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THE FUTURE OF OIL PRODUCTION IN RUSSIA: LIFE UNDER SANCTIONS

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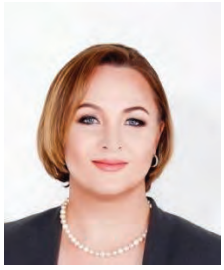
THE AUTHORS



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EXECUTIVE SUMMARY: "COMPOUND INTEREST RATE" EFFECT

The new sanctions imposed in the summer of 2017 in relation to the Russian oil industry combined with an objective decline in the quality of Russian reserves pose a question on the future of oil production in Russia and the reliability of budget revenues generated by the industry in the long term.

At the moment it is possible to say that the Russian oil companies have completely adapted to the new conditions and the sanction regime. Oil production in Russia has been growing in the past five years, despite relatively low price conditions and the sectoral sanctions introduced by the US and the EU in 2014. Huge past investments, numerous tax breaks, as well as Rouble devaluation allowed not only to avoid reduction in production, but also ensured its record growth. But future prospects of the Russian oil output are not that clear.

An analysis of all the sanctions imposed in 2014-2017 shows their high conditionality: vague wording became an important feature of these documents, creating a possibility for wide interpretation and application depending on the circumstances and the degree of political confrontation. Both a "Baseline" (keeping the status quo) and "Intensified sanctions" scenarios are possible within the framework of the sanctions already imposed. The latter will include tougher interpretation of the active sanctions and their application to specific projects, as well as the imposition of new ones.

An analysis of the companies and fields which assesses availability of technologies and investment, as well as modelling production have shown that in the period to 2020there is potential for further production growth. This can be done by using the greenfields which have already been prepared. However, this short-term potential can be limited by the agreements with OPEC.

In the mid-term period to 2025 oil production will not suffer greatly even given a tight ban on technologies and low oil prices. The difference between the "Baseline scenario" and the "Intensified sanctions" scenario in our analysis totals 30 million tonnes (5%). The main reason for decreasing production in this period is not so much limited access to western technologies at new projects but the absence of technological capacity to intensify production at the active fields.

In the long-term after 2025 maintaining level of oil production in Russia is becoming an increasingly difficult task, primarily due to the reserves quality reduction. In principle, oil production in Russia could be supported by:

- in-depth development of existing conventional oil fields using enhanced oil recovery methods (hydraulic fracturing, multistage hydraulic fracturing, tertiary enhanced oil recovery methods etc.)
- development of onshore non-conventional oil reserves;

- development of offshore deposits (including the Arctic shelf).

However, Russian companies lack their own (domestic) technologies and equipment for the development of unconventional and offshore oil reserves, and the imposed sanctions place a tight limit on access to foreign technologies. Import replacement measures aimed at tackling this issue were adopted back in 2014 but have yet to show any significant results.

Hydraulic fracturing equipment is the most critical technology for maintaining Russian oil production. It is capable of both maintaining output at the existing fields and ensuring output growth at prospective non-conventional oil deposits. In the current conditions it is the manufacturing of hydraulic fracturing fleets domestically and training of the personnel that have to become the technological priority for the oil companies and the regulators.

Sanctions have been widely used against many countries in the last few decades and operate with a cumulative effect everywhere, similar to “compound interest” principle. We estimate that by as early as 2030 the difference between the "Baseline scenario" and the "Intensified sanctions" scenario could reach 55 million tonnes of oil (10% of current production). This difference will continue to grow faster with time — the longer the period under analysis, the more technology will potentially lag behind and the stronger the financing deficit and the adverse impact of the sanctions (including falling budget revenues from the oil industry).

The deceptively small immediate impact of the sanctions can be misleading. Despite the absence of rapid negative consequences they, nevertheless, require active measures to support and develop domestic technologies in oil production. The investment cycle in this sphere takes a minimum of 5-7 years, and to prevent a sharp fall in production after 2025, it is necessary to invest in the most important technologies today.

SANCTIONS AGAINST RUSSIA AFFECTING THE OIL INDUSTRY

In July 2014, the United States and the European Union introduced sectoral sanctions for the first time. These affected the financial and the energy sectors, as well as the supply of technologies and equipment for oil production in the Arctic offshore, deepwater and shale projects.

Soon, in September 2014, the second stage of the sanctions was initiated. It extended not only to the supply of equipment, but also to the provision of services, information exchange with Russian partners and the involvement of Western companies in the most technologically advanced oil projects .

US sectoral sanctions imposed in 2014

The first US sanctions were introduced by Executive Order No. 13666 [1] signed by Barack Obama in March 2014. Later, in addition to this order, on July 16, 2014, two directives were issued restricting access of Russian companies to financial markets, as well as of persons holding over 50% of shares in these companies. These restrictions are governed by Directive 1 for the financial sector and Directive 2 for the energy sector [2] adopted by the Office for the Control of Foreign Assets (OFAC) on July 16, 2014. Subsequently, on September 12, 2014, a new version of Directives 1 and 2 was issued, as well as two new Directives numbered 3 and 4.

- Directive 1 prohibits participation in debt and equity capital transactions of longer than 30 days maturity for individuals and companies listed in the sectoral sanctions identification list [3].

- Directive 2 prohibits participation in debt and share capital operations of longer than 90 days maturity [4] for individuals and companies listed in the sectoral sanctions identification list [5]. This US directive significantly restricted access to the US capital market for such companies as PJSC NK Rosneft, PJSC Novatek, PJSC Transneft and PJSC Gazprom Neft, as well as their subsidiaries. This measure did not apply to PJSC "LUKOIL" and OJSC "Surgutneftegas". Nevertheless, these two largest private oil and gas companies in Russia also faced the problem of worsening terms for attracting financial capital.

- Directive 3 is focused on the defence industry and is therefore not reviewed in this study.

- Directive 4 is more specific and focuses on the technological aspects of the production sector of the oil industry. It prohibits the provision, exportation, or re-exportation, directly or indirectly, of goods, services (except for financial services), or technology in support of exploration or production for deep water, Arctic offshore, or shale projects that have the potential to produce oil in the Russian Federation, or in maritime area claimed by the Russian Federation and extending from its territory, as well as shale projects developed by the largest Russian oil and gas companies [6]. These companies include PJSC Gazprom, PJSC LUKOIL, OJSC Surgutneftegas and their subsidiaries. Other companies were not included in this list.

In addition to the Directives, technological sanctions are governed by the Bureau of Industry and Security and are stipulated in the Export

Administration Act of 1979, section 746.5. These included “Russian Sectoral Sanctions” [7]. They cover export, re-export or transfer of goods which can be used directly or indirectly in exploration for, or production of, oil or gas in Russian deep-water (greater than 152 metres) or Arctic offshore locations or shale formations in Russia. They also apply when it is impossible to determine whether the goods (items) will be used in such projects. BIS also introduced a possible ban on granting licences for export, re-export or transfer of the goods (items) listed in Attachment 2, section 746 of the Export Administration Act [8]. The items subject to the ban include drilling rigs, parts for horizontal drilling, drilling and completion equipment, subsea processing equipment, Arctic-capable marine equipment, wireline and down hole motors and equipment, drill pipe and casing, software for hydraulic fracturing, high pressure pumps, seismic acquisition equipment, remotely operated vehicles, compressors, expanders, valves, and risers.

EU sectoral sanctions imposed in 2014

Similar to the US, EU introduced limitations on financial deals with certain Russian legal entities operating in the oil, financial and defence sectors. Although these limitations are not an absolute ban on the relations with these subjects, they impose significant restrictions on operations with transferable securities and money-market instruments. Transferable securities include company shares, other securities equivalent to shares in companies, partnerships or other entities, and depositary receipts in respect of shares, bonds or other forms of securitised debt, including depositary receipts in respect of such securities and any other securities giving the right to acquire or sell any such transferable securities.

Money-market instruments include treasury bills, certificates of deposit and commercial papers.

The first limitations aimed at financial institutions were introduced by the following regulations.

- Council regulation (EU) No 833/2014 [9], adopted in July 2014. It introduced a ban on deals with transferable securities and money-market instruments with a maturity exceeding 90 days.

- Council regulation (EU) No 960/2014 [10], adopted in September 2014 — maturity period was reduced to 30 days. This regulation also introduced a ban on offering new loans or credit with a maturity exceeding 30 days to any legal person, entity or body subject to the restrictions.

As a result, Russia’s largest oil and gas companies were substantially limited in attracting long term financing simultaneously in the two most developed world financial markets — the US and the EU. Moreover, top rating agencies Standard & Poor`s, Moody`s and Fitch lowered the credit ratings of the Russian oil and gas companies as an indirect result of the sanctions. This led to higher costs of borrowing in the Asian

markets, which are also guided by these ratings. In general, this measure means an increase in the cost of capital for the Russian oil sector. Moreover, problems could potentially arise even with the usual trading operations.

The EU sanctions affecting oil production technologies are largely similar to those imposed by the US and include a similar list of equipment or technologies that were banned for export or sale from the date of publication of the Council Regulation (EU) No 833/2014 [12] of July 31, 2014. The ban applies to the supply of equipment and technologies for deep water oil exploration and production, Arctic oil exploration and production and shale oil projects in Russia. These limitations apply to any equipment regardless of whether or not it was manufactured in the EU and whether it was supplied to a person or a legal entity. A prior authorization is required for the sale, supply, transfer or export, directly or indirectly, of this equipment (technology) and it may not be granted if the authority has reasonable grounds to believe that it will be supplied for use the above mentioned projects. Limitations also apply in the case of providing technical help, intermediary services or financing / financial assistance in respect of these technologies.

Later, on 8 September 2014, these regulations were extended. Council regulation (EU) No 960/2014 [12] introduced a full ban on the provision of services, including drilling, well testing, as well as the supply of specialized floating vessels for the above mentioned projects in Russia, without a possibility of submitting an application for a preliminary permission.

However, these restrictions affect only the contracts concluded after 12 September, 2014. In this edition, the restrictive measures of the EU turned out to be more lenient than the American ones: the ban on the supply of technological equipment only concerned the following companies: PJSC NK Rosneft, PJSC Gazprom Neft and PJSC Transneft. The EU, unlike the United States, completely shielded the Russian gas companies — PJSC Gazprom and PJSC Novatek — from the sanctions.

The last edition of the regulations was adopted on 4 December of 2014. Council regulation (EU) No 1290/2014 [13] establishes limitations for oil exploration and production projects, including those on the continental shelf or in the special economic zone of Russia, in the case of:

- oil exploration and production in waters deeper than 150 metres;
- oil exploration and production in the offshore area north of the Arctic Circle; or;
- projects that have the potential to produce oil from resources located in shale formations by way of hydraulic fracturing; it does not apply to exploration and production through shale formations to locate or extract oil from non-shale reservoirs.

US sanctions imposed in 2017

At the beginning of August 2017 US President Donald Trump signed the Countering America's Adversaries through Sanctions Act [14], which tightened the regime of restrictions on several countries, including Russia. Initially, this was a bill about imposing sanctions on Iran, but then Russia and North Korea were added to it. This act, in addition to sectoral sanctions, also includes sanctions for cyber threats to US elections and sanctions for the defense sector, as well as for human rights violations.

Very vague wording is an important feature of this document. In principle, it gives the US president the right to impose sanctions depending on the national interests of the United States. In general, the content of sectoral sanctions remains the same, but there are several serious amendments to Directives 2 and 4 of September 12, 2014:

- In the new edition of Directive 2, which came into effect on 28 November 2017 [15], there is a ban on the participation of US citizens in any transactions in all transactions in, provision of financing for, and other dealings in new debt of longer than 60 days maturity of persons specified in Directive 2. As such, Directive 2 reduced the date of maturity.

- Directive 4 of 12 September 2017 prohibits the provision, exportation, or re-exportation, by United States persons or persons within the United States, of goods, services (except for financial services), or technology in support (directly or indirectly) of exploration or production for new deep-water, Arctic offshore, or shale projects — 1) that have the potential to produce oil; and 2) that involve any person determined to be subject to the directive or the property or interests in property of such a person, who has a controlling interest or a substantial non- controlling ownership interest in such a project defined as not less than a 33 percent interest.

It should be noted that Directive 2 is subject to a rule which determines the share of participation of a person or company as 50%, while for Directive 4 participation in ownership interests was reduced to 33% by this Act. American oil companies were concerned by this very indicator, as it could limit their participation not only in Russian projects, but also in joint international projects in the future.

This Act also created opportunities for imposing additional sanctions on oil and gas export pipelines: “The president in coordination with allies of the United States, may impose five or more of the sanctions with respect to a person if the President determines that the person knowingly, on or after the date of the enactment of this Act, makes an investment described in subsection (b) or sells, leases, or provides to the Russian Federation, for the construction of Russian energy export pipelines, goods, services, technology, information, or support described in subsection (c)--(1) any of which has a fair market value of $1,000,000 or more; or (2) that, during a 12-month period, have an aggregate fair market value of $5,000,000 or more [16].

The EU, and Germany in particular, objected to this provision, as the United States and Europe had previously agreed that sanctions would

not target current oil supplies from Russia or the Russian gas sector (despite the US opposition to the Nord Stream 2 pipeline). Although these restrictions are primarily being discussed in relation to the construction of export pipelines, it should be noted that in theory they can apply to the servicing of all pipeline projects.

An analysis of all the sanctions imposed in 2014-2017 (Table 1) shows their high conditionality: vague wording became an important feature of these documents, creating a possibility for wide interpretation and application depending on the circumstances and the degree of political confrontation.

Technology of hydraulic fracturing is a vivid example of such a vague wording. Production of shale oil requires multistage hydraulic fracturing, which despite its similarity with the fracturing is a different technology. And in fact the technology of the hydraulic fracturing should not be subject to sanctions. However, in the US documents it is hydraulic fracturing (not just multistage hydraulic fracturing) that is sanctioned if applied for the shale oil production. It is noted also that transactions with such equipment are subject to control by regulators, and if the technology according to the regulator`s assessment can theoretically be used for the shale oil production, then the supply of such equipment must be prohibited. The EU wording is more accurate, they mention exactly the equipment for the shale oil extraction, but there is also a reservation that the final decision is made by the regulators.

Both a "Baseline" (keeping the status quo) and "Intensified sanctions" scenarios are possible within the framework of the existing sanctions. The latter will include tougher interpretation of the active sanctions and their application to specific projects, as well as the imposition of new ones. It is worth noting that even in the "Baseline scenario", we are considering the difficulties with access to hydraulic fracturing technology.

Table 1. US and EU sanctions in 2014-2017 affecting the Russian oil industry

	US 2014	EU 2014	US 2017
Financial sanctions	Provision of loans and share capital with a maturity over **90 days**	Provision of loans and share capital with a maturity over **30 days**	Provision of loans and share capital with a maturity over **60 days**
Subjects of financial subjects	• Rosneft • NOVATEK • Transneft • Gazprom Neft	• Rosneft • Transneft • Gazprom Neft • Subsidiaries with a controlling stake (over 50%)	• Rosneft • NOVATEK • Transneft • Gazprom Neft
Technological sanctions	Provision of equipment for oil exploration and production on the shelf, depth over 152 metres, in the Arctic and for shale projects • drilling rigs, parts for horizontal drilling, drilling and completion equipment, subsea processing equipment, Arctic-capable marine equipment, wireline and down hole motors and equipment, drill pipe and casing, software for hydraulic fracturing, high pressure pumps, seismic acquisition equipment, remotely operated vehicles, compressors, expanders, valves, and risers.	• Provision of equipment for oil exploration and production on the shelf, depth over 150 м, in the offshore area north of the Arctic circle and in case of production from resources located in shale formations by way of hydraulic fracturing; it does not apply to exploration and production through shale formations to locate or extract oil from non-shale reservoirs.	• Provision of goods or technologies to support oil exploration or development for new deep-water, Arctic shelf or shale projects which could produce oil. • Possible introduction of sanctions on the sale of equipment, technologies and services, as well as investment in export pipelines.
Subjects of technological sanctions	• Rosneft • LUKOIL • Gazprom • Surgutneftegaz • Subsidiaries with a controlling stake (over 50%) in Russia	• Rosneft • Gazprom Neft • Transneft • Physical persons or companies with a >50% share of participation in the financial institutions specified in the sanctions list	• Rosneft • LUKOIL • Gazprom • Surgutneftegaz • Subsidiaries with a controlling stake over 33% worldwide • Any person selling equipment, technology and services for pipeline projects for the amount over 1 million US Dollars at any one time or making an investment in the amount of 5 million US Dollars in the course of one year

Source: SKOLKOVO Energy Centre (SEneC)

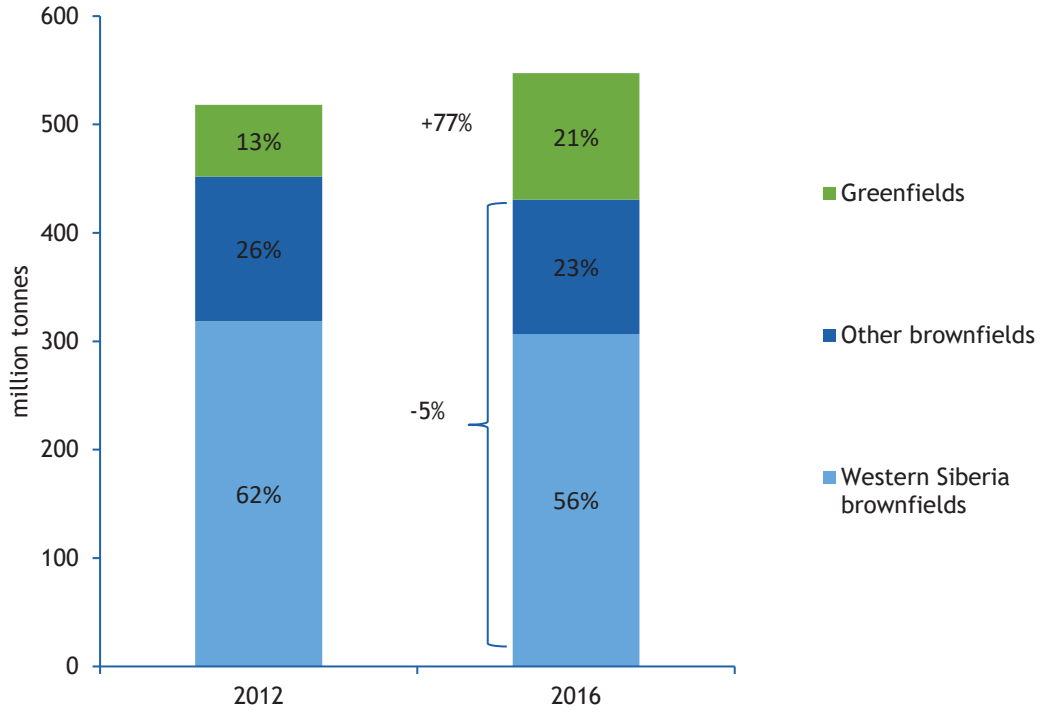
THE REACTION OF THE RUSSIAN OIL INDUSTRY TO THE SANCTIONS

Overall in 2014-2017 the Russian oil industry demonstrated high resilience to both the introduction of the sanctions regime and declining oil prices. Huge past investments, numerous tax breaks, as well as Rouble devaluation allowed not only to avoid reduction in production, but also ensured its record growth.

The reaction of the oil producing companies to the sanctions

Despite all unfavorable conditions, oil production in Russia grew by 6% — from 518 million tons to 548 million tons in five years (from 2012 to 2016) (Figure 1). At the same time, the entire increase was provided by bringing online new fields: production at these fields increased by 77% (50 million tonnes), which more than compensated for a 5% (20 million tonnes) drop in production at existing fields.

Figure 1. Oil production in Russia at the active and new fields



Source: The Ministry of Energy for the Russian Federation, SKOLKOVO Energy Centre

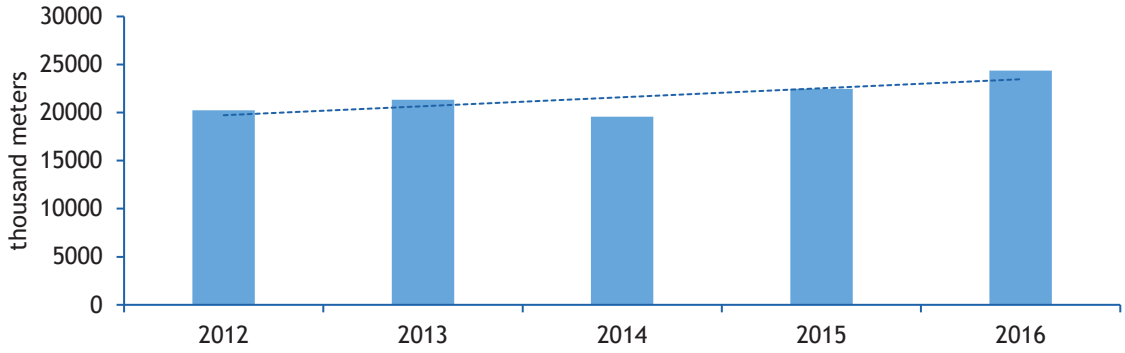
However, production dynamics at the largest active fields indicates that they have entered the phase of declining production (Table 2), and even a 22% increase in drilling penetration rate over the last five years (Figure 2) cannot compensate for this decline.

Table 2. Production decline dynamics at the 15 largest active fields in Russia

Million tonnes	2012	2013	2014	2015	2016	Average production decline per year	Overall production decline for 5 years
Priobskoye	37,5	38,1	37,2	36,0	36,0	-2%	-4%
Samotlor	23,5	22,0	21,8	21,0	20,0	-2%	-15%
Vankorskoye	18,3	21,4	21,0	22,0	21,7	0%	18%
Romashkinskoye	15,2	15,2	15,2	15,5	15,9	0%	4%
Malobalykskoye	11,6	11,6	11,3	9,5	9,0	-2%	-22%
Fedorovskoye	8,4	8,2	8,3	8,4	8,6	0%	2%
Krasnoleninskaya Group of Fields	7,9	7,5	7,3	7,2	7,1	-2%	-10%
Verkhnechonskoye	6,9	6,5	8,2	8,6	8,7	0%	26%
Tevlinsko-Russkinskoye	6,7	6,6	6,2	5,4	5,1	-2%	-24%
Talakanskoye	6,1	6,0	5,5	5,3	5,4	-2%	-13%
Vatyeganskoye	5,9	5,7	5,4	4,9	4,6	-2%	-22%
Povkhovskoye	5,9	5,7	5,4	5,0	4,7	-2%	-19%
Mamontovskoye	5,6	4,8	4,8	4,7	4,6	-2%	-17%
Labatyuganskoye Severnoye	5,3	5,6	5,9	6,1	5,8	0%	10%
Lyantorskoye	4,5	4,3	4,2	4,2	4,2	-2%	-7%
Others	307,9	303,8	301,1	298,4	296,7	-3%	-4%

Source: SKOLKOVO Energy Centre, company data

Figure 2. Drilling rate penetration in exploitation drilling



Source: the Ministry of Energy of the Russian Federation

The drop in production at existing fields is forcing producers to search for ways to replace output. In principle, the following might ensure that production is maintained at the current levels:

- development of new conventional deposits;

- in-depth development of existing conventional oil fields using oil production intensification methods;
- Development of offshore fields (including on the Arctic shelf);
- Development of non-conventional oil reserves.

Let us examine what each of these options looks like given the conditions of the sanctions.

Commissioning of conventional greenfields

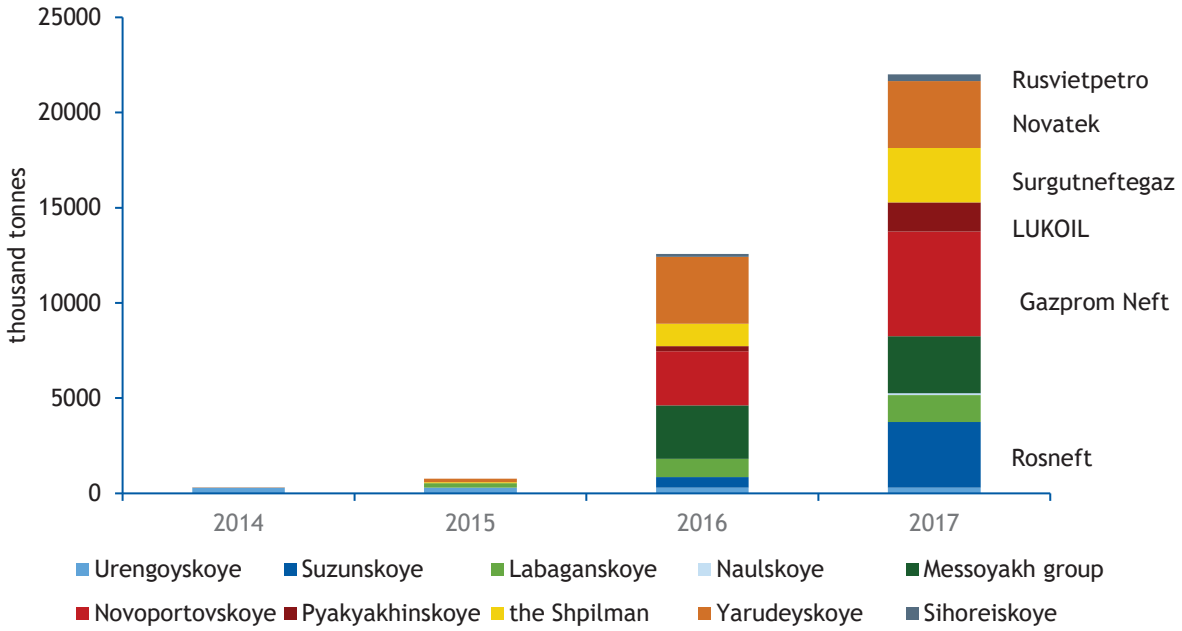
So far the oil companies have mainly focused on the most obvious option which does not require the technologies subject to the sanctions — bringing online conventional onshore oil fields. And this strategy has proved successful, providing an impressive increase in production.

Commissioning of over a dozen new deposits (including the Messoyakh group of deposits, Novoportovskoye, Pyakyakhinskoye, Suzunskoye, Yarudeyskoye and the Shpilman deposit –(Figure 3) in 2014-2017 was the result of investments that had been made during the period of high oil prices and the absence of sanctions prior to 2014. By 2017 all of these projects yielded additional output of over 25 million tonnes, with PJSC NK Rosneft and PJSC Gazprom Neft claiming two thirds of these volumes.

Several additional factors have substantially supported the economy of these projects, driving production growth:

- Rouble devaluation, which, given the prevalence of Rouble costs, significantly cut US Dollar production costs and, therefore increased the competitiveness of Russian oil in foreign markets;
- Peculiarities of the Russian tax system, which reduces budget revenues ahead of company revenues when prices fall;
- Numerous tax breaks adopted for new fields in 2013 (primarily in Eastern Siberia).

Figure 3. Conventional onshore projects commissioned in 2014-2017



Source: SKOLKOVO Energy Centre

Intensification of production at existing conventional oil fields

Despite their great potential, tertiary methods of enhanced oil recovery (EOR) have been little used in Russia in recent years for the following reasons:

- High cost of using EOR methods in Russia due to the absence of tax breaks;
- The tax system is focused primarily on the taxation of high-yield deposits. This category includes deposits that have entered the phase of falling production, for example, in Western Siberia. Most of the profits from these deposits are paid in taxes, and companies cannot direct the cash flow to invest in EOR methods;
- The system of targeted tax benefits in the industry is aimed at granting MET and export duty preferences solely to new projects.

The introduction of the sanctions coupled with falling oil prices has made this direction of development even less attractive for most of the Russian oil companies. Virtually no projects on EOR application have been implemented since 2014, with rare exceptions — see below:

- Salym Petroleum Development (SPD), a joint venture of PJSC Gazprom Neft and Shell, launched ASP mixing unit at the Salym group of fields (an innovative technology capable of significantly increasing oil recovery in the developed fields of Western Siberia [17]);
- JSC "Zarubezhneft" started using thermal gas treatment and injection of ion-modified water at the Vis field [18].

- JSC "RITEK" uses the methods of thermal gas treatment and water-alternated gas injection (currently used for low-permeability reservoirs) at its projects. The company also uses its own technologies to improve oil recovery in water-flooded fields.

- JSC LUKOIL successfully used multistage hydraulic fracturing technology at the Imilorsko-Istochnoye, Tevlinsko-Russkinskoye, Potochnoye and Severo-Pokachevskoye fields. The technology creates an artificial collector to increase reservoir recovery rate. Tests have allowed to increase debits at the wells by over 30% [19].

  However, these examples, unfortunately, are the exception rather than a serious industry trend.

Development of offshore projects

As of 2016, oil production on the Russian shelf totalled 22.3 million tonnes [20]. Almost half of this output is produced on the Sakhalin shelf. In future the main increase in production is to come from the Arctic shelf and the Caspian Sea aquatorium. A significant number of shelf projects were planned in cooperation with international oil companies or with the active application of foreign technologies.

Production on the Russian Arctic shelf is currently running only at the Prirazlomnoye field, which is operated by Gazprom Neft Shelf. Although Gazprom Neft Shelf did not attract foreign partners to develop this field, many foreign contractors and suppliers took part in the project. The following foreign service companies were employed in the drilling at the Prirazlomnoye field: Baker Hughes, Halliburton and Schlumberger. The development project also involved Aker Solutions, National Oilwell Varco, Cameron and FMC Technologies. Provisions for foreign participation were made for the stages of development of commercial projects and engineering. The drilling rig at the Prirazlomnaya platform was supplied and installed by Indrill International, an American company. Foreign contractors perform 50% of the total workload in servicing the systems operating at the Prirazlomnaya platform, as well as in the provision of services accompanying drilling [19].

The introduction of the sanctions seriously undermined the development of shelf projects, mainly the Arctic ones. Most of these projects were geared towards the involvement of foreign partners and were suspended under the pressure of sanctions (Table 3). The reason is simple — the absence of Russian technologies and equipment. However, this has not affected current production volumes, as most of these fields were to be commissioned after 2020.

The sanctions have most adversely affected future offshore projects of PJSC Rosneft, which had to cancel its joint project with ExxonMobil in the Kara Sea. This happened after the Universitetskaya-1 exploratory well had already been drilled.

Table 3. Joint shelf projects with foreign involvement which suffered from the sanctions

Project	Participants	Description	Current status
Universitetskaya-1 well (the Kara Sea) and the Tuapse deposit in the Black Sea	Joint venture PJSC Rosneft 51% и Exxon 49%	In 2011 Exxon and PJSC Rosneft formed an alliance to develop potentially vast but largely untapped resources on the Russian Arctic shelf and in the Black Sea. In September 2014, ExxonMobil and Rosneft made a major discovery of vast oil and natural gas reserves after the completion of drilling at the Kara Sea well. However, following the second round of sanctions imposed a few days before the opening, ExxonMobil suspended the project and withdrew from Russian joint ventures under the sanctions, writing off 1 billion US Dollars.	On hold
Projects: East Prinovozemelsky-1, 2, 3; North-Kara, Ust-Olenek, Ust-Lensk, Anisinsky-Novosibirsk, Severo-Wrangel-1, 2, 3; South Chukchi, Tuapsinsky Deflection	The joint venture between PJSC Rosneft" 67% and Exxon 33%	Exxon, in accordance with the sanction regulations, withdraws from the described projects	PJSC Rosneft said it will continue to develop projects independently
Two blocks in the Barents sea and in the Val Shatsky oil deposit in the Black Sea	Joint venture PJSC Rosneft 67% and ENI 33%	In 2012 Rosneft and ENI signed an agreement on the joint development of offshore fields in the Barents and the Black Seas	On hold

Source: Energy Centre SKOLKOVO Business School, based on company data

As part of this project, PJSC Rosneft also made an agreement with Norwegian North Atlantic Drilling Ltd. on drilling on the shelf, which specified long-term operation of six offshore drilling rigs in the period until 2022. A key arrangement was the long-term lease of the West Alpha platform. However, in November 2014, the Norwegian North Atlantic Drilling Limited announced that it was deferring its participation in the deal due to the sanctions.

The joint project of PJSC Rosneft and ExxonMobil on the development of the Tuapse Trough in the Black Sea suffered the same fate. Seismic exploration was carried out on this site and recoverable resources were assessed. But this project came under the sanctions as a deep-water one, and the work which ExxonMobil was to take part in, was suspended.

Perhaps the most striking example of the impact of the sanctions on medium-term production was observed in the case of the South Kirinsky deposit. It was specified in the sanctions list as a result of a special clarification by the US Treasury in the summer of 2015. This made it extremely difficult for Shell to take part in the project, and the launch of the deposit was deferred to 2023.

In general it is worth noting that in many cases the introduction of the sanctions led to substantial losses for the western companies and created serious impediments to their plans to expand cooperation with Russia.

For example, Exxon suffered losses of over 1 billion US Dollars in 2015 [22]. Moreover, positions of the European and American majors in Russia might be seriously challenged by the other market participants: in the past year there have been more active negotiations with partners from Asia, the Middle East and Latin America, although they do not have such unique technologies as majors, but, nevertheless, they can replace them in many cases.

In February 2015, PJSC Rosneft submitted a list of licensed areas located on the shelf to the State Agency for Subsoil Use, with a request to postpone their development for 1.5-2 years. In particular, this list includes 12 projects in the Okhotsk, Barents, Pechora and the East Siberian Seas. PJSC Rosneft asked for a delay as foreign involvement in the joint projects had been suspended.

It is clear that the imposition of sanctions on the supply of equipment and the construction of offshore platforms for offshore development could become a very serious constraint on this segment of oil production. In the long term, having established cooperation with Asian companies which are some of the world's leaders in the construction of offshore platforms, Russia can gain the necessary experience to independently build the top part of the platform and system integration of equipment into a single complex (offshore platform). Project Technologies and several other Russian companies are currently actively working on this issue. With a focused effort, Russia can solve this problem and start independently building offshore drilling platforms in about 7-10 years' time.

It is also worth noting some significant progress in the shipbuilding industry. Tthe project of the Zvezda shipbuilding complex in the Far East is the most noteworthy. The project includes the construction of ice class tankers jointly with Dutch Damen, the construction of drilling platforms jointly with Singaporean Keppel, and drilling equipment with American GE [23].

Bazhenov shale oil production

With the introduction of sanctions, the Russian companies have also started having difficulties with the implementation of joint projects to develop shale oil. Due to the sanctions, nearly all projects were suspended, except for the Salym project, which Gazprom Neft and Shell had been working on via Salym Petroleum Development joint venture since 2003 (Table 4). However, similarly to offshore projects, this did not affect the current levels of Russian production: in any case, significant output at these fields was only expected after 2020-2025.

Analysis of the oil companies' activities shows that, despite all the problems, PJSC Surgutneftegaz, PJSC LUKOIL, PJSC Rosneft, PJSC Gazprom Neft and PJSC Russneft are taking a number of steps to mitigate this situation and ensure future production growth by developing oil shale projects. As of 2017, accrued oil output at the Bazhenov Suite totalled over 10 million tonnes [24].

Table 4. Joint non-conventional oil projects, involving foreign companies, which suffered from the sanctions

Project	Participants	Deferred	Current status
Bazhenov and Achimov Formation in Western Siberia	JV Trizneft Pilot SARL between PJSC Rosneft 51% and ExxonMobil 49%	PJSC Rosneft and ExxonMobil signed an agreement on pilot development. They planned to do joint work to assess potential commercial production of hard to reach oil resources of the Bazhenov and Achimov Formation in Western Siberia. ExxonMobil was to invest 300 million US Dollars in the project.	Deferred
Development of Domanic deposits in the Orenburg region	JV between PJSC Rosneft 51% and BP 49%	It was planned that BP would cover Rosneft's past costs associated with work at the Domanic deposits, as well as provide carry financing of up to $300 млн. Pilot programme was to take place in 2 phases.	Deferred
Development of the Bazhenov shale oil formation in the Khanty-Mansiysk region	JV between PJSC LUKOIL and Total	The companies were planning joint exploration at three shale oil formations in the Khanty-Mansiysk Region – East Kovenskoye, Tashinskoye and Lyaminskoye in the Khanty-Mansiysk Region, with estimated costs of 120-150 million US Dollars.	Total transferred its stake in the project to PJSC LUKOIL
Development of the Bazhenov formation in the Khanty-Mansiysk region	JV «Khanty – Mansiysk Oil and Gas Union between Shell 50% and PJSC Gazprom Neft 50%	The JV received the licence for geological exploration of the Yuilsky04, Yuilsky-5 and Yuzhno-Lungorsky-1 in the Khanty-Mansiysk Autonomous Region.	Shell stopped work on the project

Source: SKOLKOVO Energy Centre (SEneC), based on company data

Oil production at the Bazhenov suite was started by PJSC "Surgutneftegas" in 2005. More than 1000 prospecting and exploration wells have been drilled at this formation. The company is operating 10 fields in the Khanty-Mansyisk region and their number is expected to increase to 13 by 2018 [25].

JSC Ritek, a subsidiary company of PJSC Lukoil, is also testing the development of shale oil deposits. The company uses the method of thermal gas injection, a controlled process of injecting air and water into the reservoir, as a mainstream technology in the development of the Bazhenov deposits.

PJSC Rosneft and Statoil (Norway) are preparing for the development of the oil deposits in the Samara region, despite the US sanctions. According to Reuters, these reserves were attributed to limestone instead of shale, development of which is not subject to the US ban [26].

PJSC Gazprom Neft is actively working to reduce dependence on foreign technologies. It plans to create Russian technologies for the construction of horizontal wells with multistage fracturing technologies (MGRP) optimized for mining and geological conditions of the Bazhenov suite, as

well as methods of including light oil reserves from the rocks of the shale formation in the development, thanks to thermochemical methods. [27]. All this is done within the framework of the national project to study the Bazhenov formations. The company will conduct R&D work at the Palyanovsky site as part of this project in the period to 2021 will and commercially implement and replicate the technologies in the domestic and external markets (2022-2025).

R&D work is currently taking place in the area of creating and developing hydraulic fracturing technologies. For example, there is a consortium led by the Ministry of Energy and the Ministry of Trade which involves various companies – primarily PJSC Gazprom Neft, the Moscow Institute of Physics and Technology and Skoltech to create a Russian simulator of hydraulic fracturing equipment – Cyber hydraulic fracturing equipment. If all of the created technologies are successfully implemented, targeted output at the Bazhenov deposits could reach around 2.5 million tonnes per year by 2025 [28], and a total of 7.5 million tonnes of oil ouput is projected in 2017-2027 [27]. This is according to the strategy of resource base development for non-conventional sources of hydrocarbons, approved by PJSC Gazprom Neft.

PJSC "RussNeft" continues testing the Bazhen deposits and in 2017 it demonstrated a unique result, having generated a debit of 100 tonnes per day at the Sredne-Shapshinskoye field. The company has developed an innovative technology — "hybrid" hydraulic fracturing using slickwater technology. The result of geological and technical work was a significant increase in the company's resource base — of over 50 million tonnes of crude oil (reserves are classified as non-conventional and lie at a depth of up to 3,000 metres) [29]. In the current year, RussNeft plans to drill 16 new wells at three sites [30].

However, in general, it can be said that, despite all these efforts, restrictions on the supply hydraulic fracturing equipment can significantly complicate the development of fields with falling production in Western Siberia and become a serious problem in the development of shale oil projects. Shlumberger, Halliburton, Baker Hughes are the world leaders in manufacturing this equipment. Russia manufactures its own equipment for hydraulic fracturing, but as of today it cannot compete with foreign models. As of 2013, only 5 fracturing operations out of 9000 were made using domestic equipment across the country. Moreover, since the introduction of the first sanctions in 2014, the situation with the Russian hydraulic fracturing equipment has not changed. Russia counts around 80 hydraulic fracturing fleets, with just 3% of these domestically manufactured. That is, not a single hydraulic fracturing fleet has been manufactured in the 3 years since the introduction of the sanctions. The existing fleet is growing outdated and requires replacement. Oil production using fracturing methods accounts for approximately 10% [31] of total production, which means that in 2016, 50-55 million tonnes out of almost 550 million tonnes of oil was extracted directly via hydraulic fracturing.

If the development of oil shale projects, for example Bazhen, is a matter of medium and long-term prospects and therefore less critical, an increase in production costs at the fields with declining production in Western Siberia can lead to serious problems for the oil companies today.

The impact of the sanctions on the globalisation of Russian companies

In the period to 2017, a number of Russian oil companies announced their intentions to expand and globalise their businesses. However, the sanctions have created too many obstacles for these plans, and now the oil companies are focusing more on improving efficiency and the development of their key assets in Russia than on the attempted international expansion.

- Global development has always been an important part of PJSC LUKOIL's strategy. Nowadays this company leads in the number of assets abroad among Russian oil companies. Companies within the LUKOIL Group operate in 35 countries on 4 continents. However, production abroad accounts for just 13% [32] of the company's total production and it is not clear whether the company will be able to implement its foreign expansion plans.

- In accordance with its development strategy in 2017, JSC Zarubezhneft should enter the stage of "new growth", which implies significant expansion of the company's activities in entering new projects in Russia and abroad. The company is considering projects in the Near East, Iran in particular. JSC Zarubezhneft and National Iranian Oil Company plan to jointly develop the Aban and West Paydar fields in Iran and aim to sign the contract in the first quarter of 2018. [33]. It is not clear if the company will succeed to enter the other markets (not only sanctioned Iran).

- PJSC NK Rosneft is participating in international mining projects: a Canadian project to extract hard-to-recover oil and a project in Vietnam [34], as well as the company's 4 oil production projects in Venezuela. The company is also taking part in projects in Kurdistan, the Zohr project in Egypt, in Norway and is planning work in Iran. However these are either in the stage of geological exploration or are just being planned.

The sanctions imposed on the active projects of the Russian companies abroad should not seriously affect their current performance, since their presence in this segment is not so great. However, further long-term development prospects can be seriously limited.

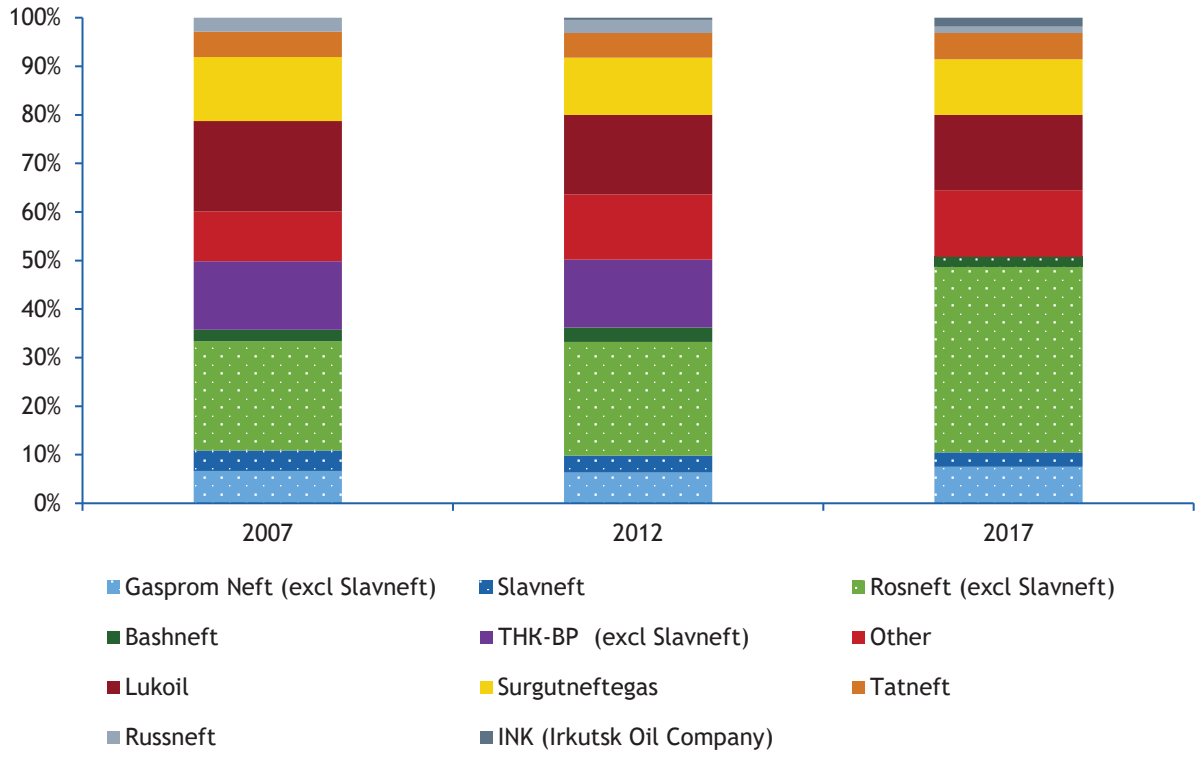
In addition to upstream, there are other overseas business segments: refining, gas stations, trading — these will also experience problems with further development and expansion in the long term because of the financial constraints and short credit leveraging.

Changes in the institutional structure of the oil industry under the impact of the sanctions

An important change in the Russian oil industry in recent years has been its growing concentration [35]. It is difficult to say how much this process is the result of the sanctions and price reductions (not always post hoc ergo propter hoc). However, we can suppose that the concentration and increase in the role of state-owned companies, at least partially supported by the state (or, at least, not being opposed to) is a kind of response to extremely unfavorable external circumstances.

As of 2017, the structure of oil production in Russia is characterized by the predominance of state-owned companies, with 38% of production attributable to PJSC NK Rosneft (Figure 4). According to the estimates by SKOLKOVO Energy Center, the share of companies with over 50% of state participation in the Russian oil production reached 48% after the return of PJSC Bashneft to state ownership (compared to 33% in 2012).

Figure 4. Oil production structure by company (shading denotes that the state has a controlling stake)

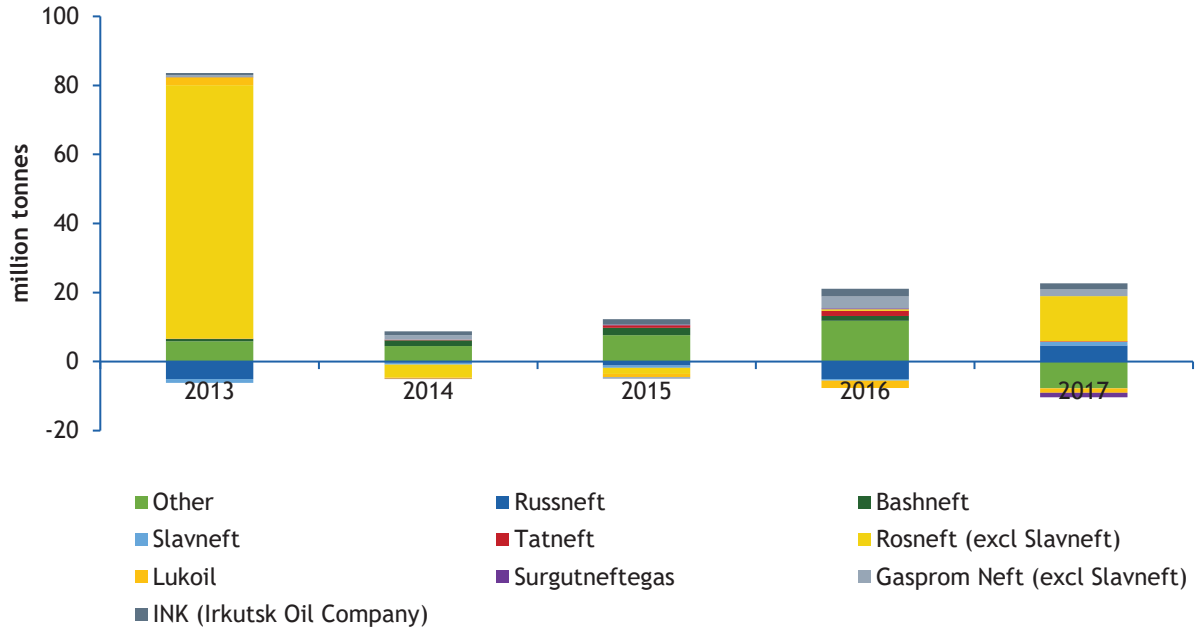


Source: SKOLKOVO Energy Centre, based on CDU TEK data

At the same time, paradoxically, an analysis of oil production by the top companies shows that in 2013-2017 many of them had a falling output (Figure 5), for example, PJSC RussNeft, PJSC Slavneft, PJSC LUKOIL. The largest increase in production among the largest Russian companies was shown by PJSC Gazprom Neft — 5 million tonnes in 2012-2017.

PJSC Rosneft increased its production in 2013 as a result of TNK-BP acquisition but it started declining after this purchase and only stabilised in 2016. The main growth in production came from mature deposits in Western Siberia. The company successfully managed to hold back natural decline in production by increasing production drilling. In addition, work is taking place at these fields to exptend geological and technical measures.

Figure 5. Change in oil production by the top companies in Russia (Y-O-Y)



Source: SKOLKOVO Energy Centre, based on CDU TEK data

RN-Yuganskneftegaz showed a positive trend in production, annual production of liquid hydrocarbons increased by 2%, to 63.7 million tonnes. There has also been positive production dynamics at the Uvat group of deposits and in the Timan-Pechora oil and gas province. In addition, in 2016, production facilities were commissioned at the East Messoyakhskoye field, and complex technological testing of oil production, preparation and transportation facilities were made at the Suzunskoye field.

At the end of 2016, Rosneft implemented a project for early delivery of oil from the Yurubcheno-Tokhomskoye field to fill the Kuyumba-Taishet main oil pipeline. Commissioning of new fields and intensification of production in 2017 all had a positive impact on Rosneft's performance. However, suh significant growth was still a consequence of the acquisition of a new asset — PJSC Bashneft. At the same time, in the first 10 months of 2017, Rosneft's output, including output by PJSC Bashneft, decreased by 0.3% year-on-year.

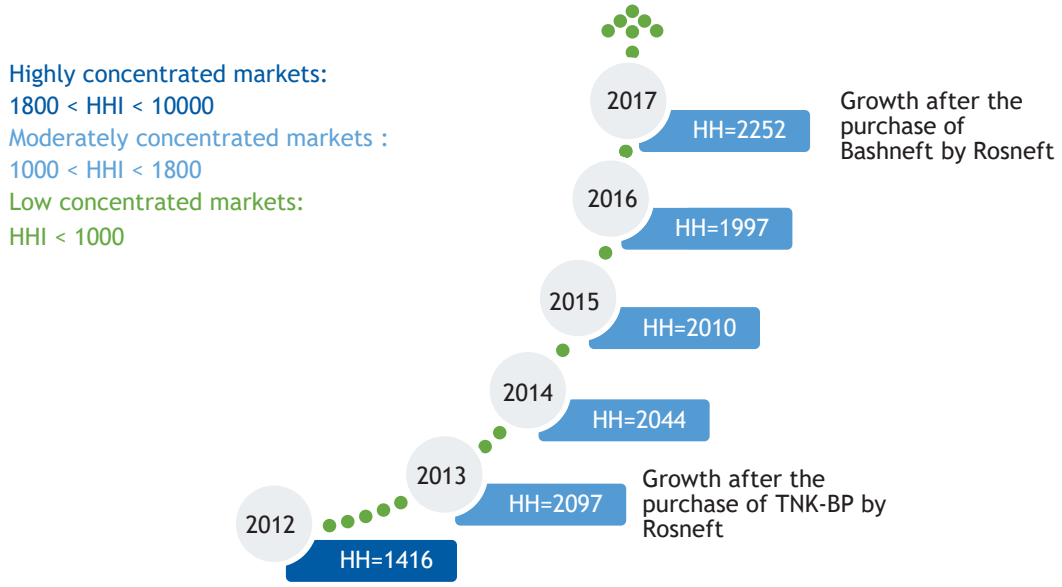
Most of the increase in production in 2013-2017 was shown by the "Other" oil companies. Thus, in 2017 recorded a 35 million tonnes increase in oil output compared to 2012. At the same time, their share in overall Russian oil output went up from 14% to 17%. At the same time, according to "Assoneft" production level of independent oil companies (IOC) for the period 2015-2017 has grown by only 3 million tons. It is worth noting the importance of a more intensive expansion of the IOC's niche where they are most effective. For the following reasons:

- Large VIOCs are, as a rule, more interested in implementing large-scale, highly profitable projects, while smaller and less profitable projects are not considered. This forms the potential for expanding the work of independent oil companies;

- A high rate of depletion at large oil fields and the onset of a phase of falling production — independent oil companies show good results with deepened development of existing fields;
- New fields are smaller in size and have more complex mining and geological development conditions, and independent oil companies are usually well suited for the development of small deposits;
- Conventional oil reserves in large fields are depleted, and there is a need to include hard-to-recover reserves in the development. Independent oil companies can be more effective in developing hard-to-recover reserves.

However, in general, despite the growth of independent oil companies, the level of monopolization in the industry has significantly grown in recent years (Figure 6). The Herfindahl–Hirschman Index was used to estimate the level of concentration in the oil production sector.[1]

Figure 6. The Herfindahl-Hirschman Index for the oil production sector in Russia



Source: SKOLKOVO Energy Centre

Industries where the Herfindahl-Hirschman index exceeds 1800 are considered highly monopolized. Calculations show that the oil production sector in Russia acquired a highly monopolized character as early as after the acquisition of TNK-BP, and this subsequently increased.

[1] The Herfindahl-Hirschman index (NN) uses data on the market share of the enterprise's products in the industry is used. It is assumed that the greater the market share of enterprise products in the industry, the greater the potential for the emergence of a monopoly. When calculating the index, all enterprises are ranked by their specific market share from the largest to the smallest: $I_{HH}=S^2_1+S^2_2+...+S^2_N$
HH — the Herfindahl-Hirschman index;
S1 — the market share of the largest enterprise;
S2 — the market share of the next largest enterprise;
Sn is the market share of the smallest enterprise.
If there is only one enterprise in the industry, then S1 = 100%, and IHH = 10,000. If there are 100 identical enterprises in the industry, then S = 1%, and IHH = 100.

The impact of the sanctions on the oilfield services market

The sanctions also had a significant impact on the Russian market of oilfield services, where in 2015 the share of the largest Western service companies was 24% [21]. At first glance, a quarter of the market is not so much, but if you look at the structure of the market, it becomes obvious that foreign service companies have practically monopolized its most critical segments. So in the segment of intensification of production, mainly using hydraulic fracturing, non-resident companies account for about 90% of the market. In the geophysics market, where software for interpreting seismic data is affected by the sanctions, non-residents account for about 50%. The horizontal drilling market also depends heavily on foreign equipment, where the strongest player of Russian origin is Eurasia Drilling Company with a market share of approximately 25% [21]. Thus, it is clear that the more highly technological the service is, the higher the share of foreign companies. Russian oilfield services companies perform mostly simple jobs.

Moreover, the problem of fixed assets depreciation and of drilling equipment fleet in particular, is great. 60% of drilling equipment is estimated to be over 20 years old (with a standard service life of 25 years) [37]. The majority of drilling rigs are imported. Spare parts are manufactured by Western companies; they also provide technical maintenance services.

The reaction to the imposition of the sanctions in 2014-2017 was an increase in the number of mergers and acquisitions of the oilfield services companies. And companies with state participation, which were under sanctions, started to actively grow their internal expertise, including by acquiring service companies.

In July 2014, PJSC Rosneft increased its assets by acquiring eight companies in the Weatherford group, engaged in drilling and repair of wells in Russia and Venezuela. This acquisition will allow PJSC Rosneft to set up a strong internal service capable of servicing the needs of the parent company. PJSC Rosneft also purchased Trican Well Service, allowing it to build up its internal service in hydraulic fracturing and well construction services.

We should note that another change as a result of the sanctions was for the Russian market of oilfield services to become more open to Asian companies.

The construction of the Zvezda wharf is an example of such coopertion. Construction will use the technologies and equipment of Chinese companies. Another example is the development of the Sea of Okhotsk shelf, a project where PJSC Rosneft managed to involve the use of a Chinese platform of China Offshore Ltd. in the stage of exploratory drilling. PJSC Rosneft also signed a memorandum in Beijing on strategic cooperation in the field of oilfield services with one of the leaders in this market — Shandong Kerui Petroleum Equipment. [38]

Chinese Kerui Group won a tender for the delivery of oilfield equipment for PJSC Rosneft worth about 60 million US Dollars The contract includes the supply of specialised trucks and equipment for hydraulic fracturing [39]. In 2015 Chinese Jereh, supplying oilfield equipment, signed a contract with PJSC Rosneft to provide maintenance services, as well as those for hydraulic fracturing. [40].

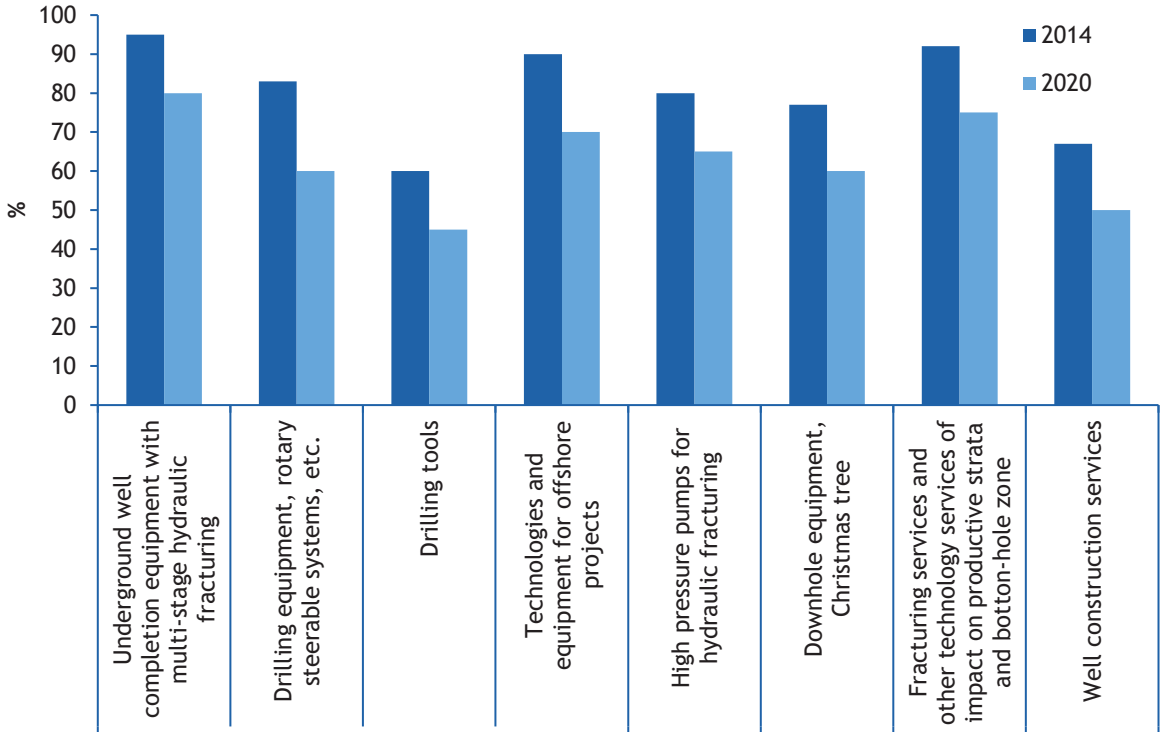
Nearly all Russian companies are doing significant work to increase domestic competencies, find opportunities for import replacement and new foreign partners in the Asia Pacific Region [35]. However, it is difficult to assess how successful these actions have been. New deals, new investment and new partners will appear in the oil sector. The period of turbulence and searching for acceptable organisational and technical solutions adapted to the “grey sanctions area” will take some further time.

The reaction of the Russian regulators to the sanctions

Back in 2014, after the introduction of the first stage of the sanctions, the government began to actively develop measures to increase import replacement in the oil and gas industry [35]. In 2014 the Ministry of Industry and Trade set up the Industrial Development Fund, focused specifically on import replacement projects. In early 2015, the Ministry of Energy and the Ministry of Industry and Trade submitted "Plans for import replacement in the fuel and energy sector," which were aimed at significantly reducing import dependence by 2020 (Figure 7).

In August 2015, the Governmental Commission for Import Replacement was established. In March 2016, as part of the implementation of the resolutions made by the Commission, methodological recommendations on the preparation of regional plans for import replacement (in addition to sectoral plans) were approved. In August 2016, the Commission approved methodological recommendations on the preparation of corporate plans for import replacement by state companies and organisations implementing investment projects listed in the register of investment projects.

Figure 7. Plans for import replacement in the oil and gas industry (dates on X axis show the start of the programme, blue – the situation in 2014 and cian – target performance)



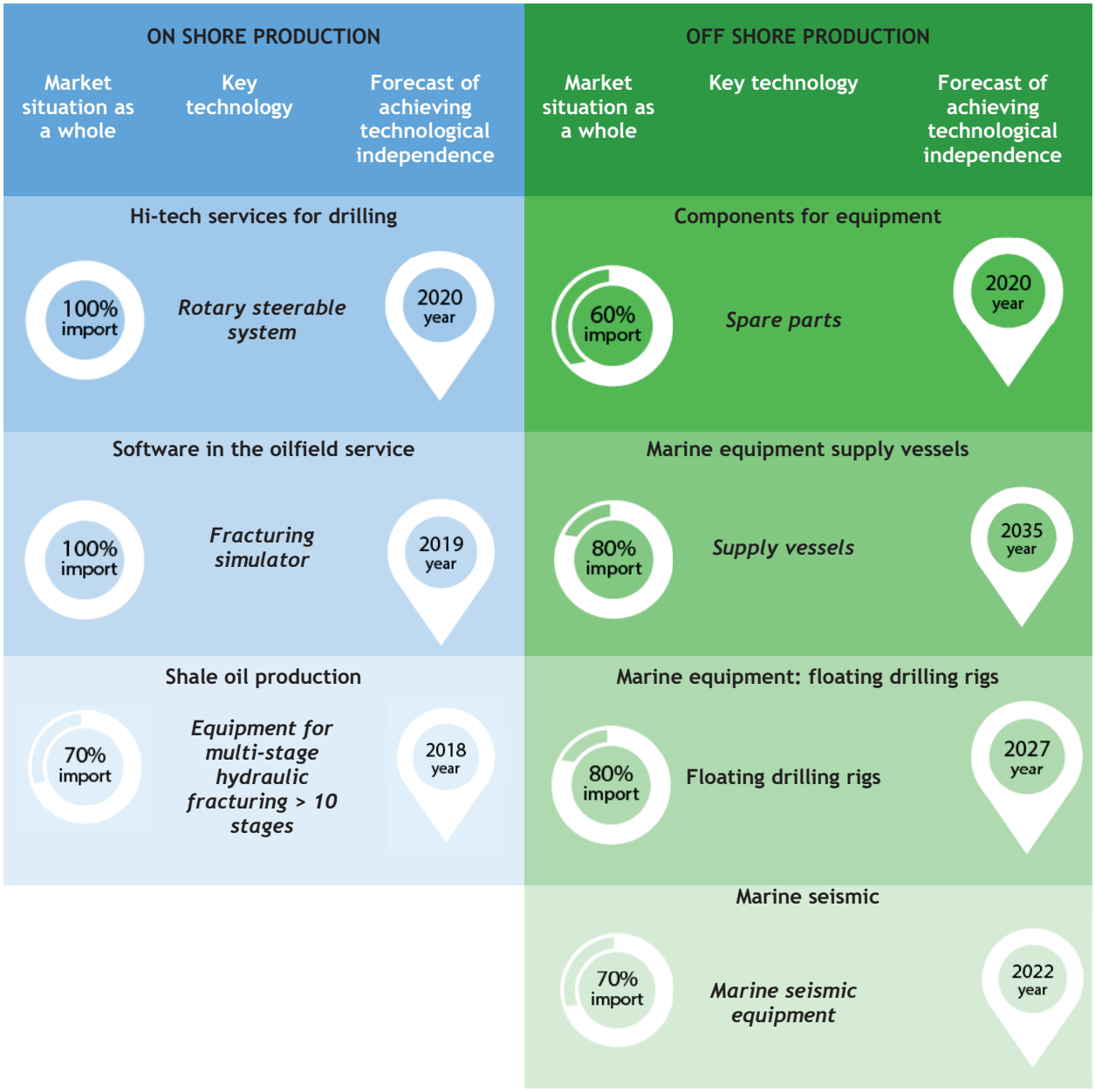
Source: Planned measures to replace import in the oil and gas manufacturing segment, oil refining and the petrochemical segment of Russia's oil and gas industry

As of 2014, the two types of equipment most vulnerable to the effect of the sanctions were equipment for offshore projects and equipment to increase oil recovery, including hydraulic fracturing (up to 90%). At the same time, both technologies are critical for the Russian oil industry. The first is key to the successful operation of the oil industry in the future, and the second is a guarantee of being able to maintain production at the active fields in the medium term, as well as the ability to develop shale formations.

Hydraulic fracturing has become an integral part of the oil field development process. It is carried out at 50-80% of producing wells. The contribution of hydraulic fracturing to the achievement of the final oil recovery rate value in new oil and gas fields reaches 80% [41]. Moreover, practically the whole of the hydraulic fracturing fleet operating in Russia is over 10 years old [42], i.e., it will have to be replaced relatively soon.

As far as oil production in deep-water areas is concerned, the situation is slightly better, but is complicated by the fact that most of the prospective resources are in the Arctic zone, and of over 700 drilling platforms in the world, only 13 are of ice class [43]. The situation is similar with vessels adapted for operation in arctic latitudes.

Figure 8. Imported equipment for onshore and offshore work and an assessment of potential import replacement



Source: Strategic replacement, the main directions of the import replacement programme in the oil industry. Siberian Oil, № 130, April 2016

In 2015, the Ministry of Energy presented the list of required new equipment and materials:

- Hydraulic fracturing fleets — 15 pcs / year;
- High pressure pumps — 48 pcs / year;
- Rotor-driven systems — 150 pcs / year;
- Drilling rigs for drilling on the shelf — 30 pcs. to 2030

However, as of 2015 and 2016, the results of monitoring the implementation of the import substitution programme had not been presented. According to public data, in the period from 2015 to August

2017, not a single hydraulic fracturing fleet was manufactured. Rotor-driven systems, according to the site of STC PJSC Gazprom Neft [43], were in the testing phase at the end of 2016. Neither was there any mention of the drilling rigs being in industrial operation.

Therefore, so far an analysis of the implementation of the import replacement programme on import substitution in the oil industry of Russia has shown clearly unsatisfactory results. Most of the offshore projects, as well as a significant part of the projects for the development of the Bazhenov suite are on hold because of a ban on the supply of equipment and a high proportion of Western oilfield service companies in these segments.

Following the introduction of the second stage of the sanctions in 2017, the Ministry of Natural Resources and Ecology submitted to the government a draft bill that would amend the licence agreements for subsoil use which had already been granted to oil and gas companies.

The bill plans to introduce amendments to Article 12 of the Law "On Subsoil Use" before the end of 2017 [44]. According to the current version of the law, there are factors that may affect the changes in the conditions of the licence. Article 12 of the Law on Subsoil Use states : "A significant change in the volume of consumption of goods in circumstances not dependent on the user of the subsoil, the time of commissioning of facilities identified by the license agreement may be reviewed by the bodies that issued the license for the use of subsoil plots, based on a request from the user of subsurface resources" . In general, these amendments point to the fact that the sanctions regime for Russia is regarded by the government as a long-term one, and that oil companies will have a legal basis for reviewing the timing of project implementation.

RUSSIAN OIL PRODUCTION FORECAST (SCENARIO-BASED)

The state of the resource base

In recent years, the proportion of high-quality oil reserves in Russia has been steadily declining: this is indicated by the composition of the explored reserves by ABC1 categories: of the 18 billion tonnes, as much as two thirds (12 billion tonnes) are classified as hard-to-recover reserves. According to the estimates of the Ministry of Natural Resources: "The availability of explored reserves at the fields under development is 35-36 years. However, reserves-to-production ratio, without taking into account hard-to-recover oil, is no more than 20 years. Given the current state of the mineral resource base, it will be practically impossible to maintain the current production levels after 2020, without including hard-to recover-oil in production. Therefore, oil is classified among the under-guaranteed reserves of minerals "[45]. "The degree of depletion of explored reserves reaches 55%, the degree of exploration of initial overall resources is 46%" [45].

In recent years, oil reserves in Russia have been growing steadily, but the bulk of the increase is not due to the discovery of new deposits, but to additional exploration of the fields under development and the introduction of modern production technologies, which significantly increase the oil recovery ratio.

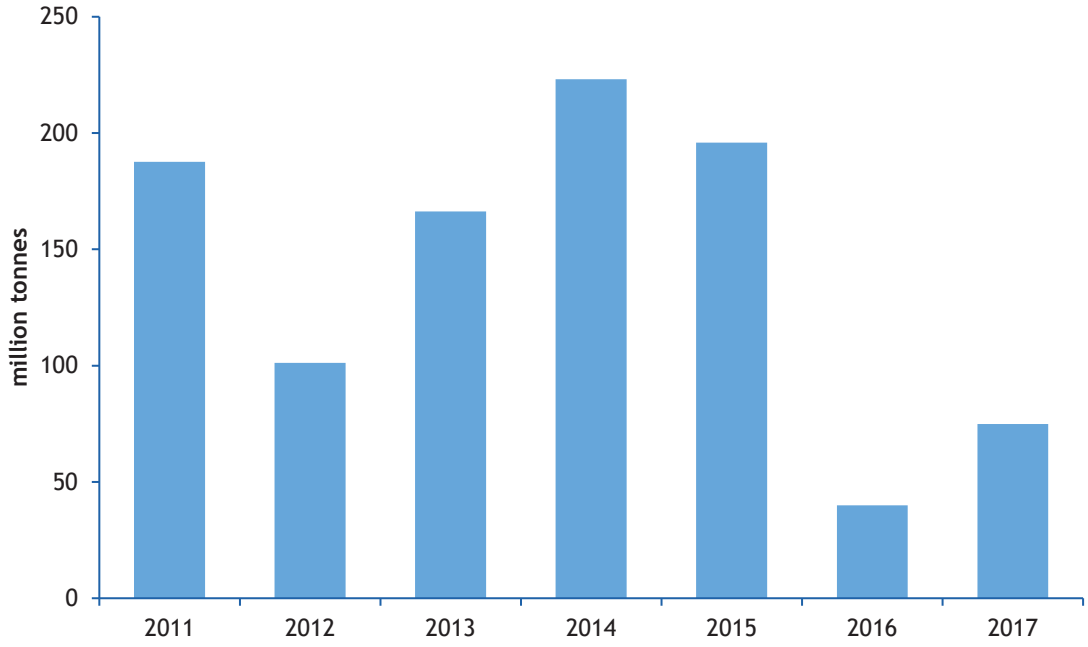
At the same time, despite a direct increase in reserves, their quality is declining substantially. The size of newly discovered fields has decreased: while a large field with reserves of 50 million tonnes used to was considered a very common discovery, today oil companies are pleased with the discovery of small deposits of 3 million tonnes.

Thus, according to the Ministry of Natural Resources, if in 2005 2107 oil deposits were registered at the Ministry, then by 2015 their number was up by 40%, while the reserves growing by 7.6%. Most of the new deposits are located far from the infrastructure, so they may be unprofitable to develop, especially given small reserves. And, finally, the quality of oil in new fields is worse in terms of chemical composition, in terms of sulfur content and density. The decline in the quality of the resource base is a serious challenge for Russia's oil and gas sector along with the EU and the US sanctions.

Putting new reserves on the balance sheet requires additional investment, which is becoming difficult given the current price environment. So in 2016, the industry showed the lowest additional increase in reserves relative to production over the last 6 years — less than 50 million tonnes. In 2017 the figure increased to 72 million tonnes, but these indicators are still smaller than those prior to 2016 (Figure 8). Such a low increase can be explained by the fact that investments into geological exploration (Figure 9) fell significantly in 2015, as well as by the fact that there are only 6% of reserves of ABC1 + C2 category left in the unallocated fund. The

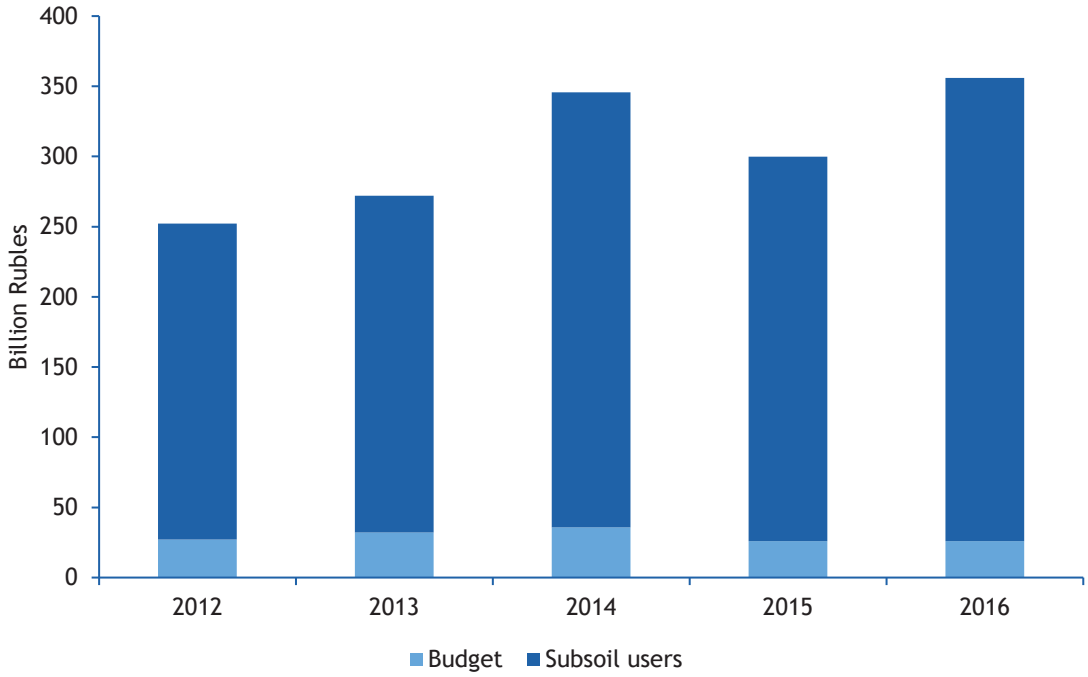
Erginskoye field, the last large oil deposit in the unallocated fund, was sold at an auction in July 2017.

Figure 9. Annual growth in reserves relative to oil production



Source: The Ministry of Natural Resources

Figure 10. Investment in geological exploration in Russia

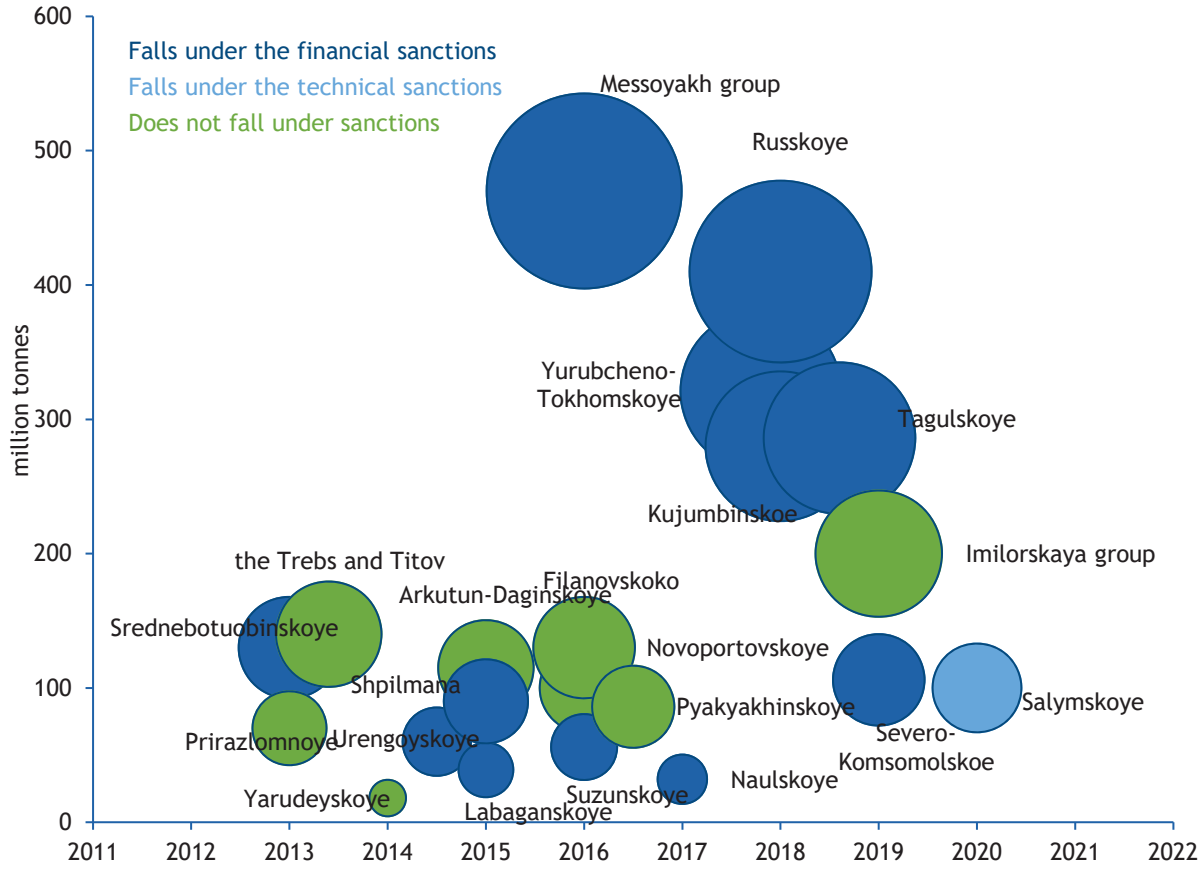


Source: the Ministry of Energy, materials for a presentation at the session of the State Duma of the Russian Federation on 21 January 2015 within the "government hour"

As of today, it is possible to single out more than 20 new large oil and gas condensate projects, the Russkoye field being a unique deposit. It holds over 400 million tonnes of high-viscosity oil. Other deposits can be classified as large.

It is important to note that all major deposits and groups of deposits with reserves of over 200 million tonens -the Mesoyakh group, Russkoye, Yurubcheno — Tokhomskoye, Kujumbinskoe and Tagulskoye — are subject to financial sanctions. Smaller projects, such as the Srednebotuobinskoye deposit, the Labaganskoye and the Urengoyskoye deposit, Shpilman, Suzunskoe, Naulskoye and Severo-Komsomolskoe fields, are also subject to financial sanctions. (Figure 10). And, given that the Messoyakh group, the Urengoy field, the Srednebotuobinsky and Labaganskoye fields were commissioned as of August 2017, the commissioning of other deposits can be postponed due to financial sanctions and low oil prices. Salym oil production projects at the Bazhenov suite are also subject to technological sanctions.

Figure 11. Reserves and commissioning of the largest new fields given the sanctions



Source: SKOLKOVO Energy Centre

It is worth remembering that the timing of commissioning new projects is affected not only by the sanctions, but also by Russia's participation in the OPEC + agreement to cut production. Possible prolongation of the agreement can also have an impact on the timing of bringing projects online and the intensity of their development.

Scenario assumptions

Two scenarios were created for the purpose of this study – the baseline scenario and the "Intensified sanctions" scenario.

The **"Baseline scenario"** envisions that:

- Oil price is in the range of 50-60 US dollars per barrel in the period to 2025;
- There is no further tightening of the sanctions. At the same time, within the framework of current sanctions documents access to fracturing technology is deteriorating;
- New projects planned for commissioning by 2025 are implemented according to company plans;

The scenario **"Intensified sanctions"** provides for the following:

- Oil price up fluctuates around 40 US Dollars per barrel in the period to 2025;
- Financial sanctions are toughened (ban on borrowing with 30 days' maturity implemented by all countries);
- A ban is introduced on the supply of equipment and services for all projects in Russia;
- Operation of foreign service companies in Russia is restricted;
- New projects planned for commissioning before 2025 and subject to sanctions are cancelled.

It is assumed that Russian companies will not develop their own technologies capable of replacing foreign prototypes for the purposes of calculations in both scenarios. This allows us to see the "net" results of such a stress test, but it is evident that in reality it is the development of domestic technologies and expertise that should become the main way to mitigate the negative consequences of sanctions.

Russian oil production forecast (scenario-based)

Oil production forecast for Russia was made using the economic-mathematical optimization model of the world oil and petroleum products market, World Oil Model (WOM)[2].). Future production volumes are set based on oil extraction rates stated by the companies or based on the linearization of the Hubbert curve taken outside the model

[2]A model for forecasting long-term development of the liquid fuels market. Certificate of state registration of computer program No. 2015662377. The model allows to solve problems aimed at forming forecasts for the development of the oil industry, interconnected with other fuel and energy resources. The objective function of the model is to meet the demand for petroleum products given for the forecast period due to existing production, processing and transport capacities with minimal total costs along the entire chain, taking into account the cost of alternative energy sources. The database of ERI RAS "World oil fields" (Certificate of state registration of database No. 2015621825) is used as internal data. It includes data on costs and production profiles for large oil fields, prospective projects, and production regions.

calculations. It is possible to calculate the breakeven price of oil using the modelling complex. The model also allows you to artificially set the price limit.

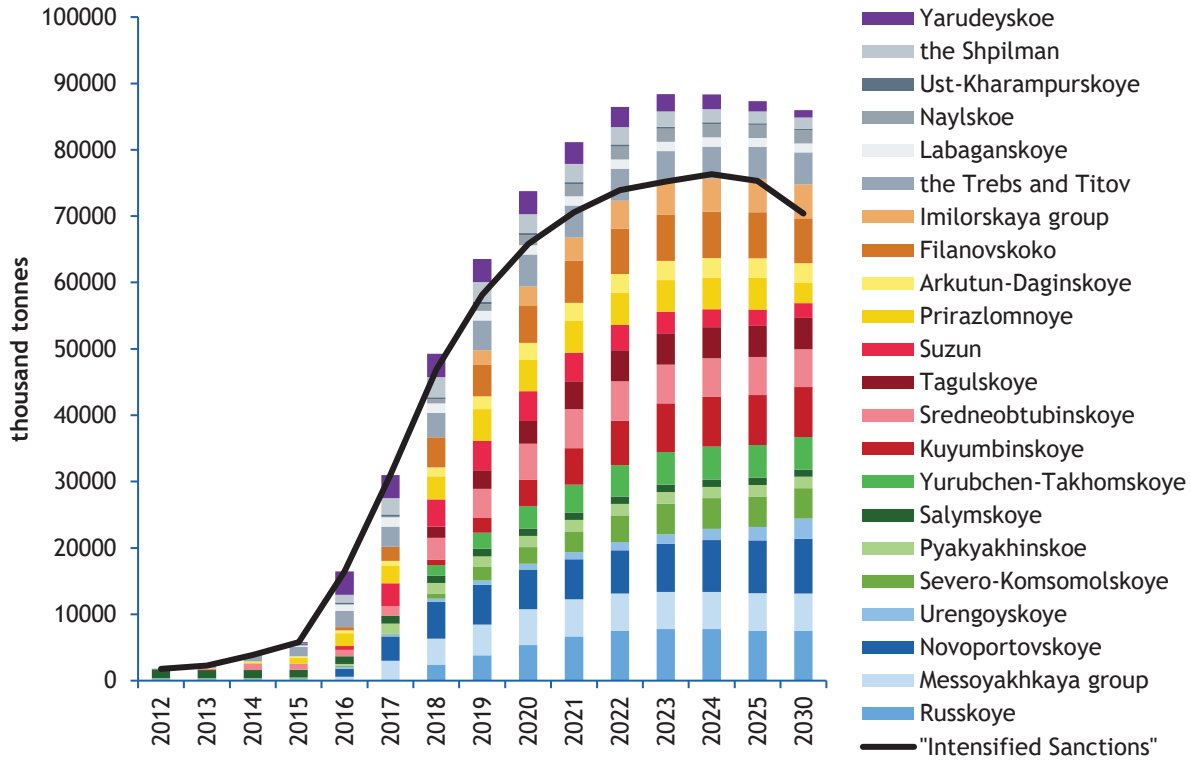
The results of the calculations show that production at the largest new fields will peak at around 90 million tonnes in the period up to 2025 (Figure 11) within the baseline scenario.

Within the "Intensified sanctions" scenario, production at the largest new projects will also grow steadily, but will only reach 75 million tonnes. Thus, the difference in production at these projects between the two scenarios will be 15 million tonnes of oil in 2025 and in 2030 .

Such a small difference between the scenarios is explained by the fact that most of the projects that will be brought online in the coming years have already been financed and can effectively work at an oil price of 40 US Dollars per barrel.

Most of the new deposits belong to the preferential category: some fields are exempt from MET, while others — from export duties. At the same time, given low oil prices and a weakened Rouble exchange rate, oil companies receive rent for devaluation: selling oil for export in foreign currency and bearing production costs in Roubles, the companies reduce their costs due to currency exchange rates.

Figure 12. Projected oil and gas condensate production at the largest new fields in the Baseline Scenario and in the "Intensified sanctions" scenario for the period up to 2030



Source: SKOLKOVO Energy Centre

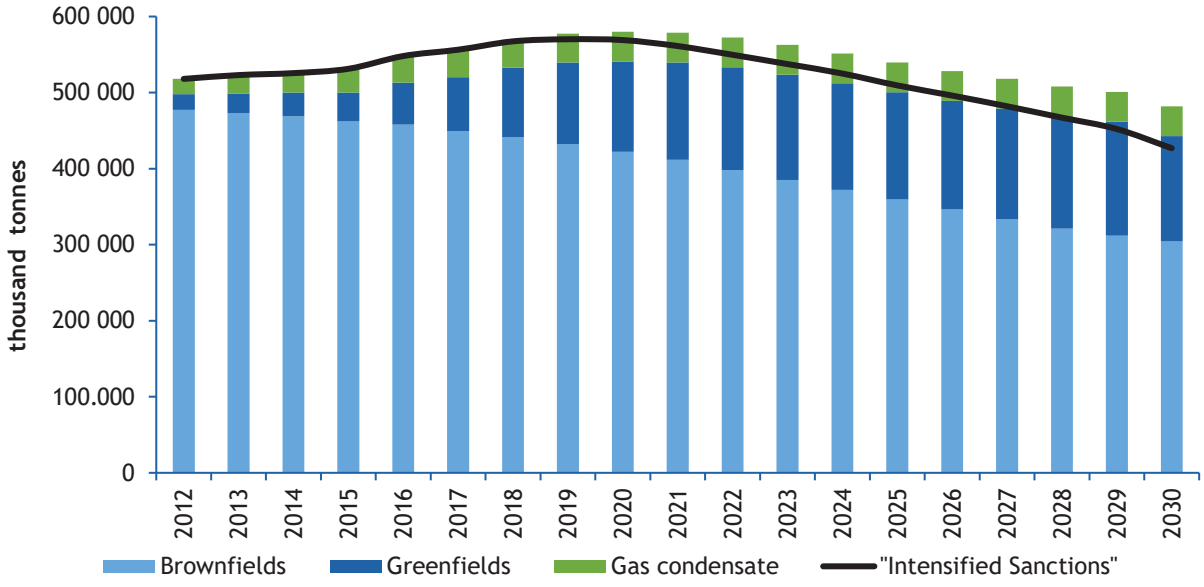
Overall oil production at the operating and new fields is projected to decrease in the forecast period up to 2030 (Figure 12). In the Baseline scenario, production is expected to reach 580 million tonnes in 2020, but it should be noted that these production volumes may be limited by the market needs, both domestic and external. It is quite likely that Russia will have the potential for free production capacity.

By 2025, oil production will drop to 540 million tonnes. In the "Intensified sanctions" scenario, it will peak as early as 2019 due to the cancellation of major projects, and will total 505 million tonnes by 2025.

The difference in production between the scenarios reaches 35 million tonnes by 2025, and is reached not only due to the cancellation of several new projects, but also due to faster decline in production at the existing fields. By 2030, these processes are exacerbated: in the Baseline scenario, production falls to 480 million tonnes, and in the "Intensified sanctions" — to 425 million tonnes. Thus, in 2030, the difference in production between the scenarios reaches 55 million tonnes.

It is important to note that production volumes subject to the sanctions at the Bazhenov suite and on the shelf (including deep-water and the Arctic) are not large. The share of offshore fields in total Russian production virtually does not change in the Baseline scenario: In 2016 it was 4% (22 million tonnes [46]), and by 2030 it will grow to 8.2% (40 million tonnes). In the "Intensified sanctions" scenario, production on the shelf goes up to to 5% (25 million tonnes). The share of oil from the Bazhenov suite grows from 1% (approximately 6 million tonnes [46]) to 4% (19 million tonnes) by 2030 in the Baseline scenario and up to 16 million tonnes in the "Intensified sanctions" scenario. In any case, the main impact of sanctions is a reduction in production at conventional fields.

Figure 13. Projected oil and gas condensate production in Russia in the period to 2030



Source: SKOLKOVO Energy Centre

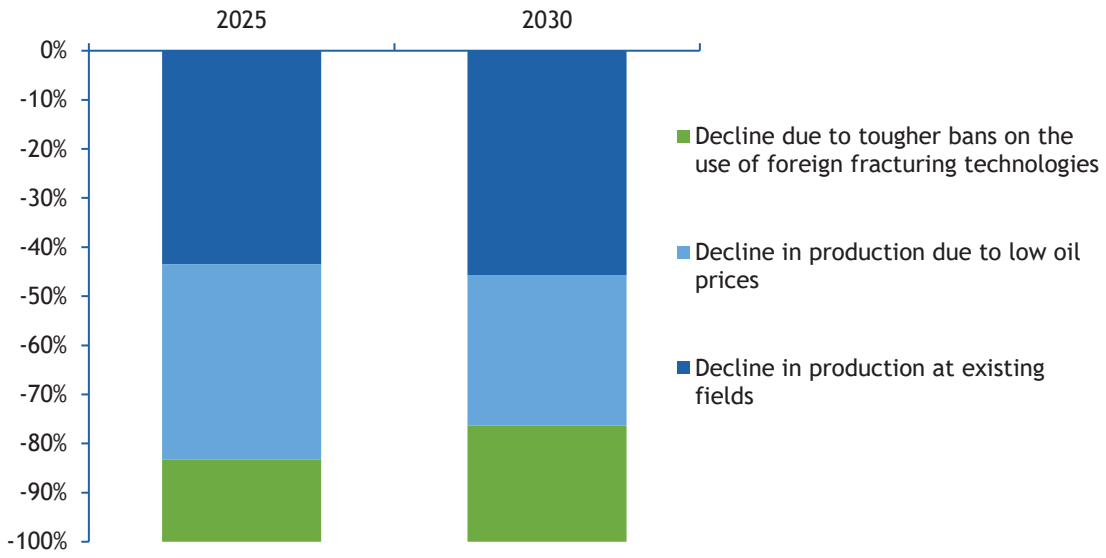
The impact on budget revenues

Figure 14 shows the structure of lost production in 2025 in the "Intensified sanctions" scenario compared to the Baseline scenario. The main factors of production decline are as follows:

- 45% of the 30 million tonnes of falling production is attributed to faster decline in production at the brownfields
- 40% of the drop in production is due to the fact that, given low price conditions
- 15% of the drop in production is due to tougher bans on the use of foreign fracturing technologies

By 2030, the situation is somewhat different: the share of production dropping due to natural decline is up to 45%, while the share pf production falling due to tighter bans on the application of foreign hydraulic fracturing technologies goes up to 25%.

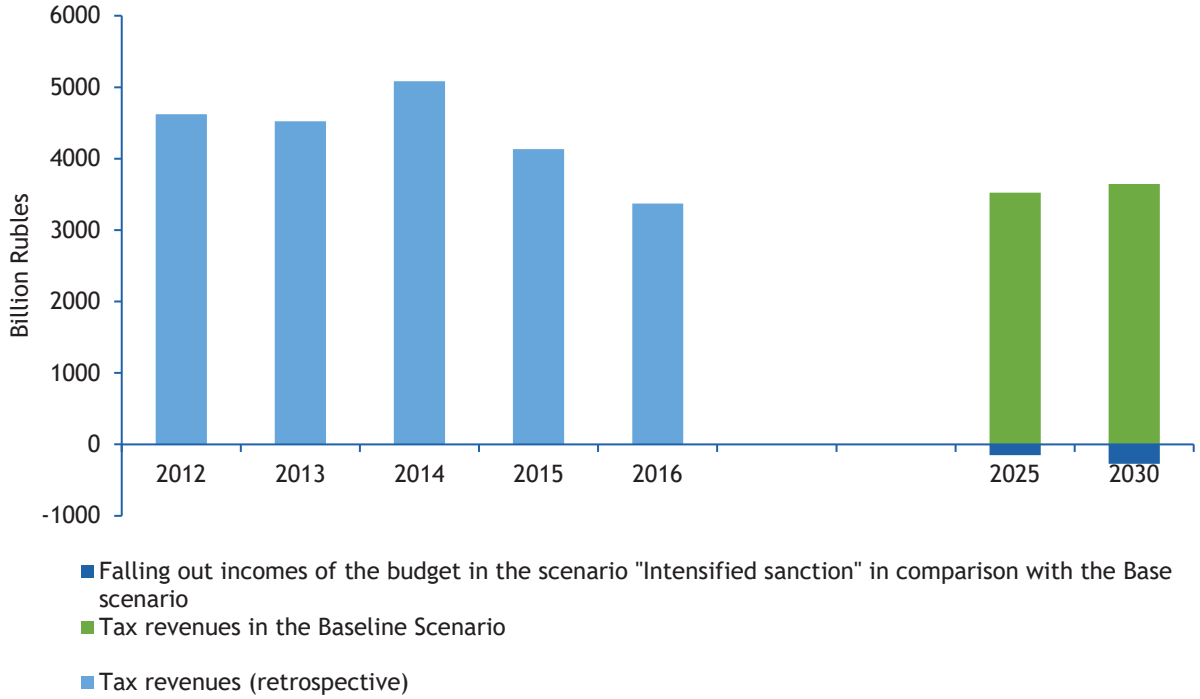
Figure 14. The structure of production decline in 2025 и 2030 in the "Intensified sanctions" scenario compared to the Baseline scenario



Source: SKOLKOVO Energy Centre

A drop in budget revenues due to reduced production driven by the sanctions, and as a result of a consequent decrease in export duty and mineral extraction tax revenues in 2025 will not be great — around 150 billion Roubles, according to the calculations by SKOLKOVO Energy Centre. This is equivalent to 4% of total export duty and MET revenues in 2016. By 2030, these missing revenues will go up to 270 billion Roubles (10%), but their impact will still be significantly lower than the impact of the price environment, a change in which in 2014 led to a 34% drop in revenues in 2016 compared to 2014.

Figure 15. Decrease in budget revenues from MET and export duty on oil in scenario Intensified sanctions compared to Baseline scenario



Sources: SKOLKOVO Energy Centre, the Treasure of Russia

RECOMMENDATIONS

The Russian oil industry is facing a rather complex challenge to choose an optimum direction of development in the new conditions. On the one hand, active deposits are growing depleted for natural reasons and most new projects are either located far from consumption areas or are classified as hard-to-recover. On the other hand, the imposed sanctions will continue to put increasing pressure on the sector. Unless domestic technologies and expertise are developed, oil production decrease can become rather noticeable.

As we have already mentioned, there are several options for maintaining oil production volumes, in addition to the development of new conventional deposits:

- in-depth development of existing conventional oil fields using production intensification methods;
- development of unconventional oil reserves on land (including shale oil);
- development of offshore fields (including the Arctic shelf).

Our analysis shows that, from a technological point of view, hydraulic fracturing is the most critical technology for maintaining Russian oil production. This technology can ensure that production is maintained at both active and prospective fields (both unconventional — shale and hard-to-recover fields which are not classified as shale deposits).

Moreover, development and production of own hydraulic fracturing fleets will reduce the actual monopoly of foreign service companies in this segment.

This requires an integrated approach both from the regulators and the companies. The regulators should provide transparent and preferential regimes for this segment. For example, a reduction in tax rates for the manufacturing or import of equipment for hydraulic fracturing fleets. Oil companies and service companies should train their own specialists who will be able to manage this equipment, probably in cooperation with international and Russian educational centers. In the future, training should also be carried out in Russia. Special attention should be paid to manufacturing of fluids for hydraulic fracturing and manufacturing of rotary controlled systems and software development.

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