

# Hard-to-recover oil reserves in the context of sustainable development of resource regions

Valeriy Kryukov and Anatoliy Tokarev\*

Institute of Economics and Industrial Engineering; 17, Ac. Lavrentiev Ave., Novosibirsk, 630090, Russian Federation

**Abstract.** The main objectives of the study are to assess the potential socio-economic effects of hard-to-recover oil reserves (HROR) development at the regional level and prepare recommendations for institutional conditions that guide oil and gas companies to develop such resources. An approach was developed to analyze the potential socio-economic effects from the implementation of HROR development projects. The methodology is based on methods for evaluating investment projects and analyzing intersectoral relations. The study was carried out on the example of the Khanty-Mansiysk Autonomous Okrug (KhMAO). The calculations show that the development of HROR will form the prerequisites for stabilizing production volumes in the KhMAO, generate significant direct and indirect effects for the region related to the increase in tax revenues, maintenance of related industries and employment.

## 1 Introduction

In today's conditions, HROR play an increasingly important role in the global oil and gas sector (OGS) [1]. The broad concept of hard-to-recover reserves includes high-viscosity oil, reserves of the Bazhenov formation, products obtained from rocks with low permeability and oil recovery, as well as from highly mature fields. The effective development of such reserves requires the application of innovative technologies, the creation of which is largely determined by a favorable institutional environment [2].

The scale of the tasks of developing HROR in our country is characterized by data on the size and structure of recoverable oil reserves. According to the Ministry of Energy of the Russian Federation, more than 2/3 of the oil reserves are HROR. The share of traditional oil reserves is declining, while the role of HROR in Russia is increasing. Therefore, the production of HROR already now determines, and in the future will decisively influence the volume and dynamics of oil production both in the country as a whole and in individual oil regions and, accordingly, on the socio-economic development of these territories.

---

\* Corresponding author: [Tokarev@ieie.nsc.ru](mailto:Tokarev@ieie.nsc.ru)

## 2 Development of HROR and socio-economic effects

In the present-day global environment, the trend of growth in oil production from hard-to-recover reserves has taken on a sustainable character. In the oil industry, for example, shale resources are becoming increasingly important. Technically recoverable shale oil reserves in the world account for 345 billion barrels. Currently, hard-to-recovery resources in many oil and gas regions of the world are one of the key factors for maintaining and increasing oil production and obtaining the corresponding socio-economic effects. This applies, for example, to the USA, Canada, Venezuela, Brazil, Norway. Moreover, these processes largely affect already “mature” production areas. The already existing infrastructure (pipelines, social facilities), the availability of qualified labor force make it possible to largely offset the increased costs associated with the development of HROR.

In this context, the oil and gas regions of the United States, which are producing shale oil and shale gas, are a good example. Thus, since the late 2000s, there has been a significant increase in hydrocarbon production in key oil and gas states, the reserves of which in terms of traditional oil has long been considered depleted. Favourable institutional and economic conditions, new technologies have made it possible to involve significant reserves of shale oil in economic circulation and ensure the growth of production volumes. As a result, shale oil today provides about 2/3 of the total production in the United States.

The growth of HROR production provides significant socio-economic effects for the economy of the respective regions. In general, the policy of the main oil and gas states take into account the fact that the development of mineral resources should bring significant social and economic benefits to the local population.

Another example illustrating the importance of development of HROR is Alberta, Canada's largest oil and gas province. For a long time, the provincial government has been implementing a number of programs, both scientific and technical, and tax incentives for oil and gas production. These programs are designed and implemented taking into account the potential social and economic benefits that oil and gas development can bring [3].

The development of HROR in Alberta provides a significant amount of investment, jobs, business development opportunities (primarily oil and gas field services; suppliers of goods, equipment and materials), budget revenues (taxes and royalties), which are directed to finance the socio-economic programs of the province. At the same time, each job in the oil and gas sector creates 2.5 jobs in other industries.

As a result, both the absolute volumes of HROR production and their share in the total volume of hydrocarbon production have been growing in the province for a long time. Currently, oil sands production accounts for 85% of all oil production in Alberta.

From the point of view of general socio-economic effects from the development of HROR, it is important to note that their production in the province of Alberta provides demand for the supply of equipment, goods and services from almost all regions of Canada. For example, in 2019, local oil sands companies spent more than \$4 billion to supply products and services from over 2,700 companies in nine provinces and three territories. These deliveries included a wide range of products: from metal to environmental monitoring services. Thus, the development of HROR in Alberta creates demand for products and services throughout Canada, stimulating economic development not only in the production region, but also in other regions of the country. Thus, the development of HROR becomes an important factor in the socio-economic development of not just resource regions, but also in maintaining the economic activity of other territories – suppliers of goods and services.

### 3 Assessment of socio-economic effects

When analyzing the prospects for the development of HROR in Russia, a number of research questions arise. What potential socio-economic effects can be obtained from the development of HROR? What are the prerequisites and obstacles for this at present? What institutional changes are required in the Russian OGS to transform the considered oil potential into real social and economic benefits?

The development of a number of Russian regions (primarily the Asian part) is determined by the position of the primary industries. Unfortunately, until now, in very rare cases, it has been possible to ensure the sustainable development of resource regions with a significant decrease in the volume of raw materials production. Supporting sustainable development (e.g. in terms of gross regional product – GRP, employment) at the expense of other industries in resource regions is a very difficult task, especially in difficult climatic conditions and in remote areas.

In practice, a more realistic and reliable factor in the sustainable development of oil and gas regions (at least in the medium term) seems to be the stabilization of production, based on the use of innovative technologies. The most striking foreign example is the “shale revolution”. Such an extension of maturity may be accompanied by stabilization and even a new increase in production, as evidenced by the experience of a number of foreign regions.

For resource regions, not only the volume of oil extraction is important, but also those real socio-economic effects that the territory receives or may receive in the future from the oil extraction. At the same time, it is necessary to take into account not only direct, but also indirect effects associated with the maintenance of business activity and the development of related industries and types of economic activity. When evaluating such effects, a number of approaches and techniques can be used [4, 5]. To assess the potential regional socio-economic effects from HROR development, a special approach was developed and used. It is based on the methods for evaluating investment projects and analyzing inter-industry relations.

The developed models for evaluating oil production projects (taking into account the specifics of HROR, for example, in terms of the dynamics of development of reserves, tax conditions) evaluate the effectiveness of projects for oil companies and resource regions. Available technical and economic parameters of HROR development projects abroad and in Russia and forecasts (of oil companies, federal and regional authorities) of the volumes of HROR production were used as initial information [6, 7, 8].

Today, one of the important elements of the state scientific and technical policy in relation to HROR in Russia is the federal project “Technologies for the development of hard-to-recover hydrocarbons.” Its goal is to create cost-effective technologies for the exploration and production of HROR, as well as localization of the production of the required equipment and the formation of a domestic high-tech oil field service. The emphasis is on the creation of domestic technologies and innovative equipment for the development of the reserves of the Bazhenov formation. This focus is related to the scale of the tasks. The Bazhenov deposits are spread across the territory of Western Siberia over an area of more than 1 million km<sup>2</sup>, and their geological resources exceed 60 billion tons of oil.

Within the framework of this federal project, by 2025 it is planned to ensure the involvement in the development of more than 760 million tons of recoverable oil reserves, the creation of 60 complexes of domestic equipment for the production of HROR. The implementation of the project can provide up to 50 million tons of additional production per year by 2030.

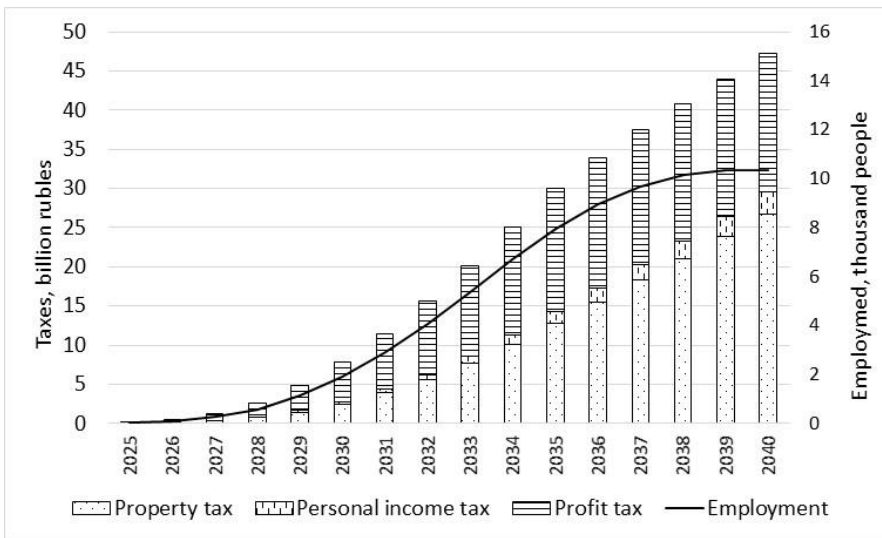
An assessment of the potential socio-economic effects from the involvement of HROR in the economic circulation was carried out using the KhMAO as an example. The choice of the region was due to the scale of its oil and gas sector – its importance for the country's overall

production and the presence of large volumes of HROR, as well as the growing need to counter the downward trend in oil production that has been taking place since 2008.

The impact of HROR production projects on the socio-economic system of KhMAO was assessed using dependencies reflecting the impact of oil production on key related industries – electric power, construction, and transport. At the same time, the retrospective dynamics of indicators of the socio-economic development of the KhMAO was used (including the structure of GRP, the dynamics of employment, taxes). It should be noted that in the case of KhMAO, the task of assessing indirect effects is somewhat simplified, since, in general, the okrug's economy is actually a mono-industry (in the GRP, oil production takes 60–70%).

The implemented approach makes it possible to evaluate projects both at the micro level and at the level of a region; to estimate direct effects (value added, taxes, employment in oil production) and indirect effects associated with the development of related sectors of the okrug's economy.

Our estimates show that HROR development projects in the KhMAO will form the prerequisites for stabilizing production volumes, generate significant direct socio-economic effects for the region associated with the stabilization and growth of budget revenues (primarily profit tax, personal income tax and corporate property tax), as well as maintaining the level of employment (Fig. 1).



**Fig. 1.** Socio-economic effects from development of HROR in KhMAO: regional taxes and employment.

Equally important is the fact that the economy of the KhMAO will receive significant indirect benefits associated with the maintenance and development of related industries, primarily construction, transport, and the electric power industry.

Thus, the development of hard-to-recover reserves can become an important factor in the stabilization (and, possibly, growth) of oil production and, accordingly, indicators of the socio-economic development of the KhMAO. The success of the implementation of projects for the development of HROR will largely depend on:

- cooperation of oil companies (primarily their R&D centres);
- comprehensive interregional cooperation (for example, in the development and use of new equipment and materials) [9];

– creation of adequate institutional conditions, including development of the oil and gas field service, small and medium-sized oil production companies, as well as tax incentives for the production of HROR [10, 11].

The assessments of the socio-economic effects from the development of HROR in the KhMAO characterize the aggregate potential benefits that the region can receive from the development of these reserves. Foreign experience shows that in order to transform these potential benefits into real ones, it is necessary to create appropriate institutional conditions. What conditions have determined and continue to determine the successful development of HROR abroad? Among the main factors are: the diversity of exploration and production oil and gas companies; developed oil and gas field service; state stimulation of HROR production (first of all, tax incentives); purposeful R&D policy.

There is a need for systematic implementation of measures and mechanisms of state policy at the federal and regional levels. This implies the creation of a developed institutional environment, including tax incentives; ensuring guaranteed access to infrastructure capacities; development of the organizational structure of OGS. Independent innovation-oriented small and medium-sized companies in production and service are one of the most important conditions for sustainable (both in terms of production dynamics and maintaining business activity in related sectors of the economy) functioning of the OGS, especially in the transition to an ever wider development of HROR.

## 4 Key conclusions

1. Foreign experience (first of all, the development of shale oil and oil sands resources) shows a significant increase in the production of hard-to-recover reserves as a result of close interaction between the knowledge economy and the resource sector. This experience allows us to take a fresh look at the development of resource regions in modern conditions – based on the growing role of the knowledge economy. This situation to a large extent transforms the understanding of the conditions and dynamics of sustainable socio-economic development of resource regions. Production growth creates new opportunities for creating the prerequisites for sustainable development. Resource regions have additional opportunities, for example, to create capacities for deep processing of hydrocarbons, develop human capital, generate new local knowledge and practices, and produce goods for the implementation of innovative projects. The most important condition for realizing the potential opportunities for development HROR is the close integration of knowledge, innovative technologies and adequate institutional conditions.

2. From the point of view of the availability of HROR, Russia undoubtedly has a huge potential. But it is necessary to create a whole range of institutional conditions for the effective development of HROR. It would be wrong to say that nothing is being done in this direction in Russia. Tax incentives have been developed and are being used, although not always consistently and steadily. Important steps are being taken to form technological testing grounds for the development of innovative technologies for HROR extraction.

Important obstacle for the development of HROR in terms of institutional conditions is current organizational structure of the OGS of Russia. This concerns, first of all, two closely interrelated factors. One of them is the weak and declining role of innovative small and medium-sized oil companies. These companies are among the most important drivers of innovation processes in world practice. Another key driver of these processes is a specialized oil field service, the presence of a full-fledged market for these services.

3. Specific features of HROR development are associated with the importance of local knowledge and practices, local innovative production and field service companies. These factors require strengthening the role of regions in the regulation of OGS. This includes creating favorable conditions for the development of innovative companies and independent

oil and gas field services. At the same time, the application of effective mechanisms at the regional level is possible only if they have the appropriate authorization and competencies.

## References

1. H. MahdaviMazdeh, C. Saunders, R. Hawkins, J. Dewald, *Resour* 72, 102044 (2021).
2. L. Zheng, P. Wei, Z. Zhang, S. Nie, X. Lou, K. Cui, Y. Fu, *Nat. Gas Ind. B* **4**, 6, 477–490 (2017).
3. E. Tretter, *Capital. Nat. Social.*, **31**, 1, 1–20 (2019).
4. M. Nourelfath, H. Lababidi, T. Aldowaisan, *Int. J. Prod. Econ.* 246, 108416 (2022).
5. P. Byakagaba, F. Mugagga, D. Nnakayima, *Extr. Ind. Soc.* **6**, 2, 358–366 (2019).
6. R.L. Kleinberg, S. Paltsev, C.K.E. Ebinger, D.A. Hobbs, T. Boersma, *Energy Econ.* 70, 70–83 (2018).
7. E.D. Attanasi, P.A. Freeman, *Nat Resour Res* 29, 1471–1486 (2020).
8. M.H. Vatter, S.A. Van Vactor, T.C. Coburn, *Nat. Resour. Res.* 31, 713–734 (2022).
9. V.A. Kryukov, A.N. Tokarev, *Stud. Russ. Econ. Dev.* **34**, 1, 25-32 (2023).
10. V.A. Kryukov, A.N. Tokarev, *Reg. Res. Russ.* **12**, 2, 113–123 (2022).
11. V.A. Kryukov, A.N. Tokarev, *Reg. Res. Russ.* **8**, 3, 248–257 (2018).