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Situation of CCS in Russia

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Abstract

As part of the Kyoto Protocols, Russia has agreed to hold its greenhouse gas (GHG) emissions at 100% of 1990 levels by 2012. According to the Energy Strategy, carbon dioxide levels are expected to be at 75-80 percent of 1990 levels and not exceed 1990 levels until 2020. On this basis, Russia will likely meet its Kyoto obligations without any legislative action on GHGs.

At this point of time Russia is not considering carbon capture and storage (CCS) as a priority GHG mitigation technology. Currently the focus is on energy efficiency. CCS plays only a marginal role in the strategic thinking. Russia is however aware of the growing interest to CCS around the world and follows global CCS-related developments and discussions. It has also devoted some limited resources to CCS-related R&D.

During 1980 – 1990 large scale pilot tests were carried out in the southern Ural area, where CO2 formed at petrochemical plants was used for EOR (enhanced oil recovery). Recent government-organized scientific research has been aimed at the development of advanced and economically attractive solutions for the future. Issues looked at include advanced capture technologies, CCS potential, identification of large point pollution sources and links to potential storage sites. In addition, the Russian State University of Oil and Gas has been looking into EOR and ECBM opportunities. At this stage it seems that most CCS research in Russia has been suspended. This is likely because Russia's Kyoto obligations will be met with no action.

The potential for storage in Russia has not yet been systematically studied. The Russian Federation is however extremely rich in oil and gas deposits with high potential for storage. Storage in aquifers probably has even a greater potential but has not been investigated. Areas with storage potential in western Russia include: Barents Sea, Timan Pechora, Volga Ural, Moscow basin and the Baltic Sea.

According to Russian investigations, economic benefits from CO2 storage can in Russia presently be achieved only if the technology is used in the production of hydrocarbons. Especially in the cases of low permeability fields or viscous oil, conventional methods such as water flooding are not effective. In these cases the use of CO2 for EOR (enhanced oil recovery) could generate approximately 5-10 % higher production. Due to the lack of cheap CO2 in Russia, EOR technology using CO2 has not yet been implemented on a commercial scale. It is however estimated that a shift from extensive development of new fields towards more intensive development of old fields will at some point become necessary. An important condition for the implementation of CCS projects would be the participation of oil and gas companies. Oil companies, especially active in old oil-producing regions, should be interested to increase the degree of extraction of oil from oil reservoirs and the development of stranded oil. Mean and small companies would probably be most interested in implementing new technologies. According to the Russian studies the most prospective regions for early CO2 sequestration projects lie in the southern Ural area.

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1 GHG (Greenhouse Gas) mitigation in Russia

Russia has signed and ratified both the UNFCCC and Kyoto Protocols. Russia has committed to hold its emissions at 100% of 1990 levels by 2012.

The Energy Strategy of Russia for the Period of up to 2020 emphasises the need to converge with European ecological standards. The Energy Strategy notes the need for environmental requirements on energy intensive activities or economic stimulation for more environmentally sensitive production methods. According to the Energy Strategy, carbon dioxide levels are expected to be at 75-80 percent of 1990 levels and not exceed 1990 levels until 2020. On this basis, Russia will likely meet its Kyoto obligations without any legislative action on GHGs (GCCSI 2009).

Currently the priority of the energy strategy is on energy efficiency, nuclear, hydro, renewables, and coal: supercritical and IGCC (Integrated Gasification Combined Cycle) plants. CCS (Carbon Capture and Storage) plays only a marginal role in the strategic thinking (Ellina 2012).

There are at present no trade schemes, taxes or legislation involving emission reductions for GHGs in Russia (IGCC 2009).

2 Status of CCS (Carbon Capture and Storage) in Russia

2.1 CCS Regulations and incentives

Currently Russia is not considering CCS as a priority GHG mitigation technology. There are no laws that specifically address CCS technology or projects and no governmental support and no plans to provide support in the near future to companies to invest in CCS. Due to the lacking climate-related regulations and incentives there is no serious activity by the private sector in this area (Ellina 2012).

Russia does not have any specific legislation in the domain of exploration of potential carbon sequestration sites. These issues are governed by Russian general subsoil legislation. Due to the fact that subsoil within the territory of the Russian Federation, including the underground space and mineral resources is a state property, granting of subsoil for use shall be legalized by a special state permit in the form of a licence. This is a document certifying the right of its holder to use a subsoil plot within specific boundaries in accordance with the purpose stated therein for specified period of time (IGCC 2009).

Exploration subsoil licences for the exploration of potential carbon sequestration sites would be issued by the Russian Federal Subsoil Use Agency (Russian subsoil licensing authorities) and require a decision of a special commission formed by the

Agency. If the respective subsoil plot qualifies as a plot of federal significance the grant of exploration rights requires a special decision of the Russian government. It is noteworthy that although Russian subsoil legislation allows non-Russian companies to directly hold Russian subsoil licences, in practice such licences are not issued to non-Russian companies (IGCC 2009).

The absence in the Russian Federation of any exploration policy or legislation for carbon sequestration is not likely, of itself, to be a major hindrance to the exploration and development of such storage facilities. Russia has a relatively well-developed regulatory regime for oil and gas exploration and extraction, which could provide the basis of future GHG regulation (IGCC 2009).

Some government-organized scientific research has however been conducted. The scientific work has been aimed at the development of advanced and economically attractive solutions for the future, like IGCC with pre-combustion, oxyfuel, chemical looping combustion (CLC) and new methods for enhanced oil recovery (EOR). Any fast implementation of presently available technologies has not been seriously studied (Ryabov et al. 2009).

2.2 CCS R&D in Russia

Russia is aware of a growing interest to CCS around the world and follows global CCS-related developments and discussions. It has also devoted some limited resources to CCS-related R&D.

During the period of 1980 – 1990 large scale pilot tests were carried out in the southern Ural area, where CO2 formed at petrochemical plants was used for EOR. The tests consisted of injection of carbonated water, CO2 and water. The tests were effective (up to 12% increase in recovery) in fields containing heavy oil, highly mineralized waters, and in steeply dipping layers with low permeability. Problems were related to CO_2 capture and corrosion of the equipment and transport systems. It seems that most of the injected CO2 was recovered from production wells during the experiments (Kuvshinov, 2006).

In August 2001, the Russian Government approved the program of scientific research for 2002 – 2006. One of the initiated programs was the assessment of geological capacity for CO2 storage, and another the research into capture technologies. Goals of the programs were: assessment of CCS potential for Russia, scientific justification, geological and economic assessment of storage capacity; development of geological models and atlases. Under the program, the Ministry of Education and Science arranged competitive tenders for research in various areas of CCS technologies. Several scientific research institutes won these tenders and r eceived governmental financing in their respective areas of CCS technologies. In

October 2006, the Russian Government approved a new scientific research program for 2007-2012 to fund CCS pilot projects (IGCC 2009). The Ministry of Education and Science has been cooperating with CSLF and GCCSI and is also interested in enhancing its international cooperation on CCS (IEA 2011). The leading Russian organisations are: Joint-Stock Company All-Russia Thermal Engineering Institute (www.vti.ru), Gubkin Russian State University of Oil and Gas (www.gubkin.ru) and the Skochinsky Institute (http://igds.ru/app/en.php). The Russian Federal Agency for Science and Innovation has also funded some research related to CCS.

At this stage it seems that most CCS research in Russia has been suspended. This is likely because Russia's Kyoto obligations will be met with no action so there is no urgent need to decrease carbon dioxide emissions by developing CCS technologies (IGCC 2009).

2.2.1 Gubkin Russian State University of Oil and Gas (Gubkin)

Gubkin has made screenings of large point pollution sources and links to potential storage sites, risk assessment of geological storage, monitoring of storage sites, and investigated opportunities for the development of a pilot project. Gubkin is also looking into EOR and ECBM (enhanced coal bed methane) opportunities (IEA 2011).

According to Khlebnikov et al. 2009a economic benefits from the implementation of CO2 storage can in Russia presently be achieved only if the technology is used in the production of hydrocarbons. Old oil fields usually contain at least 50 % of stranded oil. Especially in the cases of low permeability fields or viscous oil, conventional methods such as water flooding are not effective. In these cases the use of CO2 for EOR could generate approximately 5-10 % higher production. Due to the lack of cheap CO2 in Russia, EOR technology using CO2 has not yet been implemented on a commercial scale. Since 2008 the oil production has decreased due to lower prices but also due to less easily accessible fields. A shift from extensive development of new fields towards intensive development of old fields is now necessary. In Khlebnikov et al. 2009a different EOR options using flue gases and CO2-gas mixtures are also being discussed. Results of laboratory experiments on aquifer storage and EOR are presented in Khlebnikov et al. 2008.

In Khlebnikov et al. 2009b the most promising regions for storage projects of greenhouse gases in Russia was studied. The positional relationship of emission sources, geological traps, infrastructure development degree and the prospective of project commercialization was studied. According to this study the most prospective regions for CO2 sequestration lie in the southern Ural area and are Bashkortostan and Tatarstan republics, and probably Samara region. In these regions there is a minimal distance between large point sources and suitable oil fields for EOR, one of the best examples being the district of Ufa in Bashkortostan (Fig. 1). It was also in these same regions that the pilot injections were made during the 1980s. An important condition for the implementation of CCS projects would be the participation of oil and gas companies. Oil companies, especially active in old oil-producing regions, should be interested to increase the degree of extraction of oil from oil reservoirs and the development of stranded oil. Mean and small companies would probably be most interested in implementing new technologies. Also from this point of view, Tatarstan and Bashkortostan are the most promising regions for at CO2 storage. Some other oil regions in the northern parts were regarded as more problematic due to high construction costs and less suitable oil fields (i.e. depth and type).

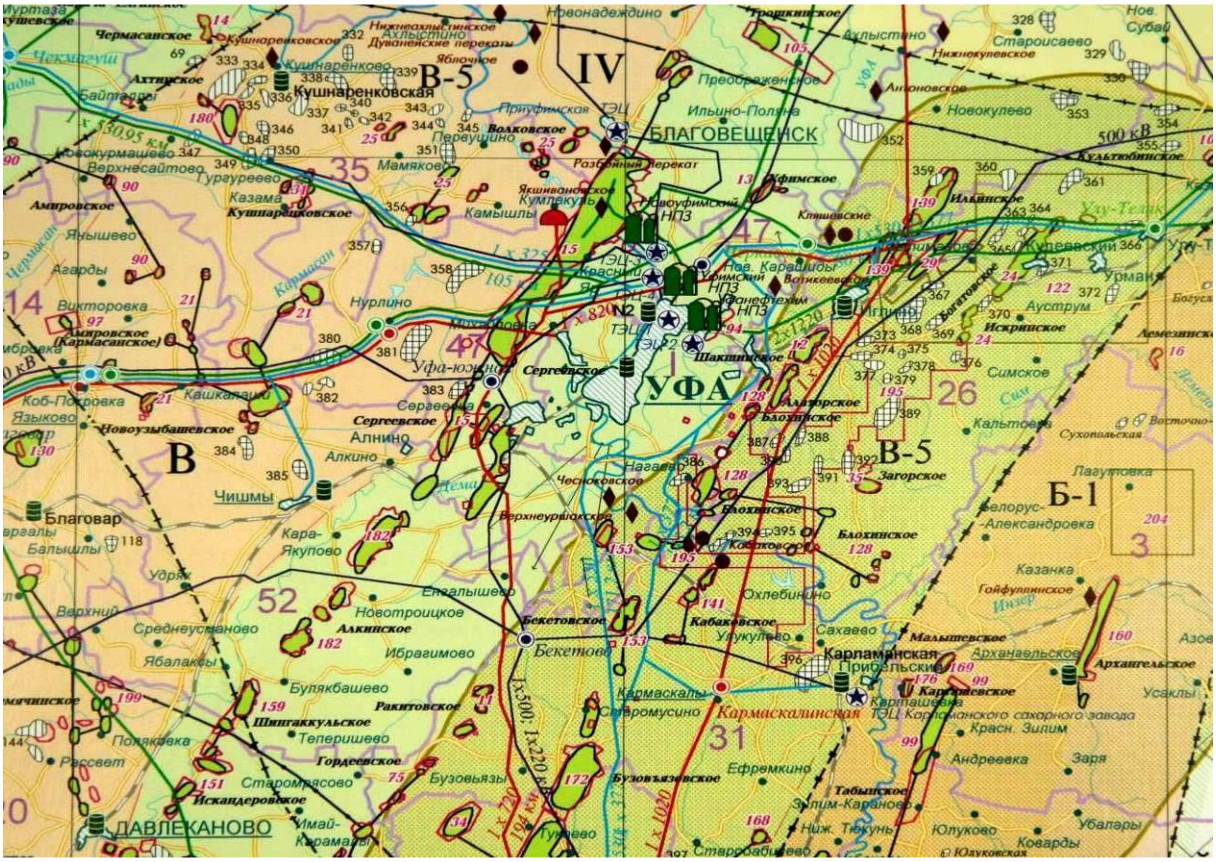

Figure 1. Energy Map of the district of Ufa (Khlebnikov et al. 2009b).

Test and modelling results on saline aquifier storage is presented in Gushchina et al. 2008. In this paper the Schigrovskogo Ryazhsky horizons and Devonian deposits in the Moscow region are mentioned as highly permeable sandstones with aquifers suitable for disposal of CO2. These layers have been used as gas storages. The Moscow region is also evaluated in Khlebnikov et al. 2009b, but in spite of potential storage sites in Devonian aquifers and huge emissions, this area was not regarded as very potential due to costs of aquifer storage and the high density of the population.

2.2.2 All-Russia Thermal Engineering Institute (VTI)

VTI has conducted R&D on CO2 capture technologies, focusing on oxyfuel and chemical looping. It was earlier in the process of developing a roadmap for Russia on clean energy technologies, and CCS would potentially be a part of this roadmap (Ellina 2012).

All-Russian Thermal Engineering Institute (VTI) started up an investigation in the field of CO2 capture and storage financed by Russian Ministry of Science and Education. The focus of the investigation was the feasibility of using iron and nickel oxide as an oxygen carrier (NiO-Fe2O3/AL2O3, in size of 0.1 – 0.15 mm). VTI also started up investigations in the field of oxyfuel combustion and a test rig was constructed. The calculations and mathematical model of CLC and oxyfuel were developed as schemes of pilot, demo plants and economical analyses of these implementations were made (Ryabov et al. 2009).

2.2.3 Skochinsky Institute of Mining

Skochinsky Institute of Mining has been appointed by the Ministry of Energy as a coordinator of CCS-related activities in the coal sector. This Institute recently received a national grant from the Ministry of Education and Science to analyse the CCS potential in Russian coal sector and identify a pilot project, which is likely going to be a CCS with ECBM project in Kuzbass (Ellina 2012).

2.2.4 Russian Petroleum Research Exploration Institute (VNIGRI)

VNIGRI has been involved in some international cooperation in relation to CCS and has also been making estimations of the potential CO2 storage capacity by oil and gas deposits in NW Russia. Preliminary estimations have been published by Cherepovitsyn & Ilinsky in 2006.

2.2.5 Permafrost assessment

Under the auspices of INTAS (International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union), a two year project (2007-2009) “Assessment of the Feasibility of CO2 Storage in the Russian Permafrost” was carried out in Russia, with the Siberian branch of the Russian Academy of Sciences. The purpose of the project was to assess the feasibility and capacity of CO2 storage in the northern territories of Russia underlain by permafrost.

Nfrfdcx<ZSZC FZThe project assembled information on the particular conditions of the permafrost, and it evaluated how these conditions will influence – in a positive or a negative way – the process of CO2 storage. Considering that the northern territories of Russia are the site of intense oil and gas exploitation, the project also considered the compatibility of CO2 storage with the oil industry. The project also recommends future studies in order to further investigate the technical aspects of the application of the method in the permafrost. A major aim of the project was to disseminate the project results and conclusions to decision makers and to the public in order to promote the application of this method in the region. This was achieved through the web site http://www.ibes.be/permafrost/. The results were that the permafrost alone might not be suitable for storage but would act as a secondary cap-rock if the immediate cap-rock should fail, trapping the CO2 as hydrate (EnErg 2009).

3 CO2 Storage potential in Western Russia

The potential for storage in Russia has not yet been systematically studied. The Russian Federation is however extremely rich in oil and gas deposits, accounting for 13% of the world oil reserves and more than 30 % of world gas reserves. The north-central European part of Russia includes hydrocarbon fields in the Volgo-Ural and Timan-Pechora oil-gas provinces, Kaliningrad Region and offshore regions including the Barents Sea and Baltic Sea (Fig. 2). The north-western region has 10% of all Russian oil and gas reserves. About 50 of hydrocarbon fields of NW Russia have already been depleted and could in the future be of great interest for the East–European countries for enhanced oil and gas recovery (EOR and EGR) (Shogenova et al. 2011).

Preliminary estimations of the potential CO2 storage capacity by oil and gas deposits in NW Russia were published by Cherepovitsyn & Ilinsky in 2006. According to these estimates there is a theoretical storage potential of 19-25GtCO2 in oil and gas fields in north-west Russia, assuming an optimistic 1:1 ratio of volumetric replacement between hydrocarbons and CO2.

The capacity of Russian saline aquifers is probably very large but has not yet been estimated. Based on discussion with VNIGRI the storage potential of saline aquifers in Russia could be about 10 times higher than that of the hydrocarbon fields.

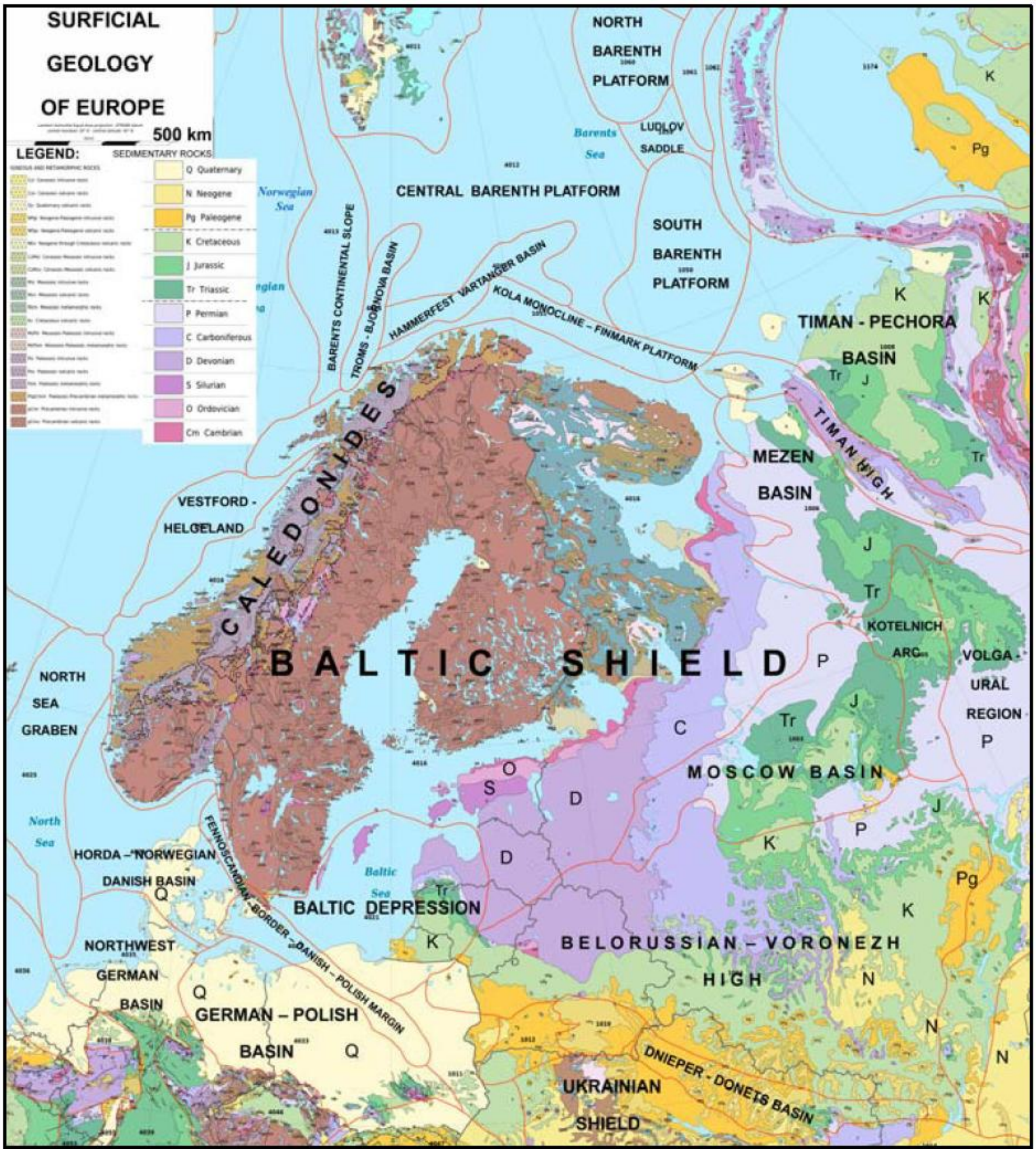

Figure 2. Geological map of NE-Europe with borders of oil and gas provinces (Shogenova et al. 2011).

3.1 Timan Pechora

As many as 210 hydrocarbon deposits are found onshore in the Timan-Pechora oil-gas province (Fig. 2). Nearly 100 deposits are in exploitation in the NW region (Shogenova et al. 2011). Hydrocarbons in Timan-Pechora are trapped in Ordovician through Triassic reservoir rocks at 200 to 4500 meter depths (Lindquist 1999). In this region the oil industry will probably be extensive in the near future and development of old fields is not yet necessary. According to Khlebnikov et al. 2009b the northern regions are not the most favorable for CO2 storage due to high construction costs.

3.2 Volga Ural & Western Sibera

Both Western Sibera and Volga Ural regions (Fig. 2) have large potential for CCS. There are oil fields suitable for EOR at a close proximity to large stationary sources of CO2 in both regions. In western Siberia the oil fields are at greater depths and the construction costs are greater, therefore the most suitable region for early implementation of Russian CCS projects is probably in the Volga Ural area (Khlebnikov et al. 2009b).

3.3 Moscow basin

The Moscow Basin (Fig. 2.) is prospective for CO2 storage in Devonian deep saline aquifers (Gushchina et al. 2008) but due to the high density of the population, this area is not the most suitable for CO2 storage, according to Khlebnikov et al. 2009b.

3.4 Mezen basin

Seismic data suggests that the depth of the basement is 4.5-8 km in the Mezen (Fig. 2). The stratigraphic column of Mezen is similar to that in the Moscow basin; however, the old Proterozoic interval is much thicker while the prospective (Devonian) layers for CO2 storage are much thinner and mostly restricted to the Timan Foredeed. Economic oil fields are not found in the Mezen basin and therefore reservoir properties are poorly studied. The porosity, permeability and depth of suitably deep layers in Mezen however, seem to make them unsuitable for CO2 storage, according to information from Fedorov 1997.

3.5 Baltic Sea

The Cambrian layers of the Baltic depression (Fig. 2) have potential for CO2 storage. Some 36 oilfields, all producing from Middle Cambrian (Deimena Group) sandstones, are located in the central Baltic Basin in an area covering onshore Lithuania and Kaliningrad (Russia) and the adjacent offshore.

3.6 Other areas

The Barents Sea region (Fig. 2) has large potential for storage but is not well studied.

Based on discussions with VNIGRI there could also be other areas prospective for storage in the western margin of Mezen and in connection to salt domes inside the Mezen basin (Fig. 2).

The possibility to use the Russian permafrost as a capping layer for CO2 storages has also been discussed. At the moment it seems likely that the permafrost could in some cases function only as secondary seal.

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