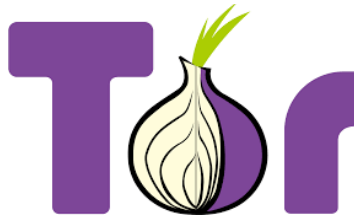
TOR originated as a research project under the US Naval Research Laboratory. Until 2012, 80 per cent of the project’s annual USD 2 million budget was financed by the US Government. The Swedish International Development Cooperation Agency (SIDA) has also contributed funding, as have many organisations promoting freedom of the press and democracy.

TOR’s own website stresses the positive aspects of being able to exchange information anonymously. Journalists can receive information from whistle-blowers. Volunteer organisations can allow staff members stationed in areas of conflict to communicate with their families without revealing who they are working for. Companies choose to use TOR when handling sensitive contract negotiations.

The downside is that the infrastructure can also be used for criminal purposes. Anonymity provides a cover for the distribution of child pornography, the sale of illicit drugs or activities for organising terrorist attacks.

### A policing challenge

The TOR network presents a unique challenge precisely because it is difficult to unmask the flow of traffic.



The dynamic nature of TOR entails that the IP addresses used in the network change continually. Information recorded at a certain point in time will be irrelevant two weeks later. A judge or a prosecutor

wishing to check a URL implicated in a specific case will find that it no longer exists. This means that investigators have to document absolutely everything by taking screenshots and recording timestamps. Otherwise, defence attorneys can claim that it was not their client who was online at a specific time.

The way in which information is compiled is also important for forensic, ethical and legal reasons.

“It is critical to maintain the integrity of the legal process throughout. This is safeguarded by following the various laws, regulations and guidelines that are in place to the letter. The retrieval of information must both be in accordance with human rights and adhere to strict scientific principles,” says Professor Oliver Popov of Stockholm University’s Department of Computer and Systems Sciences, who heads the research project’s Swedish contingent.

“The general rule is that law enforcement agencies in one country are not allowed to gather evidence from another country without that country’s consent,” says Professor Wouter Stol, a former policeman who now

lectures in cybersecurity at the Open University in the Netherlands and is project leader for the overall project.

"In the Netherlands, the police work according to the general principle that as long as a server's location is uncertain the investigation may continue," he adds. "As soon as it is determined that a server is located outside the Netherlands, the police halt the investigation until such consent can be obtained. If the server is hosted in a country the Dutch police are not able to cooperate with, the entire investigation will come to a close."

#### **International cooperation a key**

According to Professor Popov, one possibility is to try to establish a multinational platform for investigation, which could help to bridge differences in legislation between different countries.

Wouter Stol points out that international cooperation between law enforcement agencies can be effective. A recent example is from this past summer, when the Dutch police took control of Hansa Market, one of the world's largest illegal markets for drugs and weapons. For a span of one month the police took charge of administration of the site, which enabled them to collect the names of many of the site's users.

"There has been some debate as to whether the police's actions were legal or not. Is it lawful for the police to run a marketplace on the darknet? Some have accused the police of being accomplices to criminal activity, whereas others say that law enforcement needs to adopt this type strategy in the fight against crime on the darknet," says Professor Stol.

Finding the balance between the needs for anonymity and privacy on the one side with the need for effective law enforcement on the other is not going to get any easier.

"With the emergence of cloud computing and the Internet of Things, the number of sources that can generate probative evidence has increased dramatically. At the same time, artificial intelligence and data science algorithms can be of help in highly controversial areas such as predictive policing," Professor Popov says.



Professor Wouter Stol  
Photo: Josje Deekens  
Photografie



Professor Oliver Popov  
Photo: Janneke Schulman



# THE DIFFICULT ART OF MEASURING RESEARCH

Research is playing an increasingly important role in modern society. But how can we determine whether universities and university colleges are performing well? What should politicians look for when distributing research funding to the various institutions? How can a student find the institution of higher education that is the best fit for him or her?

A common method of measuring activities at universities and university colleges is to look at how frequently their research is cited in international scientific journals. This type of statistical analysis is known as bibliometrics and is a science in its own right.

There are many ways of calculating citation impact, and it is a comprehensive task. NordForsk's fresh bibliometric analysis of the citation impact of 172 Nordic universities and university colleges in the period 1999–2014 has involved some 400 000 scientific papers published during the course of those 16 years. The newly published report is entitled "Comparing research at Nordic higher education institutions using bibliometric indicators".

## **Rising international competition**

The Nordic higher education institutions increased their publication volume by an impressive 52 per cent from 1999 to 2014. Growth in world production during the same period was even higher at 80 per cent. China in particular has invested heavily in research. Thus, the Nordic countries' combined share of world production has decreased slightly, from 2.79 per cent for the first four-year period to 2.36 per cent for the last four-year period. The growth in publication volume is distributed very unevenly among the Nordic countries. Sweden, which is the largest Nordic

knowledge producer, has experienced weaker growth than the other countries, while Denmark and Norway in particular have shown a positive development.

## **Which subject fields are the most highly researched?**

The NordForsk study operated with 16 different main subject fields. The Nordic countries' scientific publication output was compared with that of the rest of the world by subject field to identify those subject fields in which the Nordic countries have conducted the most research relative to that.

The study shows that the Nordic universities have their highest share of publication volume in Social Sciences, Health Sciences, Humanities, Biology, and Business Studies and Economics. In two subject fields – Chemistry and Mathematics and Statistics – the Nordic countries rank well below the world average. While the Nordic countries are seeing good growth in publication output in Social Sciences and Humanities in particular, the growth in Agriculture, Fisheries and Forestry, Biomedicine and Molecular Biosciences, and Physics is modest.

There is great variation in the research profiles of the Nordic countries. Sweden, which is responsible for 39 per cent of all scientific output in the Nordic region, has a research profile that most resembles the world average. Given that it accounts for such a large share of the Nordic output, Sweden strongly influences the overall Nordic research profile.

Iceland is in a very different position. There, one subject field, Geosciences, accounts for 10 per cent of scientific output, which is more than double the world average. Similarly, Norway publishes a large share of its scientific papers in Clinical Medicine and Health Science. Denmark, perhaps not surprisingly, performs well in Agriculture, Fisheries and Forestry, while Finland scores high in Physics.

For many, however, national output is not as interesting as the performance of the individual

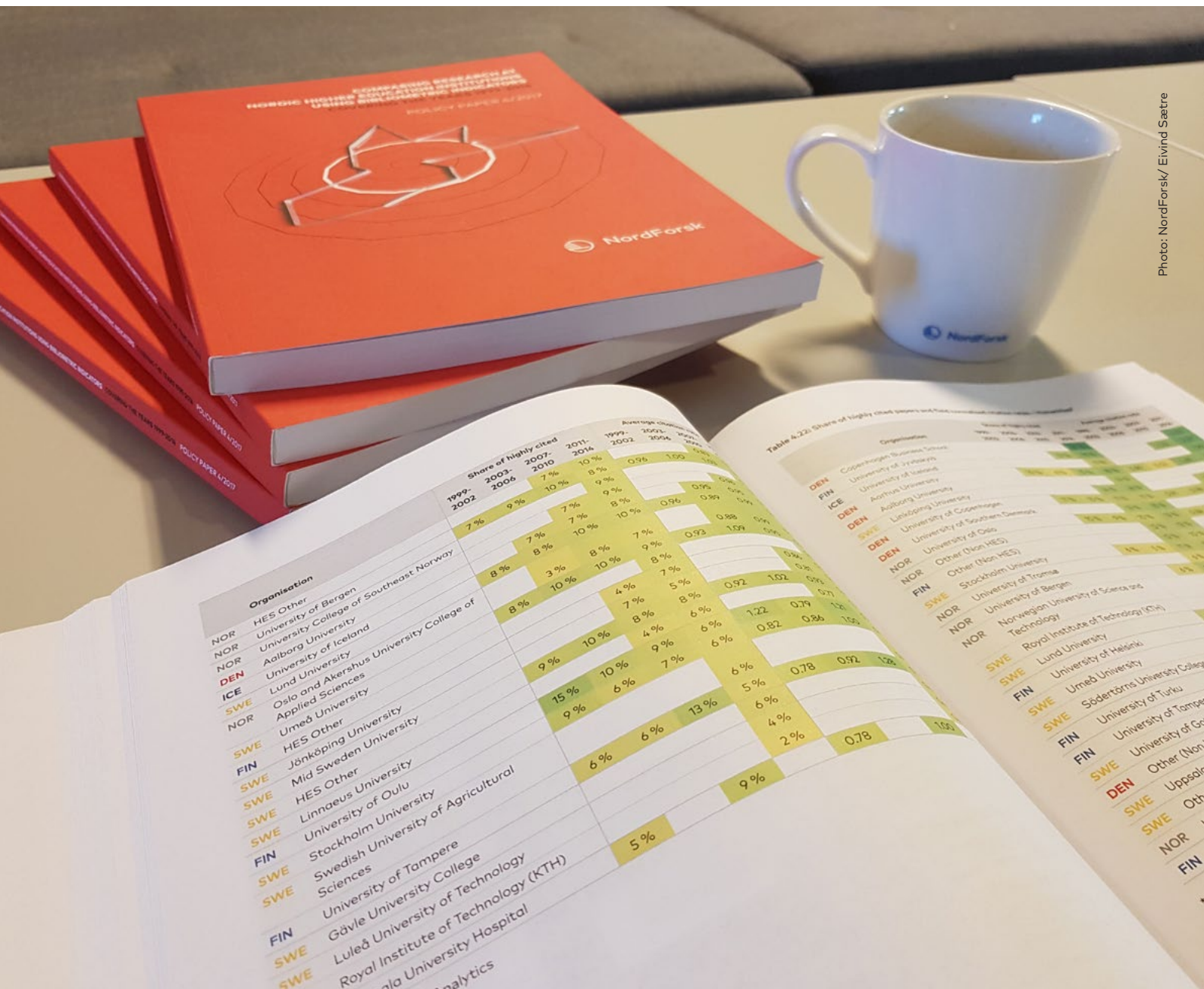


Photo: NordForsk/ Eivind Sætre

universities and university colleges. NordForsk divided the sample institutions into two groups. The first group comprises the 74 universities and university colleges with the highest publication activity. The second is a mixed group of the remaining 98 institutions, which was analysed as a single unit to ensure the statistical relevance of the figures.

The time is long gone in which scientific papers were written by a single author at a single university. Today studies commonly have a numerous co-authors who are often affiliated with different universities and university colleges in different countries, as well as with research institutes and private companies.

In the study, NordForsk applied a method called fractionalisation in which a single credit is divided equally between the institutions of the contributing authors of a publication. This method provides a fairer result than if the credit had not been divided. For example, if three researchers at a single university co-author a paper, their university receives one credit. If a researcher at one university co-authors a paper with a researcher at another university, the publication will be shared between the two universities and each will receive 0.5 credit.



## THE DIFFICULT ART OF MEASURING RESEARCH

### **Citation is a measurement of quality**

The quantity of the publications says nothing about the quality. This is where citation analysis comes in. The number of times a scientific paper is cited in other papers can be an indicator of its importance.

Traditionally publications and citations are categorised by subject field. To obtain a fairer picture, the citation rate for a publication is compared with the citation rates for other publications published that same year in that same subject field. This makes it possible to follow developments over time.

"The most stable indicator of citation impact is an institution's share of the world's most-cited publications," says Henrik Aldberg of the Swedish Research Council, who was responsible for data analysis for the report.

When looking at how well the various universities and university colleges have performed in terms of citation impact, there were a few surprises.

"Blekinge Institute of Technology in Sweden is one of the university colleges that has made the greatest strides in this area. The institution has increased its share of the top 10 most-cited publications from 9 per cent in the period 2007–2010 to 15 per cent in the period 2011–2014," he says.

### **Only a few institutions most frequently cited**

Nevertheless, the differences remain surprisingly stable. Karolinska Institutet has scored high during the entire period from 1999 to 2014, both in terms of most-cited publications (14 per cent for the last four-year period) and average citation rate (28 per cent higher than the world average).

But it is not just large-scale, established institutions such as Karolinska Institutet that have a strong citation impact.

"It is just as important to look at how a university performs in a specific subject field as it is to look at its overall citation impact," says Fredrik Piro of the Nordic Institute for Studies in Innovation, Research and Education (NIFU), who had the overall responsibility for the report.

The universities and university colleges have different profiles and different ambitions regarding the areas in which they wish to excel.

"Hanken School of Economics and Copenhagen Business School both have very high citation rates in Business Studies and Economics. Although its production output is not very large, Linköping University has the next-highest citation index in Psychology in the Nordic countries," Dr Piro points out.

The report compiles results for all the universities in all the 16 subject fields. Aalborg University and Stockholm University are among the leading institutions in Engineering. Meanwhile, the University of Helsinki is the foremost Nordic institution in Materials Science, the Norwegian University of Science and Technology has the highest citation rate in Mathematics and Statistics, and three Danish universities (Technical University of Denmark, University of Copenhagen and University of Southern Denmark) are leaders in the field of Physics.

### **International cooperation is key**

The Nordic bibliometric report concludes with several questions for the next phase of study:

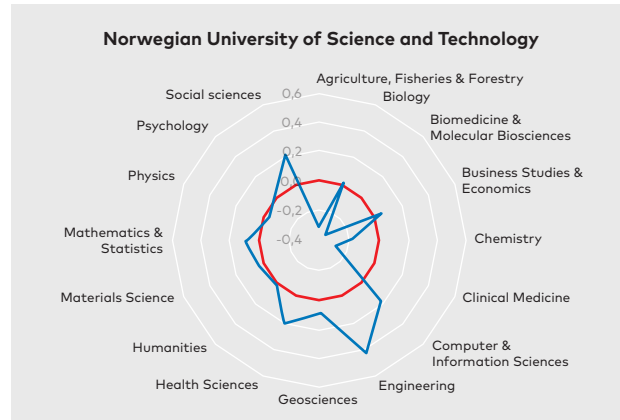
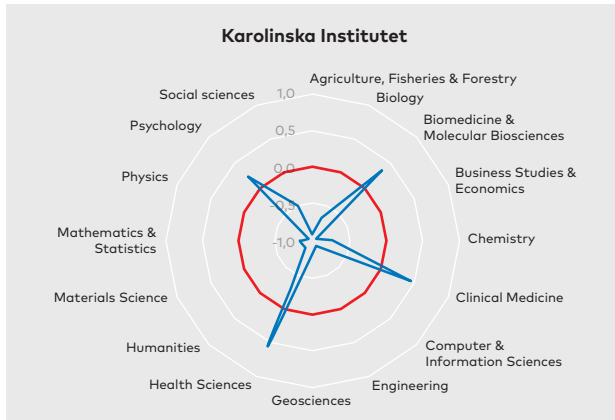
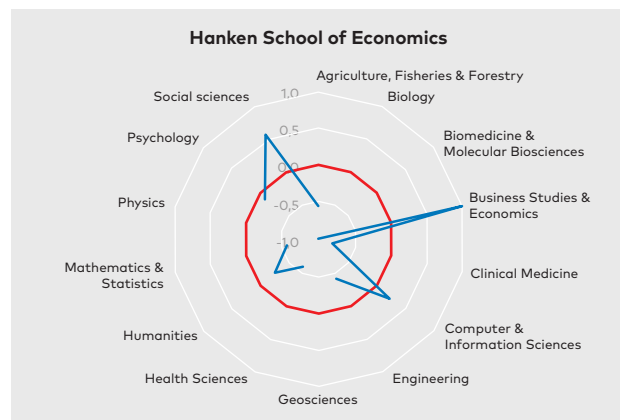
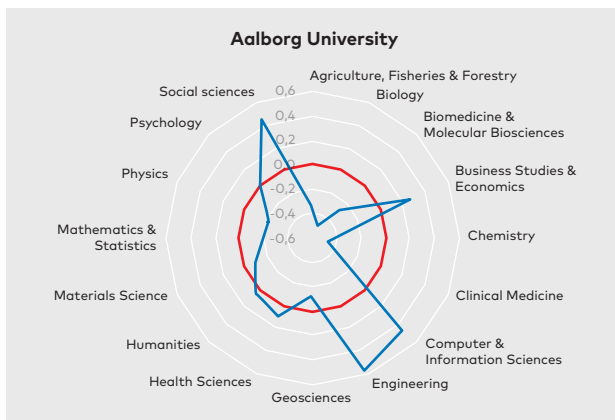
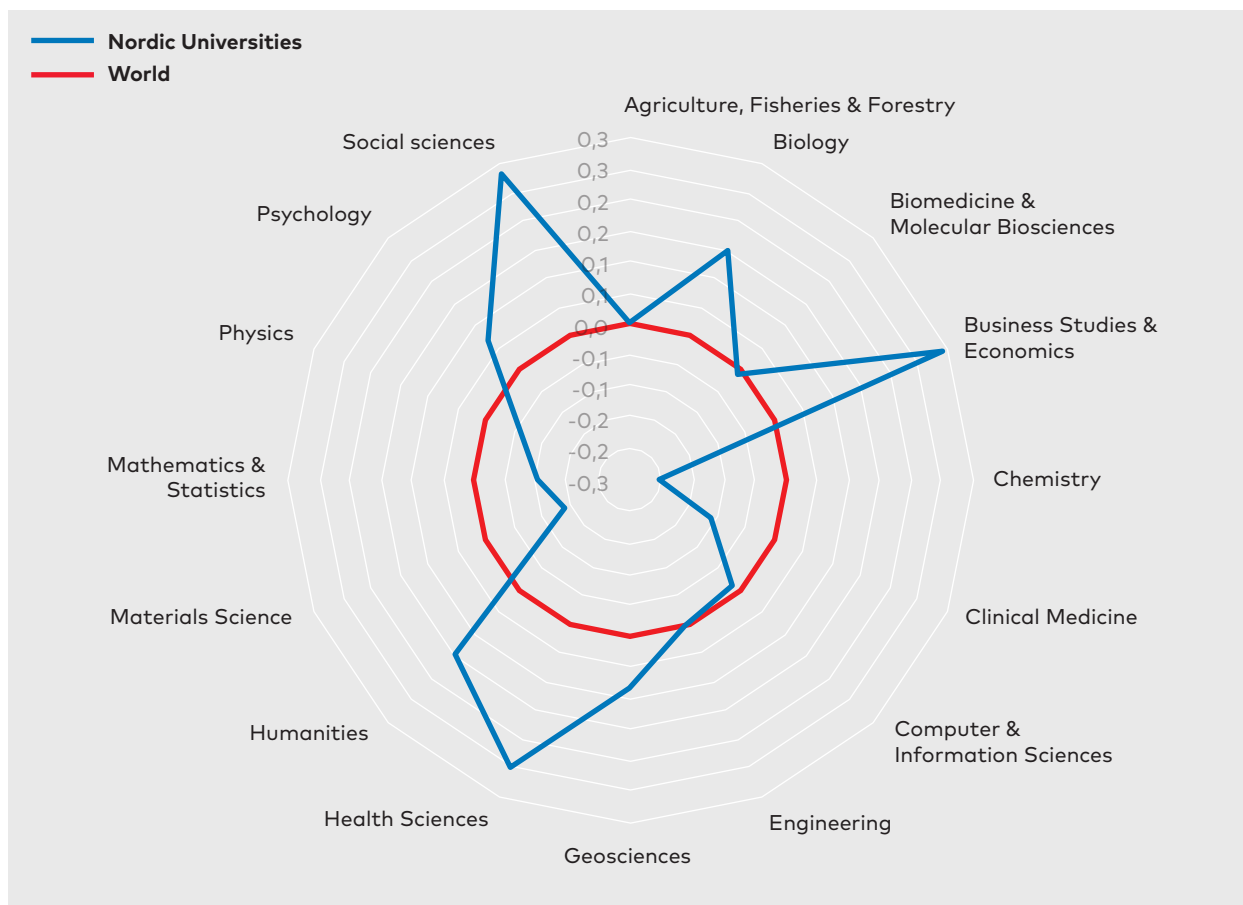
"How can we explain such stable differences? What have the few most-cited institutions done to achieve their high impact on international research? What can other Nordic institutions do to achieve the same?"

One conclusion is made very clear in the report:

Of all the Nordic publications, publications resulting from international cooperation are cited more frequently than national publications.



Fredrik Piro of the Nordic Institute for Studies in Innovation, Research and Education (NIFU) Photo: NIFU



Figures from the report "Comparing research at Nordic higher education institutions using bibliometric indicators"



# IS THERE A NORDIC MODEL FOR HIGHER EDUCATION?

For more than three years, sociologists Mikael Börjesson and Agnete Vabø have led a research project to map recruitment to and organisation of higher education in Denmark, Finland, Norway and Sweden. Despite major organisational differences, there are some striking similarities in recruitment to educational programmes, with strong gender division and a differentiated social structure.

“When one looks at which students are taking which educational programmes, the structures in the Nordic countries are surprisingly similar,” says project leader of the Nordic Fields of Higher Education project, Professor of Sociology of Education at Uppsala University, Mikael Börjesson.

In the large-scale comparative project, sociologists from the participating countries have analysed recruitment to higher education in the period from approximately

## EDUCATION FOR TOMORROW

“Nordic Fields of Higher Education” is a project under the NordForsk research programme Education for Tomorrow. The aim of the programme is to generate new knowledge about the Nordic educational systems that will better equip them to meet the needs of society – today and in the future.

Funding to the programme is being provided by the following institutions: Academy of Finland; Swedish Research Council; Research Council of Norway; Icelandic Ministry of Education, Science and Culture; Innovation Fund Denmark; Danish Ministry of Higher Education and Science; NordForsk; and Netherlands Initiative for Education Research (NRO).

**Budget:** approximately NOK 130 million

1980 to 2015. Drawing on individual-based register data, researchers have been able to map the students' social background and thereby obtain a picture of the social structure of higher education in the Nordic countries. This is the first-ever comprehensive mapping of the Nordic systems of higher education.

“There’s something very static about the way we choose an education in the Nordic countries,” says Professor Börjesson. “It’s quite surprising that so little has changed even though the system has been widely expanded.”

The overall picture may not show any major changes, but there is wide divergence in the recruitment patterns to the individual educational programmes. The education that stands out the most is medicine, which has universally strengthened its position as an elite education over the years. Here one finds the largest proportion of students who have highly educated parents, have financial resources from home, and who – very clearly – have excellent marks.



Associate Professor Agnete Vabø of Oslo and Akershus University College of Applied Sciences. Photo: Sonja Balci



### **Nordic Fields of Higher Education**

Project leader: Professor of Sociology of Education Mikael Börjesson, Uppsala University

Project period: 2013–2015

Budget: NOK 7 million

Other educations have experienced the reverse. Teacher education, for example, was very popular in the 1970s and was at the time one of the educational programmes that attracted a large number of students with good marks.

"With the exception of Finland, most of the Nordic countries are clearly having problems with recruitment to teacher education programmes," says Professor Börjesson. "Many of the students admitted do not have particularly good marks and one can ask oneself about the ramifications this will have for our educational system."

#### **Major organisational differences**

Associate Professor Agnete Vabø of Oslo and Akershus University College of Applied Sciences has led the segment of the project studying the organisation of educational institutions in the Nordic countries. The conclusion here is nearly the opposite of the other segment of the project: researchers have discovered greater differences between the Nordic countries than they had anticipated.

"In practice one can say that there are multiple Nordic models for higher education," says Agnete Vabø.

Although the Bologna Process has significantly influenced the organisation of higher education and led to more widespread standardisation of educational programmes at the European level, there are still major differences across the Nordic countries. Similarities in the organisation of the systems can be found between

Denmark and Finland on the one hand, and Norway and Sweden on the other.

"However, we are seeing steadily growing differences over time with regard to both the organisation and the financing of the systems," explains Associate Professor Vabø.

"But we are also seeing several common development trends in all of the Nordic countries. One of these is that 'elite' and 'excellence' are now part of the legitimate discourse not only in relation to research but also in relation to higher education," she points out. "The universities are more concerned with results and rankings than they used to be and there are therefore more active policies to create elite educational programmes. The egalitarian tradition, which once prevailed, particularly in Norway, is beginning to change."

The researchers have identified other areas in which they see common development trends among the Nordic countries despite the substantial differences at the institutional and organisational levels.

"A stronger focus on institutional autonomy and managerialism has emerged. In the past, confidence in an institution was more or less permanent, based purely on its academic competency. But today all institutions have to compete for resources. They need to operate to a greater degree as entrepreneurs in a market," she explains. "Our conclusion is that we are moving away from a welfare state model and towards a welfare society model in which central state governance is not as strong as it was."

#### **Does a Nordic model actually exist?**

Can a unique Nordic model for higher education be said to exist at all?

"To answer that question properly we would have to investigate all existing educational systems to determine whether there is anything specific that stands out," replies Mikael Börjesson. "But higher education in the Nordic countries does have some common features. Social recruitment is still important, although it is less important than it used to be, and there is also a willingness to invest substantial resources in education. The Nordic countries distinguish themselves from other countries here."

"One can say," adds Agnete Vabø, "that the Nordic model for higher education has been characterised by relatively liberal admission criteria, tuition-free education, and publicly-funded student loan schemes. In this sense one can talk about a model."

"I also believe that we are seeing a clear willingness to establish a Nordic model," says Professor Börjesson. "There are politicians and administrators in the education sphere who strongly support the idea of a Nordic model that they would like to see endorsed and developed."



# WORKING TO PROVIDE EASIER ACCESS TO DATA

In 2015 NordForsk awarded NOK 14 million for a research project to be conducted jointly by the Nordic national statistical institutes (NSI's). The project, Nordic Microdata Access Network (NordMAN), seeks to establish a single pan-Nordic solution to facilitate researcher access to the Nordic microdata compiled for statistical purposes, and to provide an overview of the existing Nordic registers.

Claus-Göran Hjelm,  
departmental director at  
Statistics Sweden and  
NordMAN project leader.  
Photo: Terje Heiestad/  
NordForsk





## WORKING TO PROVIDE EASIER ACCESS TO DATA

**T**he Nordic countries have a long history of collecting administrative data on individuals for statistical purposes. This practice has given the countries numerous different registers that often cover most of the population and which contain information about individuals from the cradle to the grave. Each of the Nordic statistical institutes provides its national researchers with access to de-identified microdata (data on individuals as well as companies), and register-based research is very prevalent in all the Nordic countries.

### Launched in 2015

In autumn 2014 the Nordic chief statisticians agreed to establish a joint cooperation model for providing researchers with access to Nordic microdata collected for statistical purposes. Thanks to the funding allocated by NordForsk, the NordMAN project was launched in May 2015.

"In the past two years we have been working together to simplify application-related processes for Nordic collaborative projects. For example, we've developed common procedures for researchers applying for dataset access as part of Nordic projects. Among other things, this includes legal agreements regulating the exchange of data between the various national statistical institutes," states Claus-Göran Hjelm, departmental director at Statistics Sweden and NordMAN project leader. He adds:

"It is our long-term goal that researchers who need access to datasets will only have to fill in one form instead of a different form for each country."

### THE NORDIC MICRODATA ACCESS NETWORK

The Nordic Microdata Access Network initiative (NordMAN) is funded by NordForsk and the Nordic national statistical institutes, and is part of NordForsk's Nordic Programme on Health and Welfare. In 2014 the Nordic chief statisticians agreed to work together on a joint cooperation model for researcher access to Nordic microdata initially collected for statistical purposes. The pilot project will be completed in December 2017.

**NordMAN website:** [nordman.network](http://nordman.network)

"Our webpage has a detailed guide for how to go about applying for access in each Nordic country. We hope it will be useful to researchers who are wondering how to proceed. We are also working on allowing access to cross-Nordic data via the national statistical institute in the country where the project is being coordinated."

### High level of trust

Mr Hjelm admits that the process has been a challenging one, but says that the Nordic statistical institutes have a high level of trust in one another.

"Meeting again and again has given us all the opportunity to air the various concerns that the different Nordic countries have in relation to data sharing. The security of Nordic residents has always been at the core of our discussions, and the ability to meet and exchange experiences over time has also brought us closer to drawing up guidelines we all can trust."

### Important variables with divergent definitions

One of the challenges facing the NordMAN project is that although data on the respective Nordic populations have been collected over a number of decades, this information is categorised in vastly different ways. The importance of drawing up good metadata descriptions for the registers' contents and structures was identified early on as a highly beneficial area of cooperation.

"The fact that there are so many different categories for subdividing data within each country obviously makes our work that much more difficult. It is very challenging to compare data when important variables are defined differently. A simple category such as "unemployed" may carry a different meaning from one statistical institute to the next. Together we have looked at how we can align our register descriptions more closely according to an international standard. If we can offer researchers a better overview of Nordic metadata in the future, the incredible research infrastructure that our registers represent will make it easier to answer interesting new research questions that arise," he explains.

### Find out what data are available

The NordMAN project's common Nordic metadata model has already been tested in conjunction with a number of projects.

*"It is our long-term goal that researchers who need access to datasets will only have to fill in one form instead of a different form for each country."*

*– Claus-Göran Hjelm*



"To meet the needs of researchers we have designed a common Nordic metadata model. We also hope to begin using a software application enabling researchers to find out what data are available in the Nordic region. We have been working closely with several Nordic projects, and plan to incorporate metadata into this system as we move forward," says Claus-Göran Hjelm.

#### **WHAT ARE METADATA?**

Metadata are a kind of information that describes or defines other data. Metadata are normally used to describe content or the structure of a given dataset by means of variables. Typical metadata categories are subject, title, year and place of residence.

#### **WHAT ARE MICRODATA?**

In the field of statistics and surveys, microdata are detailed information at the level of the individual, such as a person's age, home address, education level, employment status and numerous other variables.



# THE NORDIC GENDER PARADOX

Why are there so few women in senior researcher positions in the Nordic research community? While the Nordic countries often rank at the top of the European and global gender equality indices, they are lagging behind when it comes to gender equality in research and innovation. In autumn 2016, the NordForsk programme Gender in the Nordic Research and Innovation Area granted funding to two new Nordic Centres of Excellence that will help to solve the Nordic gender paradox.

The programme is funded by NordForsk, the Academy of Finland, the Icelandic Centre for Research (Rannís), the Research Council of Norway and the Swedish Research Council for Health, Working Life and Welfare (FORTE).

## **NORDICORE.** Nordic Centre for Research on Gender Equality in Research and Innovation:

Researching core problems to identify and to explain the factors that play a role in gender balance and gender equality in the research world. What will it take to resolve gender equality challenges?

“First we will map out the scope of Nordic gender policy and gender equality measures,” states the head of the centre, Mari Teigen, speaking about NORDICORE’s activities.

“Second, we will examine how the interaction between family life and working life affects the gender difference in research careers. Are there special challenges involved in combining family life with an academic career? How and why do gender differences arise when men and women with researcher training choose their career paths? What is the role of individual subject fields and other labour market alternatives? Are women and men evaluated differently when they apply for positions at academic institutions?”

The centre’s researchers will study actual recruitment processes in academia to gain more insight into how gender may affect these processes. Using an experimental questionnaire design, researchers will investigate whether unconscious ideas about gender differences affect the results of recruitment processes. Wherever possible, researchers will also

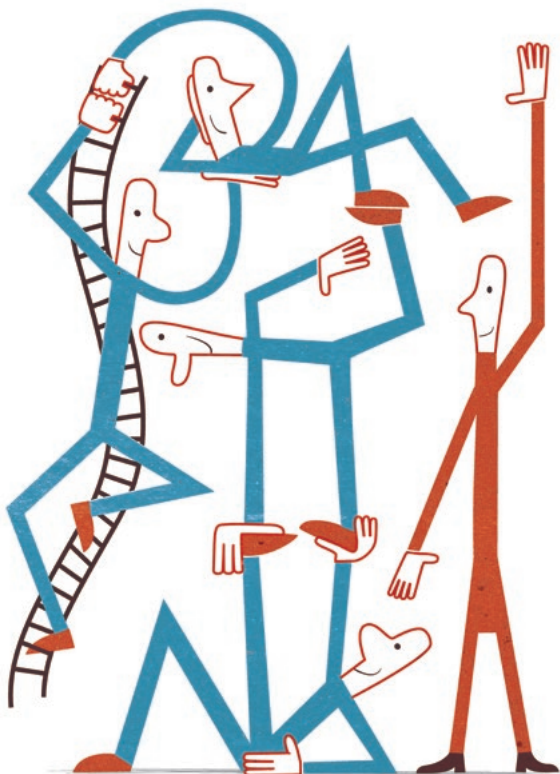


Illustration: Elisabeth Moseng



**Project leader  
NORDICORE:**  
Research professor  
Mari Teigen, Institute  
for Social Research,  
Oslo.  
Photo: Institute for  
Social Research

look at potential impacts of gender combined with an immigrant background.

A third objective of the NORDICORE centre is to study similarities and differences between academia and other areas of the labour market.

"There is a need for research-based knowledge if we are to bring about change and develop better targeted measures in this area. We believe it is important to look at this from two angles, so we can both analyse what is specific to academia and consider whether gender balance challenges in academia have any key features in common with challenges in other spheres of working life," says Mari Teigen. "Moreover, it is essential to obtain a systematic understanding of which initiatives work and which are less effective."

**Participating institutions:** Institute for Social Research, Linnaeus University, NTNU - Norwegian University of Science and Technology, Oslo and Akershus University College of Applied Sciences (HiOA), Stockholm University, Umeå University, University of Iceland, University of Helsinki.

**Duration:** 5 years  
**Budget:** NOK 21.8 million

### **NordWit. Nordic Centre of Excellence on Women in Technology-Driven Careers:**

Will study women's careers in technology-driven research and innovation. The aim is to understand the impact of working in technology-driven environments on women's employment patterns and how this might change conventional gender structures in the labour market.



**Project leader  
NordWit:**  
Professor Gabriele Griffin,  
Uppsala University.  
Photo: Mikael Wallerstedt

"Career and employment patterns have been changing for a while, as technology has begun to shape the world of work, for instance in e-health, the digital humanities and in research and innovation centres," explains Project Leader Gabriele Griffin from Uppsala University. eHealth and digital humanities are two fields where what is considered a traditionally masculine work context – technology – interfaces with traditionally female-dominated domains such as nursing and the humanities."

"These new intersectional work environments raise questions as to how they shape gender structures in the employment world, and our research will contribute to a much better understanding of this. As working worlds, including academia, are increasingly technologising, gendered divisions of labour will shift and we need to know much more about these processes," says Professor Griffin.

Activities at the NordWit centre will include action research in research and innovation centres and quantitative and qualitative research in the form of interviews and surveys involving women and men working in technology-driven contexts. In addition to the three participating academic institutions, 24 non-academic partners will contribute to research at the NordWit centre.

"Thus, the NordWit centre will provide women in research and innovation with opportunities to rethink their careers and to develop new understandings of their relation to technology and the role of technology in their work life," Professor Griffin adds.

**Participating institutions:** Uppsala University, University of Bergen, University of Tampere and Vestlandsforskning (Western Norway Research Institute).

**Duration:** 5 years.  
**Budget:** NOK 20 million.



# A REWARDING JOURNEY

At the end of 2017, after eight years of service, Gunnel Gustafsson will be concluding her tenure as Director of NordForsk.

Gunnel Gustafsson is a very open person. Within the first minute of our conversation she has already shared the most important milestone in her life. The cadence of her speech is redolent of an origin in the marsh landscape of Västerbotten in Northern Sweden.

"That's right," she says, when we comment on her dialect.

"I was born in a place where no one lives anymore: Torrberg Norsjö in inland Västerbotten. When my father broke a leg and could no longer earn a living as a forestry worker he took the family to Hjoggböle, a thriving 'metropolis' of a few hundred inhabitants where we had both neighbours and electricity. It was not a big move in terms of distance, but it was the biggest change in my life. From there I moved to Umeå, and have since lived in several places around the world. I still have my professorship at Umeå University and I often think that the university is where I can always hang my hat," she says.

Soon there will be a changing of the guard. After eight years as Director of NordForsk in Oslo her time is up. At NordForsk, the director and her staff of close to 20 have been allocating Nordic funding to research projects in areas as diverse as neutrons, gender equality, developments in the Arctic, the bioeconomy and health, to name a few. Always with the aim of generating Nordic added value,

contributing to sustainable development and meeting global challenges. And all of it based on knowledge of the highest calibre.

Just what it is that generates Nordic added value varies from project to project.

"Say we receive five grant applications that are very comparable in terms of quality. Then those who are investing money in research can gauge what will be interesting from a Nordic perspective. It may be a question of which institutions will be participating as partners, or what the prospective benefits will be for future research activity or more directly for decision-makers or other users of the research."

The value of Nordic research cooperation has been recognised in evaluations and confirmed by researchers and research groups. According to Rolf Annerberg, Chair of the Management Board for the Nordic Top-level Research Initiative for climate, energy and the environment, the high degree of trust shared between Nordic countries and researchers, along with their tradition of working together, yields "results that other regions can only dream of."

NordForsk was established in 2005 to promote effective research collaboration in the Nordic region. NordForsk receives an annual basic allocation of roughly NOK 120 million from the Nordic Council of Ministers.





## A REWARDING JOURNEY

"We are small," Director Gustafsson stresses, "but our common pot financing with funding provided by the individual Nordic countries gives us a portfolio of research activities for approximately NOK 1.1 billion. However, this sum is a little deceptive. Because our research programmes often extend over four years or more and disburse funding annually, it is not as large as it seems."

"Of course, the Swedish Research Council, the Academy of Finland and other such institutions have much more money at their disposal. NordForsk is a platform for Nordic cooperation between researchers who have already demonstrated their ability to deliver very high quality results. Research-funding bodies are demonstrating both enthusiasm about and willingness to further advance cooperation. In recent years, the overall amount contributed by Nordic national funding agencies has been more than twice the size of the basic allocation from the Nordic Council of Ministers."

"At NordForsk we always strive to promote research with an 'edge', that is, to support spearhead projects that have high aspirations and are innovative," she adds.

Gunnel Gustafsson has worked with "big picture" questions, such as how researchers can gain access to data in other Nordic countries. "Just ten years ago it was practically impossible to send data on individuals between the Nordic countries. Researchers were forced to go sit at an institution in another country to get access to the information there," she says.

She sees the value of the Nordic registers and biobanks as being especially important. These enable five countries to track their populations back many years. National ID numbers were first introduced in Sweden in 1947, with Denmark the last Nordic country to do so in 1968.

"If we could make the leap from registers for each individual Nordic country to analysing the entire Nordic region with its 26 million inhabitants, it would be much easier to identify factors that are linked to, for example, rare diseases."

One example from her own place of origin is familial amyloid polyneuropathy, a genetic disease ultimately leading to liver failure. It occurs in 20 in a million

inhabitants in Sweden overall, but 300 in a million in Västerbotten.

"It is important to distinguish between open access to data and access to research results. The latter is no longer much of a problem," she says.

"But if we could merge the Nordic countries' registers it would be possible, for example, to find out whether, and the degree to which, the policies of each of the countries matter. For instance, does living in northern or southern Scandinavia have a greater impact on people's health and well-being than living in a specific country?"

"At present, researchers often consider country of residence to be the prime factor, the independent variable or the reason behind the differences," Professor Gustafsson states.

In certain areas, the national statistics bureaus are already collaborating to dismantle national barriers to Nordic register cooperation.

"I hope this will be strengthened and expanded. The Nordic 'goldmine' of register data remains under-investigated due to legal, ethical, organisational and technical obstacles to sharing these data across national borders. If we can achieve Nordic cooperation on registers we will be able to study all kinds of other questions," she explains.

What do the major trends indicate? Is the idea of pursuing Nordic cooperation more widely still a popular one, or have the Nordic countries, too, been affected by the withdrawal of countries such as the UK and the US from international cooperation?

"I don't foresee any problem for Nordic cooperation in research. In fact, I think that other countries are tending to look more to the Nordic countries and at what we have accomplished. More and more often my colleagues and I are asked, 'How do you manage to achieve such good transnational cooperation in the Nordic region?'"

In a recently published book, *Norden sett innifrån* ("The Nordic countries seen from within"), Gunnel Gustafsson summarises how this cooperation has developed. The Top-level Research Initiative for climate, energy and the environment has played an important role.

*"At NordForsk I've had the opportunity to work with something I truly believe in and am passionate about – Nordic research cooperation."*

*– Gunnel Gustafsson*





## A REWARDING JOURNEY

"The Nordic countries have the ability to rapidly organise and implement an interdisciplinary, transnational research and innovation initiative that delivers new knowledge of top scientific quality," she writes.

It is not just about getting countries to cooperate. That is the easy part. What is more difficult is to convince different fields of research and institutions to step away from their silo mentality, where decisions and communication take place exclusively within their own sector.

What does the director believe Nordic research cooperation will involve in the coming years?

She envisions that cooperation will increase and that the digital infrastructure for research will become more important. She points to the Nordic e-Infrastructure Collaboration (NeIC), which became part of NordForsk in 2012, and which up to that point had storing and analysing data from the CERN particle accelerator facility in Switzerland as its key task.

"NeIC activities have expanded to include other research groups beyond users of CERN data. One of the NeIC's current focus areas is on protecting privacy and ensuring anonymity in registers under establishment, while at the same time providing more open access to the data. This involves technical solutions for the secure storage and exchange of vast amounts of data. Major advances have been made in this area, but there is still much to be done. Access to robust infrastructure is a must if research results are to maintain a high standard. The work carried out under the NeIC is extremely important."

"Cross-border cooperation is also becoming an increasingly important component of the ability to produce the highest-quality knowledge and, thus, our ability to help to achieve the UN Sustainable Development Goals at a time when globalisation and digitisation reign. But knowledge must also be made available to users at all levels. We need to step up our efforts to establish effective dialogue between researchers, the business sector and decision-makers both in political and public administration circles."

"NordForsk currently has an open call for proposals that targets collaboration between universities instead of research groups, and that is not limited to

a particular field of research. It is a strategic initiative aimed at creating incentives for Nordic universities to cooperate. The universities themselves are required to give priority to, and provide their own funding for, the areas in which they are seeking NordForsk funding. The university cooperation is expected to be able to stand on its own after six years. A full 68 applications have been received and they are currently being evaluated by a panel of experts."

Gunnel Gustafsson herself exemplifies the great changes that have taken place in the Nordic countries where the thirst for knowledge is only increasing.

When she defended her doctoral dissertation in 1972 it was at the relatively new university in Umeå. Before it was established, there were only four Swedish universities – in Uppsala, Lund, Gothenburg and Stockholm. Since that time a great number of Swedish and other Nordic universities and university colleges have been established, now totalling more than 170.

At the time Gunnel Gustafsson became a professor in political science in 1986 she was the first woman in Sweden to hold that title. "Since then, the proportion of women in top-level university positions has increased significantly both in Nordic countries and in the rest of the world, although not as quickly as I and many others would like," she says.

She stresses that she has had an interesting, enjoyable career, not least her years with NordForsk. "At NordForsk I've had the opportunity to work with something I truly believe in and am passionate about – Nordic research cooperation."

But the Director of NordForsk has never had her career as her only focus. Västerbotten is known throughout the Nordic region for its authors, such as Sara Lidman and Torgny Lindgren. The tiny town of Hjoggböle where her family moved in her youth is called the city of authors, home to P.O. Engquist, brother and sister Kurt and Anita Salmonsson, and Hjalmar Westerlund.

"I got my interest in literature and art by osmosis from my mother as a child, and my interest in all kinds of culture brings me much pleasure. It inspires new lines of thinking and makes it possible to take amazing journeys through time and space. These experiences have also helped me in tough times by



teaching me to distinguish between real problems and 'the small stuff', to put my own experiences into perspective – and even to laugh at my own self-centredness."

Today, much of her free time is spent with her three children and their families, including five grandchildren. After eight years with NordForsk she hopes to spend more time exploring nature and enjoying her close friends and family. But she still hungers for more, saying: "It's important to strike a balance between the 'small details' of life and the bigger questions. So I hope to have the opportunity to contribute to societal development in one way or another even after my sojourn at NordForsk has come to an end."

### **GUNNEL GUSTAFSSON**

- Professor of Political Science at Umeå University, appointed 1987
- Member of the Board of the Bank of Sweden Tercentenary Foundation, 1995–2000
- Member of the Royal Skyttean Association in Umeå, appointed 1997
- Pro Vice-chancellor at Umeå University, 2000–2004
- Deputy Director General of the Swedish Research Council, 2005–2009
- Member of the Swedish Disaster Commission after the tsunami in Thailand, 2005 and 2006–2007
- Member of the NordForsk Board, 2005–2009
- Director of NordForsk, 2010–2017
- Member of the Swedish section of the Letterstedtska Association, appointed 2013



# ARNE FLÅØYEN APPOINTED NEW DIRECTOR OF NORDFORSK

Arne Flåøyen has been appointed the new Director of NordForsk, and will begin in his new role on 1 January 2018. He is coming from the position of Head of Department for Fish Health at the Norwegian Veterinary Institute. "I see NordForsk as a catalyst for Nordic research cooperation, and my aim is to make NordForsk an even more visible, sought-after partner in the Nordic research system," says Dr Flåøyen.

Dr Flåøyen is looking greatly forward to taking up the reins as Director of NordForsk in January 2018. His interest in the Nordic community and research cooperation go back a long way.

"There are two things that have followed me my entire professional career: I am passionate about research and I am deeply committed to cooperation, particularly international cooperation. My various positions at the Norwegian Veterinary Institute, with responsibility for research for many years, have convinced me that we make research better by bringing together the best and the brightest within an area in collaboration. Moreover, exchanging experiences with, and being inspired by, colleagues in other subject areas and countries makes us better researchers," he says.

He adds: "My time as leader of a steering group under what was then called the Nordic Forestry, Veterinary and Agricultural University (NOVA) sparked my interest in Nordic cooperation. My experiences there showed me that the Nordic region has tremendous value as a cultural and structural community, and our countries also have much in common in terms of history, language, values and development. On our own we are small, but together we can help to solve the grand societal challenges."

"We can play a part in safeguarding the Nordic model and, not least, we can help our researchers to break through in the international research arena. I'm looking forward to getting started at NordForsk and I'm excited about working to further develop Nordic research cooperation. The thought of strengthening the Nordic community in this ever-changing world is inspiring."

## **Twenty years as a researcher and leader**

Arne Flåøyen is a trained veterinarian and has conducted clinical research in the field of veterinary medicine. He has spent the past 20 years as a researcher and leader at the Norwegian Veterinary Institute.

"I began doing research during my second year at the Norwegian School of Veterinary Science. I ran field trials each summer until I completed my Doctor of Veterinary Medicine degree and then completed my Ph.D. shortly after that. I published a great deal during the first 10–12 years of my career and qualified

## **ABOUT ARNE FLÅØYEN**

**Born:** 27 July 1962

**Nationality:** Norwegian

**Currently:** Dr Flåøyen is taking over the directorship of NordForsk from Gunnel Gustafsson, who has led the organisation since 2010.

**Education:** Dr Flåøyen earned a Doctor of Veterinary Medicine degree and two Ph.D. degrees at the Norwegian School of Veterinary Science. He also completed a Master of Management at the BI Norwegian Business School.

**Background:** Dr Flåøyen is leaving the position of Head of Department for Fish Health at the Norwegian Veterinary Institute. He also has international experience from his work as Project Officer at the Directorate for Biotechnologies, Agriculture and Food Research under the European Commission's Directorate-General for Research and Innovation. He was a member of the Research Board of the Division for Science at the Research Council of Norway from 2011 to 2015.



Arne Flåøyen is the new Director of NordForsk.  
Photo: Kurt Gaasø

as a professor. However, I admitted to myself that my strengths lay in leadership rather than conducting my own research, and I therefore chose to pursue a career in management. I completed a Master of Management at the BI Norwegian Business School, among other things," explains Dr Flåøyen.

NordForsk's soon-to-be director was a member of the Research Board of the Division for Science at the Research Council of Norway from 2011 to 2015, which gave him a wide range of experience that he can draw on in his new role.

"The Research Board of the Division for Science is responsible for funding basic research, independent projects, scientific equipment and infrastructure. Since I come from the research institute sector, which primarily conducts applied research, my work on the research board has provided valuable insight into both basic research and the conditions that influence research quality in the university sector. This knowledge will be beneficial to me in my role as Director of NordForsk," he says.

#### **Taking over after Gunnel Gustafsson**

Gunnel Gustafsson has led NordForsk since 2010 and prior to that was a member of the NordForsk Board.

Dr. Flåøyen sees her as a hard act to follow.

"Gunnel Gustafsson has led NordForsk for eight of the 12 years the organisation has existed. She has unique experience in and knowledge about Nordic research cooperation. I look forward to working with the talented staff of the NordForsk secretariat to build on the results that have been achieved under her leadership," he says.

#### **Broad international experience**

Dr Flåøyen has wide-ranging experience with international research cooperation via his own research activities and as Project Officer under the European Commission. He has also been an evaluator of project proposals for EU funding.

"I have participated in international research cooperation and built research groups and networks. My activities as project officer gave me insight into and experience with how the EU research system functions politically, strategically and operationally," he explains.

#### **Will work closely with the Nordic research councils**

Arne Flåøyen believes that NordForsk must be recognised as a facilitator of productive research cooperation and not be perceived as a competitor to the national research councils or the EU.

"I see NordForsk as a driver and facilitator of Nordic research cooperation. NordForsk must engage in constructive dialogue with the national research-funding institutions and be the platform they choose to use for promoting high-quality, relevant research within, for and on the Nordic countries. NordForsk is responsible for a unique niche in the Nordic research system, and in that area NordForsk must be clear, visible, closely involved and accessible. We will be a guarantor of good quality, and NordForsk must be perceived as flexible and a good listener," he concludes.

#### **Høybråten looking forward to collaboration**

The Secretary General of the Nordic Council of Ministers, Dagfinn Høybråten, is looking forward to working with Dr Flåøyen.

"As new director, Arne Flåøyen will bring broad-based experience from the research sphere and society at large to NordForsk. I'm looking forward to collaborating with him on further expanding Nordic research cooperation," states the Secretary General.



# NORDIC UNIVERSITY HUBS

NordForsk has launched a new funding instrument designed to increase cooperation among Nordic universities and university colleges.

At the request of the Nordic Council of Ministers, NordForsk along with an advisory group of experts conducted an analysis of existing and potential partnerships between Nordic universities and university colleges. These efforts led to the launch of the "Nordic University Hubs" initiative, introduced at the end of 2016 with the announcement of up to NOK 180 million in funding.

A total of 63 grant applications were submitted by various consortia in response to the call. Participants included 87 universities and university colleges, representing all the Nordic countries, as well as six non-Nordic institutions.

According to NordForsk Senior Adviser, Marianne Aastebøl Minge, the initiative gives universities and university colleges an opportunity to expand and further develop their strategic activities in areas where cooperation with Nordic partners can add value. "Universities and university colleges work in a targeted, long-term perspective, and they have strategic priorities they wish to advance. NordForsk sees the Nordic University Hubs initiative as providing a funding framework to facilitate cooperation in Nordic university consortia and enhance institutional capacity-building and excellence. The initiative is open to all thematic areas and scientific disciplines, but the consortia awarded funding must show how they will help the universities and university colleges involved to fulfil their own strategic priorities. For us there is benefit in knowing that Nordic funding is being used in areas where the institutions themselves feel they have the most to gain from Nordic cooperation – while the requirement for own funding ensures that Nordic funding is actually used in areas that the institutions want to invest in."

The initiative requires participants to contribute two-thirds of the funding needed to run a consortium, with the remaining third provided by NordForsk. Applicants must also document "Nordic benefit", i.e. added value generated by Nordic cross-border cooperation. NordForsk's principles of open competition and use of independent experts to assess grant proposals will also apply.

Funding may be granted to each consortium for up to six years. An evaluation will be carried out after three years to determine whether NordForsk will disburse funding for the final three years. For a grant application to be eligible for assessment, the universities must have committed to providing support to the consortium for six years, regardless of the result of the evaluation.



Marianne Aastebøl Minge,  
Senior Adviser, NordForsk.  
Photo: NordForsk/Terje Heiestad

# THE NORDFORSK BOARD

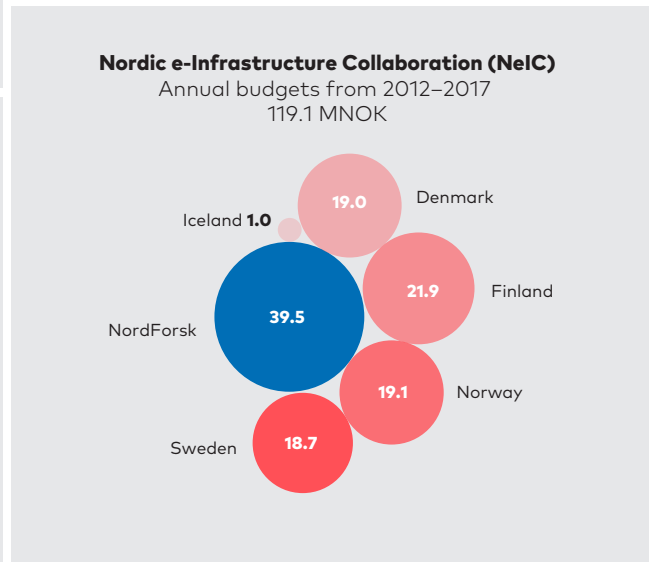
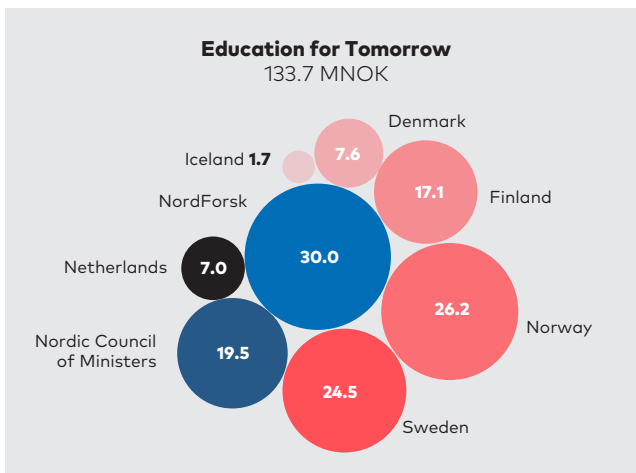
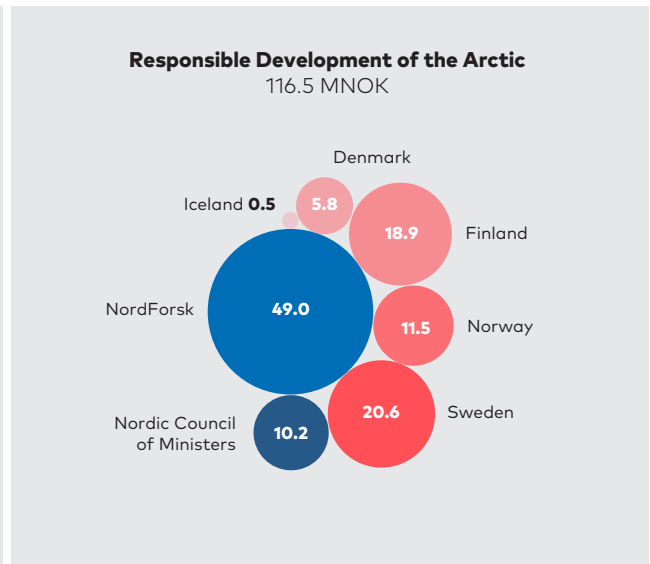
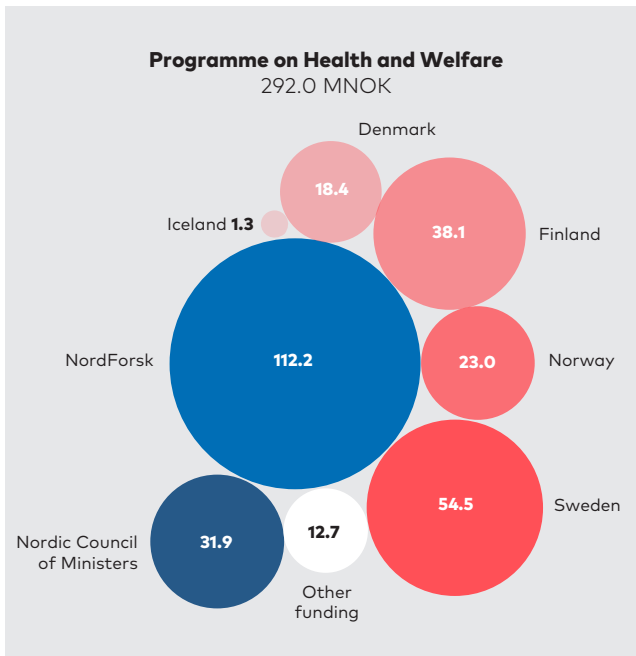
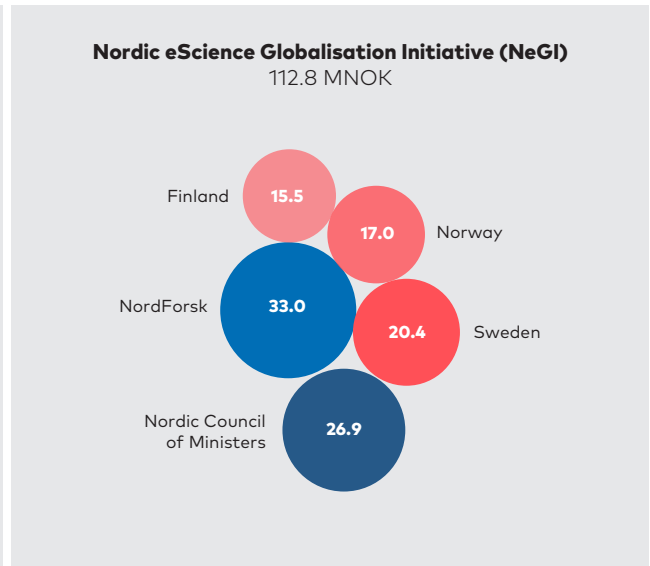
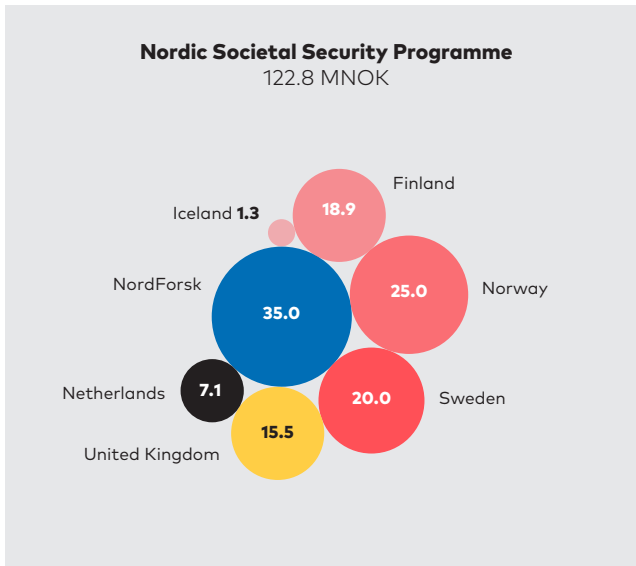


From left to right: Gitte Agerhus (Denmark), Vidar Leif Haanes (Nordic University Cooperation), Josephine Nymand (Observer, Greenland), Jonas Waller (Observer, Åland), Kristin Danielsen (Chair, Norway), Daniel Holmberg (Observer, Nordic Council of Ministers), Ragnhildur Helgadóttir (Iceland), Riitta Majjala (Finland) and Tor Martin Nilsen (NordForsk Employee Representative). Eva Björck (Vice Chair, Sweden) and Annika Sølvará (Observer, Faroe Islands) were not present when the picture was taken. Photo: NordForsk/Anders Löwdin

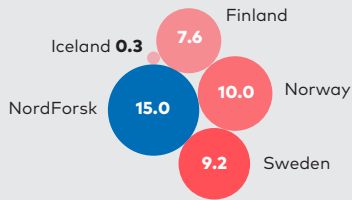


# FACTS & FIGURES

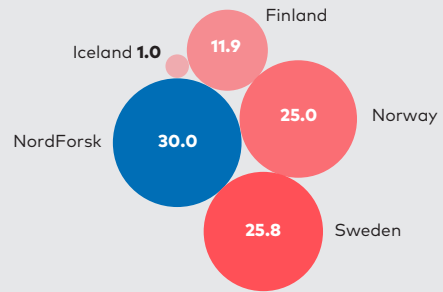
Larger active common pot initiatives.



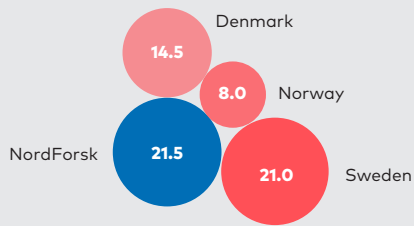
**Gender in the Nordic Research and Innovation Area**  
42.1 MNOK



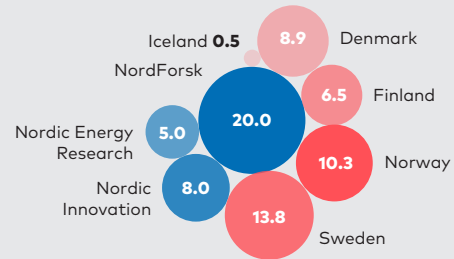
**Nordic Bioeconomy Programme**  
93.7 MNOK



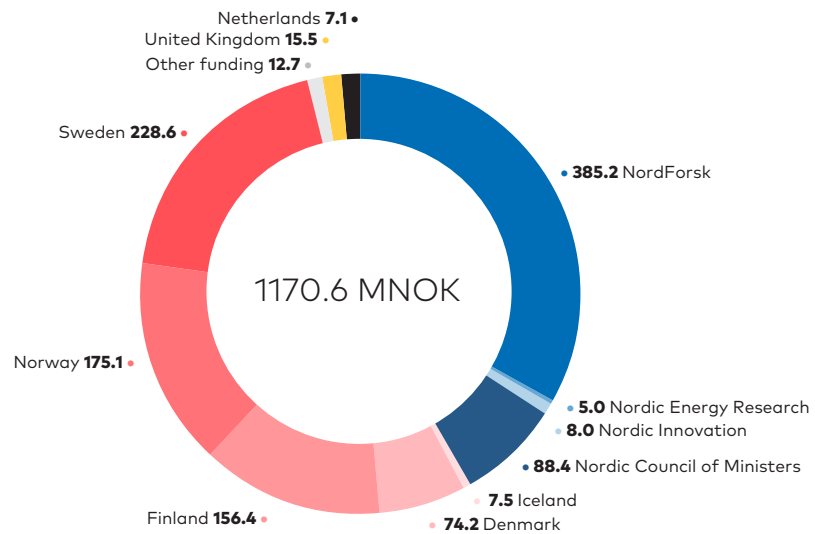
**Neutron Science Programme**  
65.0 MNOK



**Green Growth Research and Innovation Programme**  
73.0 MNOK



**Total of all active common pot initiatives**





# STAY UP-TO-DATE ON OUR CALLS FOR PROPOSALS

Research funding from NordForsk must be sought via its open funding announcements. NordForsk does not offer direct grants, fellowships or other permanent funding schemes, but issues calls for proposals regularly under its thematic research programmes. Our research programmes are multi-disciplinary, so we recommend looking at all our funding announcements, which can range from 10–20 each year.

**Funding is announced through a variety of channels, so find the one that is best for you.**

**1. NORDFORSK'S OFFICIAL WEBSITE: NORDFORSK.ORG:** Calls for proposals and pre-announcements are listed on the front page and are available under the menu item "Apply for funding". We also publish news briefs on the website whenever a call is issued.

**2. THE NORDFORSK CALL AND APPLICATION PORTAL:** To apply for funding, you must use the NordForsk Call and Application Portal ([funding.nordforsk.org](https://funding.nordforsk.org)) for the submission and administration of your application. While you can always find open calls for proposals in the Call and Application Portal, please note that pre-announcements are not published there. Even if you check the portal regularly it is recommended that you follow along via one of the other channels mentioned.

**3. E-MAIL NEWSLETTERS:** Newsletters are sent whenever news items, including funding announcements, are published. Subscribers receive information about funding announcements and a low volume of other news. Typically you will receive one news item per week. It is possible to subscribe to the newsletters on the front page of [nordforsk.org](https://nordforsk.org).

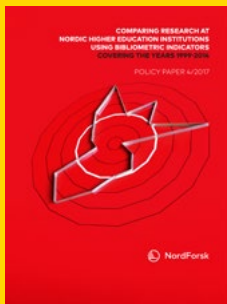
**4. TWITTER, FACEBOOK AND LINKEDIN:** Stay up-to-date on new calls for proposals and other information related to NordForsk's activity by following us via one of these social media:

**Facebook:** [facebook.com/NordForsk](https://facebook.com/NordForsk)

**Twitter:** [@NordForsk](https://twitter.com/NordForsk)

**LinkedIn:** [linkedin.com/company/nordforsk](https://linkedin.com/company/nordforsk)

**5. RSS:** Calls for proposals are published as RSS feeds via our website. Using an RSS reader you can subscribe to an RSS feed dedicated exclusively to calls:  
[nordforsk.org/en/funding/calls-for-proposal/rss.xml](https://nordforsk.org/en/funding/calls-for-proposal/rss.xml)



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Covering the years 1999-2014



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An overview 2017



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NordForsk is an institution under the Nordic Council of Ministers that facilitates and provides funding for Nordic research and research infrastructure cooperation.



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