

Paper #6-3

RESEARCH BEING DONE BY FOREIGN GOVERNMENTS

Prepared for the
Technology & Operations Subgroup

On March 27, 2015, the National Petroleum Council (NPC) in approving its report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Technology & Operations Subgroup. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 46 such working documents used in the study analyses. Appendix D of the final NPC report provides a complete list of the 46 Topic Papers. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

This page is intentionally left blank.

Topic Paper

(Prepared for the National Petroleum Council Study on Research to Facilitate Prudent Arctic Development)

6-3

Research Being Done by Foreign Governments

Author(s)

Peter Noble (Noble Associates)
Catherine Jahre-Nilsen (Statoil)
Bill Maddock (BP)
Jed Hamilton (ExxonMobil)

Reviewers

Mitch Winkler (Shell)
James Bond (ABS)

Date: August 19, 2014

Revision: Final

SUMMARY

This topic paper describes arctic and cold regions research institutes and programs organized and primarily funded by the major foreign governments within the Arctic Council. The selected countries include Canada, Norway, Finland and Russia. The objective of this topic paper is to provide a comparison basis with which to view similar national governmental research efforts in the U.S. In general government-funded research that is applicable to offshore oil and gas development in the Arctic is more extensive in Canada and Norway than in the U.S.

I. INTRODUCTION

This topic paper describes arctic and cold regions research institutes and programs organized and primarily funded by the major foreign governments within the Arctic Council. The selected countries are:

- Canada
- Norway
- Finland
- Russia

II. CANADA

As a polar nation, Canada has a considerable range of national programs engaged in northern research and development activities.

These activities are described in Table 1 below and these entities can also be sub-divided into “Doers”, “Studiers” and “Coordinator/Funders”. Most recent Canadian research is well documented and searchable on the internet, however there is an extensive body of older and still relevant research that is not accessible over the internet.

Table 1. Inventory of Canadian Northern Research Centers

	Key		
ArcticNet			
Centre for the North (CFN)		Doers	
Canadian Polar Commission (Government of Canada)		Policy Shapers	
Canadian High Arctic Research Station (CHARS)		Funders/Coordinators	
C-CORE, LOOKNorth & CARD (centers within C-CORE)			
Canadian Network of Northern Research Operators			
Arctic Institute of North America (at University of Calgary)			
NRC Arctic Program			
Program of Energy Research and Development (PERD)			
Polar Continental Shelf Program (PCSP)			
BREA Beaufort Regional Environment Assessment 2011-14			
Environmental Studies Research Funds (ESRF), CAPP supported			
The Canadian International Centre for the Arctic Region			

The following institution/organizations can be considered as fitting into the “Doers” category (they get their noses cold):

- **ArcticNet:** is a well-funded network of Canadian Universities, undertaking arctic science studies.
- **C-CORE, LOOKNorth, CARD:** are based in Newfoundland and undertake engineering R&D studies, both desk and field, utilizing government and private sector funding
- **NRC Arctic Program:** is a national government initiative for engineering R&D, both desk and field, utilizing government and private sector funding
- **Canadian High Arctic Research Station (CHARS):** is a new entity established to carry out Arctic science and technology from new facilities now under construction in Cambridge Bay

The following groups are “Studiers” and “Shapers of Policy”:

- **Centre for the North (CFN):** The Centre for the North is a forum for research and dialogue on Northern and Aboriginal issues. The Centre brings Aboriginal leaders, businesses, governments, and community advocates together to identify challenges and opportunities, and discuss how those challenges can be met. The CFN:
 - Delivers cutting-edge research based on three foundational themes of thriving communities, economic development and sovereignty and security in the North;
 - Examines issues from a Northern perspective, seeks to maximize Northern engagement, and prioritizes Northern interests;
 - Creates unique networking opportunities with Northern representatives from government, industry, academia and Aboriginal groups—the only roundtable in Canada to provide this balanced matrix of dialogue;
 - Focuses on delivering practical solutions to the wide ranging socio-economic challenges facing Canada’s Northern communities;
 - Covers the territorial North as well as the northern regions of seven provinces;

- Is supported by a roundtable of 50 members that determine and review the Centre’s research projects.
- **Canadian Polar Commission:** The Canadian Polar Commission is a Canadian government agency of Aboriginal Affairs and Northern Development Canada responsible for monitoring, promoting, and disseminating knowledge of the polar regions; contributing to public awareness of the importance of polar science to Canada; enhancing Canada's international profile as a circumpolar nation; and recommending polar science policy direction to government.
- **Canadian International Centre for the Arctic Region:** The Centre offers strategic advice to inform Canada’s Arctic advocacy, foreign policy directions and actions. It also strengthens and coordinates regional engagement with Arctic state partners and beyond. With the interest in Arctic growing exponentially, the Centre supports and works closely with Canadian missions in Denmark, Finland, Iceland, Norway, Sweden, Russia and the United States, as well as throughout Europe and increasingly in Asia. The Centre pursues four specific objectives:
 - to contribute to the development and implementation of a comprehensive Canadian Arctic foreign policy, including strengthened regional engagement,
 - to support the identification of targeted, innovative trade and commercial opportunities for the North, including and benefiting Northerners;
 - to help position Canada as a global leader in Arctic science and research; and
 - to assert Canadian positions and contribute to raising Canada's profile on Northern issues, through an active advocacy strategy involving Northern participation.

The last category in the Canadian Arctic R&D continuum is the “Coordinators” and “Funders”:

- **Canadian Network of Northern Research Operators:** The Canadian Network of Northern Research Operators (CNNRO) is a forum for operators of the many research facilities scattered across the Canadian Arctic and Subarctic. These range from well-equipped laboratories like the Polar Continental Shelf facility at Resolute Bay, to tiny cabins like the Gateshead Island Polar Bear Research Station, to floating atmospheric monitoring buoys, to research vessels like the CCGS Amundsen icebreaker. The network was formed in 2007 with assistance from the Canadian Polar Commission, and later with help from Aboriginal Affairs and Northern Development Canada. The CNNRO helps northern research operators improve efficiency and lower costs by sharing information and facilitating collaboration.
- **Arctic Institute of North America (University of Calgary):** AINA is developing a broad research program in the context of a new strategic plan which identifies three focal areas that allow the institute to fulfil its mandate to conduct research on and disseminate information about the physical, biological, social and cultural aspects of the north, and provide data and information of relevance and interest to northerners and all Canadians.
- **Program of Energy Research and Development (PERD):** The Program of Energy Research and Development (PERD) is a federal, interdepartmental program operated by Natural Resources Canada (NRCan). PERD funds research and development designed to ensure a sustainable energy future for Canada in the best interests of both our economy and our environment. It should be noted PERD only provides funding to federal departments and agencies. It is not a general funding or grant program for companies, associations or individuals.

Thirteen federal departments and agencies participate in PERD:

- Agriculture and Agri-Food Canada
 - Atomic Energy of Canada Limited (AECL)
 - Canada Mortgage and Housing Corporation
 - Environment Canada
 - Fisheries and Oceans Canada
 - Health Canada
 - Indian and Northern Affairs Canada
 - Industry Canada
 - National Defence
 - National Research Council Canada
 - Natural Resources Canada
 - Public Works and Government Services Canada
 - Transport Canada
- **Polar Continental Shelf Program (PCSP):** In accordance with Natural Resources Canada's legislative authorities, the Polar Continental Shelf Program (PCSP) coordinates field logistics in support of advancing scientific knowledge and management of Canada's lands and natural resources. As a national service delivery organization, PCSP coordinates logistics for Canadian government agencies, provincial and territorial government agencies, northern organizations, universities and independent groups conducting research in Canada's North, and through this work, PCSP directly contributes to the exercise of Canadian arctic sovereignty.

The Polar Continental Shelf Program's mission is to provide safe, efficient and cost-effective logistics services in support of science and Government priorities.

- **BREA Beaufort Regional Environment Assessment:** The Beaufort Regional Environmental Assessment (BREA) is a multi-stakeholder initiative to sponsor regional environmental and socio-economic research that will make historical information available and gather new information vital to the future management of oil and gas in the Beaufort Sea.
- **Environmental Studies Research Funds (ESRF), CAPP supported:** The Environmental Studies Research Funds (ESRF) is a research program which sponsors environmental and social studies. It is designed to assist in the decision-making process related to oil and gas exploration and development on Canada's frontier lands. The ESRF program, initiated in 1983, receives its legislative mandate through the Canada Petroleum Resources Act (CPRA), which was proclaimed in February 1987. As well the Canada-Newfoundland Atlantic Accord Implementation Act and the Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act provide legislative direction. The funding for the ESRF is provided through levies on frontier lands paid by interested holders such as the oil and gas companies. The ESRF is directed by a joint government/industry/public Management Board and is administered by a small secretariat which resides in the Office of Energy Research and Development, Natural Resources Canada, Ottawa, Ontario.

Finally there has been and still is a considerable effort by government staff and outside industry experts to conduct R&D which supports developments of Codes and Standards as noted below:

- Canadian Standards Association

- Canadian highway bridge design code (CSA-S6)
- Canadian offshore structures code (CSA-S470 series)
- Arctic Shipping Pollution Prevention Regulations (ASPPR) 1972
- Harmonized international standards
 - ISO 19906 Arctic offshore structures
 - IACS/IMO Polar Code

III. NORWAY

POLICY MAKERS AND REGULATORS

As part of the Norwegian Government's High North Policy in 2006, increased knowledge and awareness of the Arctic was 1 of 7 key priority areas. Government ambition is that Norway shall be at the forefront internationally in the development of knowledge about, for and in the High North. Awareness and knowledge is a fundamental aspect for development of the Norwegian fact-based approach to area opening and legislative approaches.

The **Storting (Norwegian Parliament)** sets the framework for the petroleum activities in Norway, in part by adopting legislation. Major development projects and issues involving fundamental principles must be deliberated in the Storting. The Storting also reviews the Government and public administration. The **Government** exercises executive authority over petroleum policy, and answers to the Storting as regards policies. To carry out its policies, the Government is assisted by the ministries, underlying directorates and supervisory authorities. Responsibility for the various roles in Norwegian petroleum policy is distributed as follows:

Ministry of Petroleum and Energy

The principal responsibility of the Ministry of Petroleum and Energy is to ensure high value creation through efficient and environment-friendly management of Norway's energy resources. The MPE is responsible for resource management and the sector as a whole, as well as the State's ownership in Statoil and Petoro AS. The MPE has responsibility for development of integrated management plans, as fact based approaches to stepwise, prudent development of the Norwegian sector.

- The **Norwegian Petroleum Directorate** is subordinate to the Ministry of Petroleum and Energy. The Norwegian Petroleum Directorate plays a key role in the petroleum management system, and is an important advisory body for the Ministry of Petroleum and Energy. The NPD exercises administrative authority in connection with the exploration for and production of petroleum

deposits on the Norwegian continental shelf. This also includes the authority to stipulate regulations and make decisions pursuant to the petroleum activities regulations.

Ministry of Labour and Social Affairs

Has overall responsibility for regulating and supervising the working environment, as well as safety and emergency preparedness in connection with the petroleum activities.

- **Petroleum Safety Authority Norway (PSA/Ptil)** is responsible for technical and operational safety, including emergency preparedness and working environment in the petroleum activities.

Ministry of Transport and Communications

Responsible for acute pollution preparedness in Norwegian waters.

- The **Norwegian Coastal Administration** is responsible for the State's oil spill preparedness. The Coastal Administration has extensive cooperation with the **Norwegian Clean Seas Association for Operating Companies (NOFO)**. Operates Norwegian Ice Service (ice warnings, ice navigation in Norwegian waters, including Svalbard and BarentsSea
- **BarentsWatch** is a comprehensive monitoring and information system for large parts of the world's northern seas. The prioritised target groups are public administration, industry, research and education. User-driven activity with user needs as the basis for the development of services supported by BarentsWatch. Organises meetings in which different user groups present their needs for information and services.

Ministry of Climate and Environment

Has overall responsibility for managing environmental protection and the external environment in Norway.

- The Ministry is engaged in strategy and policy development for marine management, polar areas, pollution control, chemicals and the European Economic Area, trade and investment agreements. The main tasks are the development of legal, administrative and economic regulations and incentives, and the implementation and further development of relevant international agreements. The department is responsible for the integrated management of the marine environment both at the national and international level. Responsibility across sectors for management plans for marine areas, for safeguarding the environment within the sectors (the petroleum industry, fisheries, shipping) and for the protection and management of marine areas/coastal areas under the Natural Diversity Act, marine environment cooperation in the High North, IMO, the OSPAR

and London conventions, and research and environmental monitoring of the marine and coastal areas.

Ministry of Foreign Affairs

The High North is Norway's number one foreign policy priority, as set out in the Government's first and second policy platforms. The Government launched its High North Strategy in 2006, and followed it up with the report *New Building Blocks in the North* in 2009 – setting out its priorities for the next 10–15 years, and a strategy and vision white paper in 2011, in which it presents a coherent, long-term Norwegian policy for dealing with the challenges and opportunities faced in the High North.

- The **Norwegian Barents Secretariat** aims at developing the Norwegian-Russian relations in the north by promoting and funding Norwegian-Russian cooperation projects. The Secretariat is also a center of competence on Norwegian-Russian relation. The Secretariat is owned by the three northernmost counties of Norway: Nordland, Troms and Finnmark. The Secretariat's budget is mainly financed by the Norwegian Ministry of Foreign Affairs.
- The Russian-Norwegian Barents 2020 project was established in 2007 based on initiative from the Ministry of Foreign Affairs. The project was supported by Russian and Norwegian authorities and by the Russian, Norwegian and international oil and gas industry industry, including experts from more than 30 Russian and international companies. The objective of Barents 2020 was to assess the standards needed for safeguarding people, environment and asset values in the Barents Sea. This project organized seven teams of leading international experts working together to make common recommendations on selected safety critical issues. The objective of the Barents 2020 project is to recommend standards for oil and gas activities in the Barents Sea which will ensure that the safety level is at least as good as in the North Sea. The results of Barents 2020 are currently being integrated into International ISO Arctic standards through industry funded JIP work.

Ministry of Trade, Industries and Fisheries

The Department for Fisheries and Aquaculture is responsible for matters related to fisheries, the fishing fleet and the aquaculture industry. There is a wide range of topics in the department's portfolio, including quota negotiations and international fisheries agreements, IUU fishing, regulation of and the right to engage in fishing, regulation of the fishing fleet, aquaculture policy and management, environmental sustainability of the aquaculture industry including fish health and –welfare, and licensing rules.

- The **Directorate of Fisheries** is responsible for matters related to petroleum activities, including impact studies. The section is also the secretariat for the compensation scheme for Norwegian fishermen pursuant to the Petroleum Act, and for the Trawler Board.

Ministry of Finance

Has the overall responsibility for taxation and fees from petroleum activities.

- The **Petroleum Tax Office** is part of the Norwegian Tax Administration, which is subordinate to the Ministry of Finance. The primary task of the Petroleum Tax Office is to ensure correct stipulation and payment of taxes and fees adopted by the political authorities.

RESEARCH AND ADVISORS

Norwegian Polar Institute

Norway's central governmental institution for scientific research, mapping and environmental monitoring in the Arctic and the Antarctic. The Institute advises Norwegian authorities on matters concerning polar issues, and the Ministry of Climate and Environment defines the scope and sets the tasks for Institute. The Institute's activities are focused on environmental management needs in the Polar Regions. In addition to collaboration on environmental protection in the Barents region, the Institute dedicates much effort to research on climate, long-range transport of pollutants and their impact on the environment, and biodiversity. Topographic mapping is also an important task.

- Climate research engages most researchers, conducting research on past climates as well as today's physical processes involving the ocean, sea ice and terrestrial ice.
- Contaminants research is performed in air, soil and sediments, in snow and ice, in salt and fresh water, in birds, other animals and humans. Polar air measurements are also performed by NILU at Svalbard (<http://polarportal.nilu.no>)
- Biodiversity research covers resource management and conservation policy on flora and fauna (polar bear, arctic fox, Svalbard reindeer)
- Geology research includes geological mapping and investigations of Polar Regions (Svalbard in particular). See separate web site GEONET/GEOKART.

Institute of Marine Research

Main task is to provide advice to Norwegian authorities on aquaculture and the ecosystems of the Barents Sea, the Norwegian Sea, the North Sea and the Norwegian coastal zone. The Institute is an important advisor in questions regarding petroleum activity in the High North.

Norwegian Research Council

The Council administrates a significant R&D portfolio covering the Northern Areas. The most important programmes on a national basis and any ongoing Arctic/Barents Sea projects are:

- **PETROMAKS2**
 - Reconstructing the Triassic northern Barents shelf
 - Barents Sea Paleozoic basement and basin configurations
 - Barents Sea Tectonic Basin Modelling (BarMod) with focus on potential petroleum systems in the central Barents Sea region
 - Indicators of environmental impact of petroleum activities: The next generation of molecular markers
 - An impact analysis modeling system for the Petroleum Industry
 - Risks during hydrocarbon exploration and production in cold offshore regions
 - Barents Sea rock properties
- **GASSMAKS:** intended to help ensure that more Norwegian natural gas is refined and used in Norway.
- **DEMO2000:** initiative supported by the Ministry of Petroleum and Energy (MPE) in order to ensure long term competitiveness in the Norwegian oil and gas business and continued profitable development of the petroleum resources of the Norwegian Continental Shelf. This is particularly relevant for increasing cost challenges going north.
- **ENERGIX:** provides funding for research on renewable energy, efficient use of energy, energy systems and energy policy. This encompasses technological, natural science and social science-based research and development
- **BIA:** funds industry-oriented research and has no thematic restrictions
- **SkatteFUNN:** The SkatteFUNN R&D tax incentive scheme is a government program that is designed to stimulate research and development (R&D) in Norwegian trade and industry. Businesses and enterprises that are subject to taxation in Norway are eligible to apply for tax relief. All branches of industry and all types of companies can apply to the SkatteFUNN tax deduction scheme.
- **European Energy Programme for Recovery:** A €4bn programme was set up in 2009 to co-finance projects (59 so far), designed to make energy supplies more reliable and help reduce greenhouse emissions, while simultaneously boosting Europe's economic recovery.
- **NORRUSS**

- Seismic expression of fault and fracture zones in Barents Sea petroleum reservoirs (SEISBARS)
- Detection and characterization of anthropogenic oil pollution in the Barents Sea by synthetic aperture radar
- Seismological research related to geophysical processes in the European Arctic
- The Permian/Triassic evolution of the Timan-Pechora and Barents Sea basins
- Environmental management of petroleum activities in the Barents Sea: Norwegian-Russian collaboration (EMAP)
- CLIMate variability and change in the Eurasian ARctic in the 21st century
- Combined effects of petroleum and environment in bivalves from the Norwegian-Russian Arctic
- Sustainability and petroleum extraction: Corporate and community perspectives in Northern Norway and the Russian Arctic

A number of Norwegian research institutions and universities are involved in executing the programmes within the portfolio. The most important institutions are:

- **SINTEF:** performs multidisciplinary research in technology, medicine and social sciences (2200 employees). Noncommercial organization where the profit are invested in new research, scientific equipment and competence development. Located in Trondheim and integrated with the university there, NTNU.
 - Oil spill in Arctic and ice-infested waters ("Oil and Ice" programme), comprising oil spill technology, field and laboratory experiments (MC)
 - SeaLab - Large scale facilities for low temperature work and simulating arctic conditions (FA)
 - Coriolis Basin - Large scale circulation of ocean currents in the Barents Sea (FA)
Multiphase flow and cold flowtechnology including hydrates, scale formation and solids transportation (PR)
 - Development of Helly Hansen's SeaAire helicopter/survival suit (multidisciplinary)
 - Traffic and surveillance, risk management, safety control and contingency planning in Arctic waters (MARINTEK)
 - Testing STX OSV specialized vessel for maintenance of subsea installations in arctic waters (2011)
 - Tests of arctic clothing, heat loss, hypothermia, etc. in cold labs (TS)

- IDAP – Main provider of field data acquisition in the OKN 1988-94 programme on sea ice and icebergs (most extensive information on drifting icebergs in the Barents Sea)
- **Akvaplan-niva:** provides consultancy, research and laboratory services to companies, authorities, NGOs and other customers worldwide. Services include environmental monitoring surveys, impact and risk assessments, arctic environmental research, aquaculture design and management consultancy, R&D on new aquaculture species, and a number of accredited environmental and technical inspections.
- **IRIS:** IRIS Energy focuses on research and development of new technologies related to safe and environmentally sound exploration and exploitation of oil and gas, sustainable energy, and storage of carbon dioxide.
- **Norwegian Meteorological Institute:** NMI provides meteorological services for civil and military authorities, commerce and industry, institutions and the general public. NMI has branches in Oslo, Bergen and Tromsø, and is a state body under the Ministry of Education and Research.
- **Norwegian Space Centre**
- **Norwegian Institute for Air Research:** Norway's main institution on air pollution and
- holds all data bases on air research
- **Norwegian Institute for Nature Research:** Norway's leading institution for applied ecological research and responsible for longterm strategic research and commissioned research (implementation of international conventions, decision-support systems and management tools).
- **NIVA:** environmental research organisation committed to research, monitoring, assessment and studies on freshwater, coastal and marine environments in addition to environmental technology.
- **Center for International Climate and Environmental Research:** Independent research centre associated with the University of Oslo, established by royal decree. Participates in a broad network of research communities both nationally and internationally. Plays an important role in setting the national agenda for climate change.
- **Nansen Environmental and remote Sensing:** World class competence on remote sensing, ocean/ice modelling and validation. Prof. Ola M. Johannessen is founder (now Chairman) and Stein Sandven and Johnny Johannessen as central scientists. Carried out many projects for Norwegian Deepwater Programme (ocean modelling, remote sensing).
- Universities of Tromsø, Svalbard, Trondheim, Stavanger, Bergen and Oslo undertake various studies on behalf of the government and industry.

These organisations also have other research projects.

INTSOK RU

Norwegian-Russian oil & gas industry cooperation to assess the gap between the technology currently available and the technology needed for extracting oil and gas resources in the Barents, Pechora and Kara Seas in an environmentally sound and safe way.

Research Centre for Arctic Petroleum Exploration (ARCEX)

The ARCEX centre is funded by the Norwegian Ministry of Petroleum and Energy and the Ministry of Foreign Affairs via the Research Council of Norway. It is a national centre, with several national and international partners, hosted at the Department of Geology at UiT the Arctic University of Norway, Tromsø. The centre aims primarily at improving knowledge of petroleum resources in northern and Arctic areas, with the complementary aim of providing essential knowledge and methodology for eco-safe exploration in the high north. Comprises of the following “work packages”:

- Basin analysis
- Petroleum systems and play concepts
- Environmental risk management
- Technology for eco-safe exploration in the Arctic
- Education and outreach

INDUSTRY INTEREST GROUPS

Norwegian Fishermen’s Association

Fishing trade union and industry interest group which plays a key role in creating a platform for coexistence and cooperation between the petroleum and fishing industries.

PetroArctic

Supplier network for petroleum operations in the north. The network has agreements with oil companies that have fields in operation or under development in the northern Norwegian Sea and Barents Sea.

IV. FINLAND

Finland is an Arctic country and it is also an active nation within the region exerting a strong presence in relation to its size and population and considers itself a leader in many Arctic activities. These include the Arctic Council, the Barents Euro-Arctic Council, the European Union (EU), the United Nations and its

sub-organizations and research networks. Its geographical location has required it to develop a strong maritime and shipbuilding capability with an emphasis on arctic and cold regions technology.

Finland's current policies and strategy for the Arctic were developed in 2012 - 2013. The government adopted four pillars of policy for Finland:

- An Arctic country
- Arctic expertise
- Sustainable development and environmental considerations
- International cooperation

Finland's strategy for the Arctic Region was prepared in 2012 [1] and adopted as a government resolution in 2013. This strategy will be implemented through sector-specific measure with central government funding with European Union (EU) funding for those projects subject to EU programs. In addition, Finland has developed a clear maritime strategy for the 2014 - 2022 timeframe [2].

The government of Finland is a major participant in supporting and funding arctic technology within the country. Tekes is the most important government funded expert organization for financing research, development and innovation in Finland. It supports innovation activities in research communities, industry and service sectors. Tekes works with the top innovative companies and research units in Finland financing some 1,500 business research and development projects, and almost 600 public research projects at universities, research institutes and universities of applied sciences.

In 2013 the government launched an Arctic Development program, Arctic Seas, through Tekes for the 2014 - 2017 timeframe.

This program has total funding of €100M with €45M funded by Tekes and the balance by industry. In addition, Tekes will provide €12M for research institutes.

The Finland government also directly supports marine companies as evidenced by the recent 66% purchase of Aker Arctic from STX Finland.

The most recent government purchased ice class vessels are:

- Offshore Patrol Vessel "Turva": dual-fuel LNG / diesel
- New icebreaker: dual-fuel LNG / diesel

V. RUSSIA

Krylov Institute, St Petersburg appears to be coordinator of Federal Target Program "Development of Civilian Marine Technologies for 2009-2016" with the total budget of 140 bln RUR (~\$4G).

75% of that amount is supposed to be spent on R&D, 21% on capital investments and remaining 4% - management etc. Under that general program there are several sub-programs including development technologies for offshore projects.

Krylov has built new ice tank and is building new multi-purpose offshore test basin. They also built new advanced arctic marine simulator where they can test different strategies for complex marine operations in the arctic including ice management. The simulator allows to model up to six independent vessels operating together in the same virtual reality. The other sub-programs include work on developing new conceptual designs for future icebreakers (both nuclear and diesel). Example of such work would be conceptual design of new 60 MWt double-draft nuclear icebreaker.

The list of governmentally-sponsored program under this umbrella also includes development of new advanced methods for calculation environmental loads on offshore structures, studies of noise impact from vessels on marine life and mitigation measures, EER in ice, multi-hull icebreaker, fire-fighting systems for new vessels.

The Arctic and Antarctic Research Institute, AARI, receives very significant funds to maintain Antarctic research program and for global climate change studies.

But perhaps the only area relevant to current NPC study is ice clearance and freeze-up forecast methods that were developed on government's dime.

AARI participates in the Russian Federal Target program "Word Ocean", which basically provides funds for data collection and analysis.