Decommissioning of oil and gas assets: industrial and environmental security management, international experience and Russian practice

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ABSTRACT

In the Russian oil and gas industry, there are still no technical regulations for unified rules and standards governing the establishment of the abandonment fund and the decommissioning of fields. With an increase in the volume of assets decommissioned, the issues of correct accounting and financial reporting of these expenses are becoming more and more urgent. There is also uncertainty regarding the taxation guidelines of operations completion on the production facilities.

The strategic aspects of the decommissioning policy of oil and gas fields are stated using the example of the North Sea countries. As part of the responsible investment policy, environmental aspects and industrial safety management during decommissioning of facilities are outlined. An overview of the Russian legislative and regulatory framework is made. Recommendations are given to improve the methodology and practice of abandonment funds management in Russia.

1. Introduction

The well decommissioning project differs significantly from the commercial oil production project, which is implemented according to the production schedule based on proved reserves. Therefore, oil and gas companies must use a flexible approach to organize a methodical decommissioning of production assets. Objectivism in this matter is of priority importance, as decommissioning should focus on the correct setting of the goal. To achieve this goal, oil and gas companies should reduce abandonment costs and systematically approach the justification of the optimal sequence for the decommissioning of assets.

According to estimates of Rystad Energy (RE 2019) and Wood Mackenzie (WM 2018), in 2018, a record in decommissioning and restoration obligations (D&R) was set, the costs of which amounted to 11.7 billion US dollars (Figure 1) for the global oil and gas industry. In 2019–2021, around 32–36 billion US dollars will be spent on these commitments worldwide according to the same estimates. However, laws and regulations on D&R in many countries remain incomplete or unverified in practice.

In 2013–2017, only on the continental shelf of the UK, the exploitation of 16% of 472 fields was stopped. The main reason was the fall in oil prices and the shift in the break-even point.

According to Wood Mackenzie (WM 2018), in the next 10 years on the continental shelf of the UK, the D&R costs will be about 30 billion US dollars considering that almost all oil and gas production is in the offshore zone.

Approximately 700 exploited fields around the world, including about 150 only in the UK starting in 2020, can stop production in the next 5 years depending on oil prices.

D&R is the most mature in the US Gulf of Mexico, where on average more than 100 platforms per year have been taken out of operation since 1985. About 9000 wells worldwide are located in fields that are currently struggling to stay profitable at oil prices of 60 US dollars per barrel. This is a relatively high break-even price, which became the Achilles' heel for many fields in 2018.

In 2013–2014, when oil prices were high, a very few companies implemented plans for D&R. Instead, they sought to maximize the current return on their production assets. In 2015–2016, when oil prices fell to painfully low levels, many of these plans to extend the life of the fields were partially or completely rejected. Only then did many companies begin to fulfill their obligations to decommission their non-competitive assets. In 2013–2017, the most active market for D&R was Europe mainly due to the UK, which accounted for more than 50% of all global

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expenditures according to Rystad Energy (RE 2019), Oil & Gas UK (OGUK 2018) and Wood Mackenzie (WM 2016).

However, D&R activities will grow significantly in other parts of the world, especially in Asia, Latin America and North America in the immediate future. In connection with the expected sharp increase in the costs of abandonment works in the oil production sector, the issues of stable financing of these works remain more and more urgent. Since oil companies must mobilize huge financial resources in the short term, the question of what should be the sources, mechanisms, rates and amounts of financing capital investments at the final stage of the oil and gas cycle becomes particularly important. World practice in this area has accumulated considerable experience, especially in the abandonment of oil and gas facilities on the shelf. This experience is very diverse and has its positive sides and significant limitations. Until now, its comprehensive analysis has not been the subject of serious research in the domestic literature, which could help avoid unwanted errors and miscalculations in future decommissioning operations of existing oil and gas fields. Foreign experience confirms the thesis that oil and gas companies at the final stage of productive life should be ready for closer and transparent cooperation with local authorities and environmental protection structures, openly share their forecasts on the timing of abandonment costs, information on the main factors affecting these estimates during the preparation of wells decommissioning, as well as information on specific assets.

Oil companies need to understand that without proper baselines, the industry cannot form realistic market expectations for decommissioning. However, the problem remains, and moreover, its significance will grow steadily as the oil industry ages and as the number of unprofitable production facilities to be closed accumulates. In the same direction, there are restrictions that have arisen in connection with the new climate agenda and the paradigm of a slow transition from hydrocarbons to renewable energy sources, which will inevitably lead to an increase in the number of operational facilities in the industry that will be forced to terminate their production cycle ahead of schedule (and some of them not to start it at all, falling into the category of “locked” assets) at an earlier date in comparison with the inertial scenario “business as usual”. At present, in Russia, the creation of an abandonment fund is envisaged only for fields developed under the terms of Production Sharing Agreements (PSAs), which is only a small fraction of the country’s total oil and gas production potential. Considering the above, the issues of creating the necessary legislative framework and timely financing of abandonment works at the oil and gas production facilities of the country acquire special urgency.

2. Decommissioning operations analysis

Relatively low oil prices in 2020 had a serious impact on the economy of the oil industry, which immediately affected an increase in the number of wells abandoned by large oil companies, including those that will still be productive in the near future. The observed spike in the abandonment of oil assets by many oil companies exceeds historical norms and represents a growing threat to the upstream sector. Indeed, after the fall in oil prices in early 2014, asset disposals or write-offs for the largest oil companies amounted to about 10% of their total market capitalization by the end of the year (Figure 2) (BCG 2017).

Since then, the companies’ obligations to decommission production wells have continued to grow steadily. According to Wood Mackenzie, the cost of decommissioning works worldwide will be about 104.5 billion US dollars by 2030. According to the most optimistic estimates, the Norwegian consulting company Rystad Energy Inc. in the North Sea alone can decommission at least 23 platforms annually.

Companies cannot just abandon outdated offshore wells. In most cases, the regulatory authorities that approve the production of hydrocarbons require companies to provide costly guarantees to ensure that these wells are properly shut-in and that there are no and will not be any environmental problems in the foreseeable future associated with their maintenance, exploitation or decommissioning.

This may require considerable additional material and financial costs associated with the need to use divers or robotic submarines to plug wells and pipelines on the ocean floor, as well as to cut and move steel structures of platforms weighing up to 17 thousand tons each.

At the same time, the cost of abandonment of operations in the coming years will form an important part of the budget of companies, especially if government agencies tighten requirements for guarantees from parent companies. The global economic crisis has accelerated the development of this situation. The significant drop in North Sea oil production since its peak in the 1990s has left so much equipment unused that Wood Mackenzie believes that by 2025, many oil and gas companies will be spending more money on disposing of surplus equipment than on developing new fields, which will undoubtedly lead to a further deepening of the sectoral financial crisis.

In the 1980s and 90s, deep sea production was a new front of business and investment activity for the oil industry, however, many of the successful projects of this period have now reached the end of their productive life, and for this reason the number of offshore oil wells requiring closure and abandonment is steadily increasing. In addition, the preceding U.S. shale boom dramatically lowered the cost of onshore
exploration and development, as well as reduced shut-in costs relative to the actual costs of similar offshore operations, which also negatively affected the competitive and profitable operations of companies. While operators and contractors play a major role in defining and implementing the practical part of the decommissioning program for exploration and production facilities, the executive branch should also assume responsibility for this process by improving the legal framework and creating appropriate institutions and integrated management systems. Such systems should ensure targeted spending of public funds, the use of world best practices in the development and implementation of projects and stimulate effective cooperation between all participants in the process.

Based on the experience of supporting oil and gas assets abandonment projects around the world, there are five main steps that need to be taken by the authorities and oil and gas companies in preparation for their successful implementation:

- Define the main goals, strategy and draft an Abandonment Plan;
- Develop and ensure compliance with relevant regulatory schemes for governance, financing, risk management, as well as technical mechanisms;
- Create a unified interaction platform for operators in order to exchange experience, resolve problems and organize joint campaigns;
- Determine the list of obligations for decommissioning oil and gas facilities;
- Create and monitor the implementation of an effective target program.

Regardless of how millions of tons of steel and pipes are removed, the governments of the countries concerned are likely to be proactive and intervene to ensure that taxpayers are not harmed by such business support measures. The impulse from the regulators has already been shown and more pressure on financial guarantees should be expected. Companies in the upstream sector were not fully prepared to take assets out of production based on the current rate and scale of their corresponding operations. And this situation may worsen in the future.

The actual and projected annual costs of decommissioning offshore oil and gas assets are shown in Figure 3. There are no prompt decisions for upstream oil companies. However, there are some reasonable actions that individual companies can take to strengthen their financial health in the face of growing asset abandonment. In addition, we should discuss the measures that could mitigate potential financial risks to society as a whole and that need to be considered by the governments of the producing countries. Let us consider a typical platform offshore the North Sea at a depth of 80 m, producing 65,000 barrels of oil per day for a 15-year service life. At first, it generates negative cash flow, which then
becomes positive, and finally, it changes sign again (becomes negative) during the platform decommissioning period.

This is illustrated in Figure 4, where the X-axis shows the operating time by years, and the Y-axis shows the accumulated cash flow. When calculating the profitability of any project, in addition to analyzing cash flows in the life cycle of a field, it is very important to take into account the cash flows due to the completion of its operation.

Some operators may be interested in designing new facilities that will be decommissioned within, for example, a four-year period and in reducing cash flow due to the impact on utilities and living quarters that need to be maintained during this period.

During decommissioning, the operator’s priorities are:

- Safety: completing the project without causing damage to people or the environment;
- Costs: economically viable performance with minimal costs;
- Reputational costs: operators' responsibility to all stakeholders;
- Future commitments: minimization of liability after project completion;
- Minimization of the operator’s labor costs during the project implementation.

The first two of these performance factors depend on decisions made during the development phase.

The main decommissioning costs can be divided into five stages:

- Operator's costs of organizing works and operating costs at the facility (onshore and offshore);
- Installation of well plugs and abandonment of wells;
- Facility and pipelines: cleaning from hydrocarbons, ensuring works safety and preparing for disposal;
- Topsides, platform support and seabed equipment: disposal and remediation of the site;
- Removal of topsides and platform support.

Figure 5 is a simplified representation of cash flow. When a field is decommissioned, the efficiency factors differ from those for a new project or a field in production.

The Association of Oil and Gas Producers of the United Kingdom (hereinafter – Oil and Gas UK) annually collects this data for all oil and gas fields in the North Sea for marketing research. Each stage of a decommissioning project has its own cost components that must be closely monitored.

For example, if the vessel used for decommissioning has been operating for fewer days, then the reduction in the cost of supporting developers, engineers and technicians, supply vessels, helicopters and fuel costs should be also considered.

It should be noted that in January 2016, Bureau of Safety and Environmental Enforcement (BSEE) and Bureau of Ocean Energy Management (BOEM) tightened the US regulations (Table 2). Since then, oil and gas companies are required to report all expenses, platform dismantling and site clean-up costs associated with field decommissioning within 120 days of completion.

The main cost components for the dismantling of objects are indicated in Table 1.

D&R operations are comparable in complexity to new field development projects. They include the following main stages (BCG, 2017):

1. Preparation (regulatory approval);
2. Planning;
3. Wells plug;
4. Equipment shutdown and cleaning;
5. Disconnection;
6. Platform dismantling;
7. Equipment disposal;
8. Monitoring.

Figure 6 illustrates an example of field development considering decommissioning costs.

This segment of the industry has high risks and is generally less attractive to contractors and operators for several reasons. This problem is also complicated by the fact that there are no uniform rules and standards in the world governing the procedure for decommissioning deposits, organizing an abandonment fund, its financing schemes and protecting mechanisms against default. Previously, oil and gas companies were given incentives to obtain additional guarantees in the form of bonds, letters of credit, third party guarantees based on sufficient net capital and financial stability of the company.

The contribution to self-insurance of field decommissioning liabilities has been reduced from 50% of the cost of tangible assets to a theoretical limit of 10%. The remaining 90% of the established obligations, according to BSEE estimates, should be covered by issuing additional

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Figure 4. Cash flows from the operation of a typical oil field in the North Sea (source: Oil & Gas UK Decommissioning Insight).
obligations to cover the entire amount. The main characteristics of the regulatory procedures related to the termination of field production in the USA and United Kingdom are summarized in Table 2.

In accordance with the US Notice to Lessee (NTL) 2016-N01, all oil and gas companies must seek collateral support to meet their decommissioning obligations, regardless of their net asset value.

Table 2 presents the main problems arising in connection with the decommissioning of oil and gas fields. To solve them, it is necessary to develop a system of measures and determine the key steps in their implementation, considering government regulation, standardization and the introduction of innovations.

The reporting of oil and gas companies should be more transparent, and the companies themselves should have incentives to cooperate. Without clear baselines established, companies and the industry as a whole will not be able to form realistic market expectations in relation to the scale of decommissioning (Thornton, 2016) (see Figure 7).
3. Industrial and environmental security management, ESG impact on the oil and gas industry in Russia

3.1. Industrial and environmental security management

UK’s Oil & Gas Authority (OGA 2017) requires a decommissioning preparation plan that identifies proposed solutions to industrial safety risk management as part of planning and management at least 6 years before the expected cessation of production.

Timely and effective interaction with parties interested in carrying out a decommissioning project reduces the likelihood of problems during the implementation of such a project. There are different stakeholder assessment methods prepared, for example, by Oil & Gas UK (OGUK 2013) or Association for Project Management (APM 2019).

The requirements of UK legislation on decommissioning are implicit and explicit. All decommissioning operations must comply with the general rules on safe working conditions or legislation on work, such as the Control of substances hazardous to health, the Work at Height Regulations, the Lifting Operations and Lifting Equipment Regulations, etc. These rules and the associated expectations are particularly relevant to decommissioning and are defined in the Guidance on managing process safety in decommissioning projects issued by the Energy Institute (EI 2010a; 2010b). It should be borne in mind that all British health and safety legislation is based on the Health and Safety at Work Act (HSWA) (HSE 1974), which obliges every employer to provide a safe and healthy work environment and provide social benefits to employees. In the United Kingdom, explicit requirements for decommissioning offshore platforms are included in the offshore Safety Case Regulations (SCR) (HSE 2015a; 2015b) and Pipeline Safety Regulations (PSR) (HSE 2015c). A similar requirement has also been established in the EU in accordance with the EU Offshore Safety Directive. Particularly noteworthy are the Construction (Design and Management) Regulations (HSE 2005), which should be observed during the disposal onshore.

As with large field development projects, decommissioning projects typically consist of four different stages, shown in Table 4 (APM 2019).

Before decommissioning of a platform, its operator and/or owner must ensure that there is an acceptable safety plan based on a risk assessment that will ensure compliance with safety measures at the engineering support stage and during work.

A critical factor in the safe execution of the decommissioning program is understanding and managing the state of the platform (buildings and structures) until it is given to the contractor responsible for its decommissioning.
The operators are responsible for ensuring safety during the decommissioning of their platforms in cooperation and the coordination with the main and other contractors, considering the following:

- provision of relevant information;
- main roles and responsibilities;
- selection of contractors and personnel performing the work;
- verification of technical suitability;
- change in hazard characteristics at the stages of the decommissioning project;
- transfer of information about dangers and risks;
- useful experience gained during other decommissioning projects;
- effective change management;
- application, monitoring and analysis of safe working methods;
- relations and interaction with regulatory authorities and stakeholders.

A large number of workers involved in the abandoned offshore facilities take part in these potentially hazardous jobs, which emphasizes the need to develop high standards of industrial safety and to comply with them when implementing projects related to decommissioning of facilities.

### 3.2. ESG impact on the oil and gas industry in Russia

The development of mineral deposits (MD) represents an important subject of government regulation. This is due not only to the large contribution of this economy sector to the consolidated budget, but also to the fact that the MD themselves are objects of state ownership. In this case, an important task of the government is to create such an organizational and economic mechanism for the development of MD, which would ensure the most efficient use of subsoil resources in conditions of incomplete and inaccurate information on the process of further development of the field.

At the same time, other economic problems arise such as the choice of the most effective version of the project (continuation of the project) and ensuring the timely abandonment of field facilities at the end of its development. Figure 8 shows a schematic overview of the ESG program.

#### 3.2.1. Efficiency – for whom?

As soon as it comes to assessing or increasing the performance efficiency, the question that has to be answered is: from whose perspective is this efficiency evaluated?

In fact, a performance that is efficient for some subject can be considered as inefficient or simply hazardous for some other subject. In theory and world practice of evaluating the efficiency of investment projects, it is usual to distinguish three types of efficiency: commercial, budget and social:

- Commercial efficiency is assessed from the standpoint of commercial structures involved in the implementation of the project. In fact, it reflects the contribution of the project to the market value of the relevant economic entity. Naturally, for different firms participating in one project, the efficiency of participation in this project will be different.
- Budget efficiency is assessed from the standpoint of the state budget and reflects the influence of the project on budget revenues and

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**Table 4. Key steps in decommissioning.**

| Stage                  | Step                                                                 |
|------------------------|----------------------------------------------------------------------|
| I. Project initiation. | Initiation of the project, confirmation of obligations, identification of possible options for action and their evaluation. |
| II. Selection and development. | Choosing a course of action and drafting a general plan of its realization. |
| III. Engineering support of the project. | Carrying out the engineering work necessary for the implementation of the project. |
| IV. Execution.         | Decommissioning.                                                     |

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![Figure 8. ESG content (source: Antea Group and Oil & Gas 360, 2020).](image-url)
charges. However, there are many state budgets in the country: federal, of federal subjects, municipal, extra-budgetary funds. Consequently, for each of these budgets, the efficiency of the same project will be different. In Russian practice, the efficiency of a project is assessed either for the consolidated or for the federal budget, or for the budget of the extended government (including extra-budgetary funds).

- Social efficiency is assessed from the standpoint of society, the country as a whole, or, as they used to say in the USSR, the national economy. In fact, it reflects the contribution of the project to the growth of the welfare of society, i.e. the valuation of all the benefits received by society from the implementation of the project, minus the cost of all expended resources. It is important that its assessment does not take into account transfer payments, mutual settlements between project participants, for example, between companies, banks and budgets of all levels (such mutual settlements do not change the total amount of benefits received by the society and are considered as “transferring money from one pocket to another”).

The main indicator of each type of project efficiency is the (integral) effect – the sum of discounted benefits from the project for the entire period of its realization. Naturally, when evaluating each type of efficiency, the benefits and discount rates of the corresponding economic entity – firm, budget and society – are taken into account (the social rate is less than the commercial rate).

It should be noted that in different sources the specified effect indicator is called differently, for example, the net present value of the project or the net current value of the project (although projects, unlike project documentation, are not sold and they have no value). Until now, it remains unclear which of these types of efficiency should be the basis for the system of state regulation of subsoil use.

The focus on the implementation of only commercially viable projects (“the struggle to attract investors”) in Russia also had negative consequences. The state examination of projects stopped paying attention to the possible socio-economic consequences. As a result, it turned out that the implementation of many projects (for example, in housing construction) led to massive discontent among the population, and the state was forced to apply administrative measures to close them. Such situations force the system of public administration in Russia to move progressively to taking into account not only the commercial, but also the social efficiency of projects. In the area of subsoil use, the issue of the criteria for choosing project options at different times was resolved in different ways. Initially, the choice of rational options for the development of hydrocarbon raw materials (HRM) was made with the consideration of the commercial efficiency rates (net present value of the subsoil user) and the oil recovery factor (ORF), which to a certain extent reflected the interests of society in the efficient use of HRM reserves. Then, the budgetary effect began to be taken into account.

Meanwhile, by exercising the functions of managing the national economy on behalf of society, the state should have society's interests at heart and take into account the social efficiency when choosing options for the MD development projects.

3.2.2. Problem of interests reconciliation

Whatever criterion is adopted by the state for the choice of the approved version of the MD development project, it will never fully meet the interests of all project participants. At the same time, it may turn out that for some entities the approved version will be inefficient. Then, they will try to take all the measures possible in order to prevent its realization or change the project in the most “convenient” way. To prevent this from happening, it is necessary that the budget and all firms participating in the project receive a positive effect from the realization of the project. This, in principle, can be ensured by choosing a suitable organizational and economic mechanism for the project realization, by which we mean the description of all the main elements of the entire system of relations between the project participants (including, of course, the subsoil user and the state).

Only the lazy does not know that the majority of large state investment projects is not implemented at all or is implemented in a completely different way than it was planned. It is less known that the reasons for this were revealed at the stage of the state examination of the projects. These reasons consisted in the fact that in the design documents submitted for examination, the organizational and economic mechanism for the project realization was never given (with the necessary justifications). The current requirements for the composition of project documentation do not envisage this even now. Apparently, when approving these requirements, the officials believed that the problems arising in the realization of the project should be resolved when they arise. Unfortunately, as a rule, it turns out that it is at this moment that they cannot be resolved. Moreover, many design technical and technological solutions depend on the way of how some future problems will be solved.

In our opinion, projects for the HRM development must necessarily provide for an organizational and economic mechanism for their implementation, which ensures the profitability of the subsoil user to comply with the basic development decisions and the disadvantage of deviations from them. Then the subsoil users, in exchange for their consent to implement the approved version of the project, receive an obligation from the state to provide it with the necessary support in possible future situations. In this case, the organizational and economic mechanism of the approved project becomes, as it were, the “internal” legislation of this project, supplementing (with the consent of the parties) the “official” legislation in the part related to the implementation of certain technical and technological development solutions. It is impossible to ensure the necessary coordination of the interests of the subsoil users and the state by administrative methods – orders or instructions – such a result can only be achieved by economic measures.

Of course, in connection with the emergence of new information, the previously approved project for the field development should be clarified. In essence, after the very first refinement, it turns into a project for the continuation of development, which may require adjustments to some development decisions. However, as the project progresses, the “field” of such adjustments is narrowing, since it is practically impossible to change some of the previously adopted development decisions.

It was said above that in order to implement the project in full, it is necessary to provide the subsoil user with a positive commercial effect. The current regulations are also aimed at this. However, closer analysis shows that this is not enough! The point is not only that “external conditions” (prices, tax rates, available production technologies, information about the developed field, etc.) may change during the implementation. In fact, a subsoil users, even if they are interested in the implementation of a project, “look ahead to the future” when making decisions. If they have the opportunity to retreat from the project or withdraw from it, they will find out if this can give them any additional benefits. For this, they must compare the commercial effects from the corresponding option for continuing the project, summing up the net present value (by the current year) generated by this option for the entire forthcoming period of its implementation. If the commercial effect of continuing the project turns out to be negative, it will be preferable for them to deviate from development decisions or stop developing the field. Such situations are quite possible.

It should be noted that an economically rational subsoil user will make decisions that increase the company's market value, i.e. give a positive commercial effect. However, even if this condition was met at the beginning of development, it is not necessarily so in the years to come. Therefore, already at the design stage, it is advisable to make sure that the effect of continuing the project will be positive in each year of the
project period. However, such a requirement can sometimes be violated. The easiest way would be to set aside the corresponding version of the project.

The logic here is simple: why recommend such an option for the development of mineral deposits, which will become unprofitable for the subsoil user after a while? In this case, some other option will be recommended, which is considered by the designers but is less effective for society (for example, an option that does not provide for the development of some operational facilities).

Unfortunately, sometimes it may seem that all technologically reasonable options for the development of mineral deposits do not meet the specified requirements or represent a too low social effect. In such cases, it will be necessary to adjust the organizational and economic mechanism for the implementation of the project.

We said above that the best project option would be the one that has the greatest social effect. However, it is unrealistic to implement such an approach today. Not because social efficiency calculations are difficult to do (as some of the developers of recommendations for choosing the best options for oil and gas projects say all the time). It is much easier to calculate the social efficiency of the project than the commercial one. The reason is different – the Ministry of Natural Resources of the Russian Federation and the Ministry of Finance of the Russian Federation cannot agree on their ideas about which behavior of subsoil users is more in line with national interests.

Considering this circumstance, at present, when considering and comparing various options for the development of mineral deposits, it is necessary to limit ourselves to the options that provide the subsoil user with a positive commercial effect of continuing the project in each year of the project period (period of profitable development). However, the best of the remaining options should be considered the option that provides the greatest social effect.

From the point of view of society, the option of developing mineral deposits and their subsequent elimination, as a rule, provides for a longer development period and a larger volume of recoverable reserves than any commercially viable option. This is due, among other things, to the fact that when assessing social efficiency, neither taxes nor deductions to the abandonment fund are taken into account, but the costs of performing abandonment works at the end of development are taken into account. Such calculation of benefits roughly corresponds to the situation when the subsoil users do not pay taxes, but at the same time finance the development of the field and its abandonment at their own expense. It is clear that then it becomes more profitable for them to carry out abandonment later and incur small losses than to immediately carry out large abandonment costs.

It would seem that in the last years of the implementation of the optimal version of the project, when the continuation of development becomes unprofitable for the subsoil users, the state should provide them with support. However, this would require not only exempting the subsoil users from taxes at the end of development, but also compensating them for losses from production in this period. Therefore, it is really necessary to count on the fact that the development time in the approved projects (and the volume of reserves recoverable during this period) will be shorter than in socially necessary projects. Most likely, the approved projects will accept the completion of the field development at the beginning of unprofitable hydrocarbon production. This will determine the moment when it is necessary to start abandonment works.

4. Russian practice of abandonment works. Recommendations for improving legislation

With the transition to a market economy, the commercial efficiency became the criterion for selecting projects (or options for one project). Business representatives began to insist that projects carried out with state participation were selected according to commercial criteria. In the same time, the technologically possible development of some operational facilities of the fields became unprofitable, and subsoil users began to demand the provision of tax incentives. These incentives, along with social and environmental projects, are considered by the financial authorities as exceptions to the “general rule” that should be minimized.

Conservation and abandonment of mine workings and other structures associated with the use of subsoil in accordance with the production sharing agreement are carried out at the expense of the abandonment fund created by the investor, the size, procedure for the formation and use of which are determined by such an agreement in accordance with the legislation of the Russian Federation.

4.1. Problems of the formation and use of the abandonment fund

To ensure financing of abandonment works, it is necessary for the subsoil user to create and replenish the necessary stock of funds in advance – the abandonment fund. The subsoil user must make contributions to the fund, where they must be accumulated to the required amount and then spent on financing abandonment works. Discussions continue on the question of who will be the manager of this fund and who should control the correctness of its replenishment and use. If the fund is state-owned, the deductions to it will turn into a kind of taxes and the abandonment of the deposit facilities will become the state responsibility. Therefore, one should proceed from the world practice, where the creation of the abandonment fund is the responsibility of the subsoil user and the state only monitors the expenditure.

So, for example, in the neighboring Republic of Kazakhstan, deductions to the abandonment fund must be transferred to a special deposit in any commercial bank and used “with the permission of the competent authority.” Of course, this raises the risk that by the time the development of the field is stopped or the company goes bankrupt, the funds will not be enough to finance the abandonment work and the difference will have to be covered from the budget. Therefore, the United States of America, the United Kingdom and Norway not only established mandatory requirements for the abandonment of basic production assets, but also provided for certain financial mechanisms to mitigate such risks. So, according to the UK legislation, if there is a shortage of funds in the abandonment fund, companies that previously sold their participation in the project must replenish them.

Thus, the state should not only monitor the replenishment, expenditure and safety of abandonment funds, but also regulate these processes, including when approving the organizational and economic mechanism of the development project.

4.2. Regulatory documents regarding the establishment of an abandonment fund

The contributions to the state-owned abandonment fund in Russia were initially set at 10 % of the recurrent payments for the Mineral Resource Extraction Tax and 10 % of deductions for the Mineral Resource Recovery Tax.

After the abolition of these payments in 2002, as well as with the introduction of the new tax code in 2007, this source of financing was abolished (Mazurina, 2010).

Currently, the abandonment fund is envisaged only for production fields developed under the terms of Production Sharing Agreements (Russian Federation Law, 1996). The existing legislation does not contain a provision on the establishment and use of abandonment funds for the oil and gas extraction companies. Abandonments expenses (Abex), as a rule, are shown only at the time of planned abandonment, i.e. when wells are decommissioned and when the entire field is abandoned. These costs are counted as expenses for the abandonment of assets, which are taken
out of operation, and refer to non-sale expenses that reduce the corporate income tax base during the abandonment period.

The requirement to abandon wells and oilfield facilities, including production and injection wells, as well as the requirement to reclaim the land after the field development is completed, is established in the RF Law “On subsoil”, which is the main legislative act regulating the relationship between the state and a subsoil user (Kryukov and Anashkin, 2012).

Currently, the Russian practice offers a simple solution to the problem of how the basic production assets can be abandoned: to assign the Abex to the expenses incurred at other facilities as well as at more profitable fields (Kryukov and Anashkin, 2012).

Regarding the establishment of an abandonment fund, in the Russian practice, it is appropriate to start with a “hybrid form”, which implies the establishment of this fund through contributions from depreciation expense and tax loss carry-back. Field abandonment implies the development of a new field that is required to compensate for the loss of hydrocarbon reserves, which means that when some wells are abandoned, new wells are brought into exploitation (Kudryashov et al., 2015).

To determine the amount of Abex, both for the purpose of estimating the size of the required abandonment fund and for taking into account the direct financing during the investment planning process, the standard practice today is the following: 1) use specific indicators of the abandonment operation costs per well, taking into account the number of wells planned for decommissioning; and 2) apply the standard norms of abandonment costs relative to the costs of construction and installation of the field facilities (Mazurina, 2010). In practice, PJSC LUKOIL and PJSC Gazprom use a coefficient equal to 10 % of the cost of basic production assets for all groups of field objects (excluding wells) when performing a feasibility study for the development of hydrocarbon fields (Isachenko, 2004).

4.3. Recommendations for improving the legislation on subsoil use in the context of creating an abandonment fund

The draft acts of the proposed amendments to the Law “On subsoil” secure (guarantee) financial support for the completion of abandonment works in full at the expense of the subsoil user, government bodies are endowed with powers, duties and rights to control the establishment of abandonment funds.

An abandonment fund is established for each subsoil plot for the period of subsoil use. Deductions to the abandonment funds of fixed assets related to production are formed in proportion to the extraction of minerals and on an even basis during the period of use of the subsoil plot. The number of deductions is included in other expenses.

The establishment of the abandonment fund guarantees the recovery of the environment and does not require the diversion of state funds to carry out abandonment works.

The expected negative effects if the amendments to the Law “On subsoil” are adopted are as follows:

1. Negative effects for business entities are expressed in the diversion of money to establish funds and, as a result, in the increase in material and time costs;
2. The emergence of additional costs at the first stage of field development and, possibly, an increase in the payback period of capital investments;
3. Without a list of abandonment and remediation facilities in the construction and operation projects of producing companies, unreasonable claims to business entities are possible from government bodies on the unjustified use of the abandonment fund;
4. The procedure for the establishment of an abandonment fund, by accumulating funds in a bank replenished deposit account with a special mode of targeted spending of funds (or by acquiring a conservative package of government securities), will lead to the diversion of working capital of producing companies for long periods (decades).
5. An efficient equalization of subsoil use is incomparably low compared to the level of profitability of organizations engaged in subsoil development. As a result of the withdrawal of funds from the turnover of industrial enterprises, the risks of maintaining the current volumes of mining operations will increase for decades and financial performance rates will decrease, which will affect tax payments to the budgets of all levels;

The adoption of the draft law under consideration seems inappropriate. The legal acts do not consider the sources of financing for abandonment and remediation works for already closed (abandoned) or closing entities at the time of approval of legal acts. It is necessary to develop a methodology for calculating the amount of regular contributions to the abandonment fund, depending on the criteria for an individual assessment of each enterprise. It is required to develop a mechanism for the distribution of the abandonment fund and control over its intended use with its uniform accumulation at the state (regional) level.

Let us outline the main problems requiring legislative solutions:

1. The licensing procedure is blurred in terms of the responsibility of the subsoil user; the license must contain requirements for the restoration and remediation of lands disturbed by the work of the subsoil user and the obligatory recycling or disposal of the resulting waste;
2. The Law “On subsoil” must establish the basic requirements for the composition and content of project documentation (technical and technological) for the development of gas fields (including abandonment), the timing of its approval, justification and procedure for making changes with the delimitation of powers of the executive authorities;
3. It is necessary to formalize in legislation the obligation to create an abandonment fund for the subsoil user, as well as to develop a mechanism for control of its targeted spending;
4. It is necessary to legally establish the elimination of gas field development and transportation by an element of the production cycle;
5. An efficient, qualified organization of environmental and geological control over the activities of subsoil users is required.

The law does not provide for a system of economic sanctions comparable to the amount of damage caused by the actions or inaction of the subsoil user.

When forming the structure and instruments for financing abandonment works in Russia, one should consider the world practice. The following main mechanisms for the formation of funds for the decommissioning of facilities and for abandonment work can be distinguished:
The area of solutions to this problem consists in the selection of the optimal combination of a sufficiently high degree of funds safety and interest rate, which provides, at a minimum, a compensation for the negative inflation impact. Another way suggested by some financial experts is to place the fund’s funds in the more profitable corporate securities in order to protect them from inflation. In this case you will have to attract a private management company to manage the stabilization fund resources.

Opponents of the second option believe that investing in stocks deprives the stabilization fund of its main purpose – the operational management of its funds through its high liquidity for timely stabilization of the budget in the event of a fall in oil prices, since it will be difficult to exchange risky shares for cash in a short time.

Investment in the sovereign obligations of other states is considered the least corrupt scheme. Basically, this means that there are two asset allocation models of stabilization fund – the first one is focused on reliability, and the second is based on profitability.

### 5.1. Example of oil production project in Russia

IAS 16 Property, Plant and Equipment and IAS 37 Provisions, Contingent Liabilities and Contingent Assets of International Financial Reporting Standards (IFRS), as well as the Petroleum Resources Management System (PRMS) developed by the Society of Petroleum Engineers (SPE), offer only some guidelines for field decommissioning and establishment of an abandonment fund. Thus, correct accounting of these expenses in financial statements needs to be ascertained, especially because such expenses influence the classification of hydrocarbon reserves as recoverable at the final stage of exploitation of mature fields. These expenses are always significant, so it is important for oil and gas companies to calculate the value of reserves and to review it annually.
The economic limit test (ELT), which do not consider any costs associated with the termination of project development, is described in the PRMS as the point in time beyond which the net operating cash flow (NOCF) is negative. Economic limit value determines the number of reserves until the end of field's economic life. In foreign and Russian practice, the final stage of field development is usually determined by the date when the exploration and development license expires or by the period calculated based on the estimated oil and gas reserves and the planned annual extraction rate (Medvedeva, 2008).

Therefore, the exploitation of some fields continues when NOCF is negative in order to delay the costs associated with the termination of project development (Abex) and to maximize extraction. For this reason, the field decommissioning costs must be included in subsequent calculations of the net present value (NPV) of the project under development; however, this will result in a negative NPV and a discrepancy despite the positive ELT forecast. To classify recoverable hydrocarbons as reserves, their amount must be commercially significant. Thus, the situation when mature fields continue to be exploited becomes increasingly common, although the reserves of these fields may need to be reclassified as contingent (Vaughan, 2017). Oil and gas companies find much more difficult to get bank loans or to attract investments when their resource base decreases.

Let us consider the economic limit value and NPV estimates by the example of a developed project to find out why they may be inconsistent. To illustrate the magnitude of the values under consideration, we will use a simple discounted cash flow (DCF) model of a medium-sized satellite field in the Nenets Autonomous Okrug, brought into production in the early 2000s and connected by two export oil pipelines with central infrastructure over several kilometers. Oil comes from several oil wells, pressure support for which is provided from a small number of water injection wells.

Economic limit is the moment when maintenance costs exceed extraction revenues. By this moment, an oil and gas company must draw and submit for approval a field decommissioning plan with an approximate schedule of operations and associated Abex (Thornton, 2016).

Table 6 shows an example of an economic limit calculated for a project under development until 2023 (the year when the NOCF becomes negative) that has 7.9 million tons of oil reserves and a positive NPV forecasted in the amount of 62.8 million Russian rubles. Table 7 shows that undiscounted Abex, calculated for the development, amount to 177.8 million Russian rubles, while the potential tax reduction in relation to the previously paid profit tax and additional fees is 23.0 million Russian rubles, which gives a total forecasted value of field decommissioning liabilities in the amount of 154.8 Russian million rubles.

However, if Abex are included in this example, the estimated NPV value becomes -0.2 million Russian rubles, which will lead to further loss of 63.0 million Russian rubles. This means that the residual hydrocarbon deposits may be counted as sub-commercial. It is expected that the extracted 7.9 million tons of oil are more appropriate to classify as contingent resources.

Table 8 provides an exemplary DCF model that has been updated to conduct a break-even NPV analysis to estimate decommissioning payments to a trust fund to meet projected obligations.

Since the DCF model describes a theoretical situation rather than a fully modeled financial state of a company, it suggests that the remaining revenue received at the field presented as an example cannot support NOCF until the well is abandoned in 2022.

Thus, if the appropriate coverage was not previously provided for the field decommissioning and it must start from 2019, then the modeled economic limit can be rescheduled, thereby reducing the estimated reserves. If an oil and gas company that develops a mature field does not accumulate sufficient reserve funds as it approaches its abandonment and does not get access to credit lines to cover its field decommissioning liabilities, it could go bankrupt.

6. Conclusion

1. The problem of effective management at the end of the life cycle of oil and gas production facilities is extremely important for the national economy, since the number of facilities to be abandoned and the corresponding funding needs grow as the oil industry ages. Under these circumstances, it is necessary to consider the increasing urgency of environmental problems under conditions of a large-scale increase
in closures of oil and gas wells and fields. This process is aggravated by the growing competitive position of alternative and renewable energy sources and the new climate policy, which creates additional risks for the oil industry associated with the possibility of suspension of existing projects or earlier termination of production for new investment projects in oil and gas production.

2. In 2013–2017, Europe was the most active decommissioning market in the world, which accounted for more than 50 % of global expenses. However, decommissioning activities will continue to grow in other regions of the world, especially in Asia, Latin America and North America and, of course, in such a large oil-producing country as Russia. The main volume of abandonment works falls on the shelf fields.

3. Oil companies must mobilize huge financial resources, which raises the most important question of what should be the sources, mechanisms and rates of financing capital investments at the final stage of the oil and gas cycle. World practice in this area has accumulated considerable experience, especially in the abandonment of oil and gas shelf facilities. The results of generalization and critical analysis of foreign practice will be useful for the successful organization, planning and financing of this important segment of the oil and gas industry in Russia.

4. Stakeholders should benefit from a comprehensive and transparent understanding of the scope, cost and timing of response activities. This transparency encourages contractor investment, improves budgeting and performance benchmarking, and helps define how operators and suppliers can collaborate.

5. Factors requiring careful consideration are:
   - Project management from the point of view of industrial safety;
   - Early identification of key stakeholders and planning for effective communication between them throughout the life of the project;
   - Cooperation with regulating authorities and ensuring compliance with applicable laws, as well as industry and corporate standards.

6. Decommissioning of an offshore platform is a complex operation comprising engineering, environmental, financial and social aspects. A multi-criteria approach is a suitable tool to optimally address such problems due to its well-structured procedure and ease of use. This approach will minimize the subjectivity of human judgment when choosing the best solutions for the decommissioning of oil and gas facilities.

7. In Russia, oil and gas companies take a negative attitude towards the government proposal of the Russian Federation to create a unified abandonment fund to eliminate environmental damage. Such an abandonment fund is not able to solve the problems of assets abandoned by subsoil users. In fact, what is meant here is the introduction of another non-tax payment, which will lead to an increase in the financial burden and, in addition, to a nontransparent scheme of using the created reserves. As a result, new costs will come upon the end users.

8. Analysis of the mechanism for creating a financial fund for abandonment works allows us to make the following preliminary recommendations for the Russian oil and gas sector:
   - From the standpoint of government departments, it is advisable to start generating funds immediately after reaching the point of return on investment for the project;
   - A variable rate of contribution to the reserve fund increases the risk of insufficient funds savings to finance the abandonment of facilities. The faster the costs rise and the later the abandonment fund begins to be created, the higher this risk;
   - The use of a constant rate of deductions makes it possible to simplify the scheme of settlements and control of annual payments, as well as to minimize the risk of insufficient funds savings;
   - From the standpoint of an investor, the mechanism for forming the fund’s assets in the form of a reserve is preferable than accumulating them in an abandonment fund;
   - Government departments are more profitable with the option of creating a reserve of funds if they are accumulated, controlled and spent under the control of the state. In the context of a PSA, payments made by the investor from compensation products to the abandonment fund are transferred to the state, which then chooses the best option for disposing of them before the start of abandonment works. Obviously, in this case, the state is not interested in delaying the start of payments.

Declarations

Author contribution statement

Ibragim Khalidov: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed materials, analysis tools or data; Wrote the paper.

Konstantin Milovidov: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed materials, analysis tools or data; Wrote the paper.

Anzor Soltakhanov: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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References

APM, 2019. Stakeholder Engagement Resources. Association for Project Management. Available at. https://www.apm.org.uk/resources/find-a-resource/stakeholder-engagement/resources/.

BG, 2017. Decommissioning of Oil and Gas wells Market Analysis. Energy Institute, 2010a. High Level Framework for Process Safety Management. Available at. https://publishing.energynit.org/topics/process-safety/leadership/high-level-framework-for-process-safety-management.

Energy Institute, 2010b. Guidance on Managing Human and Organizational Factors in Decommissioning. Available at. http://www.energypublishing.org/publication/ei-technical-publications/human-and-organisational-factors/guidance-on-managing-human-and-organisational-factors-in-decommissioning.

HSE, 1974. Health and Safety at Work Act, 1974. Available at. https://www.hse.gov.uk/legislation/l154.htm.

HSE, 2015a. The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015. L155. UK Health and Safety Executive. Available at. https://www.hse.gov.uk/pubns/books/l154.htm.

HSE, 2015b. Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 (SCR 2015) SI 2015/398. UK Health and Safety Executive. Available at. http://www.legislation.gov.uk/uksi/2015/398/contents/made.

HSE, 2015c. A guide to the pipeline safety regulations. L82. UK health and safety executive. Available at. https://www.hse.gov.uk/pubns/books/l82.htm.

HSE, 2015d. Construction (Design and Management) Regulations 2015. 2015. Guidance on Regulations L153. Available at. https://www.hse.gov.uk/pubns/books/l153.htm.

Isachenko, V.M., 2004. Estimation of Project Capital Intensity of Oil Field Development. Dissertation for the Candidate of Economic Sciences Degree. Federal State Budget Educational Institution of Higher Education Industrial University of Tyumen.

Kryukov, V.A., Anashkin, O.S., 2012. Oil Funds – a Sterilization Tool or a Modernization Tool? XIII International Scientific Conference on Economic and Social Development. National Research University Higher School of Economics, Moscow.
Kudryashov, S.I., Belkina, E.Yu., Ismagilov, A.F., 2015. Monitoring the cost of construction of field facilities at various stages of the investment cycle. Oil Indus. 11, 72-75.
Mazurina, E.V., 2010. On the formation of abandonment funds of hydrocarbon deposits. Petroleum Geology – Theoretical and Applied Studies 5.
Medvedeva, N.V., 2008. Fixed Assets Abandonment Fund and Fields Restoration. Corporate Financial Reporting, International standards. Viewed 08.12.2018.
Oil & Gas Authority, 2017. Stewardship Expectations, SE-10. Available at. https://www.ogauthority.co.uk/exploration-production/asset-stewardship/expectations/.
Oil & Gas UK, 2013. Guidelines on Stakeholder Engagement during Decommissioning Activities. Available at https://oilandgasuk.co.uk/product/guidelines-on-stakeholder-engagement-during-decommissioning-activities/.
Oil & Gas UK, 2014. Decommissioning Insight. Available at https://oilandgasuk.co.uk.
Oil & Gas UK, 2018. Decommissioning Insight. Annual Survey and Report. Available at. https://oilandgasuk.cld.bz/Decommissioning-Insight-2018/38/.
Rystad Energy, 2019. Global Decommissioning Set to Hit Record 36 Billion US Dollars over the Next Three Years. Available at. https://www.rystadenergy.com/newsevents/news/press-release/Global-decommissioning-set-to-hit-record-$36-billion-over-the-next-3-years/.
Thornton, W., 2016. Decommissioning and Abandonment. Technology Focus Article. JPT. January 2016.
Vaughan, A., 2017. Shell Begins Huge Task of Decommissioning Brent Oil Rigs. Article by the Energy Correspondent of the Guardian Newspaper. February 6, 2017.
Wood, Mackenzie., 2016. UKCS Decommissioning: Challenges in the Current Price Environment. Available at. https://www.woodmac.com/reports/upstream-oiland-gas-ukcs-decommissioning-challenges-in-the-current-price-environment-37636260.
Wood, Mackenzie., 2018. 32 Billion US Dollars to Be Spent on Decommissioning Worldwide in 5 Years. Available at. https://www.woodmac.com/reports/upstream-oiland-gas-32-billion-of-decommissioning-worldwide-over-the-next-five-years-is-the-industry-ready-9599.