

Enhanced oil recovery (EOR) methods in Russia: time is of the essence



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I. Introduction

The replacement of conventional fuels (oil, gas, coal) with alternative ones has been under intense scrutiny for several decades. Many experts believe that debates around this matter are likely to continue in the foreseeable future. In particular, BP has revised its expectations downward as to the use of biofuels in its Annual Energy Outlook 2030. With the lack of significant scientific advances on the alternative energy front, global oil demand is set to remain high. According to the consensus forecast, there will be no significant shift in oil's share of the global energy mix, which will make up 27% to 30%¹ by 2030. Hence, considering that energy consumption is expected to rise at an estimated average rate of 1.6%, oil demand, exclusive of gas condensate, might grow in absolute terms from today's 88 million barrels per day (mbd) to more than 100 mbd by 2030.

It is no secret that the age of "easy oil" is coming to an end. Most of the world's largest producing fields are approaching depletion, and their remaining reserves are classified as hard to recover. The peak of new oil discoveries occurred in the 1970s; at the same time, it takes an average of about 25 years for an oil field to enter the fourth, and last, stage of development. Therefore, exploring for new reserves and improving oil recovery factor are high on the agenda. However, given constantly increasing geological knowledge, discoveries are now becoming more predictable. It is no wonder, then, that almost all of the world's leading vertically integrated oil companies (VIOCs) invest heavily in innovative solutions focusing on reserves already explored and put into development. According to our estimates, international oil companies (IOCs) invested about US\$5b in new technologies in 2011.

The development and commercial deployment of modern enhanced oil recovery methods (EORs) is today seen as the global oil industry's core way to improve the efficiency of initial recoverable reserves through an enhanced oil recovery factor (ORF), a measure that represents the percent of the in-place oil discovered that is technically recoverable.

With over a hundred various related technologies now available worldwide, the development of new solutions continues to gather steam. Primary and secondary generations of EORs have made way for tertiary ones that are explored in this report. Traditionally, these methods have included modern enhanced oil recovery technologies (primarily thermal, gas, chemical and microbial) incorporating innovative solutions.

While involving major expenditures at the initial stage, EORs, when implemented, make it possible to expand the companies' resource bases as the essential condition for their capitalization. Some estimates suggest that the growth of the global ORF by just 1% would permit increasing conventional oil reserves by around 88 billion barrels, which is nearly three times the current annual output.

In the Soviet times, Russia was among the world's pioneers in deploying EORs – suffice it to mention reservoir pressure maintenance techniques that involve gas, air and water injections, hydrofracturing and hydrochloric acid treatment. Over the past decade, additional output gained by modern EORs remained unchanged at best. Application of these methods had no significant impact on overall operating performance, with EOR-based output accounting for only 3% of Russia's total output, compared with over 10% in the US. The lack of government support is one of the key reasons for EORs not being fully deployed in Russia. However, persistent worrying trends observed in West Siberia, the country's oil heartland (daily oil production dropped by around 7% from 2006 to 2012), and no new attractive licensed sites available in the open acreage indicate the continuing importance of EORs. Without such methods, achieving sustainable production at the levels projected in the General Plan for Oil Industry Development 2020 will be a challenge.

¹ International Energy Agency, ExxonMobil, Shell, BP, Organization of the Petroleum Exporting Countries.

II. EOR worldwide

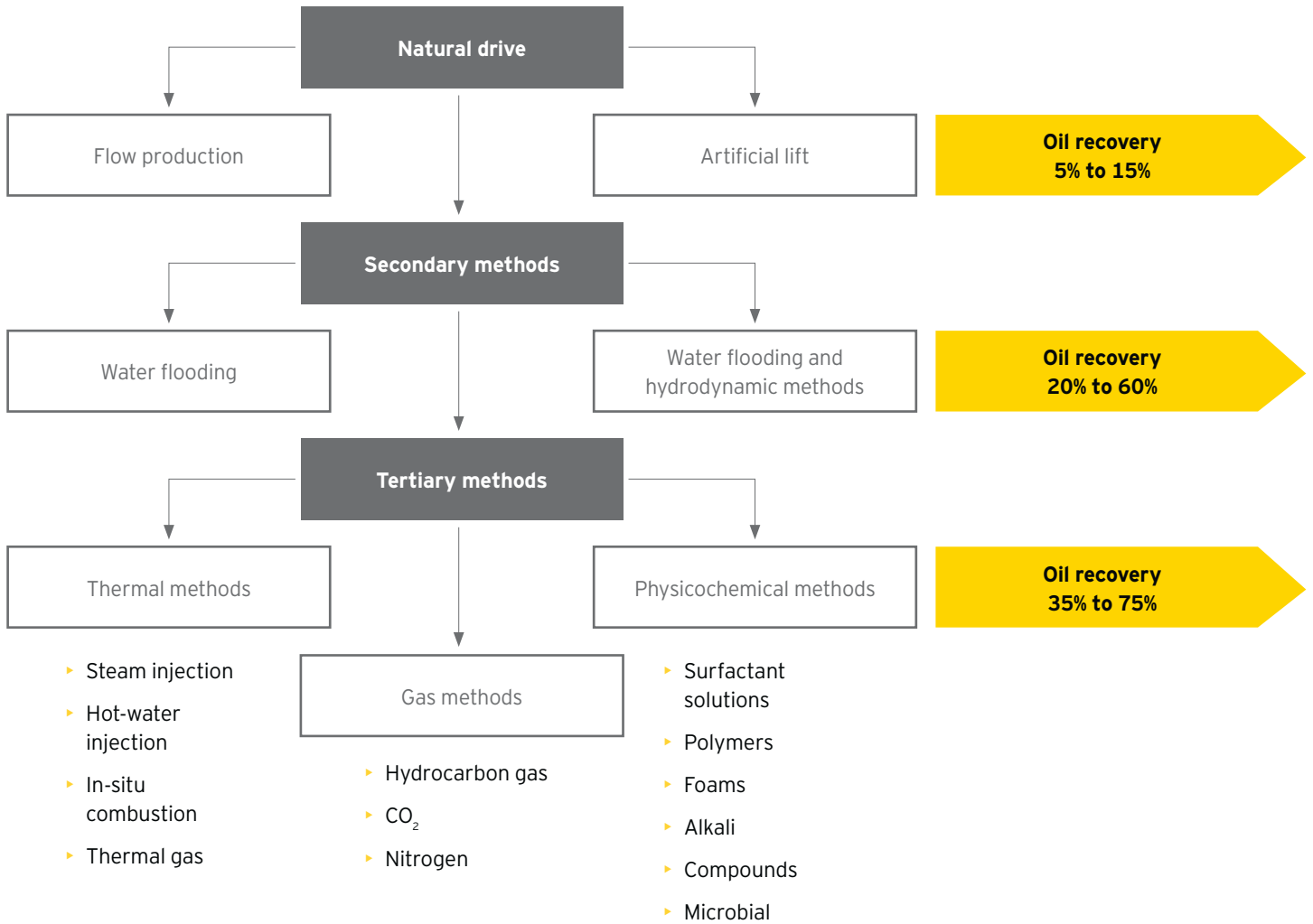
To enhance the economic efficiency of hydrocarbon development, reduce direct investments and optimize capital reinvestment environment, various oil recovery improvement methods are applied throughout the

life cycle of an oil field. They comprise three main stages (Figure 1).

The first oil extraction stage will involve using, wherever possible, the field's natural drive (reservoir pressure) that includes

elastic energy, dissolved gas drive, edge water drive, gas cap drive as well as potential gravity. The natural drive of a field actually unlocks 5% to 10% of oil.

Figure 1. Hydrocarbon recovery methods



Sources: VNIINEft; *Oil and Gas Vertical*, February 2012.

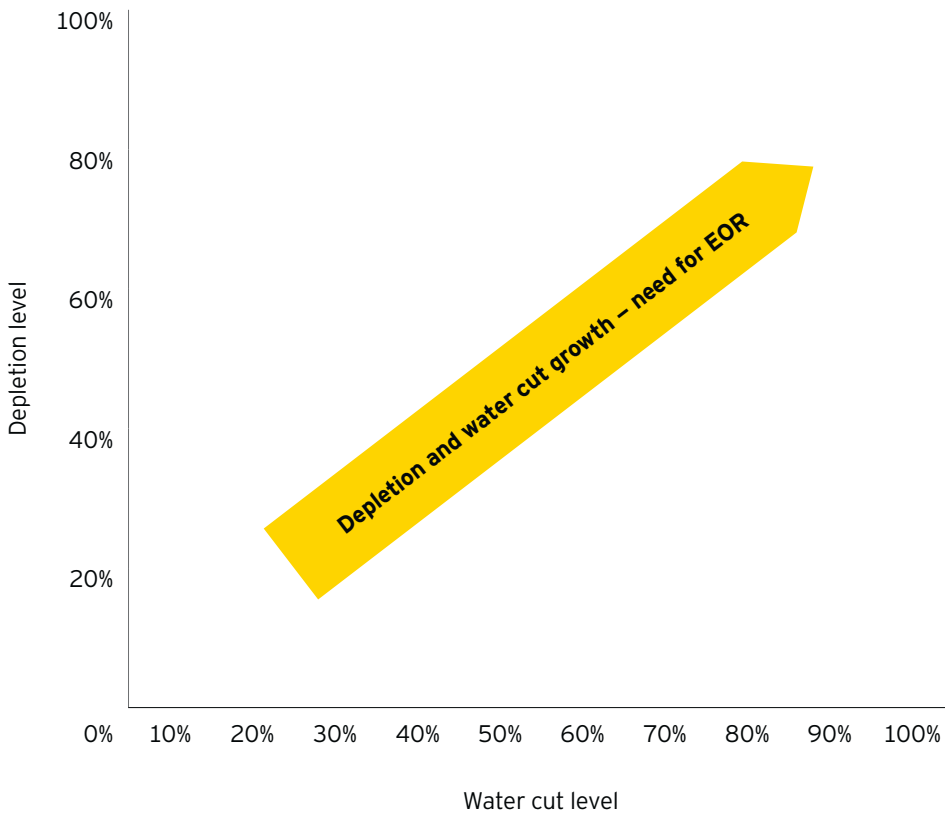
The second stage involves reservoir pressure maintenance techniques, namely water injection, that ensures 20% to 60% oil recovery.

Where a field has high water cuts and depletion level (Figure 2), the third stage will be needed to improve the development efficiency using enhanced oil recovery methods that are the subject of our study. These methods raise reservoir recovery potential from 35% to 75%.

However, secondary and tertiary recovery methods largely complement each other, and there is no clear distinction between them. Statistical sources provide different information on the use of modern EORs. Yet the professional community generally refers to the following well-varied methods as modern EORs:

- ▶ Gas displacement: carbon dioxide (CO₂), nitrogen (air) or gas injection
- ▶ Physicochemical methods: chemicals injection (e.g., alkali, surfactant or polymer)
- ▶ Heat (thermal) methods: steam injection
- ▶ Horizontal drilling with multistage hydrofracturing that consists of tubing-conveyed hydraulic jet perforating and further hydrofracturing per operation

Figure 2. Key factors driving EOR investment considerations



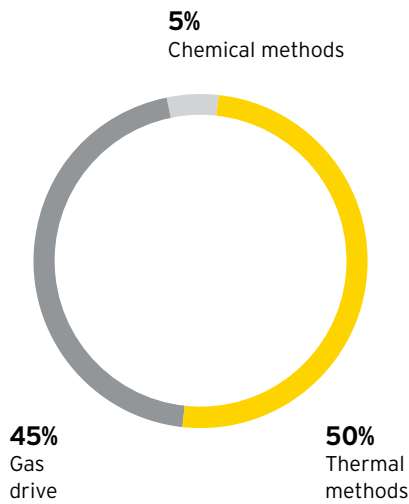
Source: Estimates of Ernst & Young's Moscow Oil & Gas Center.



Global experience shows that gas, physicochemical and thermal methods raise the oil recovery factor by 5% to 10%, 3% to 8%, and 15% to 20%, respectively.²

According to our findings, thermal projects account for 50% of the world's EOR-based output, while nitrogen and CO₂ injection share 45%, and chemical methods hold only 5% (Figure 3). Gas and thermal EORs are in widest use in the US.

Figure 3. Structure of EOR's global use



Source: Estimates of Ernst & Young's Moscow Oil & Gas Center.

As for the relevance of EOR methods, there are multifactor models describing a field's reaction to a given method. The applicability of EOR technologies depends, very broadly, on two factors: the depth of the reservoirs and the physicochemical properties of oil, primarily gravity and viscosity.

The International Energy Agency³ provides extended criteria for EOR use: depth, current recovery ratio, temperature, gravity, permeability, rock type (Table 1).

Table 1. Criteria governing the use of an EOR method

Method	Density (kg/cubic m)	Remaining recoverable reserves (% of initial recoverable reserves)	Rock type	Depth (m)	Permeability (mD)	Temperature (°C)	Expected extra ORF (%)
Nitrogen injection	>850	>40	Carbon	>2,000	190	-	n/a
Hydrocarbon injection	>904	>30	Carbon	>1,350	-	-	20 – 40
CO ₂ injection	>904	>20	Carbon	>700	-	-	5 – 25
Polymer injection	>966	>70	Sand	<3,000	>10	<95	5 – 30
Surfactant injection	>946	>35	Sand	<3,000	>10	<95	5 – 30
Thermal/combustion under rapid oxidation	>1,000	>50	Sand	>50	>50	>40	n/a
Thermal/steam injection	>1,014	>40	Sand	<1,500	>200	-	10 – 60

Source: International Energy Agency.

² "Enhanced Oil Recovery: Experience and Prospects," *Neftegazovaya Vertikal*, May 2011.

³ World Energy Outlook, International Energy Agency.

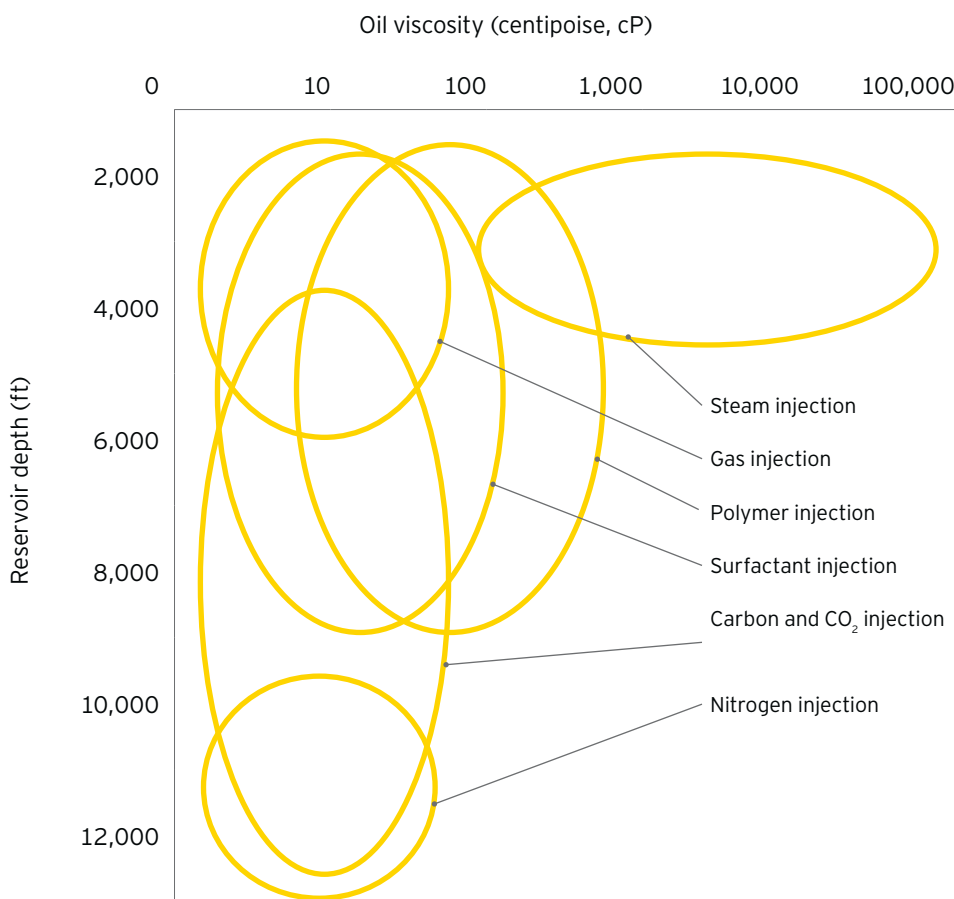


Figure 4 illustrates the criteria governing the use of an EOR method. The criteria rely on mean Russian indices and are exclusive of ultra-heavy oil or bituminous oil. As oil viscosity (density) and depth increase, a

specific EOR method is required. Thus, chemical projects are feasible at a depth of 2,500 m, while steam projects can be implemented as deep as 1,000 m.

As shown in Figure 4, certain areas allow for various EOR methods. This is to say that when regulating EOR use, the government should create a level playing field for all companies, regardless of method used.

Figure 4. Criteria governing the use of an EOR method



Source: Enhanced Oil Recovery (EOR) Report, Royal Dutch Shell.

Note that the largest oil and gas companies, capable of investing huge funds into research, use tertiary EORs with great efficiency. In implementing its LaBarge Project, ExxonMobil, for example, expanded its carbon dioxide capture plants (about 7.5 billion tons). Some of the captured gas is involved in the enhanced oil recovery project.

Royal Dutch Shell, which operates in Oman through a strategic alliance with Petroleum Development Oman, also successfully applies innovative EORs. In particular, the company injects steam in the Qarn Alam, Fahud and Amal fields, dissolved gas in sites of subsurface resources of the Al-Noor and Harvil fields, and applies chemical methods for the Marmul, Nimr and Amin fields.*

Joint ventures of Royal Dutch Shell and ExxonMobil deploy a number of enhanced oil recovery projects that involve heat (thermal) methods. These are well exemplified by the Aera Project (California) and the Schoonebeek Project (the Netherlands).*

* Corporate data.

Chevron, ConocoPhillips, Occidental Petroleum, Anadarko, Petrobras, Wintershall and TPAO actively employ various EOR methods. Although most commonly used in North America, these methods are also popular in many other countries, including Egypt, Brazil, Indonesia and the Netherlands.*

Russia's role in the development of EORs changes constantly. The USSR was originally the powerhouse for many EOR methods. Well before the 1950s, the Soviet Union started using different well patterns, adjusting injection pressure and selecting target formations, as well as employing other methods to improve efficiency. Back in the 1960s, water drive efficiency was improved, owing to the application of various additives such as surfactants, hydrocarbon gas, alkali and acids.

In the late 1980s/early 1990s, Russia practiced thermal methods with the Usinsk (Timan-Pechora) and Gremykhinsk (Volga-Ural) formations and applied physicochemical methods to the Romashkinskoye (Tatarstan) and Samotlor (West Siberia) fields. The latter underwent gas injection as well.

In 1976, the USSR Council of Ministers adopted the regulation on enhanced oil recovery methods to specify additional output volumes using tertiary recovery.

In the early 1990s, Russia's annual output grew from 6 million to 12 million tons⁴ as a result of the use of the EORs of that time. Global EOR-based production totaled about 100 million tons. By that time, Russia had been deploying over 20 methods (130 technologies) on over 330 target formations (150 fields), containing in-place oil resources of around 5 billion tons, or 75% of the reserves developed using EORs in the former USSR. Contemporary Russia's EOR deployment rate dropped in absolute terms, while in relative terms it tended to grow. Virtually no fundamental research was conducted. The Russian ORF was decreasing, with the share of tight reserves continuously growing.

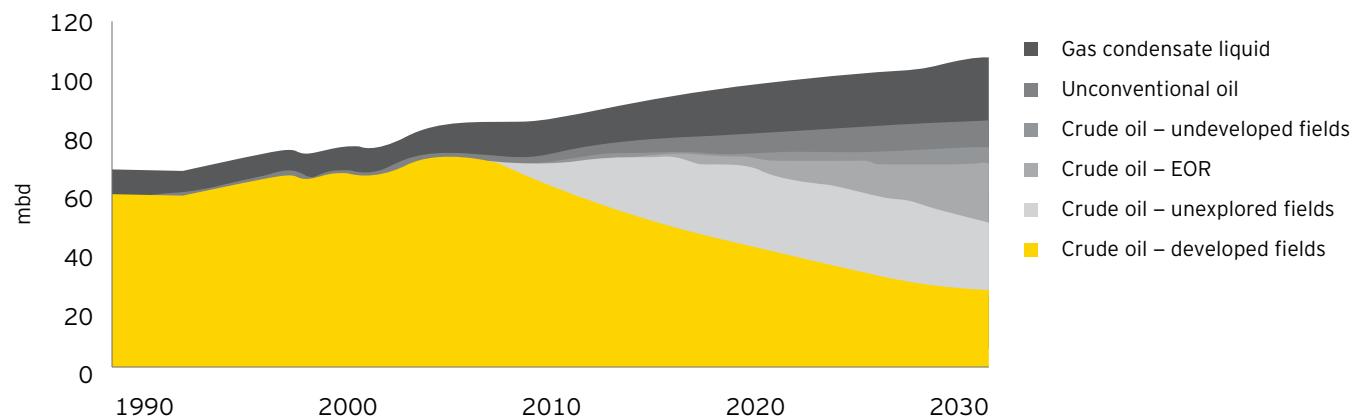
The US made use of Soviet know-how and successfully commercialized it.

The International Energy Agency estimates that about 3% to 3.5% of global oil output⁵ is unlocked by tertiary recovery projects (Figure 5).

Worldwide, EOR is estimated to produce 120 million to 130 million tons annually. In the US, such projects provide around 40 million tons,⁶ or approximately 30% of the global EOR oil. This is more than 10% of the US overall oil output.

According to forecasts by the International Energy Agency, projects involving up-to-date EOR methods will unlock over 300 million tons of oil annually by 2030. The US, Saudi Arabia, Kuwait and China will provide three-quarters of the said amount. The involvement of Russian companies is essential to foster the development of the national oil industry. Otherwise, Russia risks falling behind the rest of the world in embracing the new opportunities offered by innovative technologies.

Figure 5. Structure of global hydrocarbon production output, mbd



Source: International Energy Agency.

* Corporate data.

⁴ VNIINEft; *Oil and Gas Vertical*, May 2011.

⁵ World Energy Outlook, International Energy Agency.

⁶ "Oil Recovery Improvement Methods in Russia and Abroad: Experience and Prospects," *Burennye i Neft*, February 2011.

III. EOR's relevance and importance to Russian producers

As noted above, the age of "easy oil" is coming to an end. The share of hard-to-recover reserves in Russia's reserve balance is growing steadily (more than half with water cuts over 80%).

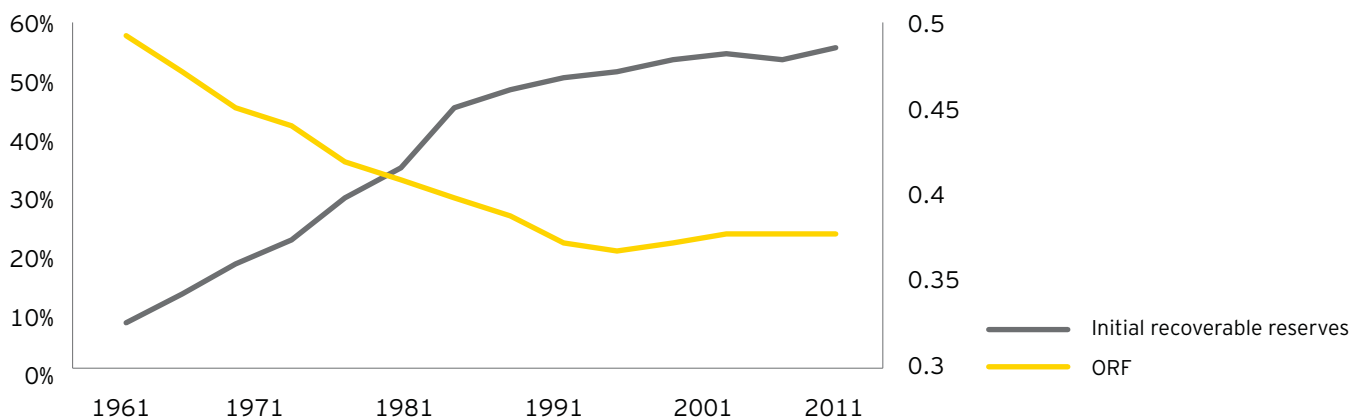
Russian ORF shows negative performance, ranging from 34% to 40% by different estimates (Figure 6). The Russian Energy Strategy to 2030 emphasizes that inefficient subsurface use, in particular low oil recovery factors, is one of the

major stumbling blocks impeding the development of the national oil sector. The document also lists challenges to pursue that include the improvement of oil extraction technologies and the implementation of modern EOR methods, which are required to stimulate ORF and achieve the strategic goals.

There is a subtle link between ORF performance and changes in the share of hard-to-recover reserves. Advances

in extraction technologies did not deliver the required efficiencies in further unlocking such reserves. ORF is an essential metric for reserves estimates – an increase of just 1% is equivalent to the discovery of new reservoirs in several midsize fields. For example, such an increase would add 42 million tons⁷ to the reserves of the Romashkinskoye field that is currently 80% depleted.

Figure 6. Share of Russia's hard-to-recover reserves vs. ORF



Source: "The use of enhanced oil recovery in Russia and abroad: experience and prospects," *Drilling and Oil*, <http://burneft.ru/archive/issues/2011-02/8>, February 2011.

According to the Russian Ministry of Energy, around 10.7 billion tons out of 22 billion tons of recoverable reserves⁸ are uneconomic to produce (Figure 8).

A significant number of Russia's producing fields, though constantly depleting, have stranded reserves that can be unlocked using cutting-edge EOR techniques.

The use of EORs in such fields seems most practical, provided that due consideration is given to technical and economic factors.

For example, deployment of tertiary recovery techniques in West Siberia, which accounts for over a half of Russia's oil output, is crucial. Recent developments in the region have not been encouraging, with daily production declining by 7% over the past seven years, from 2006 to 2012. West Siberia's contribution to the total

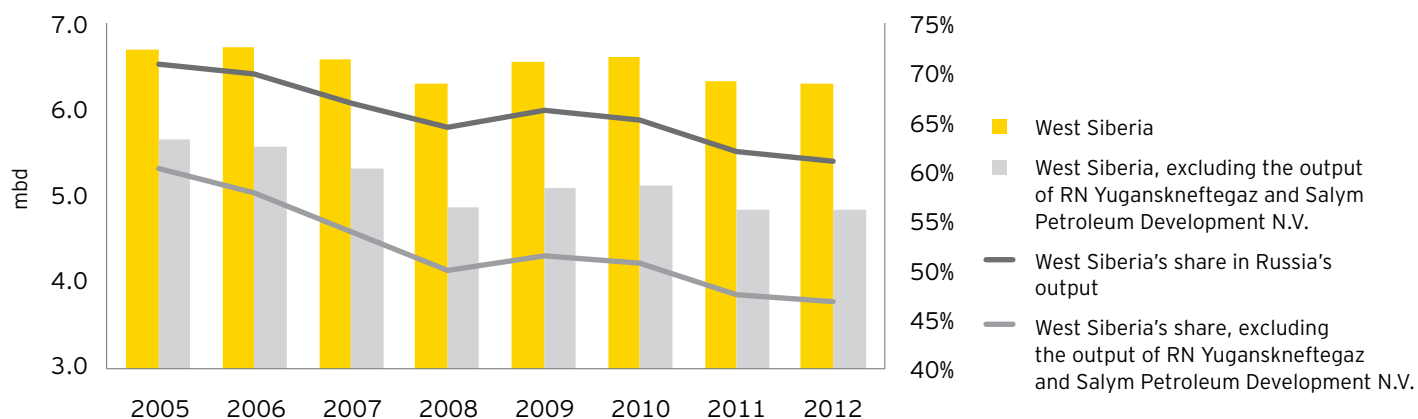
Russian output decreased from 70% to 61%. The share of mature fields (excluding major assets of Yuganskneftegaz and Salym Petroluem Development N.V.) that had been on track for steady growth before 2012 dropped from 58% to 47% over the above period (Figure 7).

⁷ Tatneft data.

⁸ Report on the General Plan for Oil Industry Development 2020, dated 28 October 2010.



Figure 7. West Siberia's daily production



Sources: Corporate data, estimates of Ernst & Young's Moscow Oil & Gas Center.

This downward trend can be reversed if modern EOR methods are introduced; otherwise, the objectives set in the General Plan for Oil Industry Development 2020, namely replacement of reserves and efficient use of mineral resources, may not be achieved.

Delays in EOR technology upgrades may substantially reduce budget revenues, which would otherwise be available, owing to:

- ▶ Multiplicative effects on allied industries such as machine building, chemical and microbial
- ▶ Developing local high technologies and services

- ▶ Increased production of "stranded" oil in mature regions
- ▶ Gains in recoverable reserves with no exploration costs

Tertiary EORs could add 2.7 billion to 4 billion tons of recoverable reserves, or 16% to 23%, to the CIS resource base, estimates by the International Energy Agency.⁹

⁹ World Energy Outlook, International Energy Agency.

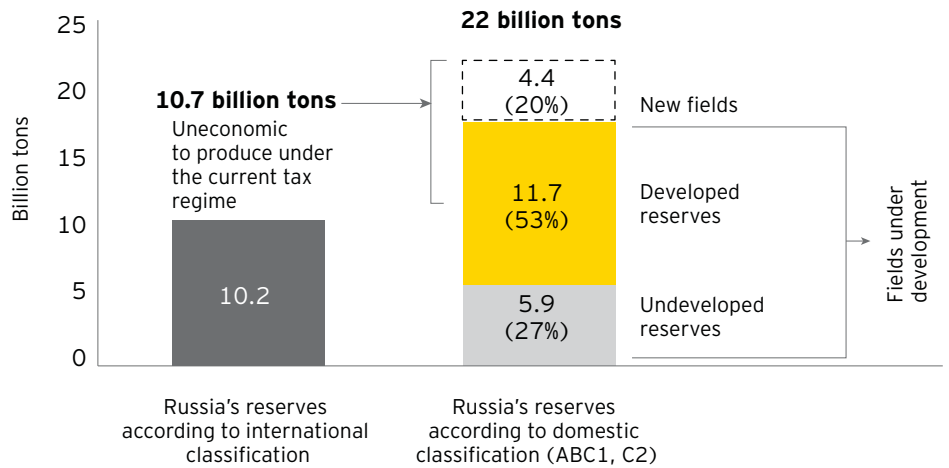
IV. EOR potential in Russia

According to the Russian Ministry of Energy, with the existing commercial reserves of 22 billion tons (ABC1, C2 by Russian classification), Russia can continue production at the current level for another 40 years. Note, however, that based on the international classification of reserves this figure is almost half, since account is taken only of those reserves that are economically extractable under the current tax regime.

Figure 8 shows that 80% of commercial reserves originate from developed fields with extended production infrastructure, while new fields account for only 20% of the total reserves. Major investments in exploration, development and new infrastructure will be required to start production from these new fields.

The Russian structure of reserves has seen the share of hard-to-recover reserves rise significantly over the past decade. Despite their growing share in total reserves (Figures 9 and 10), such hydrocarbons exhibit a slower production rate. From 2000 to 2011, the share of hard-to-recover oil reserves in Russia increased from 56% to 62%, while production grew only from 3% to 8%. This trend, resulting in shrinkage and deterioration of the resource base, is most evident in mature oil regions.

Figure 8. International vs. domestic classification of Russia's oil reserves



Source: General Plan for Oil Industry Development 2020.

Figure 9. Changes in the Russian structure of recoverable oil reserves

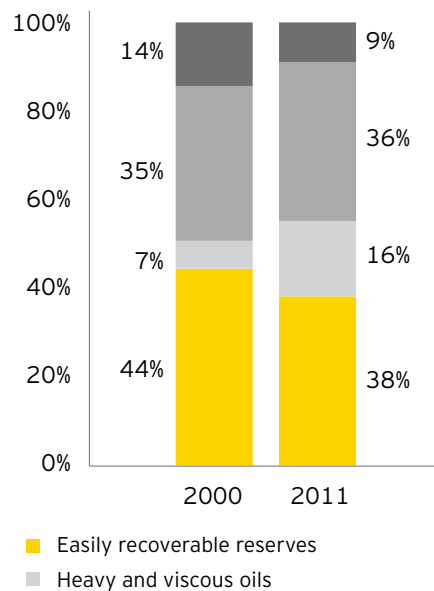
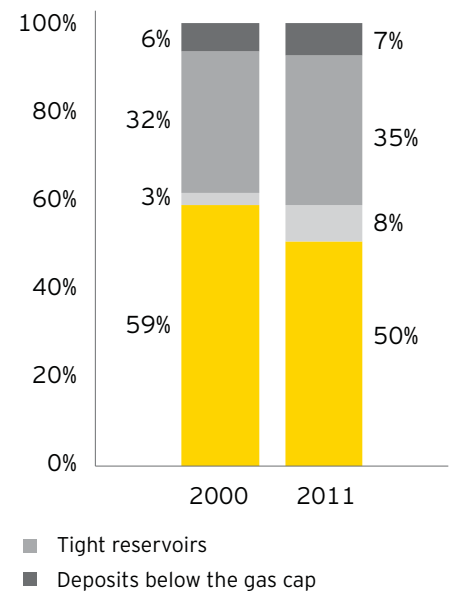


Figure 10. Changes in the Russian oil production structure



Source: Nefteservice analytical magazine, Issue 4 (20), winter 2012.

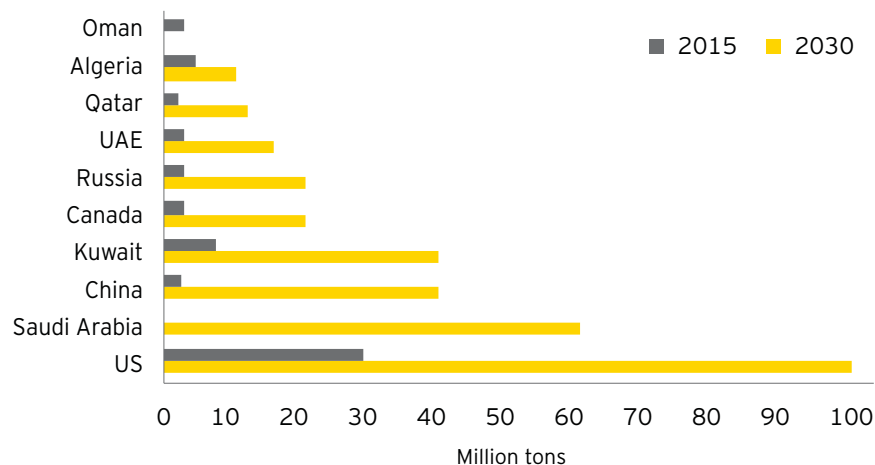


The calculations of the International Energy Agency given in Figure 11 indicate that Russia's EOR-based output will amount to some 3 million tons in 2015 and about 20 million tons in 2030,¹⁰ which is broadly in line with our estimates. However, creating an economically conducive environment for operators applying modern EOR techniques is vital for their effective deployment in Russia.

Russian companies with the largest proven reserves have developed them to a lower extent, compared with that of the world's major public oil and gas companies (Figure 12). The estimated life of liquid hydrocarbon reserves of selected domestic and international companies is some 19 and 12 years on average, respectively.

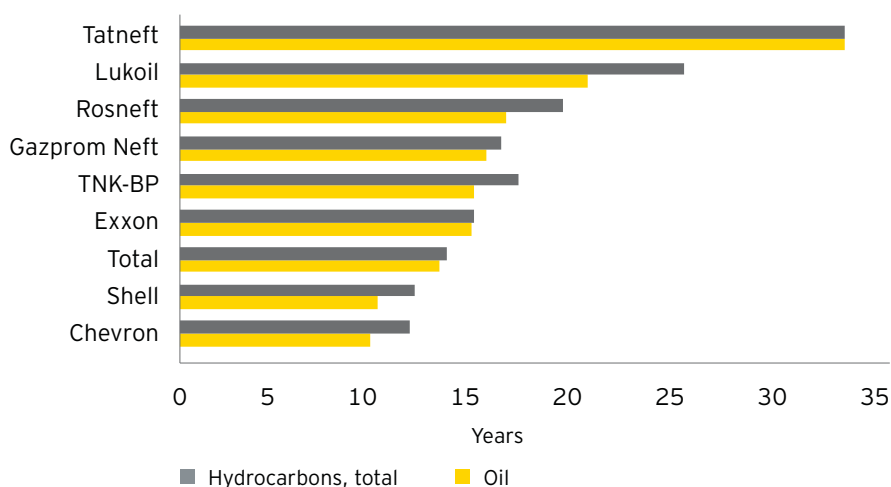
We believe that the use of modern enhanced oil recovery methods is a key to unlocking additional reserves. The optimization of the tax regime for conventional fields (discussed in the following section of this report) is important in this context.

Figure 11. Forecast of EOR-based oil production – Russia's rank among other countries



Source: International Energy Agency.

Figure 12. Reserves of major global and domestic oil and gas companies – estimated life in years



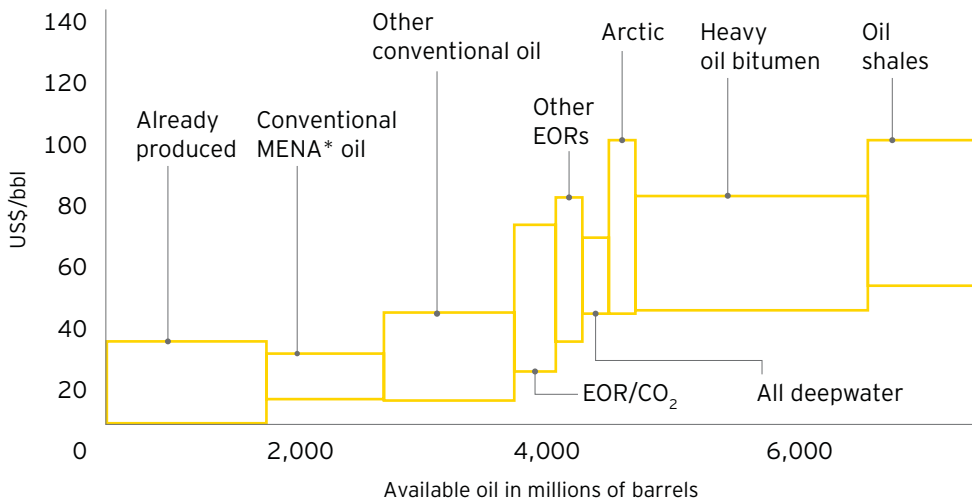
Sources: Corporate data, estimates of Ernst & Young's Moscow Oil & Gas Center.

¹⁰ International Energy Agency, World Energy Outlook.

V. Economics of EOR projects: tax burden as a driving factor

The application of EOR technologies globally has allowed some statistics on production costs in the upstream segment for different categories of projects to be gathered. According to the International Energy Agency,¹¹ these costs range from US\$20/bbl to US\$80/bbl (Figure 13).

Figure 13. Oil production costs



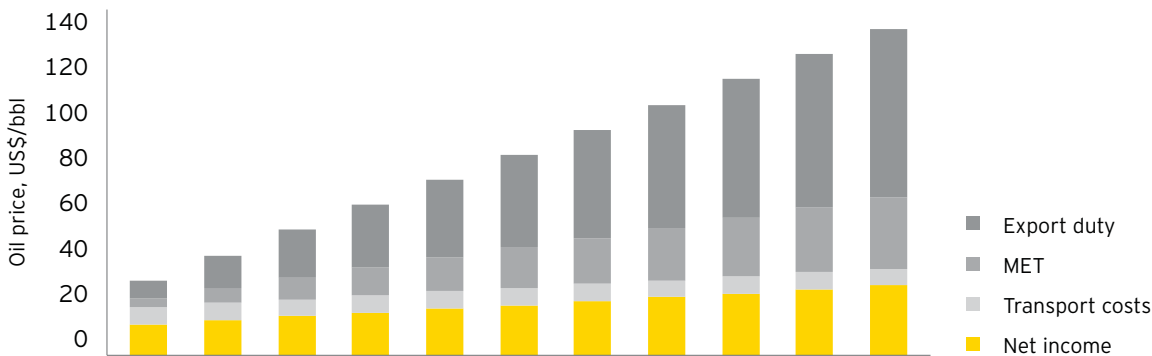
*MENA: Middle East and North Africa
Source: International Energy Agency.

The current Russian tax regime focuses primarily on high-producing fields where the mining rent accounts for a large share of the oil price. A high tax share

in revenues (around 60%) and growing transport tariffs that oil companies cannot control are the main barriers to effective cash flow management (Figure 14). Even

with the oil price at US\$110/bbl, the net income of Russian VIOCs operating in the upstream segment would be only at the lower side of the range estimated by IEA.

Figure 14. Net income structure in the Russian upstream segment



Source: Estimates of Ernst & Young's Moscow Oil & Gas Center.

¹¹ "Resources to Reserves," International Energy Agency, 2010.

The fiscal policy adopted by the government generally lacks flexibility, with no consideration given to objective factors such as growing production costs due to slower flow rates and higher water cut, which make the share of the mining rent in the oil price shrink drastically. The current tax incentives, including MET

and export duties, are rather narrow and targeted only at greenfield projects, except for some special circumstances. Not all incentives stimulate the use of modern EOR techniques in Russia. In our view, the introduction of preferential tax treatment for depleted fields, projects involving the production of heavy and extra heavy

oils and certain types of reserves that are hard to recover (not yet adopted), coupled with the reduction of export duties under the "60-66" tax regime, will encourage wider deployment of EOR.

Table 2. List of current and future tax benefits available to domestic oil producers (Urals price of US\$110/bbl)

Grounds for tax benefit	In effect from	Eligibility criteria	Tax benefit period, years	Reduction of tax burden, US\$/bbl*	Positive effect for EOR
Mineral Extraction Tax (MET)					
Mature fields	2007	Depletion over 80%	Unlimited	7-23	Yes
Heavy oil	2007	No production constraints	Unlimited	23	Yes
Oil extracted under PSA projects	2003	No production constraints	Unlimited	23	No
Yakutia, Irkutsk Region, Krasnoyarsk Territory	2009	Production up to 25 million tons**	10*	23	No
Continental shelf above the Arctic Circle	2009	Production up to 35 million tons**	10	23	No
Azov and Caspian Seas	2009	Production up to 10 million tons**	7	23	No
Yamal Peninsula, Yamal-Nenetsky Autonomous Region	2009	Production up to 15 million tons**	7	23	No
Black Sea	2012	Production up to 20 million tons**	10	23	No
Okhotsk Sea	2012	Production up to 30 million tons**	10	23	No
Regions north of 65°N (exclusive of the Yamal Peninsula)	2012	Production up to 25 million tons**	10	23	No
Reserve size (for projects depleted by less than 5%)	2005	Reserves less than 5 million tons	Unlimited	0.1-10	No
Government Decree No. 700-p of 3 May 2012	TBD	Reduced MET for hard-to-recover reserves	Unlimited	0.1-23	Yes
Government Decree No. 443P of 12 April 2012	TBD	Continental shelf, ad valorem tax rate from 5% to 30%	N/A	23	No



Grounds for tax benefit	In effect from	Eligibility criteria	Tax benefit period, years	Reduction of tax burden, US\$/bbl*	Positive effect for EOR
Mineral Extraction Tax (MET)					
Export duties					
60-66***	2011	Exported crude is taxed at 60%	Unlimited	4	Yes
Benefits for certain regions (West Siberia, Caspian Sea, Yamal)	2013	Yakutia, Irkutsk Region, Krasnoyarsk Territory, Nenets Autonomous District, Yamal, Caspian Sea, continental shelf	Until IRR reaches 16.3%	28	No
Heavy oil	2012	N/A	Unlimited	49.5	Yes
Regulation No. 443P of 12 April 2012	TBD	Continental shelf	N/A	55	No

* At the oil price of US\$110/bbl.

** Whichever is earlier.

*** 60 means 60% of crude export revenue levied in addition to US\$4/bbl where the oil price is above US\$25/bbl. Prior to the introduction of the new tax regime, this rate was 65%.

Source: Estimates of Ernst & Young's Moscow Oil & Gas Center.

The introduction of the "60-66" tax regime in October 2011 was the first step in encouraging greater investment in West Siberian brownfields. Suffice it to mention that the around US\$4/bbl gained by oil producers in the new tax environment is

equivalent to additional gains from the Brent price rising by of almost US\$25/bbl. The new system can extend the life of a midsize field by at least five years. However, the advantages of the new tax regime for oil producers (namely,

US\$4.4/bbl at the Urals price of US\$110/bbl) were largely negated by a higher MET. With the basic rate growing from RUB419 to RUB470 per ton, oil producers lose around US\$2.5/bbl at the oil price of US\$110/bbl.

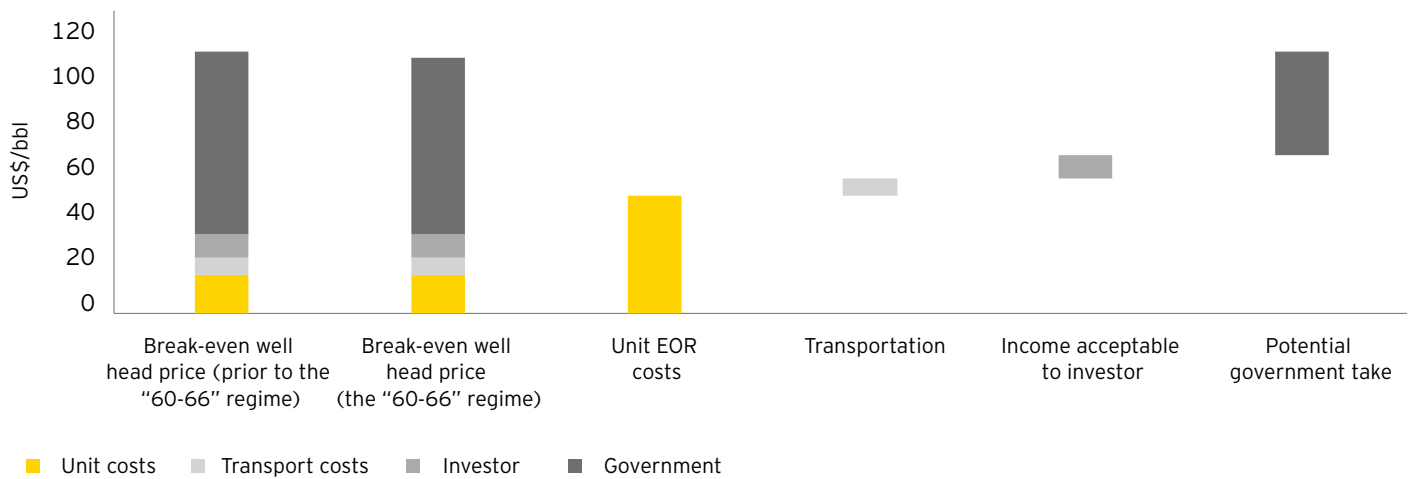


Despite the introduction of the “60-66” regime, the overall tax burden on the oil sector remains high. According to our estimates, oil producers now earn 18 cents on every dollar gained from the oil price rising above US\$25/bbl,

compared with 13 cents before the new regime was introduced. Depending on the sales structure, VIOCs with balanced operations may earn similar returns, benefiting from improved refining margins, higher sales and gas business.

The specific tax burden on the oil sector, particularly on upstream brownfield projects in West Siberia, is considerably higher than that borne by the world’s oil and gas majors. Taxation is therefore a barrier to investing in innovative EORs.

Figure 14. Price structure of a barrel of EOR oil



Source: Estimates of Ernst & Young’s Moscow Oil & Gas Center.

The expected EOR-based production costs are estimated at US\$50/bbl, compared with around US\$15/bbl for oil produced using conventional techniques. To guarantee an acceptable level of income for investors, the tax take should not exceed US\$45/bbl (about 80% of the export duty rate, or 0.48 against the current 0.60 used in the calculation formula) at the

oil price of US\$110/bbl and US\$25/bbl at the oil price of US\$90/bbl (based on the forward curve as it stands today, this price is essential to the assessment of EOR projects’ sensitivity). These levels of tax take will allow for large-scale deployment of EOR in Russia.

Note that the US, Canada, UK and other countries already benefit from a favorable

fiscal framework that guarantees an acceptable level of return on investment and promotes a wider use of EOR technologies. Russia may follow suit by introducing a windfall tax payable on net income. Why not try it on pilot projects where EOR methods are used?

VI. Other constraints to the EOR use in Russia

The measurement of additional production resulting from EOR programs is a challenging task. This is because such programs rely heavily on simulation techniques, and exact numbers required by tax authorities cannot be accurately calculated.

Given that the core principles of the Russian fiscal system will remain unchanged, with tax to be assessed on revenues, rather than on the financial results, an industry-specific methodology will be required to estimate extra output of EOR oil. Such methodology should be approved by the Federal Tax Service. Otherwise, a direct accounting for an additional output may require not only drilling more wells but allocating EOR products to individual transport streams, which may, in some cases, require construction of integrated oil processing facilities.

This will significantly increase EOR costs that currently stand at US\$50/bbl. It means that the government will either have to offer better tax benefits or include indirect accounting into the equation. What are the possible solutions? If the government feels strongly against any calculation methodologies that would allow for an accurate assessment of extra EOR-based output, introducing a windfall tax would be the perfect solution. Before such a tax is introduced, the government may agree with license holders that they

will maintain a specified production level (e.g., a few percent above the natural decline rate of the base production) and negotiate with them a number of mutual obligations (including tax preferences granted upon achieving the target levels of production). While this solution will obviously have to be thoroughly reviewed by lawyers, strategically it will enable the government to effectively manage Russia's oil production levels and control the amount of tax receipts generated by such projects.

Besides, there is the possibility of full windfall tax implementation for pilot projects.

The use of EOR is also hindered by cumbersome and time-consuming procedures involving the approval of a field development plan. More importantly, countries that stimulate development of unconventional hydrocarbon reserves and deployment of EOR tend to amend their national legislation to provide industry players with more flexibility and agility in managing their businesses. To reach the required return on investment, companies often have to revise the initial development plan as new geological data becomes available.

The longer the revision process and the waiting time to obtain permits, the stronger the impact on the project economics. While modifying development plans post factum is also possible, this creates more legal risks for license holders.

Human capital is another vital factor to the efficient deployment of EOR in Russia – innovative growth of the entire industry is impossible without a comprehensive approach to the training of technical and engineering staff. Moreover, it is crucial to realize that such projects will require innovative thinking and the revision of certain corporate governance practices. Critical decisions are not always well informed and are usually surrounded by multiple risks. EOR projects require a different approach, namely investing in accurate data to minimize risks when making the final investment decision.

VII. Most promising projects in Russia

Despite persisting challenges, many Russian VIOCs realize the importance of EOR for their long-term growth and are considering involvement in modern EOR projects to target the following:

- ▶ Tight light oil plays
- ▶ Heavy oil and natural oil bitumen

- ▶ Complex carbonate reservoirs
- ▶ Unconventional reserves of West Siberia (Bazhenov, Tyumen, Achimov and other formations), Volga-Ural province (Domanik formations) and the south of Russia (Khadum formations).

So far, EOR methods have seen limited deployment in Russia.

Information on EOR projects of domestic oil companies is summarized in Table 3.

Table 3. Pilot EOR projects in Russia

Operator	Field	Region	Narrative	EOR method
LUKOIL	Yareg	Timan-Pechora	Heavy oil and natural bitumen	▶ Thermal methods (two types)
LUKOIL	Usinsk (Permo-Carboniferous)	Timan-Pechora	Heavy oil and natural bitumen	▶ Compound (thermal and chemical)
LUKOIL	Tevlinsk-Russkinsk	West Siberia		▶ Multistage hydrofracturing
LUKOIL-RITEK	Sredne-Nazymkoye, Galyanovskoye	West Siberia	Unconventional reserves in the oil source rock of the Bazhenov formation	▶ Thermal and hydraulic methods
TNK-BP	Talinskoye	West Siberia	Tight light oil plays	▶ Gas methods
TNK-BP	Koshilskoye, North Khokhryakovskoye	West Siberia		▶ Multistage hydrofracturing
Surgutneftegaz	Aj-Pimskoye	West Siberia	Unconventional reserves of the Bazhenov formation	▶ Thermal and hydraulic methods
Gazprom Neft	Muravlenkovskoye	West Siberia	Depleted high-yield field (over 80%)	▶ Integrated
Gazprom Neft and Rosneft	Priobskoye	West Siberia	Tight light oil plays	▶ Gas methods ▶ Thermal and gas methods



Operator	Field	Region	Narrative	EOR method
Salym Petroleum Development N.V. (Gazprom Neft and Royal Dutch Shell)	West Salym, Upper Salym and Vadelyp	West Siberia		<ul style="list-style-type: none"> ▶ Chemical methods
Tatneft	Romashkinskoye	Volga-Ural	Depleted high-yield field (over 80%)	<ul style="list-style-type: none"> ▶ Chemical methods ▶ Gas methods
Tatneft	Alshalchinskoye	Volga-Ural	Heavy oil and natural bitumen	<ul style="list-style-type: none"> ▶ Thermal (steam and thermal gas methods)
Zarubezhneft	Visovoye	Timan-Pechora	Complex carbonate reservoirs	<ul style="list-style-type: none"> ▶ Thermal and gas methods

Source: Ernst & Young's Moscow Oil & Gas Center.

VIII. Conclusions

Given the high risks and significant capital investments involved, implementation of EOR projects in Russia is not economically justified under the existing tax regime, which tends to focus on gross production, rather than the profitability of the project. This keeps the tax burden growing regardless of the operating conditions of the site, affecting the investment capabilities of mineral rights holders and deterring them from participating in innovative projects such as EOR. In other words, the fiscal function is the dominant element of the Russian tax system, which serves to provide the government with a stable revenue stream and has no effective instruments to stimulate innovation in the oil sector. With the age of “easy oil” coming to an end, such an approach could be detrimental to the long-term future of the domestic oil sector.

According to estimates by Ernst & Young’s Moscow Oil & Gas Center, the deployment of EOR technologies on a commercial scale is not possible under the current tax regime. International experience offers proof, with EOR projects being implemented primarily in countries with a cost-sensitive tax system.

Since EOR projects are more of a venture whose success is contingent on many variables, management decisions cannot be predetermined and involve significant risk. It is therefore necessary to remove bureaucratic roadblocks hindering the development of the national oil and gas sector. To generate maximum added value for themselves and for the government, market players must be relieved of time-consuming efforts to obtain required approvals.

One of the ways to lay the groundwork for a commercial rollout of EOR technologies would be to set up joint operations under full government control and to compensate operators for the portion of capex/opex to be subtracted from tax payments in the amount commensurate with incremental production.

Alternatively, to avoid potential controversies around the calculation of EOR oil, the government may agree with the mineral rights holder on a certain target production level to be achieved and maintained for a specified period of time. The entire amount of incremental oil in excess of the established levels may be subject to preferential tax treatment.

There is an opportunity to transfer pilot projects to be based on windfall tax on net income.

Such a collaborative approach will help secure government buy-in and shape tax incentives for future EOR projects. However important the Arctic, East Siberia and other new provinces may be, the monetization of existing oil reserves, which cannot be achieved without EOR technologies, is key to the long-term sustainable development of the oil and gas sector and securing stable revenue streams for the government. Pilot projects with windfall tax implementations should be selected in mature regions where most domestic producers are present and where production is sliding into terminal decline. For example, the Volga-Ural region, which contributes 20% of Russia’s oil production, would be a good fit for a pilot project. Major domestic VIOCs operating in this region include Tatneft (26 million tons), TNK-BP (about 20 million tons), Rosneft (17 million tons), Bashneft (15 million tons), LUKOIL (15 million tons) and Gazprom Neft (1 million tons). Other companies produce around 20 million tons in this region.

Overall, there is a wide range of companies featuring various corporate cultures.

Transitioning from revenue-based to profits-based taxation of mining income (a windfall tax) would create long-term economic incentives and enable the full-scale deployment of advanced oil extraction technologies. We are confident that this will help Russia to bridge the technology gap and catch up with other oil-producing nations.



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