which adapted to Arctic conditions will be forced to replace their habitat. In addition, many species of plants and animals will just disappear if they are not able to adapt to new habitual conditions.

What are consequences of global warming for mankind? In the short-term period of climate change people are threatened with drinking water problems; cultivation of agricultural grounds. Besides, they will lead to growth of infectious diseases. According to scientists' comments, about six hundred million people will be faced with starvation. By 2080 residents of China and Asia can experience ecological crisis caused by change of precipitation pattern and glaciers melting. The same process will lead to flooding of many small islands and coastal territories. In the flood-impacted zone, there will be about hundred million people, many of which will be forced to migrate. Scientists predict disappearance even of some states (for example, the Netherlands and Denmark). It is probable that under water there will be a part of Germany as well.

As for a long-term perspective of global warming, it can become the next stage of evolution of the human.

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GAS HYDRATE DEPOSIT DEVELOPMENT IN THE ARCTIC: GEOECOLOGICAL AND TECHNICAL CHALLENGES

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In the 21st century, the prospects of global energy production are alternative and unconventional sources of energy. A remarkable example of alternative fuels is gas hydrate, which can be a reliable source of natural gas with competitive advantage to outperform the greatest hydrocarbon reserves, including those of coal and oil. Gas hydrate reserves are estimated at 250 trillion m^3, which is twice as much as proven world reserves of coal, oil, and gas [5].

Gas hydrates are crystalline substances composed of low molecular weight gases (CH_4, C_2H_6, C_3H_8, C_4H_{10}), in which gas molecules are accommodated in hydrogen bonded water molecules in a cage-like structure (or clathrate) under particular pressure and temperature conditions: the temperature lower than 10 degrees ^0C and the pressure up to

40MPa [6]. When temperature and pressure change, gas hydrate changes its state as a solid and is broken down into gas and water. In general, gas hydrate looks like loose snow or ice. The main gas in gas hydrate composition is methane (98%) since it is the lightest alkane. Due to hydrate structure, one unit volume can give up to 160 unit volumes of gas.

Gas hydrate stability zones (GHSZ), at which methane clathrates naturally exist, are those characterized by particularly low temperatures (terrestrial permafrost) or underwater areas under the conditions of low temperature and high pressure. Therefore, natural reserves of gas hydrates are located within permafrost areas, in glaciers and subglacial formations, seafloor sediments of sub-arctic basins, on the continental margins and in deep waters of World ocean [6].

The cryolite zone of Arctic Shelf provides favorable conditions for gas hydrate formation, and it is Arctic Shelf where numerous reserves are located. The Arctic is a unique area since it holds enormous hydrocarbon reserves, which attracts oil and gas companies from all over the world. The Arctic resources claimed by the Russian Federation make about 80% of national hydrocarbon reserves [3], and this is apart from gas hydrate reserves, which are estimated by VNIIGAZ to be in the range of 100–1000 trillion m^3 [7].

Being a reliable resource providing new significant supplies for environmentally friendly fuel, gas hydrates production faces serious challenges connected with ensuring environmental and technological safety. Moreover, the technologies of natural gas recovery fail to be effective for hydrates and there is an urgent need to implement new ideas and approaches to field development.

The first technological challenge is technogenic hydrates which accumulate in pipelines and wellbores and result in obstructions and plugs preventing gas flow. This causes pipeline failures and field accidents. In addition, circulation of warm drilling mud in the wellbore can result in the temperature increase in the surrounding rocks containing gas hydrates. The increase in temperature causes the clathrate structure to *break* down, which prevents well control and can even result in explosion [2]. For instance, as Dan Zimmerman reported to Minerals Management Service (MMS), over the period 1960–2006, there were 500 offshore oil and gas accidents across the globe, with gas hydrates being the major cause for the disasters. To prevent the negative effect of gas hydrate formation, inhibitors are applied, as a rule, toxic methanol, which has a significant negative impact on natural balance of water ecosystem.

As for gas hydrate deposit development, well drilling does often cause too much associated gas released. Even minor fluctuations in the system macroscopic structure cause it to dissociate, which reduces rock rigidity and results in accidents. There can also be blowouts sometimes causing long-term emissions of up to 14000m^3 per day [6].

Another topical issue is stability of continental slopes, which is reduced due to shelf development and exploration and well drilling into the sea floor. Gas hydrates occurring in the rocks of the sea floor can trigger submarine landslides ranging from local to extensive ones causing tsunami. As experts suppose, gas hydrate destabilization (large amounts of gas released out of sea floor sediments) is a probable cause of unexpected and unpredictable ship sinking, including that within the Bermuda Triangle [6].

The major environmental risk connected with gas hydrate recovery is the effect of “clathrate gun” [1], which implies that global warming resource exploitation in the Arctic can trigger the sudden release of methane from methane clathrate compounds. The methane released is 20-24 times as dangerous as carbon dioxide in terms of greenhouse effect, therefore, sudden releases of methane in the atmosphere stipulate the temperature increase, which, in its turn, releases caged methane.

The Arctic's environment is a fragile ecosystem, with all the components being closely interconnected. Currently, there is continuous degradation of submarine permafrost in the East Siberian Arctic Shelf, and large amounts of methane released cause negative environmental impact [4]. Though gas hydrate resources are enormous, the efficiency of the production depends on the technological advances implemented to mitigate the negative environmental impact and improve the safety of field exploitation. Hydrates are particularly responsive to any changes, and inadequate solutions taken with regard to economic reasons can result in irrecoverable damage.

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PROBLEMS OF BARENTS OFFSHORE OIL PRODUCTION BY MEANS OF GAS HYDRATES

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Next few years there will be the development of unique deposits of hydrocarbons on the Russian Arctic shelf covering an area of more than 6 million km^3. At the same time the largest resources of oil (more than 3 billion tons) are concentrated in the Barents Sea [1]. There are the most severe climatic conditions in the world, so there is a number of problems associated with permafrost bottom of the sea - "Submarine Cryolithic Zone". Possible formation of crystalline compounds of water and gas called "gas hydrates" is associated with this area. Outwardly, they look like ice or snow. Figure 1 shows a map of the Arctic Ocean in relation to the forecasts of gas hydrate accumulations [2].

Unfortunately, the studies of gas hydrates in the Barents Sea are not classified and virtually have not been carried out yet. The formation of gas hydrates occurs due to the negative impact of freezing temperatures and freezing of the bottom layer of water.