Arctic expertise in Finland
# Table of contents

Foreword 1

Preface 2

I Finland in the Arctic seas 2
   Shipping companies; Shipyards; Technology, equipment and design; Security

II Livelihoods in the Arctic regions 8
   Mining industry; Metal industries; Wind power; Environmental technology; Traffic and transport; Tourism; Reindeer husbandry and nature-based livelihoods

III Finland’s role in Arctic research and training 12
   Extensive Arctic research; Experts in Arctic nature; Research on Arctic conditions; Cold technology research

Contacts 20

---

Except for the Foreword, the text of this publication has been compiled by Markku Heikkilä and Marjo Laukkanen from the Science Communications of the Arctic Centre in the University of Lapland.

The Unit for Regional Cooperation in the Department for Russia, Eastern Europe and Central Asia of the Ministry for Foreign Affairs is responsible for the preparation of the publication.

Further information about the publication:
MINISTRY FOR FOREIGN AFFAIRS OF FINLAND
Unit for Northern Europe (EUR-10)
Tel. +358 9 16005
E-mail: eur-10@formin.fi

---

Graphic design and layout: Mika Kettunen
Map on the cover: Suomen Kuvapalvelu Oy/Finnish Press Agency
Printing: Edita Plc
Foreword

The first Arctic expertise in Finland brochure was published in the autumn of 2009, when no one yet knew of the exceptionally long and hard cold spell that was to hit the country that winter. The temperatures for the following winter repeated the same pattern and Finland’s ability to remain operational under Arctic conditions was even covered by the foreign media. International news channels reported that Helsinki-Vantaa airport was able to keep working through the atrocious weather and Finnish snow-how was commended. The capacity to get on in icy conditions goes back to earlier times; with the development of foreign trade in the 19th century, if not earlier, solutions had to be found for year-round navigation at a time when all of Finland’s ports were blocked with ice. The Finnish flair for innovation was making its own special contribution to our Arctic expertise even then, generations ago.

The impacts of climate change are manifold and as of yet unpredictable. They are most intense in the Arctic region at the world’s northernmost latitudes. The Arctic region’s significance in international politics, from both environmental and economic perspectives, has grown in recent years. Because of the receding ice sheet, natural resources and new sea routes can be exploited more effectively, simultaneously heightening risks for maritime transport and putting pressures on indigenous peoples’ livelihoods and modes of living. Provisions for this change are made by means of international cooperation in which the Arctic Council, formed by the Arctic countries, is a key player. Finland is an active and expert Arctic operator.

The transformation of the Arctic regions not only presents challenges for Finland, but also opens up major opportunities. This updated brochure provides an overview of the multiplicity of Finnish Arctic expertise and know-how. Even many Finns may be surprised to learn how broad and comprehensive this expertise is. Sustaining our society requires maritime expertise, weather forecasting, environmental technology, energy production and other solutions that allow us to respond to change in the Arctic region. Multidisciplinary long-term Arctic training and research have laid the foundation for this expertise. The competence that has been accumulated over decades, even centuries, is unique to us. Finland can be proud of this and offer it actively to other Arctic players.

The Arctic Centre of the University of Lapland has compiled the text of this brochure for the Ministry for Foreign Affairs. We wish to express our warm thanks for their work.

Erkki Tuomioja
Minister for Foreign Affairs

Alexander Stubb
Minister for European Affairs and Foreign Trade
Preface

Finland is one of eight Arctic countries, including the other Nordic countries, Canada, Russia and the USA. Finnish expertise in Arctic issues has evolved out of the natural need to adapt to cold living conditions. Finnish actors and know-how have gained much exposure now that international interest in the Arctic is on the rise. This publication deals with the Arctic roles of Finnish research, business and industries. They form the setting for the full picture of Finland’s versatile expertise in the northernmost regions of the globe.

In the sections which deal with business activities the focus is on expertise in Arctic sea conditions. Reference is made to tourism, the expanding mining operations, and other branches of the economy. Many companies other than those mentioned by name in this publication are active in the Arctic regions.

Definition of the Arctic region

While an internationally confirmed definition of the Arctic region has never been formulated, in Finland the southernmost border of the Arctic is most often considered to run across the Arctic Circle. Thus Lapland, a third of Finland’s land area, falls under international cooperation conducted in the Arctic region. In the natural sciences, the southern border of the Arctic has been defined in accordance with the Arctic Circle, the tree line, the southern limit of tundra or permafrost, or an average temperature of below +10 °C in June. In the social sciences, the Arctic region is understood to be the areas populated by the Arctic indigenous peoples.

I Finland in the Arctic seas

Even though Finland is not a coastal state of the Arctic Sea, Finnish Arctic shipping, and shipbuilding technology suited for Arctic conditions have long traditions. A. E. Nordenskiöld, the Finnish explorer and scientist, was the first person to sail through the Northeast Passage on his research vessel Vega in the late 1870s. Expertise in winter navigation has also been vital for Finland, because it is the only country in the world where all of the ports can be blocked with ice in the winter.

Many companies and actors make Finland one of the leading experts in Arctic shipping and offshore activities.

Shipping companies

Arctia Shipping

Arctia Shipping is a state-owned shipping company specialising in icebreaking, multi-purpose vessels and international freight services as well as oil spill response. Arctia’s services include assisting vessels in ice, planning routes and providing related navigation guidance.

Arctia has three strong multi-purpose icebreakers, one oil recovery icebreaker and four conventional icebreakers. The well-equipped multi-purpose icebreakers Botnica, Fennica and Nordica have been designed not only to break ice in the Baltic Sea, but also to operate in difficult Arctic conditions and perform challenging tasks in both gas and oil fields as well as expeditions in different parts of the world. Multi-purpose icebreakers can assist, for example, in drilling in Arctic conditions by keeping floating ice packs at a safe distance from the drilling site.
The oil recovery vessel Kontio is equipped with two separate oil recovery systems and tanks capable of holding over 2,000 m³ of collected oil. IB Kontio is the European Maritime Safety Agency’s (EMSA) stand-by oil response vessel for the northern parts of the Baltic Sea. The conventional icebreakers Voima, Sisu, Urho and Otso perform thousands of assistance tasks every year, playing their part in ensuring undisturbed winter navigation in Finland. They can also serve in ice management and oil spill recovery tasks.

**Neste Oil & Neste Shipping**

Neste Oil Corporation is a Finnish oil refining and marketing company specialising in high-quality traffic fuels with reduced environmental impact. The company derives its strength from its long experience in refining, storing and transporting oil in cold conditions. Neste Shipping stands out as a specialist in maritime transport and in the requirements that cold conditions set on ships. The company’s double-hull fleet are ice-strengthened and capable of operating in demanding conditions. Neste Shipping has devised many improvements that boost ship performance and safety. Its innovations range from double action tankers and an integrated bridge to satellite navigation in icy conditions. Ship simulators are used to train steering in changing conditions as well as escort tugging. The company’s ice-strengthened escort tugs are the only ones of the type in the world. Neste Shipping also cooperates with shipbuilders and designers, universities, VTT Technical Research Centre and other research institutes.
are constantly looking for new solutions in order to build as safe, well-functioning and eco-friendly vessels as possible.

Finnish shipyards have built more Polar class icebreakers than any other shipbuilding country in the world. Finnish shipyards have delivered about 60 per cent of all icebreakers in the world. Their product portfolio comprises vessels for Arctic, Subarctic and Antarctic operations.

The STX Rauma shipyard is well known as a builder and designer of multi-purpose icebreakers, Polar class research vessels, and cruise ferries. The most recent project in the shipyard is a new-generation Polar Supply and Research Vessel. As a leading builder of extra large cruise ships the STX Turku shipyard is renowned for its advanced and innovative ship design capability and efficient construction facilities. STX Turku is capable of designing and building Polar class LNG (liquefied natural gas) carriers suited for very demanding Arctic conditions and other purpose-built tonnage such as floating offshore structures and modules.

Arctech is currently building two new multi-purpose icebreaking service vessels for the Russian shipping giant Sovcomflot and an innovative emergency and rescue vessel for the Russian Ministry of Transport. Like its predecessors, STX Finland has a long history of close cooperation with Russian shipbuilding companies, shipyards and other organisations, and it has delivered more than 2000 vessels. Arctech Helsinki Shipyard cooperates with Russian shipyards in new construction projects.
Technology, equipment and design

**ABB**

ABB develops, delivers and maintains Azipod® technology-based electrical propulsion systems for icebreakers, ice-going cargo vessels and other Polar class vessels. The deliveries include generators, electrical systems as well as propulsion and automation systems. Azipod® technology provides superior icebreaking and ice navigation characteristics and ships using the Azipod® system are capable of operating independently even in very demanding ice conditions, enabling more efficient and economical operation of merchant vessels.

**Aker Arctic Technology Inc.**

Aker Arctic Technology Inc. was established in 2005 to continue the successful research and product development operations of Kvaerner Masa-Yards’ Arctic Technology Centre. The company develops Arctic marine logistics and offshore industry solutions and designs ships to meet the needs of clients operating in Arctic waters. The company runs an ice model testing facility – the only one in the world – where research and product development focusing on maritime transport, ships and ports is conducted in field and laboratory environments. The company’s services also include crew training for ice-going ships.

In addition to three shuttle tanker traffic systems, which have been built on the Pechora and Kara Seas, the company is developing and investigating transport systems to carry Arctic natural gas and minerals, and research and production drilling systems to be introduced to global markets. Aker Arctic has created several successful ship concepts for Arctic navigation, such as the first so-called oblique icebreaker concept, which is being built at Arctech Helsinki Shipyard. The company is also involved in the European Polar Research Icebreaker Consortium Aurora SLIM, and planning a new Polar class icebreaker for Canada.

**Cargotec**

Cargotec’s subsidiary brands, Hiab, Kalmar and MacGregor, are world renowned cargo and load handling solution providers. Cargotec’s roots are in the Nordic region, which has played a role in the direction of its R&D.

Cargotec offers a range of cargo handling solutions, such as MacGregor hatch covers, cranes and cargo securing equipment for vessels operating in harsh Arctic waters. Its offshore segment provides load handling solutions which meet the different ice class requirements. In the design phase extremely demanding conditions have been taken into account, including mechanical damage caused by freezing, electrical components suited for cold conditions, and safe and reliable functioning also in ultra-deep waters.
Steerprop has been chosen as the supplier of the main propulsion machinery for the ice-strengthened multi-purpose rescue vessel concept designed by Aker Arctic Technology, which will be built in the Arctech Helsinki Shipyard.

STX Finland Cabins

STX Finland Cabins is a world leader in its branch of activity. STX Finland Cabins’ prefabricated modular cabins and entire accommodation areas are used on icebreakers, research vessels in Arctic seas, fishing vessels, offshore ferries’ living quarters, car and passenger ferries and luxury cruise liners.

Thanks to its advanced prefabrication technique, comprehensive testing is possible in the manufacturing phase. The cabins’ fire safety and sound insulation are top quality. STX Finland Cabins’ Product Development Department keeps looking for opportunities to make use of new innovations in cabin manufacture and delivery.

Trafotek

Trafotek’s domain of expertise includes transformer solutions for the shipbuilding industry, in use in more than 600 vessels, of which the majority are icebreakers or multi-purpose icebreaking support vessels with a variety of uses. The company also has a wide selection of chokes and filters to meet the challenging needs of shipbuilding and offshore industries.

Trafotek’s products are custom-made to suit each client’s specific needs, taking note of the product’s end use. The mechanical structure of the transformers is extremely strong and the products can sustain marked variations in the transformer load and installation environment, including changes in temperature and vibration.

Mobimar

Mobimar Ltd is a marine technology company specialising in the design and building of workboats and oil spill response systems for Arctic conditions.

During recent years, the company has been engaged in the development of a novel, trimaran hull vessel with a low running resistance and the capacity for icebreaking. Icebreaking tests conducted in ice laboratories have been so promising that the new feature has been patented. As the vessel is very steady-going and can be navigated in shallow water, it is ideal for not only icebreaking but also many Arctic tasks year-round, such as marine research and oil spill response.

Steerprop Ltd

Steerprop Ltd designs and manufactures azimuth propulsors, specialising especially in the supply of ice-strengthened propulsors for demanding conditions in Arctic seas. To ensure its products’ structural tolerance and reliability, Steerprop has carried out a significant amount of R&D. Steerprop’s azimuth propulsors combine cost-efficiency with fuel economy. In the future, the company aims to expand into the manufacturing of more powerful propulsors and larger ships.

Steerprop has delivered the world’s largest mechanical azimuth propulsors to Russia for the Polar icebreaker Varandey, operating in the Barents Sea. Icebreakers St Petersburg and Moscow, which operate in the Baltic Sea, are also equipped with Steerprop azimuth propulsors. As a result of its long-term research and product development,
Wärtsilä

Wärtsilä has a strong position as the supplier of engines for icebreakers and other vessels operating in the Arctic region. The deliveries also cover automation systems, propulsion equipment and ship design. Energy-efficient, integrated overall solutions and, among other things, the use of gas as fuel enhance the vessels’ eco-friendliness.

Wärtsilä Ship Design designs different types of vessels for several ice classes, such as chemical tankers, Arctic research vessels, offshore support vessels and fishing vessels. Designing encompasses solutions from demanding Arctic icebreakers to merchant vessels which, if necessary, can navigate ice-covered waters. Tests are carried out in an ice laboratory to improve the manoeuvrability and icebreaking capacity of vessels. Aurora Borealis, an icebreaking research and drilling vessel planned for the EU, which is capable of operating in temperatures as low as -50 °C, is an example of Wärtsilä’s design projects.

Wärtsilä has also strengthened its cutting-edge position as a provider of maintenance services for ships in the Barents Sea region. In 2010 the company opened a service centre in Murmansk, which provides a broad range of services for all marine and offshore clients. In addition, Wärtsilä designs and supplies power plants to the northern regions.

Security

Finnish Transport Safety Agency (Trafi)

The Finnish Transport Safety Agency (Trafi) is responsible for the safety of shipping in Finland. From the point of view of safe winter navigation, it is important to know about the strain on vessel structures in ice conditions and vessels’ capacity requirements and ice classes. The Finnish and Swedish maritime authorities have prepared and published joint *Finnish-Swedish Ice Class Rules* since 1971. They determine the minimum engine output, hull strength, machinery and propeller strength.
for ice-going vessels. The rules are set to ensure that vessels operating in the Baltic Sea are equipped as required for ice conditions.

Keeping the Ice Class Rules updated demands continuous research and development. Trafﬁ and the Finnish Transport Agency are funding research on winter navigation in cooperation with their Swedish counterparts. The key themes of the research include issues relating to ice forecasts and smooth winter navigation.

**Finnish Transport Agency**

The Finnish Transport Agency is responsible for safe and smooth winter navigation and the availability of icebreaking services off the Finnish coast. In cooperation with the other countries bordering the Baltic Sea, the Finnish Transport Agency participates in winter navigation research and in enhancing knowledge of navigation in ice. It is essential to see to it that icebreakers are available and capable of operating in any extreme conditions at all times in the winter. The Finnish Transport Agency is responsible for freighting icebreakers and for the effective implementation of icebreaking services by means of guidance and an advanced traffic information system (IBnet) designed for winter navigation.

**IlLivelihoods in the Arctic regions**

Finnish industries and businesses are active in global markets. Now that the economic prospects of the Arctic region are rapidly growing, the opportunities opening up in the north are a natural field of operation for Finnish companies.

The **Lapland Chamber of Commerce** is the northernmost chamber of commerce in the European Union and well known for the development of an Arctic business environment. It plays an important role in promoting the cooperation and networking of companies in the Barents Euro-Arctic region. It holds the presidency of the Euro-Arctic Chamber of Commerce (EACC) and the chairmanship and secretariat of the Barents Business Advisory Group (BBAG). The **Arctic Business Forum**, organised annually by the Lapland Chamber of Commerce, deals with the development of investment and businesses in the northern regions.

In accordance with the updated Investment Catalogue of the European High North, published by the Lapland Chamber of Commerce in February 2012, the projected value of investment in the northern regions of Europe in the course of the next ten years will be EUR 125 billion: Northern Finland, EUR 22 billion; Northern Sweden, EUR 30 billion; Northern Norway, EUR 32 billion; and Northern Russia (Murmansk and Arkhangelsk) EUR 41 billion.
Mining industry

The importance of Northern Finland as an internationally significant mining industry area is rising and there are plenty of job and investment opportunities in this branch of activity. Finland offers a safe operating environment and good infrastructure for mining companies. Finland’s other strengths include solid technological expertise, the manufacturing of mining equipment, and basic geological mapping carried out by the Geological Survey of Finland.

In land use, it is important to pay attention to the respective requirements of mining, environmental protection, tourism and reindeer farming.

In Finland, geology can be studied at the Aalto University and at the Universities of Oulu and Turku. The University of Oulu focuses on responding to the needs of the mining industry in Northern Finland (Oulu Mining School).

Active Mines and Current Projects

Geological Survey of Finland

Precious Metals
1. Iso-Kuotko gold – Agnico-Eagle Ltd
2. Hanhima gold – Dragon Mining Ltd
3. Kittilä gold – Agnico-Eagle Ltd
5. Naakenaavaa gold – Taranis Resources Inc.
6. Pahtavaara gold – Lappland Goldminers Ab
8. Rompas gold, uranium – Mawson Resources Ltd
9. Suhanko-Kontijärvi PGE – Gold Fields Arctic Platinum Oy
10. Kuusamo gold – Dragon Mining Ltd
11. Laiva gold – Nordic Mines Ab
12. Hirsikangas gold – Belvedere Resources Finland Oy
13. Ängesneva gold – Belvedere Resources Finland Oy
14. Kopsa gold – Belvedere Mining Oy
15. Taivaljarvi silver – Solkamo Silver AB
16. Pampalo gold – Endomines AB
17. Seinajoki gold, antimony – Nortec Minerals Corp.
18. Osikonmäki gold – Belvedere Resources Finland Oy
19. Haveri gold – Lappland Goldminers Ab
20. Orivesi gold – Dragon Mining Ltd
21. Jokisivu gold – Dragon Mining Ltd
22. Kaapelinlumia gold – Dragon Mining Ltd

Base Metals
1. Rikontoski copper, gold – Taranis Resources Inc.
2. Kevitsa nickel, copper, PGE – First Quantum Minerals Ltd
3. Sakatti nickel, copper, PGE – Anglo American Exploration B.V.
4. Läntinen Koillismaa (LK) nickel, PGE – Finore Mining Inc.
5. Kuhmo nickel – Altona Mining Ltd
6. Kuhmo nickel – Anglo American Exploration B.V.
7. Talvivaara nickel, zinc, copper – Talvivaara Mining Co.
8. Hitura nickel – Belvedere Mining Oy
9. Pyhäsaalmi zinc, copper, pyrite – Inmet Mining Corp.
10. Rautavaara nickel, zinc, copper – Western Areas NL & Magnus Minerals Oy JV
11. Kylylahdi copper, gold, zinc, nickel, cobalt – Altona Mining Ltd
12. Valkeisenranta, Särkiniemmi nickel, copper – Altona Mining Ltd
13. Kylylahdi copper, gold, zinc, nickel, cobalt – Altona Mining Ltd
14. Valkeisenranta, Särkiniemmi nickel, copper – Altona Mining Ltd
15. Länttä lithium – Keliber Resources Ltd
16. Siilinjärvi phosphorus – Yara International ASA
17. Eno uranium – Mawson Resources Ltd
18. Tammela lithium, tin, tantalum – Nortec Minerals Corp.

Diamond
1. Kuusamo – Sunrise Resources Plc
2. Kuhmo – Karelian Diamond Resources Plc
3. Kaavi-Kuopio – Sunrise Resources Plc
4. Kaavi – Mantle Diamonds Ltd & Firestone Diamonds Developments JV

Other Commodities
1. Sokli phosphorus, niobium – Yara International ASA
2. Sivakkalehto iron – Tertiary Minerals Plc
3. Kolari iron, gold, copper – Northland Resources Ab
4. Kemi chromium – Outokumpu Chrome Oy
5. Ranua uranium – Mawson Resources Ltd
6. Mustavaara vanadium – Mustavaaraan Kaivos Oy
7. Punasuo talc, nickel – Mondo Minerals Oy
8. Alann talc – Luzenac Suomi Oy
9. Lättä lithium – Keliber Resources Ltd
10. Koivusaarenneva limeite – Kalvinit Oy
11. Siilinjärvi phosphorus – Yara International ASA
12. Eno uranium – Mawson Resources Ltd
13. Tammela lithium, tin, tantalum – Nortec Minerals Corp.
Metal industries

Finnish metal industries are closely linked with shipbuilding and offshore industries in that the branch of industry has expertise in the manufacture of materials suited for cold conditions. Equipment used in harsh conditions must be furnished with special qualities and resilience. Finnish-made steel structures have been delivered, for example, to oil platforms.

Outokumpu in Tornio and Rautaruukki Corporation in Raahe are two large global metal industry companies on the Bothnian Bay. SteelDone Group Ltd, which is owned by five Finnish metal industry companies, is a good example of a business with an interest in operating in markets in the north. The company has delivered special steel structures to the Barents region. Challenging welded and machined steel solutions as well as equipment and partial assemblies based on these structures are provided to especially cater to the needs of the oil, gas and energy industries.

Wind power

The objective to increase renewable energy sources has boosted interest in the use of wind power in the northern regions in Finland. The biggest problem is the accumulation of ice in the propeller blades and equipment of wind turbines.

Winwind is a wind power solution provider, which develops Arctic wind power and standards for cold conditions. The company has set up a consortium, which is designing an Arctic 3-MW wind turbine. In addition to the northern regions, its market area will also include mountainous regions in Central Europe. The project also develops Arctic wind power expertise in Finland on a more general plane. Tekes – the Finnish Funding Agency for Technology and Innovation, which funds business reform projects, is supporting this project.

Environmental technology

Fragile Nordic nature needs close attention. Finnish environmental technology can be used to clean up Arctic environments and to secure that production plants use low-carbon technology. Finland has the know-how and technology needed to respond to oil spills in the Arctic regions. The leading global expert in the field is the Finnish company Lamor.
Traffic and transport

In the Arctic, infrastructure must have the capacity to withstand changing conditions and to adapt to both cold and warm weather. The management and construction of road infrastructure in the Arctic regions will be important because of the exploitation of natural resources – Finnish expertise may be in demand in the future. The Finnish Transport Agency is responsible for the maintenance of roads and sea lanes in Finland. In Lapland, there are businesses that specialise in testing vehicles and tyres under winter conditions; one of them, Test World, is based in Ivalo. Many global car manufacturers test their products in the winter on the test tracks in Lapland. The only European snowmobile manufacturer is BRP Finland, on the Arctic Circle in Rovaniemi.

In Finland airports are kept open in all weather conditions, be they freezing temperatures or snowfall. Finavia is responsible for keeping the airports operational. North of the Arctic Circle there are four full-size airports: Rovaniemi, Kittilä, Ivalo and Enontekiö.

Tourism

In Arctic tourism, Finland is a great power. A major part of the accommodation capacity of the Arctic region is located in Finland. Northern Finland, in particular, is a popular winter destination, which is why the travel business is a significant industry in the north. Well-known winter resorts include Levi, Ylläs, Saariselkä, Salla, Luosto, Rovaniemi, Pyhä and Ruka. Winter tourism combines nature, adventure and shopping. One of the main attractions is Santa Claus’ workshop in Rovaniemi.

The largest individual travel destinations in Lapland have over 20 000 beds and the annual number of stays overnight in Lapland is well over two million. Further investments in tourism are being planned. Lapland’s asset with regard to winter tourism is that there is always snow in the winter. Examples of activities include downhill skiing, cross-country skiing, reindeer and dog sledge safaris, and different entertainment services. Thanks to airports with international connections and good road and rail networks, the destinations are within easy reach for both independent travellers and groups. Activities and services are also provided outside the winter season. Another high season is the autumn, with the glowing foliage and changing look of the flora.

Reindeer husbandry and nature-based livelihoods

Reindeer farming is common in the north of Finland. Reindeer herding is an important livelihood, practised by the indigenous Saami people and the main population in the rural north. Reindeer are an integral part of the culture and image of the region and essential for tourism. Reindeer meat is a sought-after specialty, currently an object of active interest for food processing.

Freely available natural products that anyone can pick for themselves – such as cloudberry, cowberry, cranberry, blueberry and other berries form a vital part of the trades and ways of life in the north. Many locals have started a small business in the health food and handicrafts sector.
III Finland’s role in Arctic research and training

Finland invests in expertise and research in the northern regions. Two universities located in Northern Finland serve what forms the backbone of Arctic expertise in Finland: state-of-the-art, multidisciplinary Arctic research and training. Diverse Arctic research is also conducted in many other universities and research institutes.

Knowledge of the special characteristics of Arctic nature, atmosphere and soil demands long-term research and field work. In Finnish Lapland a dense network of research stations and institutes has been established to map and monitor the state of the environment and atmosphere. Acting in the Arctic regions calls for manifold research and development in cold technology.

Extensive Arctic research

University of Lapland and the Arctic Centre

The University of Lapland is the northernmost university in the European Union with hands-on expertise in and connections with the people and cultures of the Arctic region. In the four faculties of the university and in the Arctic Centre, research focuses on Arctic people, communities, the environment and arts, and the interaction between them. Training linked with the North is available at both basic studies and post-graduate level education. In addition, the University of Lapland has a national responsibility for research in social sciences relating to the Saami people and for research into Saami Law.

The Arctic Centre of the University of Lapland is located in the Arktikum House, which is a museum, science centre and conference venue, and it is the only institute in Finland specialising expressly in Arctic questions. Its international and multidisciplinary research deals with three themes: global change, which focuses on the natural sciences; sustainable development, which focuses on the social sciences; and Arctic law. The Global Change Research Group is studying the impacts of increasing economic activity on the Arctic ecology, environment and communities. The group has special proficiency in research on the effects of Arctic energy industries in Siberia, where they cooperate with researchers, indigenous peoples, local inhabitants, industries and administrative public authorities. The Sustainable Development Group is studying environmental policy and the economy and communities’ adaptation and vulnerability. The Indigenous Peoples and Sami Research Office which participates in the work of the group, specialises in indigenous people’s folklore, politics and identity. The Northern Institute for Environmental and Minority Law addresses legal issues relating to international agreements and provisions concerning the Arctic region, the implementation
of environmental impact assessment processes, and land and environmental law as it applies to the Arctic indigenous peoples.

One organisation, the Arctic Centre, conducts research, has an Arctic science centre and a strong role as a communicator, and has contacts with many Finnish and international stakeholders. The Centre coordinates the multidisciplinary Arctic Doctoral Programme Arktis and, in cooperation with other faculties, implements an Arctic Studies programme. A group of international partners and the Arctic Centre have made a proposal for the establishment of an EU Arctic Information Centre with headquarter in Rovaniemi.

**University of Oulu and Thule Institute**

The **University of Oulu** is one the biggest universities in Finland. It is an international science university, where several disciplines focus on research on issues relating to the North and the Arctic. The university particularly specialises in bio-sciences and health, information technology, the environment, natural resources and materials, and cultural identity and communications. The university is engaged in development and innovation in close cooperation with businesses and other research institutes. The **Giellagas Institute** at the University of Oulu has a special responsibility for Saami language and culture research and language teaching as well as for research into the Saami history and communities.

The **Thule Institute** is a specialist in circumpolar issues and operates as a research centre focusing on northern and environmental issues and natural resources at the University of Oulu. It has four units: Centre for Arctic Medicine, Northern Environmental Research Network NorNet, Environmental Technology Development Unit NorTech Oulu and Oulanka Research Station. The themes of the institute’s four-year research programmes include Global Change in the North; Northern Land Use and Land Cover; Circumpolar Health and Wellbeing; Environmental Technology Development and associated Environmental and Resource Economics. The research groups study climate change and adaptation to it, sustainable use of natural resources, people’s health risks and adaptation to the northern environment, as well as environmental and energy economies in the north. The Thule Institute also takes part in the development of research infrastructures. The institute offers doctoral and Master’s degrees and plays a strong role in international cooperation in Arctic and polar research.
Networking and vocational education

The University of the Arctic (UArctic) is an international cooperation network of universities, colleges and other educational institutions with over 140 members. UArctic offers multidisciplinary training, student exchanges and cooperation across different disciplines, focusing on issues pertaining to the North. The University of Lapland is in charge of the administrative governance and coordination of UArctic while the Thematic Networks Coordination Office of UArctic is located in the Thule Institute of the University of Oulu.

The University of Lapland, the Kemi-Tornio University of Applied Sciences and the Rovaniemi University of Applied Sciences form the Lapland University Consortium (LUC). The Lapland Institute for Tourism Research and Education, the Lapland University Consortium Library and the Institute for Northern Culture are also parts of the consortium.

The Rovaniemi University of Applied Sciences conducts research, training and development work related to the management of cold conditions. The key themes include Arctic testing and product development, snow and ice in the urban environment, and sustainable use of the natural resources of the North. The Arctic Power laboratory (pLab) addresses issues related to cold and winter technologies, and the ENVI Virtual Center of Wellness Campus (European Network of Living Labs, ENVI) concentrates on safety and wellness technology solutions serving in cold conditions.

The Sámi Education Institute, Sámi oahpahusguovddás, is a provider of a variety of training programmes in Inari. Education is given in Finnish and Saami. The mission of the institute is to support and promote the Saami languages, culture and occupations. Vocational upper secondary education and training is designed to serve the needs of the Saami region. The institute also offers education in Saami culture, preparatory courses for vocational degrees, and adult education in a variety of subjects. One of the strengths of the institute is a well-functioning network of cooperation with the other educational institutions and organisations of the Arctic indigenous people. The main form of cooperation is development of training and education in reindeer farming and supporting livelihoods linked with reindeer farming in a manner that respects the indigenous people's traditions and the environment.

Everyday life and well-being in the North is also studied and supported elsewhere in Finland. The Tampere Peace Research Institute (TAPRI), for example, conducts Arctic research focusing on climate change and the security policy effects of globalisation in the high north.
Experts in Arctic nature

Research and expert organisations

The Finnish Environment Institute, SYKE, is represented in projects of the Arctic Council’s Arctic Monitoring and Assessment Programme (AMAP), in which information is collected about environmental toxins, climate change, and short-lived substances with an impact on climate. In cooperation with its research partners, SYKE has studied contaminants in lake sediments and the movements of harmful airborne substances. SYKE is also involved in the Arctic Council’s Action Plan to Eliminate Pollution of the Arctic (ACAP), in which concrete projects to reduce emissions are carried out, especially in northern Russia.

The Centre for Economic Development, Transport and the Environment (ELY Centre) in Lapland is responsible, among other things, for monitoring environmental stress, the state of the environment, and the materialisation of natural and cultural values in Lapland and participating in the international management of environmental issues in the north. The ELY Centre takes an active part in the Arctic and Barents Euro-Arctic cooperation and in

the Arctic Council’s Arctic Monitoring and Assessment Programme (AMAP).

The Finnish Forest Research Institute, Metla, generates solutions to issues related to the management and use of forests and products, services and intangible values linked with forests. Metla has offices in different parts of Finland, the northernmost units in Rovaniemi and Kolari. It studies issues linked with northern nature, focusing especially on the reconciliation of different uses of forests and sustainable nature tourism.

The need to reconcile the interests of different types of livelihoods is highlighted in the North, where forestry, tourism as well as reindeer farming and mining are all important sources of income.

The Finnish Game and Fisheries Research Institute (FGFRI) has several units in the very north of Lapland. In the Reindeer Research Station in Inari, research work concentrates on reindeer and reindeer husbandry. Game research focuses on monitoring and studying wildlife populations, such as willow grouse, elk and large carnivore populations. The FGFRI also monitors salmon stocks and is engaged in related research. It also follows the native and cultivated species in inland waterways and the use of fish populations in the fishing industry and leisure time fishing.
In the northernmost unit of MTT Agrifood Research Finland in Rovaniemi, researchers concentrate on and support plant production in the extreme conditions north of the Arctic Circle and on entrepreneurship in sparsely populated rural areas. Projections are also made for changes caused by climate change on agriculture, horticulture and nature-based production in the North. Raw materials obtained from the North can be processed into new special products and wellness services that improve the global competitive capacity of primary producers, service providers and industries, which rely on natural raw materials.

University research stations in the North

The Kevo Research Institute of the University of Turku is located in the sub-Arctic zone in Utsjoki. The research station is engaged in diverse biological, geographical and environmental research. The Oulanka Research Station of the University of Oulu is located in Kuusamo. The station promotes research and education focusing on the local natural resources, environment and tourism. In addition, the station conducts long-term monitoring and surveys of the environment.

The Kilpisjärvi Biological Station is run by the University of Helsinki, and the key research activities carried out at the station comprise long-term follow-up studies, which have received international recognition. A series of observations of small mammals (rodents) describe the population dynamics for over 50 years. The station also accommodates the Seismological Station of the University of Helsinki. Research at the Värriö Subarctic Research Station in Salla includes, for example, systematic snowline tracking and observation of large carnivores.

Research on Arctic conditions

Finnish Meteorological Institute

The Arctic Research Division of the Finnish Meteorological Institute (FMI) studies the different layers of the polar atmosphere, biosphere and earth, and produces accurate information about the atmosphere, climate and the environment. The Division comprises the Arctic Research Centre in Sodankylä (FMI-ARC) and the aurora research group in Helsinki. The Satellite Data Centre of FMI-ARC is becoming
The Geological Survey of Finland (GTK) conducts geological, geochemical and geophysical research and explores natural resources in northern regions. Soil map surveys and bedrock mapping produce information and digital observation data for use in research, building, planning and environmental management. The GTK’s Arctic research programmes have produced a method based on geophysical, electronic and electromagnetic soundings, which can be used to monitor the structure of and changes in the surface layers and melted top layer of permafrost. The mapping technique can be applied, for example, to help construct roads, pipelines and production plants on a sustainable foundation in the oil and gas production areas of the Russian Arctic regions.

Ice research in the FMI focuses on investigating and developing remote sensing methods and ice modelling. Remote sensing research of sea ice includes the maintenance and development of cutting-edge technology satellites. Radar satellites can be used, for example, to figure out how thick ice is. The FMI uses forecast models, which take into account the northern conditions and the impact of ice. The principal users of the Finnish Meteorological Institute’s ice service are merchant vessels and icebreakers. Vessels receive real-time ice maps, produced by means of satellite images, radar images and coastal observation stations.

The GTK is involved in the coordination and development of groundwater research in the Arctic regions. The objective is to clarify the impact of the ice-age cycle on the composition of bedrock water, the hydrological flow of groundwater and the physical characteristics of rock. For groundwater surveys, the GTK develops new methods which would facilitate operation in exceptionally cold conditions. The results of such research are also useful for Arctic research more widely, including when climate change questions are handled.
Radiation and Nuclear Safety Authority

The Regional Laboratory in Northern Finland of the Radiation and Nuclear Safety Authority (STUK) in Rovaniemi is the northernmost laboratory specialising in the monitoring of radioactivity in the EU and is a part of a network that is monitoring and evaluating the Arctic environment. It participates in national radiation monitoring and in research projects in Arctic and sub-Arctic regions. In addition, the laboratory monitors the levels of radioactivity in foods produced in the region and makes measurements for clients.

University research institutes

The Sodankylä Geophysical Observatory, a department of Oulu University, concentrates on research and measurements of the Earth’s magnetic field, near-earth space above the polar region and cosmic rays. In addition, the observatory develops radar measurement and research methods as well as observation techniques. It is one of the receiver stations of EISCAT, a leading international research organisation operating incoherent scatter radar systems.

In the Department of Geology at the University of Helsinki, Arctic research is carried out in three different research groups which examine events during and after the ice age. The research especially focuses on the ice sheet periphery at Svalbard and the Arctic regions in Canada and on trends in Eurasian tundra vegetation. The Department of Geography conducts permafrost surveys in Lapland and Canada. In the past few years, permafrost research has concentrated on assessing the sensitivity of permafrost regions in different climate change scenarios.

Arctic research conducted by the cryosphere – snow and ice – research group in the Department of Physics at the University of Helsinki deals with the lakes and various aspects of snow in the Lapland tundra, glaciers in Svalbard, polar oceanography and Arctic sea ice. Practical applications are linked with Arctic seas, and above all with the exploitation of oil and gas resources, shipping, impacts of climate change, and environmental protection. The group has gained a high scientific profile in research concerning the dynamics of drift ice and Arctic lakes.

The Department of Environmental Science at the University of Eastern Finland studies biological processes of carbon and nitrogen linked with the production and consumption of greenhouse gases in Arctic soil and greenhouse gas flows between Arctic ecosystems and the atmosphere. The objective is to gain an understanding of how Arctic greenhouse gas flows change as a result of climate change and reducing permafrost. The risk is that the warming climate will accelerate carbon dioxide and methane release from the breakdown of a now frozen, vast organic matter reserve.

Cold technology research

VTT Technical Research Centre of Finland

VTT Technical Research Centre of Finland is a globally networked multi-technological contract research organization. Its research into cold climate and Arctic technology focuses on ice-going vessels and maritime structures and improved energy-efficiency of buildings and the urban environment. VTT is involved in all phases of the design process of ice-going ships. Special attention is paid to structural solutions for ships and ice loads as well as the performance of ships in ice-covered seas. VTT has also participated in the development of international regulations pertaining to ice-going ships.

In cooperation with the public authorities and service providers, VTT is developing tools for icebreaking in the Baltic Sea. Operational tools can be used to illustrate ice conditions and the location of vessels at sea to enable effective activities. Strategic tools can be used to simulate winter traffic and assess the need for icebreakers in different areas and under different ice conditions. In past years, VTT has concentrated on developing ice modelling, which can be applied to the optimal measurement of maritime structures, such as wind farms at sea. VTT has also studied sea spray icing on ships and maritime structures by means of theoretical modelling.
VTT's Arctic expertise also covers ground freezing and construction in cold environments. Accumulation of ice on power lines, TV towers and the propeller blades of wind turbines caused by cloud droplets and freezing precipitation is one of the topics under active research. VTT investigates soil freezing, frost heave and thawing and its effects. It has developed a major part of the ground freezing measurement methods that are currently in use. The results are applied in structural foundations and underground piping as well as in road and street construction. VTT also studies and models ice friction in cooperation with companies and the Aalto University. Applications of this modelling include winter tyre development, the reduction of slipping accidents, and development of winter sports equipment.

**Aalto University**

Arctic technology is one of the key areas of research at the Aalto University School of Engineering. Themes of research in the Department of Applied Mechanics include ice loads on ships and marine structures and ship performance in ice conditions. Ice mechanics and winter navigation systems are also objects of research. In Otaniemi, Espoo, researchers have access to a Marine Technology Multifunctional Ice Basin, which is ideally suited for testing ship and other maritime structures in ice conditions. The Vehicle Engineering Group in the Department of Engineering Design and Production investigates, among other things, tire–road contact in winter conditions. The Group especially concentrates on the simulated theoretical research of tyre performance on ice and snow and friction measurements.

In the Department of Civil and Structural Engineering, the performance of different materials has been studied experimentally and by means of theoretical models for several decades. The Department's internationally recognised expertise qualifies it for engaging in mathematical modelling and numerical simulation linked with Arctic technologies. Arctic technology involves, for example, water freezing in porous materials, such as soil and concrete, and dynamic impacts caused by avalanches on structures.

The Geo-engineering Group of the Department of Civil and Environmental Engineering investigates problems arising in cold conditions to find out about and to prevent the adverse effects on structures caused, mainly, by frost heaving. The thaw period is an important area of research and focuses on thawing ground frost which softens the soil and weakens the load-bearing capacity of roads.

Arctic issues are also studied at the Aalto University School of Electrical Engineering, which specialises in remote sensing research, and at the School of Science, where the physics of ice is an object of research.
Contacts

Shipping

ABB, www.abb.com
Arctech Helsinki Shipyard, www.arctech.fi
Arctia Shipping, www.arctica.fi/front_page
Aker Arctic Technology, www.akerarctic.fi
Cargotec, www.cargotec.com
Mobimar, www.mobimar.com
Neste Oil & Neste Shipping, www.nesteoil.com
Steerprop Oy, www.steerprop.com
STX Finland, www.stxeurope.com
STX Finland Cabins, www.stxeurope.com/cabins
Traf, www.trafi.fi/en
Trafotek, www.trafotek.fi
Wärtsilä, www.wartsila.com

Other businesses

BRP Finland, www.brpscanadavia.com
Finavia, www.finavia.fi/home
Lamor Oy, www.lamor.com
Lapland Chamber of Commerce, www.lapland.chamber.fi/
index-english.html
Outokumpu, www.outokumpu.com
Rautaruukki, www.ruukki.com
Test World Oy, www.testworld.fi
Winwind Oy, www.winwind.com

General contacts in business life

Ministry of Employment and the Economy, www.tem.fi/
index.phtml?i=en
Tekes, the Finnish Funding Agency for Technology and
about+us/
(Pages)/Index

Research and training

Aalto University, www.aalto.fi/en/
Arctic Centre, University of Lapland, www.arcticcentre.org/
InEnglish.iw.3
University of the Arctic, network of cooperation, www.uarctic.org/
Frontpage.aspx?m=3
Geological Survey of Finland (GTK), http://en.gtk.fi/
Giellagas Institute, University of Oulu, www.oulu.fi/giellagas/en/
index.html
University of Helsinki, www.helsinki.fi/university/index.html
| arctic-research
University of Eastern Finland, www.uef.fi/uef/english
Kemi-Tornio University of Applied Sciences, www.tokenm.fi/
In_English/Home.iw3
Kilpisjärvi Biological Station, University of Helsinki, www.helsinki.fi/
kilpis/english/index.htm
Centre for Economic Development, Transport and the Environment
Lapland University Consortium, www.luc.fi/In_English/About_us.iw3
Kevo Research Station, University of Turku, www.chev.utu.fi/en/
University of Lapland, www.ulapland.fi/InEnglish.iw3
MTT Agrifood Research Finland, portal.mtt.fi/portal/page/portal/
mtt-en
Oulanka Research Station, University of Oulu, www.oulu.fi/oulanka/
en_index.html
University of Oulu, www.oulu.fi/english/
Tampere Peace Research Institute (TAPRI), University of Tampere,
Finnish Game and Fisheries Research Institute, www.rktl.fi/english/
Sodankylä Geophysical Observatory, University of Oulu,
www.sgo.fi/index.php
asp?node=4032&lan=en
Thule Institute, University of Oulu, www.thule.oulu.fi/english/
index.html
VTT Technical Research Centre of Finland, www.vtt.fi/?lang=en
Värriö Subarctic Research Station, University of Helsinki,
www.helsinki.fi/forestsceinces/varrio/

Other contacts

Academy of Finland, www.aka.fi/ en
index.html
Thule Institute, University of Oulu, www.thule.oulu.fi/english/
index.html
VTT Technical Research Centre of Finland, www.vtt.fi/?lang=en
Värriö Subarctic Research Station, University of Helsinki,
www.helsinki.fi/forestsciences/varrio/

Photo: Finnish Tourist Board