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Possibilities for The Use of Alternative Energy to Reduce Power Supply Costs at Far North Fields

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Abstract*: *The article reviews macroeconomic and internal factors that influence the efficiency and stability of operation of oil and gas enterprises, particularly oil price fluctuations in the global market and a rising share of difficult-to-recover reserves held on enterprises' balance sheets. The article examines the possibility of using renewable energy in operations carried out by oil and gas companies in the Far North due to the remoteness and harsh climate conditions requiring the introduction of complicated technological solutions. Renewable energy can be used for the reduction of energy costs, improvement of stability and efficiency of operations. The possibility of using renewable energy is shown on the example of offshore fields located in the Far North. The Shtokman field is taken as an example to substantiate expediency of the use and the provision of the territory with solar and wind resources used as an additional source of energy.

Index Terms*: *renewable energy, cost reduction, sustainable development, efficiency, oil and gas production.

I. INTRODUCTION

Fuel energy companies play a leading role in the Russian economy. The society's welfare and economic stability depend on sustainable development in the oil and gas industry. Like any other system, enterprises in the sector are sensitive to the influence of various internal and external factors that can result in such adverse consequences as weaker financial, technological or environmental stability. Over the past few years, the oil and gas industry has substantially experienced the influence of such negative factors as a sharp decline in global oil prices, the depletion of explored fields and an increase in difficult-to-recover reserves that enterprises maintain on their balance sheets [1]. Moreover, the external environment has a negative effect on costs and, consequently, the relevant tariffs. This, in turn, leads to the inflation spiral and the relevant adverse consequences.

The development of the Far North, including regarding its resource (raw material) potential, is currently a strategic task set at the highest level of management. It is extremely difficult to accomplish this task as production facilities are far away from infrastructure and, consequently, it is essential to create necessary conditions. This task needs to be accomplished provided that environmental damage to the territory under review is minimized.

The development of fields in similar areas requires substantial initial and high consequent exploitation expenses for the development and recovery of reserves. The specified multi-criteria problem can partly be solved by using alternative energy to keep production and household facilities of an oil or gas field power supplied.

II. PROPOSED METHODOLOGY

Nowadays, there is a wide range of possible renewable conventional and non-conventional alternative sources of energy: solar, hydrothermal, wind, wave, current, tide and ocean, biomass energy, hydro energy, etc. Each of them has advantages and disadvantages, as well as certain conditions of application.

We systematized information about the territories operated by a major Russian company from the oil and gas sector and reviewed possibilities and conditions for the use of renewable energy (RE) at each of them (Table 1).

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Table 1: Possibilities for the use of RE in various territories operated by the oil and gas company.

Region	Natural and climate conditions; peculiarities	Possibilities and conditions for the use of alternative energy
Russia's European South	• solar radiation is 3.5-4.5 kW/h; • solar insolation is over 2,000 hours per year; • western winds blow from the Atlantic at the annual average speed exceeding 6 m/s; • concentration of various types of energy along the Caspian coast; • hurricanes with the speed of around 30 m/s arise from time to time; • the Caspian Sea's wave energy resources with the annual average of around 40 kW.	It is reasonable to use a combination of three types of alternative energy (solar, wind and waves) on the Caspian coasts – in areas of hydrocarbon production. 1,000 kW wind units (VU) and 750 kW wave units (WU) are intended to be created and placed along the perimeter of oil and gas platforms. WU will help save around 800 tons of fuel per year, and WU, despite the moderate wave roughness in the Caspian Sea, will help save about 400 tons of fuel per year. The sufficient volume of solar radiation will also make it possible to use solar energy.
Central Russia	• zones of low wind activity; • average values of incoming solar radiation; • availability of the developed system of central power supply.	The use of electric power from central power supply networks is a reasonable solution because these areas do not have any problems with electric power distribution.
Western Siberia	• boggy soils; • average wind activity is 3-5 m/s, with an increase up to 12 m/s in the areas near rivers and lakes; • solar radiation is 3.5-4.5 kW/h; • solar insolation is around 1,700 hours per year.	It is reasonable to use a central power supply in the regions where it is possible. The use of diesel units and gas stations is suitable for difficult-to-access areas. The creation of hybrid solar-gas power units is possible. This method makes it possible to use already existing infrastructure (turbines and power transmission lines), reducing initial capital outlays. It is possible to build wind power units in Siberian steppes.
Eastern Siberia and the Far East	• geothermal resources of the Earth in the Kamchatka Peninsula and the Kuril Islands, the potential is estimated at 20 million tons of coal equivalent; • low wind activity in the central part of the region, with the speed not exceeding 6 m/s; • the region's southern territories have a long period of sunshine, around 2,000 hours per year; • high solar insolation of 4 to 5 kW/h in both the region's southern and central areas; • there are lots of areas which are far away and difficult to access for central power supply; • high water potential of rivers.	Ample possibilities for the use of RE, including solar, wind and hydro energy. Wind resources available near the region's northern part are conducive for the installation of wind generation units in coastal areas. The technically available potential of tidal energy is over 80-100 GW in terms of capacity and 220 billion kWh in terms of annual generation.
Far North and the coastal areas of the Arctic Ocean	• high wind activity in the coastal area and the northern part of Sakhalin, with hurricanes arising from time to time; • the long duration of daylight during the polar summer, with solar radiation ranging from 3.5 to 4 kW/h; • the annual average energy value per meter of the wave front of northern seas is around 90 kW; • there are no power transmission lines, it costs a lot to install them; there are problems with fuel delivery.	It is expedient to use units equipped with heavy-duty wind engines (two- and three-bladed engines) which are designed for a wind load of 40 m/s. A combination of 750-kW VU and WU is intended to be used, to be placed along the perimeter of an oil platform. The use of VU and WU will help save more than 1,000 tons of fuel per year.

At the initial stage of development in Far North territories, many tasks require unconventional multi-criteria solutions. It is difficult to conduct SWOT analysis regarding the classification of separate factors as threats or opportunities when solving a problem related to cost management while developing hydrocarbon resources in this territory.

In this case, it is reasonable to assess each specific situation critically and to seek opportunities for the resolution of the problem in evident threats. For this reason, it is proposed to abandon conventional differentiation of factors and to consider them as peculiarities of the territories under review (Figure 1).

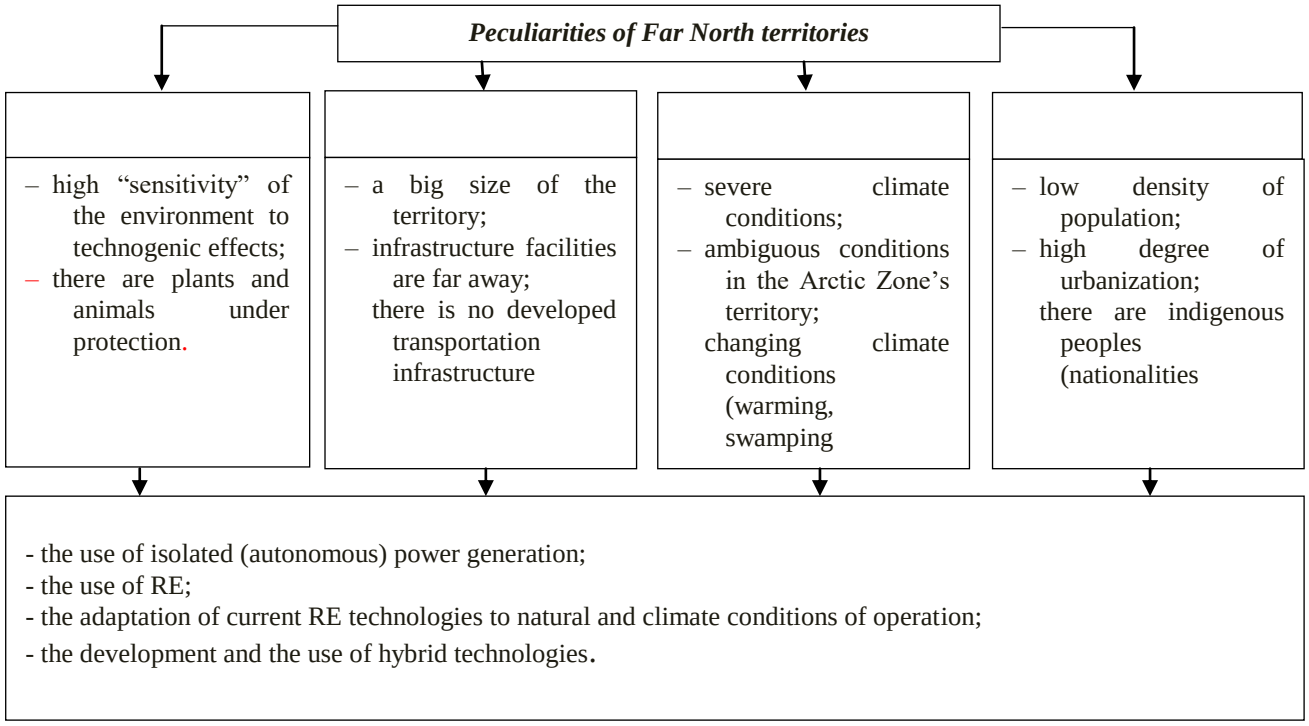

Fig. 1: Power supply solutions for Far North facilities.

The location of such major fields as Prirazlomnoye and Messoyakhskoye oil fields, as well as Shtokman and Pomorskoye gas and gas condensate fields, coincides with the location of quite sizeable RE resources such as wind, solar and tidal energy.

The creation of energy units using RE implies substantial financial investment. With output in offshore Arctic fields forecast to reach 30 million tons of crude and 130 million cubic meters of gas per year, power supply needs will increase to roughly 3.4 GW [2]. This will require either higher fuel shipments or the search for means to build a new nuclear power plant in the Arctic area.

For example, the power load is expected to grow from 500 to 1,400 MW depending on the development stage of the Shtokman gas condensate field. The liquefied natural gas (LNG) plant and the field are supposed to be power supplied from the grids running from the Kola NPP 2 and the Murmansk TPP. Considering the launch of capacity in the region, it is necessary to build an independent power supply system (PSS), especially in the first stages of the field's development. For the reduction of PSS costs, it is reasonable to buy electric power from the Murmansk Wind Farm that will be put into operation in 2021. The project has all prospects for development as it is located 35 km away from the LNG plant, wind activity is high (7-9 m/s), highways and power transmission lines are available. This will not create any obstacles for the purchase and transmission of electric power. Keeping the Shtokman field and the LNG plant power supplied by the Murmansk Wind Farm has a big economic effect. With gas prices averaging 322 US dollars per 1,000 m3 in 2014, profit from gas sales can exceed 90 million US dollars [3].

III. RESULT ANALYSIS

Based on the results of the conducted study, one can note that in the conditions of constantly rising costs related to the extraction, transportation and refining of hydrocarbons, bigger distances to hydrocarbons and more complicated conditions of exploration oil and gas, companies seek to cardinally resolve the specified problems, including through the exploration of ways to use RE. In the article, by the example of a company we tried to systematize possible RE types by territories, in which the company operates. Later on, we plan to provide a more detailed description of the algorithm for the most preferable type(s) of RE for targets to be subsequently set for developers and researchers with regard to the creation of new energy storage facilities (generators), including with the use of hybrid technologies, or to adapt available solutions to the special conditions of their operation. We also plan to elaborate a model of multi-criterion optimization that will help substantiate the choice of preferable RE based on a complex of quantitative and qualitative criteria.

IV. DISCUSSION

Several researchers who study the opportunities related to the use of RE in the Arctic currently regard mainly general prospects of using alternative energy without considering specific features of operations conducted by industrial concerns in this area [1, 2].

Most authors view RE as a tool for the reduction of the environmental danger posed by the use of conventional fuel and expenses incurred to deliver and transport fuel to remote northern localities [3]. Individual studies consider the peculiarities related to the use of RE at various industrial enterprises, especially those concerning the exploration and production of oil and gas [4, 5], including at offshore drilling rigs [6].

Many Russian and foreign scientists devote their papers to the consideration of measures and tools for the development and introduction of RE in the Arctic [7]: the creation of a unified information base for the distribution of examples of successful experience related to placement of RE facilities in Arctic zones [7], the elaboration and improvement of a system designed to fund and subsidize the introduction of RE, the creation of funds to support innovative initiatives, the development of a specific certification system [7]. A lot of research papers consider risks associated with power supply in the remote Arctic and Far North regions through both traditional energy and RE. This is primarily associated with the difficult weather conditions of the territory [8, 9].

Having studied the relevant scientific-methodological sources, one can draw a conclusion that issues related to the peculiarities of using RE at various industrial enterprises situated in the Arctic, especially in the oil and gas industry, are not sufficiently covered in Russian and foreign literature.

V. CONCLUSION

The relevance of alternative energy is increasing year by year for Russia and oil and gas producers. This stipulates the need of oil and gas producers to be more interested in developing alternative energy because the use of RE as an additional source of energy not only reduces the harmful impact on the environment but, most importantly, also allows companies to cut power supply costs.

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