Major Trends in the Global Liquid Hydrocarbon Market to 2035
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FORWARD-LOOKING STATEMENTS

Some statements contained herein are forward-looking statements. In particular, such statements cover future events that include the Company’s perception of the global hydrocarbon market prospects and trends. All and any information, other than historical facts, is of a predictive nature.

Words like “assume”, “expect”, “suppose”, “plan”, “intend”, “reckon”, or similar expressions are intended to indicate forward-looking statements, and shall not be construed as the conclusive way of designating the same.

By their nature, forward-looking statements involve some unavoidable risks and ambiguous matters, both general and specific. There is also a risk that expectations, forecasts, or some forward-looking statements may not be realized due to various factors. Actual data, events, or facts may turn out to be substantially different from the forecasts, expectations, or assessments expressed in such statements.

We hereby expressly waive any obligations to update or modify any forward-looking statements included herein, whether based on new data, subsequent developments, or otherwise.
FORECASTING APPROACHES

The primary sources of actual data used in the preparation of forecasts are those recognized by the expert community, such as the IEA, the EIA, OPEC, the UN, the IMF, the Russian Ministry of Natural Resources and Environment, the Russian Ministry of Energy, and CDU TEK. All and any forecasts presented herein have been constructed using analytical models developed by the LUKOIL Strategical Development Unit experts. The basic premises and assumptions used in the forecasting are the product of discussions within the Company.

Numerous forecasts included in the Report come with multiple scenarios. The scenarios describe potential future states, however fail to exhaust all possible alternatives of future performance. Given the major uncertainty faced by the global energy industry, we deliberately refrain from attributing probabilities to specific scenarios, thus leaving some room for discussion regarding the future development paths to be followed by the global liquid hydrocarbon market.
INTRODUCTION

The world is changing rapidly, and the energy industry is no exception. We are witnessing a massive change in the primary consumption of energy, higher demand for natural gas, fast-paced development of the liquefied natural gas market, increased popularity of renewables, and gradual proliferation of electric vehicles.

Dwelling on the subject of liquid hydrocarbon market prospects, it should be noted the attention that the world community pays to the problem of global-climate change. The 2015 Paris Climate Agreement called to reduce greenhouse gas emissions became a milestone in the development of the global energy industry. Many experts believe that the reduction of human impact on the climate is impossible without a large-scale reduction in fossil fuel consumption. And yet, multiple issues, such as public access to electricity and clean cooking, remain unresolved in many countries. Mankind is now faced with a challenge: to provide the planet’s growing population with affordable energy, and at the same time mitigate the adverse environmental impact, also by cutting down greenhouse gas emissions.

With Russia ratifying the Paris Agreement in September of 2019, new prospects will open up for the country’s energy industry. Given a vast potential for mitigation of the climatic exposure, Russia is set to remain the leading energy supplier globally by using technological innovations.

Even though this Report focuses on the liquid hydrocarbon market, this market is viewed in the context of the development of the global energy system. The prospects of the liquid hydrocarbon market to a great extent depend on the decisions to be made by the world’s leading economies to maintain the balance of keeping the energy affordable for consumers and mitigating the adverse environmental impact.

Following publication of the previous report in 2016, the global energy industry has seen many developments calling for revision of our long-term forecasts. The most crucial landmark developments shaping the market include raising public awareness of climate change, Russia – OPEC cooperation on regulation of oil production, US – China trade war, imposition of sanctions on Iran, and economic crisis in Venezuela. These developments were taken into account while forecasting long-term trends in the global liquid hydrocarbon market.
Traditionally, the Report highlights challenges and prospects of the Russian oil industry. While Russia is a key element in the global energy system, the change that the global energy industry is now experiencing has direct impact on the Russian energy sector. In their turn, the trends that are observed in the Russian oil industry, are vital for understanding the global energy picture. The Russian oil sector is currently undergoing structural transformation: resources deterioration push the companies to rely more on innovative oil production techniques, ramp up the production of hard-to-recover reserves, and continue upgrading their refineries. Future competitive performance of the Russian oil industry is in many ways dependent on the ability of the Russian oil companies to use technological innovations.

We are hopeful that this Report will make a useful contribution to the debate over the future of the global liquid hydrocarbon market and global energy industry.

**KEY FINDINGS**

- Solving the global climate change problem has become the central pillar of energy policies in many countries.
- Mankind is faced with the challenge of satisfying the energy demand and at the same time bringing down greenhouse gas emissions.
- The rates at which renewables and electric vehicles are expected to gain ground are too slow to reverse the trend of global temperature growth.
- To keep global warming substantially below 2 °C, extensive use of renewables for power generation must be coupled with the intensified introduction of CO₂ capture, utilization, and storage technology, and adoption of more environmentally friendly afforestation and land management approaches.
- Expansion of the middle class in the developing countries will continue to drive the global demand for hydrocarbons.
- With improved fuel efficiency of vehicles and internal combustion engines, and gradual adoption of alternative vehicles, the demand for petroleum products from motor vehicles is expected to decelerate.
- Petroleum products consumption growth will be the highest in, commercial transportation, air transportation, marine transportation and petrochemicals.
- Future dynamics of the oil demand will be greatly dependent on climate policies pursued by the leading economies.
- With the current climate policies and existing fuel efficiency improvement programs in place, the demand for liquid hydrocarbons is set to grow until 2035.
- Regardless of the oil demand scenario, the requirement for new oil production projects will remain due to a natural decline in the production of mature fields.
- The US oil production growth is expected to gradually decelerate due to technological constraints encountered in the development of shale formations.
- Reduction of investments into the global exploration and oil production leads to a shortage of oil supply in the market.
- The OPEC+ agreement reshaped the global oil market, contributing to the rapid balancing of supply and demand.
- Global refining is expected to undergo transformation due to commissioning of modern refineries in the developing countries, imposition of strict environmental requirements, and changes in the composition of the feedstock being processed.
- In Russia, there is a tendency to deterioration of the resource base due to the increase in the depletion of deposits in traditional production regions.
- Over the longer term, Russia does have the potential to ramp up its annual production to over 600 million tons, primarily through higher Oil Recovery Factor (ORF) and development of hard-to-recover reserves.
- Unlocking Russia's oil production potential will call for further tax reforms, and institutional liberalization.
- Due to the stimulation of investments into refining, before 2035 Russia is set to experience a net surplus of motor fuels on its market, even in optimistic scenario for domestic demand growth.
1
KEY CHALLENGES FOR THE GLOBAL ENERGY INDUSTRY
1.1. PROVIDING MANKIND WITH AFFORDABLE ENERGY AND DECARBONIZATION

The industrial revolution fundamentally improved the wellbeing of mankind. Nowadays the global GDP per capita is 5 times that of the early 20th century. And this is despite the four-time growth of the planet's population over the previous century.

Thomas Malthus' (1766 – 1834) widely acclaimed theory offered a valid explanation of the economic cycles in the agricultural age. The theory suggests that mankind is doomed to a life on the verge of starvation, since population growth resulted in the reduction of the per capita income. However, the growing global economy in the industrial age proved that the technological progress is capable to overcome the Malthusian trap.

Deterioration of the planet's environment is our pay for the technological progress. Despite multiple scientific confirmations of the fact that the global temperature changes are of a cyclical nature, numerous researchers in the recent decades have associated global temperature growth with human activity. According to the Intergovernmental Panel on Climate Change (IPCC), the primary cause of global warming is the intensification of the natural phenomenon commonly referred to as the 'greenhouse effect' resulting from human economic activity.

The key greenhouse gases are known to include water steam, carbon dioxide, methane, nitrogen oxide, and many other man-induced gases. If the atmospheric humidity does not substantially depart from the long-time average, the atmospheric concentration of greenhouse gases is unavoidably driven up by human economic activity. The annual quantity of man-induced gases nears 50 billion tons of CO2e.

The Earth's surface and the World Ocean are natural sources of CO2 sequestration. However, man-induced CO2 emissions are roughly two times the amount that can be naturally sequestered by the oceanic surface and forests. This leads to an increase in the atmospheric concentration of CO2. Whereas back in 1980 the atmospheric concentration of CO2 was 0.0335%, these days this indicator is at 0.0415%. According to climate experts, if preserved, the trend toward growing greenhouse gas atmospheric concentrations will result in a 4.1-4.8°C global temperature increase by late 21 century vs. pre-industrial levels.

The global community is increasingly concerned with climate change. Signing of the 2015 Paris Agreement as part of the United Nations Framework Conven-
tion on Climate Change entitled the beginning of a new phase in combating global warming. Having ratified the Paris Agreement, numerous industrialized nations determined their long-term greenhouse emission reduction targets, the so-called National Determined Contributions (or NDCs). E.g., the EU’s goal by 2030 is to reduce its greenhouse gas emissions by 40% of its 1990 levels, and by 2050 reach an 80% reduction. China announced its determination to reduce GDP carbon intensity by 60–65% by 2030, whereas India seeks to achieve a 33–35% reduction. Russia’s long-term objective by 2030 is to limit its greenhouse gas emissions at 70–75% of its 1990 levels.

It is already obvious that the announced national determined contributions will not be sufficient to accomplish the primary goal of the Paris Agreement, to keep the increase in global average temperature to well below 2°C above pre-industrial levels. Moreover, withdrawal of the US, being the largest greenhouse gas emitter, from the Paris Agreement makes it even more likely that the global temperature worst case scenario will be realized.

What makes greenhouse gas emissions issue problem so complex is the uneven distribution of wealth amongst countries. Normally, the more developed a country is, the higher is its energy consumption and CO₂ emissions per capita. In 2018, the developed countries had 3 times more CO₂ emissions per capita, than the developing ones. This difference is due to low accessibility of modern energy sources in the developing countries. According to the International Energy Agency (IEA), some 860 million people currently

Possible trends in greenhouse gas emissions, billion t CO₂eq

![Graph showing possible trends in greenhouse gas emissions](source: Climate Action Tracker)
have no access to electric power, and 2.6 billion of the Earth’s population use wood or other primitive fuels to prepare their food. Most of these people are residents of South-East Asia and Africa.

To overcome poverty, one has to supply the planet’s growing population with affordable energy. In a number of countries fossil fuels are viewed as the most cost-efficient energy sources. However, growing consumption of fossil fuels in the developing countries is sure to drive up CO$_2$ emissions. This is what makes the task of improving the standards of living in the developing countries and at the same time cutting down on greenhouse gas emissions very challenging and dependent upon technological breakthroughs in various fields.
Russia’s Policy on Climate Change

In 2016 Russia joined the Paris Agreement on Climate, and in September 2019 the Russian Government issued a decree to ratify it. The goal of Russia is by 2030 to achieve a 70–75% reduction of its 1990 levels while fully accounting for the absorptive capacity of its forests. As of 2017, greenhouse gas emissions in Russia, net of the absorptive capacity of forests, totaled 67.6% of the 1990 levels, and 50.7% including such capacity. Thus, we assume that the national GHG reduction goal set for 2030 is highly likely to be achieved.

Fulfilling the obligations under the Paris Agreement implies adoption of a long-term low-carbon development strategy by the country. This document is intended to define GHG reduction targets beyond 2030 and ways of achieving this goal. In 2018, the Russian Ministry of Economic Development proposed a draft Federal Law “On Governmental Regulation of GHG Emissions and Amendments to Certain Statutory Acts of Russia.” In its initial version, the bill proposed to introduce greenhouse gas emission targets for companies, fees for any emissions in excess of the set targets, and CO₂ emission trading system. Following public consultation, and given the negative feedback from the industry, multiple ministries, and agencies, it will have to be revised. We expect Russia to develop its regulatory climate framework in the next several years.

LUKOIL is supportive of the global effort to reduce GHG reductions and accomplish the targets outlined in the Paris Climate Agreement. Even though Russia’s regulatory framework on climate is in its inception phase, the Company intends to take measures to cut back on GHG emissions resulting from its operations, preempting future statutory changes. LUKOIL is currently working to set long-term GHG reduction targets.

1.2. GLOBAL ENERGY DEVELOPMENT SCENARIOS

The future of the global energy hinges on a variety of different factors. To get a better understanding of the scale of uncertainty associated with the prospects of global energy development, the Company uses several long-term scenarios.

The “Evolution” scenario assumes progressive development of the global energy industry as part of the existing energy policy, national programs, and long-term corporate plans. Primary energy consumption for the Evolution scenario is expected to go up 20% by 2035, and 70% by 2100. The number of individuals without access to modern energy sources decreases, how-
ever the gap between consumption per capita in the developed and developing countries remains wide. The Evolution scenario takes into account the national determined contributions proclaimed by the parties of the Paris Agreement. The effort put into restricting greenhouse gas emissions will have a anthropogenic CO₂ emissions peak in 2040, totaling 42 billion tons, after which it is expected the emissions to decline gradually. It is currently estimated that the CO₂ emissions trend in the Evolution scenario matches a 2.6–3.2 °C rise of the global temperature by the end of 21st century.

The “Equal Opportunities” scenario is based on the assumption that the gap in energy consumption per person between developed and developing countries will significantly narrow in the future. As it stands, the annual primary energy consumption in numerous African and Southeast Asian countries is less than 1 TOE per capita. To put this in perspective, the annual primary energy consumption in Europe is around 3.2 TOE per capita, and 6.8 TOE per capita in the US. Based on the UN estimates, there’s a positive dependence between the Human Development Index and primary energy consumption per capita with the most significant increase in the index, when the energy consumption is between 0.7 and 2.4 TOE. The “Equal Opportunities” scenario assumes an increase in specific consumption by developing countries to a level that meets the high living standards of European countries. This will drive the global primary energy consumption, which will more than double in 2017–2100. However, as a result of this scenario, the tendency to increase CO₂ emissions will continue for a long time.

The Climate scenario relies on the assumption that the leading economies will put in additional efforts to achieve the Paris goals of keeping the global warming way below 2 °C by 2100 due to investments into low-carbon technologies. What is specific about this scenario is that the gap between energy consumption by the developed and developing countries will be closing.

GHG reductions are driven in the Climate scenario by a large-scale transformation in global energy. It is not only all about renewables, although their role in this scenario is really important. The expected growth rate in renewables and electric vehicles is not high enough to rely on these technologies alone in tackling the climate change problem. In our opinion, it will be a tough challenge to achieve significant greenhouse emission reductions without extensive usage of the Carbon Capture, Utilization and Storage technologies (CCUS). In addition, one of the key aspects in the Climate
A scenario is to improve land use and forestation efficiency. Currently, human economic activities lead to forest degradation, which affects the capacity of the forests to absorb CO$_2$. The Climate scenario assumes that in the course of time this negative trend will be overcome.

### Description of global energy development scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Scenario's key assumptions</th>
<th>Energy consumption per person, TOE/year</th>
<th>CO$_2$ emissions in 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evolution</strong></td>
<td>• Limitation of greenhouse gas emissions within the established national goals&lt;br&gt;• Gradual change of the energy mix&lt;br&gt;• Preserving the inequality in energy consumption between the developed and developing countries</td>
<td><img src="graph1.png" alt="Graph" /></td>
<td>42</td>
</tr>
<tr>
<td><strong>Equal opportunities</strong></td>
<td>• Growth of energy consumption per capita in developing countries up to 3 TOE per capita by 2100.&lt;br&gt;• Removal of limitations on greenhouse emissions in developing countries&lt;br&gt;• Domination of fossil fuels in the global energy mix</td>
<td><img src="graph2.png" alt="Graph" /></td>
<td>47</td>
</tr>
<tr>
<td><strong>Climate</strong></td>
<td>• Achieving the Paris Agreement goals of keeping the global temperature growth well below 2 °C by 2100&lt;br&gt;• Closing the gap between different countries in energy consumption&lt;br&gt;• Mass distribution of new renewables, as well as CO$_2$ capture, utilization and storage technologies</td>
<td><img src="graph3.png" alt="Graph" /></td>
<td>27</td>
</tr>
</tbody>
</table>
Primary energy demand growth is expected in all the scenarios. Irrespective of the scenario, developing countries account for just about the whole growth, which is due to the demographic trends and the rate of economic development.

The long-term primary energy demand in the Climate scenario is higher than that in the Evolution scenario. This assumption relies on the fact that the use of new technologies will help to achieve a higher level of energy supplies for the population in developing countries while reducing greenhouse emissions.

Considering primary energy demand forecasts in various global energy development scenarios it can be concluded that in the next 30 to 50 years to come fossil fuels will still dominate the global energy mix. Even in the Climate scenario, by 2050 fossil fuels will account for more than 50% of the primary energy demand mix.

The shrinking share of coal in the global energy mix will be most noticeable among all fossil fuels. This is due to the fact that in many regions coal power generation can be quite easily replaced by natural gas or renewables. In the Evolution scenario, the share of coal will be down from today’s 27% to 18% in 2050, and to 11% in 2100. Note that in the Equal Opportunities scenario

* The scenario range was chosen in reliance on the climatic scenario explorer database published along with the IPCC special report on 1.5°C global warming. The data was obtained from the following URL: https://data.ene.iiasa.ac.at/iamc-1.5c-explorer/#/workspaces.
the coal demand will grow up to the end of the XXI century, although its share in the total energy consumption will be gradually diminishing.

The share of oil in the energy mix will also reduce, but the rate of reduction won’t be as high as that of coal. While in road transportation in the long-term perspective electricity and gas will be able to compete with conventional motor fuels, in sectors like petrochemicals, road construction, and motor lubricants petroleum products will remain the most cost-efficient raw material.

The natural gas share is expected to rise in the next 20 to 30 years in all the three scenarios as it offers the lowest carbon content among all fossil fuels. The growth of natural gas consumption is not only expected in energy generation, but also in transportation.

Renewable energy consumption will grow faster than consumption of fossil fuels. In the Evolution scenario the share of renewables in the global energy mix will be up from today’s 2% to 11% by 2050. The Climate scenario suggests even more aggressive growth of the share of renewables compared to that in the Evolution scenario. Renewables will gain popularity in the mid-term due to the solar and wind generation becoming much less expensive as well as due to the adoption of energy policies that focus on all-round support for renewables pursued in many countries. In the longer term, renewables will provide a foundation for the development of hydrogen energy. Today, most hydrogen is produced in catalytic reforming units, which causes considerable amount CO₂ emissions. Adoption of the electrolytic process technology in combination with renewables will help to produce hydrogen with zero carbon emissions.

Biomass is a conventional energy source in many developing countries used for heating and cooking. Wood burning results in significant atmospheric CO₂ emissions. As the modern energy sources become more affordable, the use of wood for heating and cooking will see a decline. This will be accompanied by an increasingly higher importance of other bioenergy sources such as new generations of biofuels, and the Bioenergy Carbon Capture and Storage (BECCS). These technologies are actively used in the Climate scenario.
1.3. INVESTMENTS TO PREVENT GLOBAL WARMING

The world’s overall annual investments into renewable energy grew by 65% over the last 9 years to reach $330 billion in 2018. This figure is already comparable to the total investments into oil and gas. Most investments into renewables consists of wind and solar energy. Despite significant investments, the share of modern renewables in the global energy mix is only about 2%. Every year renewable technologies become cheaper, but it will still take some time to reach the cost-efficiency level comparable to that of fossil fuel investments.
Incentives for renewable energy and electrification of the transportation sector are key focus areas in the climate policies of many countries. Producers of renewable energy and electric vehicles receive the major share of government subsidies directed to energy decarbonization. Other promising technologies to combat global warming receive much less support. For example, the total investments into carbon capture, utilization and storage over the last decade hardly exceeded $10 billion. At the same time, the high cost of most currently known carbon capture technologies makes it impossible to attract sufficient private investments to this sector.

**Investments into renewables, $ billion**

**Government support for certain low-carbon technologies, $ billion**
The development of alternative energy and transports requires considerable subsidies. Many countries provide subsidies for renewables by imposing taxes on fossil fuels. Increasing the tax burden on fossil fuels first of all affects the purchasing power of the poorest part of the population, which promotes social inequality. Thus, an increase in motor fuel taxes was one of the reasons that provoked a surge of yellow vest protests in France.

The Climate scenario involves significant changes in the climate policy of leading economies, which means that support will be provided to the most promising CO₂ emission reduction technologies, including CCUS, BECCS, and Direct Air Capture. The Climate scenario also expects that by 2050 around 10 billion tons of CO₂ will be captured with the use of CCUS and Direct Air Capture technologies, while by 2100 about 20 billion tons of CO₂ will be captured.

### Promising CO₂ emission reduction technologies

**Carbon Capture, Utilization and Storage (CCUS)** is a technology that helps to capture CO₂ generated by fossil fuel combustion in power generation and industrial operations, for further conversion or storage. The process includes three basic stages: capturing CO₂ emitted during combustion, its transportation, storage or further industrial use.

**Bio-Energy with Carbon Capture and Storage (BECCS)** is a technology of growing biomass to be used as fuel for power generation that is followed by carbon capture or storage.

**Direct air capture (DAC)** is a technology of capturing CO₂ directly from the atmosphere, its treatment and compression to be further utilized or stored.

In the Climate scenario, a major contribution to GHG reduction is made by reforestation activities. Forests are natural carbon absorbers. The ongoing trend towards loss of forest area across the globe due to deforestation and forest fires is a huge contributor to anthropogenic emissions of CO₂.

One of the key issues with reforestation is that huge areas are required to achieve notable carbon emission reductions. On average, each fir tree at its active growth stage absorbs 1–2 tons of CO₂ per hectare. To remove 1 billion tons of CO₂ from the atmosphere, an area of 1–2 million hectares will have to be planted with such trees, which is comparable to the territory of Russia. However, some tree species demonstrate higher absorption capacity: some fast-growing trees can capture 25–27 tons of CO₂ per hectare per year. Hybrid plants with increased carbon capture capacity may appear in future. In the Climate scenario, we assume that in the long term the efficiency of reforestation activities will be increasing.
Improvement of the existing agricultural practices can have a significantly impact on greenhouse emissions. Currently, the agriculture accounts for about 14% of the total greenhouse emissions. Pasturing large amounts of cattle causes loss of forest area, and pasture degradation. The Climate scenario proposes a gradual transition towards sustainable agricultural and livestock farming practices, which will help to stop deforestation for agricultural purposes.

In the “Climate” scenario, it is predicted that by 2035 the negative impact on climate produced by deforestation will cease completely, after which the forestry will start making increasingly significant contribution to the reduction of man-induced carbon emissions. This will be achieved by the use of BECCS technology, planting fast-growing trees, and the use of new approaches to agricultural practices.

Thus, the achievement of the Paris Agreement goal is a tough challenge that requires leveraging every available solution and technology.
Structure of low-carbon investments in the Climate scenario

![Pie charts showing the structure of low-carbon investments in 2017 and 2050.]

Trajectory of anthropogenic CO₂ emissions in the Climate scenario, billion t

![Graph showing the trajectory of anthropogenic CO₂ emissions from 2000 to 2020, with bars representing different sectors and lines indicating the balance.]

- **Power Sector and Industry**
- **CO₂ capture, utilization and storage**
- **Land use and forestry**
- **Balance**
2
GLOBAL DEMAND
FOR LIQUID
HYDROCARBONS
2.1. DEMOGRAPHIC TRENDS AND GLOBAL ECONOMY GROWTH

According to the UN forecast the world population will grow from 7.7 billion in 2019 to 8.9 billion in 2035. The fastest population growth will occur in Africa and Asia where by 2035 78% of the planet’s population will live.

Africa will be the largest contributor into population growth with 40% more people living on the continent in 2035 vs. 2019. Asia will demonstrate a 10% population growth during the same period of time. Europe will experience a trend toward population decline.

Global population growth is accompanied by an increase in the share of people residing in urban areas. We expect that between 2018 and 2035 urban population share will increase from 55% to 63%. Asia will account for about 90% of the urban population growth. At the same time, the trend towards middle class growth will also continue. Our estimate is that between 2025 and 2030 the number of middle-class representatives will exceed 5 billion.

During the forecast period, developing countries will demonstrate higher economic growth than the developed countries. By 2035, the developing countries will account for about 50% of the global GDP. China and India will remain leaders in terms of growth rates among emerging economies. However, in order to preserve their high growth rates these economies will have to introduce institutional reforms. USA will be the leader in economic growth among developed countries up to 2035 as the country has favourable environment for economic development.

The nature of economic relations between the leading economies will be of major importance for global economic prospects. In recent years, the anti-globalist campaign has become an increasingly powerful movement in the developed countries. It has manifested in the imposition of duties on Chinese goods by the USA and the BREXIT. Protectionism and trade wars currently represent one of the key risks for long-term sustainable growth of the global economy.
In the next decade the global vehicle fleet will continue to grow fast mostly due to the developing economies of Asia-Pacific. China and India will account for most of the increase in the global passenger car fleet to 2035. The demand for motor vehicles in these countries is still far from saturation. The number of cars per capita in China and India is much lower than this figure for this region’s more developed economies. In China there are about 100 passenger cars per 1,000 people, while in India the figure is 30. High economic growth rates in these countries are accompanied by the growth of per capita income, which promotes private car sales. China has already entered a phase of active motorization, whereas India is at the beginning of this path. In India, still more two- and three-wheelers are sold than passenger cars.

According to our estimates, the global fleet of passenger cars will grow from the current 1.1 billion to 1.8 billion vehicles by 2035. Most growth is expected in China where the passenger car fleet will grow from the current 240 million to 400 million vehicles by 2035.

The global economic growth will involve the growth in transportation sector and higher demand for commercial vehicles. We expect that the global fleet of commercial vehicles will increase from the current 236 million to 377 million vehicles by 2035.
The structure of the global vehicle fleet will experience a gradual change towards a higher share of alternative energy vehicles (electric vehicles, hybrids, and gas-powered vehicles). Despite the legislative support for electric vehicles, the dominant type of cars in the forecast period will continue to be cars with internal combustion engines (ICE). In the Evolution scenario such vehicles will account for about 80% of the global passenger vehicle fleet by 2035, while in the Climate scenario this figure is 74%.

One of the possible directions for development of clean transportation is that of the hydrogen-powered motor vehicles. Although the use of hydrogen as a fuel is yet to gain traction, many countries are betting on it. In total, there are about 11.2 thousand vehicles powered by hydrogen in the world. The main factors hindering the spread of hydrogen cars are their high price, underdeveloped fueling infrastructure and concerns about the safety of such vehicles. Given the above limitations, before 2035 we do not expect intensive growth of the hydrogen vehicle fleet.

**Global vehicle fleet forecast in the Evolution scenario, million vehicles**

<table>
<thead>
<tr>
<th>Passenger cars</th>
<th>Commercial vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional (ICE)</td>
<td>Methane (CNG/LNG)</td>
</tr>
<tr>
<td>Plug in hybrids (PHEV)</td>
<td>Battery electric vehicles (BEV)</td>
</tr>
<tr>
<td>Fuel cell electric vehicles (FCEV)</td>
<td></td>
</tr>
</tbody>
</table>

2017 2019 2021 2023 2025 2027 2029 2031 2033 2035
0 500 1000 1500 2000
0 100 200 300 400
2.3. PROSPECTS FOR ELECTRIC VEHICLES

The electrification of the transportation sector serves as an underlying concept for climate policies in many countries. A number of countries have already announced their preparedness to discontinue the use of conventional vehicles with internal combustion engines. The UK and French authorities are planning to ban the sales of ICE vehicles in 2040, and countries such as Sweden, Denmark, and the Netherlands are going to impose a ban on sales of ICE vehicles even earlier, in 2030.

The idea of switching the world vehicle fleet to electric motors has been supported by leading car manufacturers. Automotive companies are planning to heavily invest in the development of new electric models. According to their plans, over 100 new electrified models will be available on the market by 2025, while sales of new electric passenger cars may be as high as 50 to 100 million vehicles.

Many countries have electric vehicle transportation support programs in place. In the USA and a number of European countries, tax incentives are available for those who buy electrically-driven vehicles. In 2018, China introduced a target program to ensure a minimum number of alternative vehicles are produced. Since 2019, the minimum quota for the production of alternative vehicles for manufacturers will be 10%, and in 2020 the quota is expected to increase up to 12%. Some countries offer additional benefits for electric vehicle owners, such as free parking, free use of toll roads, free charging and simplified registration procedures.

Despite active government support, the electric car market is still relatively small. In 2018, a total of 2.1 million electric vehicles were sold around the world. Of these, only 1 million vehicles are purely electrical, i.e. vehicles using electric drive only. For comparison, about 80 million passenger cars were sold in the world in the same year, 2018. The share of pure electrical vehicles in total 2018 sales of passenger cars was 1.2%. The leader in electric vehicle sales is China. It accounts for around 60% of all global electric vehicle sales. Moreover, unlike other countries, 80% of electric car sales are pure electric cars.

By the end of 2018, the global fleet of electrical vehicles totaled 5 million, of which 2.2 million were purely electrical vehicles. The share of purely electrical vehicles in the global fleet is still insignificant – only around 0.2%.
One of the most significant obstacles to the massive spread of electric transport is its high cost. If we compare two cars of the same class, the price of an electric car without subsidies will be 75% higher than that of a similar car with an ICE. The main reason is the presence of a powerful battery in an electric car. The battery pack cost accounts for 30–40% of the cost of electric vehicle. The prospects for distribution of the electric transport will largely depend on how quickly the battery cost will be going down.

As of 2018, the average cost of a battery pack was around 200 $/kW*h. In order to achieve parity in the cost of ownership between ICE and electric vehicles, the unit cost of a battery pack should be reduced to at least half the current number to 100 $/kW*h.

The cost of lithium-ion batteries could potentially be reduced by varying the component mix of the active materials in the battery. Active materials are the materials from which the main elements of battery cells are made – the cathode, anode, electrolyte and separator. The most expensive element of a battery cell is the cathode, which is made of metal. We estimate that a transition from the currently popular NMC (111) cathode assembly to NMC (811) would reduce the cost of active battery materials by 50% through the replacement of expensive cobalt with cheaper nickel.

**Average battery pack cost forecast, $ 2018/kW*h**
Production scale growth is another important area to focus on in order to achieve a lower battery pack production cost. Cost reductions will be achieved through a higher efficiency in the use of resources, the workforce, and accumulated knowledge. Many companies are currently investing in expanding their electric car battery production capacity. A threefold increase in battery production capacity is expected by 2022. Almost a half of that capacity will be built in China.

According to our estimates, in the Evolution scenario, the average cost of batteries will reach an average of $100/kW*h by 2030. At the same time, the cost of ownership of electric vehicles and ICE vehicles will be equal by 2030-2035, depending on car class and region. For example, the cost of ownership of sub-compact and crossover vehicles will achieve parity later than compact vehicles. The parity in the cost of ownership will be reached earlier in high-tax environments (EU member states) than in low-tax countries (USA).

It should be noted that an increase in the production of electric vehicles could cause an increase in the prices of metals that make up the batteries. If we assume that the cost of lithium, nickel and cobalt will double by 2025 compared to 2019 and will remain at this level for some time, then the battery cost of $100/kW*h will not be reached by 2035.

Electric vehicles have an advantage in maintenance costs and fuel costs compared to traditional cars. However, currently electric vehicle ownership involves extra expenses. Firstly, if the electric vehicle is used on a regular basis, the life of the lithium-ion battery will be 5-7 years, after which its power decreases. Therefore, when calculating the total cost of ownership of an electric car, it is necessary to take into account the costs associated with replacing the battery. Secondly, electric vehicle insurance is more expensive than that for an ICE car. Thirdly, according to existing estimates, the average annual mileage of electric vehicles is lower than ICE vehicles. This is due to the fact that electric cars are often used as the family’s second car for short city drives. Long-distance travel is carried out on ICE vehicles or other forms of transport, such as planes or trains. The use of alternative transport involves extra fuel consumption and carbon emissions. As the charging infrastructure becomes more developed, this effect will be less significant than it is at present.

The electrification in freight transportation is slower than in the case with passenger cars. This is due to inherent engineering issues. Large-capacity transport requires powerful batteries, which also take up a lot of space. The electrification
of light commercial vehicles appears to be a more promising area in the short term rather than attempting to use electric drive in heavy-duty trucks.

China is the leader in sales of electric commercial vehicles. In 2018 about 200 thousand electric trucks and buses were sold in China. Programs for electrification of public transportation in big cities contribute a lot into the sales of commercial electric vehicles. For example, in 2017 the Chinese city of Shenzhen, with a population of more than 12 million, converted 100% of its bus fleet to electric drive. In other countries, the pace of electrification of commercial vehicles is much slower than in China. At the end of 2018, 2.6 thousand electric freight vehicles, including buses, were sold in Europe.

As the production cost of batteries gets lower, sales of electric commercial vehicles will rise. However, we expect that the electrification of the commercial fleet will go slower than that of the passenger car fleet.

An important question in analyzing the prospects for the spread of electric vehicles is how much these cars can reduce greenhouse gas emissions compared to traditional ICE vehicles. For a correct comparison, it is necessary to take into account emissions for the entire life cycle of the car from production to its disposal. More CO₂ is emitted during the production of electric vehicles than
the production of ICE vehicles. However, during the course of its operation, an electric vehicle produces less CO\textsubscript{2} than its ICE equivalent. The rate of carbon emission reduction resulting from the distribution of electric vehicles will largely depend on the power generation fuel mix. The more renewables in the energy mix, the better the prospects for carbon emission reduction due to the growth of the electric transportation sector. Our estimate is that, if we take the US en-
Comparing greenhouse emissions over the entire life cycle of a passenger car, tons of CO₂ equivalent

* The following assumptions were made for calculation purposes: vehicle class – compact, vehicle service life – 15 years, average annual kilometrage – 15,000 km, emissions from ICE vehicle operation include emissions related to manufacturing, transportation, and use of motor oil, emissions from electric car operation include emissions related to electricity generation and battery replacement.

The need for metals to produce battery units for electric vehicles, thousand tons

<table>
<thead>
<tr>
<th>Lithium</th>
<th>Cobalt</th>
<th>Nickel</th>
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<tbody>
<tr>
<td>2018</td>
<td>2018</td>
<td>2018</td>
</tr>
<tr>
<td>EO</td>
<td>EO</td>
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</tr>
<tr>
<td>Evolution</td>
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<tr>
<td>Climate</td>
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<td>2018</td>
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<td>EO</td>
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<td>2035</td>
<td>2035</td>
<td>2035</td>
</tr>
</tbody>
</table>

The energy mix as an example, during its entire lifecycle, an electric vehicle produces 25% less CO₂ than its ICE equivalent. Given that the large-scale electrification of transport requires massive investments in R&D and infrastructure, for many countries, the transition to electric vehicles will prove to be an extremely expensive and inefficient way to reduce carbon emissions. Our calculations suggest that reducing 1 ton of CO₂ emissions in the USA through the use of electric vehicles requires...
vehicles will cost over 500 dollars, which is much more expensive than many other greenhouse emission reduction technologies.

Despite certain advantages in terms of reducing CO₂ emissions, electric cars can harm the environment and the health of people involved in their production. Lithium and cobalt, being key components of electric vehicle batteries, are classified as extremely hazardous elements. The penetration of cobalt or lithium into the soil leads to its contamination. Nevertheless, we may still expect that, as the time goes by, the component mix of batteries will change, and the major focus will not only be on the cheapest materials, but also on those that cause the least damage to the environment.

2.4. NATURAL GAS CONSUMPTION IN THE TRANSPORTATION SECTOR

The imposition of tighter climate policies in many countries is contributing to the popularity of natural gas as a motor fuel.

In the transportation sector, natural gas is used in a compressed (CNG) or liquefied (LNG) state. The advantage of LNG compared to compressed gas is the increased energy capacity of this type of fuel. This helps to reduce the size of the fuel system and increase the range. However, there are a number of factors that prevent the rapid spread of LNG as a motor fuel. Firstly, LNG has a higher production cost than CNG. With the current gas to diesel price ratio in a number of countries, it is not economical to convert heavy-duty vehicles. We estimate that the acceptable payback parameters of converting heavy-duty trucks are achievable in Europe, where diesel is subject to high taxes, and in China, where LNG trucks are cheaper than in many other countries. Secondly, the cost of LNG refueling infrastructure is significantly higher than the cost of constructing pumping stations.

Passenger cars and light commercial vehicles powered by CNG are in direct competition with electric vehicles. Currently, in many countries, electric vehicles receive much more support than gas-fueled motor transport. The exception is Russia, where there is a large-scale program to support gas-fueled vehicles. We expect that the share of natural gas vehicles in the global passenger car fleet will be several times lower than that of electric cars. A different situation will be observed in commercial transport. In this field, due to technical issues, gas powered trucks can compete with electric vehicles, especially in the heavy-duty segment. Therefore, it is expected that by 2035,
the share of natural gas vehicles and that of electric trucks in the global commercial vehicle fleet will be roughly the same.

Another source of growth in natural gas consumption in the transportation sector is marine bunkering. Imposition of tighter environmental standards for marine fuels by MARPOL in 2020 will result in higher LNG consumption by marine vessels. By 2035, LNG may gain up to 10% of the marine fuel market. The most active conversion to LNG is expected among fixed route vessels such as ferries and barges. In addition, with the development of international trade in LNG, the number of methane tankers will increase, which will also contribute to an increase in the consumption of natural gas in shipping.

As of 2019, the marine fleet using LNG as a fuel totals 170 vessels, with a further 184 vessels on order for construction. Europe is the key region for the development of marine LNG shipping. Development of the LNG Masterplan project is currently underway. The project focuses on LNG conversion of river barges running on European navigable rivers.

### 2.5. LIQUID HYDROCARBONS CONSUMPTION BY THE TRANSPORTATION SECTOR

Trends such as imposing more strict environmental standards for CO₂ emissions in many countries, increasing sales of electric vehicles, and the spread of natural gas vehicles will cause the growth in oil demand from the trans-
portation sector to gradually slow down. In the Evolution scenario, we do not expect a peak in demand for oil in road transportation. A slight decline in consumption of petroleum products by passenger cars will be compensated by their higher consumption by commercial vehicles.

In the Climate scenario, which assumes tougher environmental restrictions than the Evolution scenario, the decline in oil demand from road transportation begins after 2030.

The greatest influence on the growth rate of oil consumption in road transportation in the forecast period will be improvements in fuel efficiency. The Evolution scenario assumes that the unit fuel consumption of new cars will decrease by an average of 30% during the forecast period. The influence of fuel efficiency on oil demand in the forecast period will be more significant than the effect of the spread of alternative transport.

Consumption of petroleum products in sectors such as marine transport, air transportation, river and rail transport will be growing faster than in road transportation. The highest growth rate (more than 60%) is expected in air transportation. The growth of the middle class in developing countries will stimulate the demand for air transportation. It is also not expected that alternative fuels will be able to seriously compete with aviation kerosene in the next 10–15 years.

The growth of international trade will promote the consumption of petroleum products in marine transportation. The share of LNG as a fuel for marine ves-

**Demand for liquid hydrocarbons in road transportation in the Evolution scenario, mb/d**

<table>
<thead>
<tr>
<th>Year</th>
<th>Passenger transport</th>
<th>Commercial transport</th>
<th>2/3-wheeled transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
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<tr>
<td>2035</td>
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</tbody>
</table>
sels will be growing steadily. However, this process will occur rather slowly as the fleet of ships is updated and international trade in LNG increases.

In the Evolution and Equal Opportunities scenarios, oil consumption in the transportation sector is expected to increase throughout the forecast period. In the Climate scenario, oil consumption in the transportation sector is expected to gradually decline starting from 2030.

**Factor analysis of liquid hydrocarbons demand change in road transportation in the Evolution scenario, mb/d**

**Liquid hydrocarbon consumption projections for the transportation sector, mb/d**
2.6. LIQUID HYDROCARBON DEMAND IN PETROCHEMICAL SECTOR

Refined petroleum products such as naphtha and LPG are a traditional feedstock for the production of petrochemical products. The consumption of liquid hydrocarbons in the petrochemical industry will grow faster than in other sectors. The traditional regions with a predominance of naphtha consumption by steam crackers are the countries of the Asia-Pacific region. North America and Middle Eastern countries mostly use NGL as a petrochemical feedstock.

The rapid development of the petrochemical industry in Asia-Pacific is a key growth driver for the consumption of petroleum products in petrochemicals. China will be the leader in the growth of monomer production in the next five years.

The rapid growth of U.S. shale gas production resulted in higher supply of gas feedstock for the petrochemical industry. Therefore, the USA is planning to significantly increase ethylene production. In the next 5 years, the USA is expected to commission a number of major petrochemical facilities, with a total ethylene production capacity of 12 million tons.

Despite the expected growth of global polymer production capacity, certain factors will slow down the growth of demand for liquid hydrocarbons from the petrochemical industry. Such factors may include the development of polymer recycling and legislative limitations on the use of disposable plastic products in a number of countries.

**Ethylene production capacity forecast, million tons**
In the Evolution scenario, the demand for petrochemical feedstock will experience an 18% increase by 2035 relative to the level of 2018. In the Climate scenario, the demand for petrochemical feedstock will be lower than in Evolution scenario due to tighter polymer market regulation.

### 2.7. Oil Demand in Other Sectors

The industrial development and urbanization in developing countries are the key drivers of petroleum product consumption in the industrial sector. Consumption growth is expected in sectors such as metallurgy, concrete production, building, and road construction. In developed countries, the consumption of petroleum products by the industrial sector will gradually decrease due to increase in energy efficiency.

Households are major consumers of petroleum products. LPG and heating oil are used in many countries for cooking and heating. Unlike natural gas, significant investments in infrastructure are not required to consume propane-butane. Therefore, we can expect an increase in demand for LPG in developing countries due to the transition from burning wood to using LPG for the same purpose. Gasoil consumption for heating is likely to be reduced due to its replacement with natural gas and electricity.
Global population growth will lead to an increase in demand for agricultural products, which in turn will contribute to an increase in demand for diesel fuel, the main fuel for agricultural machinery.

Over the past few decades, the demand for petroleum products from power generation sector has been declining. We expect this trend to continue in the future. The decline in consumption of petroleum products will be due to their replacement with natural gas and renewables. Residual fuel oil and gasoil will still be used as a backup fuel for power plants and social infrastructure facilities.

**2.8. GLOBAL LIQUID HYDROCARBON DEMAND SCENARIOS**

Summarizing the findings of the global demand analysis by individual industries and the analysis of macroeconomic trends, we can conclude that the global demand for liquid hydrocarbons will most likely grow until 2035. In the Evolution scenario, we expect that demand for liquid hydrocarbons will increase from the current 100 mb/d to 110 mb/d. At the same time, we expect to see a gradual decline in the growth rate of the global demand for liquid hydrocarbons.

If we proceed from the assumption that passenger cars will become more affordable due to lower environmental standards (the Equal Opportunities scenario), the global demand for liquid hydrocarbons should rise to 120 mb/d by 2035.
Tighter environmental legislation in major economies can lead to a reduction in demand for liquid hydrocarbons. In the Climate scenario, oil consumption peaks in 2027. Prior to that time, oil demand will continue to grow, mainly due to the inertia of the global vehicle fleet structure, although the growth rate will be slightly lower than in the Evolution scenario.
GLOBAL LIQUID HYDROCARBONS SUPPLY
3.1. OPEC OIL PRODUCTION POTENTIAL

Oil production by OPEC is at the heart of the existing model of the global oil market. OPEC members such as Saudi Arabia, Kuwait, UAE, Iran, Iraq, and Libya accommodate the world’s largest oil fields, discovered in the mid 20th century.

Due to the unique geological properties of their major oil fields, OPEC members have substantial spare production capacity. Spare capacity is normally defined as additional oil production that can be reached within 30 days and maintained for at least 90 days. If necessary, OPEC participants can quickly supply additional volumes of oil to the market, which allows these countries to quickly influence the balance of supply and demand in the global oil market. Recent experience has shown that no other country outside of OPEC, including the US, can regulate the oil supply as fast as the OPEC members.

Saudi Arabia, Kuwait, and UAE play a decisive role in shaping OPEC policy. These producers constitute the largest coalition within OPEC, accounting for over a half of the organization’s production and most of its spare production capacity.

Saudi Arabia holds the world’s largest proven oil reserves. In 2018, the first independent audit of Saudi Aramco reserves was conducted, which showed that the state-owned company has more than 200 billion barrels of proved reserves.

Due to the geological properties of the fields and the low cost of delivering oil to major consumers, the total cost of oil production in Saudi Arabia is one of the lowest in the world and amounts to about 20 $/barrel. Saudi Arabia seeks to maximize the value of its reserves by gradually bringing them into development, and thus extending the lifetime of its oil deposits. Between 2004 and 2009, Saudi Aramco increased its production capacity from 10 to 12 million barrels per day with the help of the Khurais, Khursaniyah, Shaybah and Nuayyim fields. The strategy of Saudi Aramco is to maintain its long-term production capacity at 12 mb/d. After 2020, this target level will be maintained through offshore projects (Zuluf, Marjan, and Berri). We assume that until 2035, Saudi Aramco will keep production at a level slightly below its production capacity.
The United Arab Emirates are in the top ten countries in terms of proven reserves. Most of the country’s production comes from mature fields. The cost of oil production in the UAE is on par with Saudi Arabia. In the coming years, the UAE, with some assistance from international companies, expects to increase its production capacity by 500 kbbl/d, primarily through offshore projects. The long-term goal of the UAE national oil company, Adnoc, is to bring production capacities to the level of 5 mb/d. We estimate that up to 2035, the UAE will maintain its oil production somewhat below its production capacity, at around 4 mb/d.

Kuwait’s proven oil reserves total some 100 billion barrels, with most of the production coming from mature fields. For many years, the country wasn’t really pushing for the development of new fields, since the government took a critical stance towards foreign investors. However, in the past few years, the situation has changed significantly, which has contributed to the arrival of international companies in the country. When implemented, the new projects are expected to boost Kuwait’s oil production in the coming years to 3 mb/d.

Some of the OPEC members are countries with enormous resources. However, their potential is not realized for various reasons. These countries include Iraq, Iran, and Venezuela. The key to success in developing resource potential
in these countries is economic and political stability. Events such as the political crisis in Venezuela and the imposition of sectoral sanctions on Iran make the prospects for production growth in these countries highly uncertain.

Iraq has significant growth potential for low-cost oil production. With more foreign investors coming in, the nation’s oil production has risen by 40% over the last 5 years. Further growth in oil production in the country will be determined by the investment activity of foreign companies. Oil accounts for up to 90% of Iraq’s fiscal revenue, which is why the socio-economic situation in the country is strongly dependent on oil prices and export volumes. According to experts, Iraq is capable of reaching the 8 mb/d production mark by 2030, which is below the 12 mb/d initially planned by the Iraqi government. Expectations regarding the implementation of new projects have been lowered due to a number of reasons, including strict terms and conditions stipulated in contracts with foreign companies, contract payment delays, bureaucracy, security issues, and infrastructural constraints. Despite the existing risks, we still expect the country’s production to grow in the long term. The bulk of the increase in oil production in Iraq will be from large fields in the south of the country.

Iran is a country with vast conventional oil resources. As of 2019, the crude production capacity of Iran is estimated at 3.9 mb/d. Most of the coun-
Production of oil and condensate in Iran and Iraq, Evolution scenario, mb/d

Between 2015 and 2018, the socio-economic crisis and the imposition of US sanctions triggered a more than twofold decline in Venezuela’s oil production. The possible scenarios of how the political situation in Venezuela will unfold render the prospects of the country's oil production highly uncertain. Most of Venezuela's undeveloped reserves are heavy oil in the Orinoco Belt. To develop these reserves, the country needs foreign investment and technology. However, the cost of producing heavy oil is high, and the implementation time for such projects is long, which may scare away many potential investors, even in case of a change in the political regime in the country.

African countries account for roughly a quarter of the total OPEC oil output. OPEC members such as Nigeria and Libya are sources of constant uncertainty in the supply of oil. The Nigerian petroleum infrastructure is repeatedly attacked by rebels, which adds to the instability of oil production in the country. The Lib-
yan oil production that was restored over the last few years also appears unstable against the backdrop of the intensification of the internal political conflict.

The future production potential of African OPEC member countries is associated with the implementation of deepwater projects. According to our estimates, until 2035, the increase in production from new projects on deepwater offshore will not be sufficient to compensate for the decline in production at mature fields. In the Evolution scenario, oil production in African OPEC member countries will drop from the current 6.8 mb/d to 4.8 mb/d in 2035.

### 3.2. US OIL PRODUCTION POTENTIAL

In recent years, US oil production growth has surpassed all the optimistic forecasts. Since the beginning of 2016, oil production in the country has grown by more than 3 mb/d and reached 12 mb/d in early 2019, surpassing the historical record of 1970. The key driver of the US production is still tight reservoir oil, which is often called shale oil.

An important trend in recent years has been the explosive growth of oil production in the Permian basin. Since the beginning of 2016, oil production in this formation has grown by more than 2.5 times, reaching 4 mb/d in the second half of 2019. Such rapid growth was due to the favorable geology of the Permian formation and its relative proximity to markets. Between 2016 and 2019,
the other major shale formations, such as Bakken and Eagle Ford, demonstrated much slower growth rates compared to Permian.

The growth of the US shale oil production has proven itself resilient to global oil price fluctuations. Such resilience is due to high stability of the increase in the efficiency of new wells drilling. Since 2010, the US has been optimizing its drilling rigs fleet, improving well designs, and quality of proppant used for fracking. In addition, trying to maximize the involvement of the most productive parts of shale formations, the US producers have been active at infill drilling. This considerably lowered the breakeven points for typical shale wells. As of the second half of 2019, a typical Bakken well pays off at a WTI price of 50–60 $/barrel. The breakeven point of a typical Permian well is even lower at 30–40 $/barrel.

There are a number of factors that prevent a further reduction in the cost of shale oil production in the United States. The aggressive growth of oil production in the Permian formation has led to a significant increase in the utilization rate of the transport infrastructure and the widening of the spreads between the oil price at the wellhead and the price of WTI. The lack of sufficient pipeline throughput capacity generates risks of production limitation. In addition, for the Permian formation, there are problems related to the utilization of associated petroleum gas, the use of water from fracking activity and a shortage of labor resources.
Recently, there have been more and more indications that the limit to which a shale formation development can be improved through infill drilling has been reached. If located excessively closely, the wells interfere with one another, which drives down individual well production rates. This trend forces operators to move to the frontier zones of shale formations, which have a higher production cost. According to some sources, in multiple Permian locations, infill wells constitute half of the total well count.

Another noticeable trend of the shale industry is its consolidation i.e. a reduction in the number of small producers. The oil and gas majors, such as ExxonMobil and Chevron, have added a considerable amount of shale assets to their project portfolios. This is accompanied by simultaneous increase in size of enterprises that focus on shale oil production. In 2018–2019, a number of mergers and acquisitions were conducted, as a result of which new large players involved in the production of shale oil were created. We expect that in the long run it will be large companies with significant financial resources that will demonstrate growth in shale oil projects.

The financial factor in the form of a high debt burden has a strong impact on small and medium-sized shale companies. The 2014 decline in the oil price have undermined the financial solvency of many companies which growth was fueled by debt. Those companies that managed to avoid bankruptcy and stabilize the level of debt, as oil prices recovered, preferred, for the most

**US shale oil production projections, Evolution scenario, mb/d**

![Graph showing US shale oil production projections](image-url)
part, to invest again in production growth, rather than to pay dividends. This strategy is currently severely critiqued by investors. The change in strategy by small and medium-sized producers under pressure from the investors will most likely decelerate production growth for this category of companies.

Thus, the indicated trends allow us to talk about the soon transition of the shale industry in the United States to a new stage of development, characterized by a slowdown in growth rates and stabilization of production. We expect that the growth of shale oil production in the USA will practically stop by 2025 and shale oil production itself will stabilize at around 10 mb/d.

The most important issue for predicting the potential for oil production in the United States is the assessment of the country’s resource potential. Given the unconventional nature of reserves, there is significant variation in the estimates and, as a result, the long-term potential for shale oil production in the United States is estimated differently by different analysts.

In our opinion, oil production in the United States will reach 14 mb/d by 2035. Shale oil will be the main source of production growth in the country in the next decade. In addition to shale oil, some increase in production is expected due to the implementation of deepwater projects in the Gulf of Mexico. Removing restrictions on the exploration of the US Arctic shelf will have a positive effect on oil production in the country. However, we do not expect

**Production of oil and condensate in the USA, Evolution scenario, barrel**
US production in the Arctic offshore to play a major role until 2035.

The rate at which US oil production will continue to grow in the years to come will, in many ways, depend on the fluctuations of global oil prices. In terms of production costs, as it stands, US oil is fairly competitive with the production projects in other countries. However, in the long term, the cost of production in the United States is expected to increase, since the maintenance of production will require the development of new, less productive areas of shale formations.

3.3. SHALE OIL OUTSIDE THE USA

Vast shale oil reserves were discovered in more than 10 countries. Despite the existing resource potential, shale oil production outside the United States, as of 2019, is only about 600 kbbl/d. The growth of shale oil production outside the United States is mainly hampered by adverse institutional conditions and technological constraints.

Around 40% of all oil shale resources are situated in water deficient areas. Some countries do not have drilling rigs of the right design at hand to drill complex wells. No country, except the USA, has a sufficiently developed service sector capable of quickly accommodating the needs of oil producers. The combination of these factors contributes to the high cost of developing

Comparison of breakeven prices for typical shale wells*, $/barrel

* Calculations are based on 10% rate of return. Calculation results are normalized for Brent.  
** A preliminary estimate of the achievable cost of production based on data available for drilled wells.
Shale oil production outside of the United States, mb/d

shale reserves outside the USA.

Currently, oil production from tight oil reservoirs, in addition to the United States, is carried out mainly by Canada and Argentina. These countries will provide the main increase in shale oil production outside the United States until 2025.

Shale oil production in Canada is carried out in the Montney and Duvernay formations, which can be compared to production in US shale basins in terms of cost. Canada is the first country, other than the US, to commence large scale development of its shale oil resources. The country has favorable conditions for shale projects, such as a developed market of privately-owned service companies, cheap capital, availability of ready-made infrastructure, low population density, and extensive water resources. However, growth in shale oil production in Canada is constrained by high transportation costs and limited pipeline capacity.

The Vaca Muerta formation in Argentina is the only shale formation outside of North America to transition from exploratory drilling to full-scale production. According to experts, the resource potential of this region is huge and surpasses the super-productive Permian basin in the United States. However, development of most of the Vaca Muerta formation is rather challenging. The key challenges include the need to invest in the infrastructure, including water supply systems, a lack of qualified labor, and the macroeconomic instability in Argentina.
Growth in shale oil production in other countries is expected in the longer term. Competition from conventional resources will restrain shale oil production growth in countries such as Mexico and Algeria. A significant increase in shale oil production outside the USA is expected after 2030. At the same time, Russia and China have the greatest potential for increasing shale oil production.

As part of the efforts of the Chinese government to increase domestic energy supply amid falling oil production at mature fields, CNPC and Sinopec have increased investment in exploration of tight oil reservoir in Western China. The exploration activity is centered around the Songliao, Ordos, and Junggar basins. In 2018–2019, Petrochina repeatedly reported the discovery of shale oil reserves. Notably, when testing an exploratory well at the Jimsar field, whose reserves are estimated at 1 billion tons, an oil inflow of 100 tons per day was obtained. If the shale development program is successful, China could become one of the largest producers of unconventional oil outside the United States. However, given the early stage in the development of shale reserves, we do not expect a significant increase in shale oil production in China until 2030.

Russia, like China, is at an early stage in the development of unconventional resources. According to our forecasts, industrial oil production from the reservoirs of the Bazhenov formation will begin in the next 5 years. A more detailed analysis of the prospects for the extraction of unconventional oil in Russia is given in section 6.3.

### 3.4. SUPPLY OF LIQUEFIED GASES AND OTHER LIQUID HYDROCARBONS

In addition to oil, an important component of the global supply of liquid hydrocarbons are liquefied gases, refined products obtained using gas-to-liquids (GTL) and coal-to-liquids (CTL) technologies, and biofuels. In 2018, these sources added about 13 million barrels per day to the global supply.

In recent years, the share of NGL in the liquid hydrocarbons supply has increased considerably. The increase in liquefied gas production is associated with the development of the gas industry, the growth of shale gas and oil production in the USA, and the implementation of large LNG projects.

About a half of the NGL output is currently concentrated in the United States. The increase in shale oil production is accompanied by an increase in the production of associated petroleum gas, which is used by gas processing plants.
as feedstock to produce NGL. We expect that the upward trend in the supply of NGL in the United States to continue until 2025, after which the NGL output will stabilize.

In addition to the US, traditionally, the major NGL producers have been Middle Eastern countries i.e. Saudi Arabia, UAE, Qatar, and Iran. The NGL production by this group of countries is expected to be relatively stable. The NGL production in Russia is expected to grow due to the commissioning of new gas fields.

Other significant sources of liquid hydrocarbon supply include biofuels and the production biofuels using GTL/CTL technologies. The growth in biofuel production in recent years is a consequence of international policies to combat greenhouse gas emissions. Many countries have standards that mandate the use of biofuels as components of gasoline and diesel. However, increasing the share of biofuel in motor fuels up to 10–15% would require retrofitting engines and fuel injection systems, thus limiting the potential expansion of biofuels. In addition, existing biofuel production technologies are quite expensive and are associated with significant greenhouse gas emissions. The introduction of a new generation of biofuels that do not compete with crops for acreage may well give biofuel industry a new impetus.

All petroleum product projects implemented to date using GTL and CTL technologies have been highly capital intensive. Given the unstable link between gas, coal and oil products prices, we do not expect significant investments in such projects.
3.5. THE CONSEQUENCES OF THE “INVESTMENT GAP” FOR THE GLOBAL OIL SUPPLY

The majority of the major oil fields were discovered in the 1950s and 1960s. Most major fields are currently in the late stages of development, which is characterized by a natural decline in production. The volume of liquid hydrocarbon reserves discovered annually is declining. New discoveries are dominated by reserves with high development costs. In the last few years, the biggest discoveries have been made in deepwater offshore areas.

The fall in oil prices in 2014 led to a sharp decline in investment in oil production and exploration projects. In 2016, the volume of investment in oil projects was almost two times lower than in 2014. Since 2016, there has been a tendency towards a slow increase in investment. However, the current volume of investment is still way below the 2012–2014 levels.

The decline in investment has led to several negative consequences for the industry. Firstly, a number of new projects have been rescheduled or postponed. Secondly, the natural decline in the production at mature fields has accelerated. Thirdly, the volume of new discoveries have decreased. These tendencies create conditions for a supply shortage in the market. According to our estimates, the shortage of new production projects will begin to be noticeable in 2022–2023.

Capital investment in oil exploration and production, billion $
3.6. REVIEW OF THE PRIMARY SOURCES TO FILL THE SUPPLY SHORTAGE

Currently, a large number of oil projects with different production costs compete in the market. The lowest production costs are associated with projects for the development of conventional fields in the OPEC member countries located in the Persian Gulf. The most expensive projects include Arctic offshore projects and projects for the production of heavy viscous oil in Venezuela and Canada. A distinctive feature of the last five years has been the change in the shape of the supply curve for new production projects – it has become more flat than it was before, due to lower cost of shale oil production in the USA and the decrease in cost of deepwater offshore projects.

From the publication of the previous report in late 2016, new production projects tend to have lower breakeven prices. This trend is a consequence of a number of factors, among the most significant of which are: the weakening of the national currencies of oil-producing countries, the optimization of technical solutions, the standardization and scaling of projects, and the application of digital technologies. The reduction in production costs is most noticeable when implementing technologically complex projects.

Average breakeven prices for new projects*, $/barrel

* Calculations are based on 10% rate of return. Calculation results are normalized for Brent.
2016 to 2019, the breakeven price for deepwater offshore projects decreased on average by 22%, and for US-based shale projects, the figure is 30%.

We estimate that in the medium term, the breakeven prices for new production projects will be relatively stable. After 2025, we expect a slight increase in the cost of shale oil production in the United States due to the exhaustion of the potential for infill drilling in the most productive areas of shale formations.

### 3.7. IMPACT OF THE DIGITAL TECHNOLOGIES ON OIL PRODUCTION

An important trend of recent years is the great attention of international energy companies to the use of digital technologies in various aspects of their activities. Digital technology is normally defined as a set of engineering solutions designed to improve the operating performance of an enterprise, such as predictive analytics using artificial intelligence, big data analysis, computer vision, creation of digital twins of assets, or robotization of routine operations.

The use of digital solutions in the oil industry can considerably increase the efficiency of modelling and forecasting of various production processes, shorten the time needed to select optimal equipment, minimize downtime and maintenance periods, ultimately reduce the cost of field development and improve ORF. Digital technology also contributes to a better understanding of the geology of oil reservoirs. This results in a lower exploration risk.

We anticipate that the widespread use of digital technology across the oil industry is capable of slowing down the decline of production at mature fields and reduce the cost of oil production by 10%-15% by 2035. As a result, the reduction of costs through digital technology will help to curb the growth of new project production costs amid the deterioration of the resource base.
4
THE GLOBAL BALANCE OF SUPPLY AND DEMAND OF LIQUID HYDROCARBONS
4.1. THE ROLE OF OPEC IN REGULATING THE GLOBAL OIL MARKET

The present structure of the oil market is close to an oligopoly, in which OPEC plays a leading role. The organization controls more than 70% of the world’s proven oil reserves and more than 50% of the international oil trade. The most influential participants in OPEC are countries such as Saudi Arabia, Kuwait and the UAE, as they have at their disposal about 50% of OPEC’s proven oil reserves and almost all of the spare production capacity in the world. Due to these features, OPEC policy is largely dependent on the actions of these countries.

The oil industry is the core of the economies of OPEC member countries. In some countries, such as Iraq or Libya, the revenue from oil exports exceeds 90% of all export earnings. Therefore, maintaining stable oil prices is a matter of survival for many OPEC member countries.

Certain OPEC members have attempted to reduce their dependence on oil exports. A vivid example of such policies are the reforms implemented by Saudi Arabia. As part of the national program “Vision 2030”, projects aimed at building infrastructure, developing tourism, creating new industries, and using renewable energy sources are being realized. However, in order to carry out these reforms, the country needs a stable inflow of revenues from the sale of hydrocarbons. In 2018, Saudi Arabia budget was balanced with Brent price at 84 $/barrel. At the end of 2019, it is ex-
pected that with an oil price below 85 $/per barrel, the Saudi budget will be in deficit. Therefore, Saudi Arabia is still interested in keeping the market prices fairly high.

Another argument in favor of a stable price policy is the initial public offering of Saudi Aramco stocks. Saudi Arabia is interested in attracting the highest possible sums of money from the sale of the company’s stock and in maintaining stable stock price.

OPEC members budget breakeven prices in 2019, $/barrel

Source: IMF

4.2. IMPACT OF OPEC+ ON THE GLOBAL OIL MARKET

OPEC traditionally acted as a market stabilizer, reducing oil supply at times of surplus and compensating for any shortages by utilizing spare production capacity. The attempt to abandon production management in 2014 resulted in higher market price volatility and greatly increased the sustainable development risks faced by the oil industry.

A landmark event that greatly reinforced the role of OPEC in the global oil market was the signing of the OPEC+ Agreement in late 2016 between OPEC members and a number of independent producers. OPEC + Agreement was
supported by 11 independent producers, including Russia, Mexico, Oman, Kazakhstan and Azerbaijan. The OPEC+ Agreement became a reality primarily due to the cooperation between Saudi Arabia and Russia. As a result this Agreement, OPEC decided to reduce production volumes, putting an end to the policy of non-intervention.

Between 2016 and 2019, the OPEC+ Agreement proved its effectiveness, with the key parties to the Agreement fully complying with their obligations to regulate production. Such well-coordinated interaction amongst the oil producing countries is a rare occurrence within OPEC. The OPEC+ parties succeeded in bringing their commercial stock of oil and petroleum products back to normal level, and reducing market price volatility.

The readiness of the OPEC+ parties to preserve the regulation mechanism was reiterated through the signing of the Charter for Long-term Alliance. The Charter is a new framework document, fixing the format of cooperation between the countries participating in the OPEC+ Agreement. The document was made for an indefinite period of time. The Charter is non-mandatory and open to all oil market players. The Charter defines OPEC+ as a permanent

**Actual and target production levels of OPEC+ members, mb/d**

![Graph showing actual and target production levels of OPEC+ members from 2016 to 2019.](image-url)
discussion forum and establishes the structure and regularity of meetings to discuss the oil market situation. In addition, the Charter sets a number of important goals, such as facilitating dialogue between oil producing countries, technological cooperation, the long-term use of oil in the global economy, as well as the overall development of the oil market.

4.3. RANGE OF POSSIBLE PRICE SCENARIOS

We use the equilibrium price at which future oil demand is fully satisfied through the implementation of new production projects as long-term price benchmarks when constructing scenarios for the future development of the oil market. In this case, the equilibrium price will be that of the marginal producer at a given level of oil demand.

The natural decline in production at mature fields creates a need for investment in new production projects. We estimate that the average rate of decline in production at existing fields for the period 2018–2035 will be 3.5%. The difference between oil demand and production at mature

**Evaluation of demand for new production projects till 2035 under various scenarios, mb/d**
fields will determine the need for new production projects. According to our estimates, by 2035 the required new project production will be between 36 and 54 mb/d. Thus, regardless of the demand scenario, the need for investment in new production projects will remain until 2035.

The composition of future production projects is important to determine the equilibrium oil price. In the Evolution scenario, it is expected that the need for new production projects will be 46 mb/d by 2035. By 2035, about ¼ of new production projects will be those involving onshore and offshore production of conventional oil in the countries that are parties to OPEC+ agreement. Projects in this group will have the lowest cost of production. By 2035, about 8 mb/d will be added by projects with low production costs in countries outside OPEC. The remaining demand for new projects, some 50% of the total demand, will be satisfied through technologically complex deepwater offshore oil projects, the development of shale formations and the production of heavy oil. These projects, on average, are characterized by higher production costs compared to traditional onshore and offshore oil production projects.

**Breakdown of new production projects by reserves types, Evolution, mb/d**
In the Evolution scenario, in accordance with our balance model, the equilibrium price of oil in the period from 2025 to 2035 will be 70 $/barrel in 2018 prices. At this price, oil demand will be fully satisfied through new oil production projects. In addition, this price level is quite comfortable for parties of the OPEC + Agreement. Oil prices in the range of 60–80 $/barrel meets the budgetary requirements of the majority of the OPEC+ members, and they will try to maintain the price of oil within this price band.

In the Climate scenario, the equilibrium price of oil drops to 50 $/barrel in 2018 prices due to lower demand for new production projects than in the Evolution scenario. We also assume that in the market situation modeled in the Climate scenario, the OPEC+ members will be unable to keep the oil price above 60 $/barrel for a long period of time.

The Equal Opportunities scenario assumes an increased forecast for oil demand. Such assumption results in a higher price of the marginal producer on the new oil production project supply curve. In the Equal Opportunities scenario, we assume an equilibrium oil price of 90 $/barrel in constant prices.
4.4. FACTORS CONTRIBUTING TO PRICE VOLATILITY

In this section, we will address only a few factors, which, in our opinion, can significantly affect the oil market and lead to an increase in price volatility.

Traditionally, one of the most important factors that directly affect the oil market is the escalation of geopolitical conflicts, which often results in disruptions in oil supplies. This factor often leads to price volatility. A striking example of geopolitical risk is the attack on the oil infrastructure of Saudi Arabia in September 2019, which resulted in a record 6 mb/d increase in global supply disruption. Even though the disruption of supplies in Saudi Arabia was promptly overcome, often disruptions of supplies can continue for a prolonged period of time. The introduction of US sanctions against Iran in 2018 led to the withdrawal of more than 1 mb/d from the oil market. The timing for such volumes re-entering the market remain highly uncertain.

Oil is a commodity, so its price is highly dependent on the situation in financial markets. Currently, derivatives trading that do not require physical supplies of oil significantly exceeds the volume of physical trade. In the last few years, the volume of oil trade on the largest exchanges has continued to grow exponentially. For speculative purposes, financial market participants can, during

Unplanned Supply Disruptions, mb/d
certain period of time, cause oil prices to fluctuate excessively. The tendency towards higher numbers of traders that rely on algorithms in their financial transactions contributes to price volatility in the market.

Being a part of the global financial market, the oil market is strongly influenced by the monetary policy pursued by the US Federal Reserve System. A tightening of the US Federal Reserve policy may trigger an outflow of speculative capital from the oil market. Conversely, the adoption of a loose monetary policy will stimulate an inflow of speculative capital into the oil market.

The US exchange rate, in relation to other currencies, is also capable of strongly influencing the oil market. The majority of oil delivery contracts are denominated in USD, therefore a stronger dollar results in a higher cost of oil for non-US consumers. This trend has been highly apparent since 2015.

To lower their dependence on exchange rate fluctuations, many countries are attempting to make mutual transactions in their national currencies. An important step towards the adoption of alternative methods of payments for oil was the launch of the yuan denominated oil futures contract in Shanghai in 2018. Nevertheless, on the time horizon until 2035, in our opinion, the US dollar will retain its leading role in international settlements and continue to influence the oil pricing.

The oil market has been historically highly volatile. When exposed to a variety of factors, the oil price may vary within a broad range. We expect the volatility of oil prices to continue into the future. However, having the OPEC+ Agreement in effect will help to make price fluctuations less intense.
Variations in Brent oil prices in different currencies (Jan 2014=1)
GLOBAL REFINING TRENDS
5.1. DEMAND FOR KEY PETROLEUM PRODUCTS

The future demand for key petroleum products will depend on specific regional factors. In the Evolution scenario, we estimate that lower consumption of light petroleum products by developed economies will be compensated by higher consumption in the emerging markets.

Consumption growth rates will differ for various petroleum products. By 2035, the largest increment in consumption, in absolute terms, will be seen in the diesel market. The rise in diesel demand will be supported by a number of global industry-specific trends. Diesel is one of the key fuels for heavy-duty trucks, construction and agricultural machines. Our estimate is that the replacement of diesel with alternative fuels in heavy-duty sector will be a relatively slow process. The growth of international trade will promote demand for commercial transportation and, therefore, higher diesel consumption. In addition, the rapid development of the Indian and Chinese economies will involve the active construction of buildings and transportation infrastructure, which will also cause the rise of diesel demand. Another important factor in increasing demand for diesel fuel is the population growth in developing countries and the associated increase in food demand. This factor will drive higher demand for diesel from agricultural machines. Finally, the tightening of MARPOL standards in 2020 will lead to increased demand for diesel fuel from marine transport in the medium term.

The introduction of restrictions on diesel cars in Europe after the Dieselgate scandal will lead to a gradual reduction in diesel consumption in the region. However, Europe accounts for only 15% of the global diesel market. Therefore, the decrease in diesel consumption in Europe will be balanced by higher consumption in other regions.

The global demand for gasoline will grow slower than that for diesel. Unlike diesel, almost the entire volume of gasoline is consumed by one sector – road transportation. Given that in many countries there are quite ambitious goals to increase the fuel efficiency of the transportation sector, including programs to support the spread of alternative transport, the growth rate of gasoline consumption in the world will gradually slow down. Nevertheless, the key gasoline demand driver, the motorization in Asia-Pacific countries, will continue to support demand for gasoline in the next 15 years to come.

The increasingly high global consumption of polymer products will promote the demand for steam cracking feedstock, including naphtha. Despite the ex-
pected rise in the volumes of processed gas feedstock, primarily in the USA, the demand for naphtha will be maintained due to the construction of new petrochemical plants in the Asia Pacific.

Another growth area in global demand for liquid hydrocarbons lies in the aviation kerosene market. There is a positive correlation between disposable income and the number of flights. The growth of middle class in developing countries will stimulate high growth in demand for air transport and, therefore, aviation kerosene. However, we do not expect that by 2035 alternative fuels will be able to seriously compete with kerosene due to technological constraints.

Unlike light petroleum products, the fuel oil market will decline over the forecast period. Firstly, the share of fuel oil will further decline in electricity generation. Major consumers of fuel oil, such as the Persian Gulf states will gradually replace fuel oil with natural gas and renewables. Secondly, more stringent environmental requirements imposed by MARPOL will cause the fuel oil demand from marine vessels to decline.

Products like motor oils, road asphalt, and petroleum coke account for about 10% of the global demand for petroleum products. It is expected that over the forecast period the demand for these products will follow a positive trend. The demand for motor oils will rise due to the growth of the global vehicles fleet. The key driver for bitumen demand will be road construction in developing countries. The prospects of the petroleum coke market are largely associated with the development of the industrial and energy sectors in Asia.

Key petroleum products demand change in 2018–2035 in the Evolution scenario, mb/d
5.2. NEW MARPOL REQUIREMENTS FOR MARINE FUELS IN 2020

The year 2020 will see a major development in the global refining industry – a reduction of maximum permitted sulfur content in marine fuel from 3.5% down to 0.5%. Currently, 3.5% sulfur heavy fuels account for about 75% of the 5 mb/d consumed in marine bunkering. Thus, the main fuel that has long been an industry standard is going to be banned. In order to continue the use of 3.5% sulfur fuel, vessel owners will have to install expensive exhaust gas treatment systems, so called scrubbers, on their ships. As of the end of 2019, about 1.5% of the marine trade fleet were equipped with scrubbers. Vessel owners failing to meet the MARPOL requirements will face a difficult challenge from 2020, as major ports will only sell MARPOL compliant fuel to vessels without scrubbers. This means that in 2020 we will see a significant decrease in the consumption of 3.5% sulfur fuel. Refiners will offer vessel owners who have failed to install scrubbers low-sulfur fuels, consisting of a blend of various oil fractions.

There is huge uncertainty as to how the imposition of more strict environmental requirements by MARPOL will influence the balance of petroleum products supply and demand. Many experts believe that the demand for middle distillates will increase significantly, while that for residual fuel will see a decline. This will be followed by an upswing of diesel prices, a fall of residual fuel price, as well as a decrease in the prices of medium heavy and heavy oil grades that provide a high yield of dark petroleum products.

In our opinion, the global oil refining industry has considerable flexibility and will be able to quickly adapt to the needs of the market without seriously affecting crude and petroleum product prices. In 2020, a total of about 2.5 mb/d of refining capacity is expected to be commissioned around the world, most of which will be located in the Middle East and Asia-Pacific. Commissioning this capacity will allow an increase in production of middle distillates by about 1 mb/d. In addition, current modernization of Russian refineries are increasing Russian diesel production. Another factor that partially mitigates the effect of MARPOL is the replacement of medium-heavy oils with lighter ones as a result of restrictions under OPEC + and sanctions against Iran.

Most industry experts agree that the effects of MARPOL 2020 will be short-lived. The consumption of heavy fuel with sulfur content of 3.5% will partially recover in 3 to 5 years due to the installation of scrubbers on ships. Since most marine fuel is used by large vessels, installation of scrubbers on 10% of total marine fleet will be enough to restore the 3.5% sulfur residual fuel demand up to 3 mb/d.
In 2018, the IMO set a 50% carbon reduction emission target for marine transport by 2050. To achieve this target, a significant increase in the fuel efficiency of marine engines and the use of alternative fuels are required. Carbon emission reductions can be achieved in marine bunkering by converting vessels to LNG. Currently only 0.1% of the global fleet is powered by LNG. Norway is the global leader in gasification of waterborne transport. 69% of the world’s methane powered vessels are registered at Norwegian ports. With the development of infrastructure and fleet renewal, the share of vessels using LNG as fuel will increase.

5.3. THE CONSEQUENCES OF DIESELGATE FOR MOTOR FUEL CONSUMPTION

The widespread use of diesel passenger cars in Europe is a result of that, until recently, due to their high efficiency, diesel engines were perceived as being more environmentally friendly than gasoline powered ones. The proliferation of diesel cars was stimulated by an excise policy that resulted in a lower retail price for diesel than gasoline.

Things completely changed in 2015 after the so called Dieselgate. The governments in many European countries have taken initiatives to ban diesel
cars. Limitations on the use of diesel cars were imposed in major cities like London and Paris.

One of the consequences of Dieselgate was the adoption of a new fuel consumption and exhaust gas metering technique, the WLTP (World Harmonized Light-Duty Vehicles Test Procedure). The previous technique, the NEDC (New European Driving Cycle), understated the fuel consumption and exhaust gas emission figures. The WLTP introduces a new drive cycle with a longer test period at a higher maximum speed.

The Dieselgate scandal mostly affected light-duty vehicles. New diesel car sales have already seen a major decline. In the last five years, the share of diesel cars in the total European passenger car sales decreased from 55% to 32%. We expect this trend to persist, which will lead to lower diesel consumption by light-duty vehicles in the long term.

The light-duty fleet accounts for about 25% of the European diesel demand. In Europe, the main amount of diesel (about 50%) is consumed by the commercial transportation sector. While the transition to other types of fuel, primarily gasoline, can be achieved relatively quickly for light-duty vehicles, there is currently no economically feasible alternative on the market for certain types of commercial vehicles.
Our predictions suggest that in the forecast period, European countries won't be able to completely abandon the use of diesel, as commercial transport is the main consumer of diesel in Europe. For a short period, European demand for diesel may even grow as a result of the increased demand from marine transport due to the expected imposition of more strict MARPOL requirements in 2020.

5.4. CHANGE IN THE MIX OF REFINED OIL GRADES

The US tight oil production growth has heavily affected the ratio between light and heavy grades in the total mix of refining feedstock. Oil from shale formations is light and has low levels of sulfur. The rise in production of such crude shifted the balance towards lighter oil grades. While in 2015 the share of light sweet crudes in the total feedstock was around 27%, in 2019 this figure exceeded 30%.

Changes in the balance of light and heavy crudes were also largely driven by absence of Iran and Venezuela from the market, both major suppliers of medium-heavy and heavy crudes. In addition, production limitations imposed by the OPEC+ Agreement led to the reduction of the number of heavy

**Share of light sweet oil in total global oil consumption, %**
barrels on the market. These factors caused the price spreads between light and heavy grades to narrow and the economics of light production to worsen.

In the long run, we expect that the share of light grades in the mix of refined feedstock will reduce as US oil production stabilizes and we see a production growth in Iran and the OPEC+ Agreement states. This will increase the spreads between light and heavy oils, and promote spread growth between dark and light petroleum products. Consequently, this will improve the economics of refinery conversion processes.

5.5. GLOBAL INVESTMENTS INTO OIL REFINING AND COMMISSIONING OF GREENFIELD PROJECTS

Given the expected rise in consumption of petroleum products, oil companies plan to expand their refining capacities. In the next few years, there are plans to commission a number of complex, high-capacity refineries. In 2020, refiners will have to face yet another challenge as MARPOL imposes new requirements on marine fuels. In order to maintain the existing level of marine operations, the marine transportation sector will need additional volumes of fuel that meet the strict environmental requirements.

Predicted commissioning of crude distillation capacity by region, kb/d
New refineries will be commissioned mostly in regions with a growing demand for petroleum products – Asia-Pacific, the Middle East, and Latin America. According to our estimates, between 2020 and 2025, the global distillation capacity will increase by 12 mb/d. Major commissioning of greenfield projects are expected in 2020 and 2024.

Most new refineries are complex facilities that offer low operation cost due to economies of scale. In 2020, several mega-projects are expected to be put onstream such as the 600 kbbl/d Al-Zour refinery in Kuwait and the Hengli and Zhoushan refineries in China, each with a capacity of 400 kbbl/d. The introduction of new modern refineries can change the balance of power in global oil refining sector, squeezing out less competitive participants from the market.

Given the severe environmental restrictions and high electricity prices, it will be difficult for European refiners to compete with those from other regions. In the mid term, another wave of refinery closures may be expected in Europe.

5.6. OIL REFINING AND CLIMATE CHANGE

The oil refining sector is a major source of carbon emissions. EU-based refineries alone emit 118 million tons of CO₂ every year. There is a direct correlation between the production of high quality light petroleum products and the volume of carbon emissions. The more complex the refinery, the more conversion processes it runs and the more carbon it generates.

Currently, there is a number of technological solutions that can significantly reduce CO₂ emissions even at highly complex refineries. The most promising solutions are carbon capture and utilization, the use of renewable energy for the production of hydrogen, the production of modern biofuels and energy efficiency improvement.

Carbon emissions at refineries are mostly generated by processes that involve fuel burning. Carbon capture at refineries is a complex engineering challenge as the refineries generate numerous gas flows with different CO₂ concentrations. The greatest potential for the use of carbon capture technologies lies in processes that make it possible to obtain a high-concentration CO₂ flow, for example, hydrogen production at methane reforming unit.
Significant investment is required to implement carbon emission reduction technologies at refineries. In the EU member states, where there are environmental incentives for carbon emission reductions in place, the attractiveness of such investment is much higher than in other regions.
6

THE RUSSIAN LIQUID HYDROCARBON MARKET
6.1. RUSSIA’S PARTICIPATION IN OPEC+ AGREEMENT

Along with Saudi Arabia, Russia is a key party to the OPEC+ Agreement. Russia’s entry to the OPEC+ Agreement helped to harmonize the regular OPEC members’ views on production limitations. In 2019, the Charter of Cooperation between OPEC+ countries was signed, securing the long-term nature of cooperation between Russia and OPEC member states. We think that the actions undertaken by the parties of the OPEC+ Agreement will help to efficiently balance the oil market and reduce the volatility of global oil prices. Having this Agreement in effect is positive for both oil producers and consumers. On the one hand, the producers can maintain a steady level of investment in the development of reserves, while on the other hand, the risk of price shocks for consumers is reduced.

Since the OPEC+ Agreement was signed in 2016, Russia has fulfilled all its obligations to limit production. In 2017, Russian condensate production was cut by 300 kbbl/d relative to the level of October 2016 and remained stable almost all of 2017. In 2018, Russia increased its production following the OPEC+ resolution to make up for the loss of supply from production cuts in Iran and Venezuela. However, in 2019, Russian production was again reduced to meet updated production targets. In December 2019, at the OPEC+ meeting, it was decided to further reduce production until the end of the 1st quarter of 2020, excluding gas condensate from the calculations of the quota, in order to balance the market in the winter period.

Unlike, Saudi Arabia, Russia does not possess any free production capacity that can be managed dynamically. Therefore, Russia’s compliance with OPEC+ production change decisions takes some time. The existing well stock allows Russia not only to reduce production, but also to increase it if necessary. We expect that Russia will remain a party to the OPEC+ Agreement for a long time, coordinating its activities with other oil-producing countries.
6.2. THE STATE OF THE RESOURCE BASE

Russia has some of the biggest oil reserves outside OPEC, with about 200 billion barrels according to the Russian classification (ABC1+C2) and 80 billion barrels of proven reserves according to the international classification. Since 2010, Russia has demonstrated steady oil and condensate production growth. The key production growth drivers are enhanced oil recovery at mature fields, new fields commissioned in new production regions and higher gas condensate production.

In 2018, Russian oil production was at a record high of 11.1 mb/d (556 million tons). According to our estimates, if the restrictions imposed by OPEC+ are lifted, Russia may continue to increase production in the next few years.

Despite the significant production gains observed over the past few years, the challenge of long-term sustainability of achieved production still remains. About 50% of Russian oil production comes from fields commis-
sioned prior to 2000. Such fields are characterized by a high rate of natural decline: 8–10% per annum for the base well stock. Drilling injection wells helps to slow down the decline, yet reversing the trend is virtually impossible – the water cut in the fields is growing. Between 2008 and 2018 the oil production in Western Siberia fell by 10%. In order to make up for the natural decline in production at mature fields, new reserves should be aggressively put into development.

Currently, more than ⅔ of the residual oil reserves are difficult to develop and require the use of innovative technology, which involves significant cost. As time goes by, the share of technologically complex reserves in total oil reserves will increase. In order to make sure oil production remains steady, Russia has to provide economic and institutional framework to gradually draw such reserves into development.

In 2019, the Federal Subsoil Use Agency (Rosnedra) announced the completion of the inventory of Russian oil fields. The scope of assessment covered only major fields with total reserves of 17.2 billion tons. The inventory demonstrated that 67% of reserves are economically profitable. The findings suggest that there is potential for growth of commercially recoverable reserves in Russia, in case that production technologies become less expensive and favorable tax conditions are created.

Change in the structure of Russian oil reserves between 2018 and 2035 in the Evolution scenario, %
6.3. PROSPECTS FOR DEVELOPMENT OF HARD-TO-RECOVER RESERVES IN RUSSIA

Development of hard-to-recover reserves (HRR) is one of the priority areas in maintaining stable oil production in Russia. According to estimates by the Russian Ministry of Energy, there are 6.2 billion tons of ABC1+C2 HRR. However, it should be noted that only those reserves for which tax exemptions were granted were included in this category. According to the current tax laws, HRR refer to tight deposits whose permeability is below 2 md, reserves of Khadum, Bazhenov, Abalak, Domanic, and Tyumen suites, as well as extra viscous oil and bitumen. If HRR were to refer to all reserves that require the use of innovative technologies to develop, then the definition of HRR would cover about ⅔ of all Russian oil reserves. However, within the scope of this Report we use the narrow definition of HRR that corresponds to the estimates of the Russian Ministry of Energy. As of 2018, HRR production, except production of oil from low permeability deposits not belonging to suites, amounted to 38 million tons.

HRR development requires various engineering approaches. In international practice, low permeability reserves can be classified as either conventional or unconventional, depending on the technologies applied to the development of such fields. According to their geology, Bazhenov and Domanic formations are broadly similar to US shale formations, which are generally classified as unconventional reserves.

Currently, oil production from the Tyumen formation at conventional fields dominates the HRR production mix. According to our estimates, this trend will persist until at least 2025. In the longer term, HRR production will grow due to the development of unconventional reserves.

In terms of growth potential, the most promising in the long run is the development of the Bazhenov formation in Western Siberia. According to current estimates, the recoverable reserves within this formation are around 10 billion tons. The Bazhenov formation's geological resources may be in the range of 100 to 500 billion tons. The area of the formation's sediments is around 1 million sq. Km. The total organic carbon can be as high as 25% in certain parts. According to experts, the geological characteristics of the deposits within this formation generally correspond to that of successfully developed US shale formations, which suggests the potential for cost-effective development. However, the Bazhenov formation has some geological features that must be taken into account when considering a development plan.
Little statistical information is currently available about the Bazhenov formation compared to its US counterparts. A large-scale research program that involves the drilling of numerous wells is required to successfully select the production sites and technologies. The Bazhenov formation is located within the boundaries of existing active fields, which simplifies the licensing process and allows the use of existing infrastructure.

Russian oil companies are currently putting a lot of effort into the exploration of areas within the Bazhenov formation. A special-purpose test site was created at the Palianovskoye field to test the technologies for production of oil from the deposits of the Bazhenov formation. This project was given the status of a national project, which implies certain benefits from the state for its participants. As part of the Bazhen national project, companies actively exchange information, which promotes a more efficient search for optimal engineering solutions for the development of unconventional reserves in Russia.

So far, Russian companies have drilled several dozen high-tech wells in areas of the Bazhenov formation. A commercial inflow of light oil was obtained from a number of wells. Further success in the development of the Bazhenov formation will largely depend on success of replicating the engineering solutions used and reducing the cost of production.

According to our estimates, in the Evolution scenario, commercial production of unconventional oil from the Bazhenov formation will start in 2025 and will demonstrate a gradual growth to 35 million tons in 2035. The Equal Opportunities scenario, which assumes an increase in the demand for hydrocarbons, allows a rise in production from the Bazhenov formation to 77 million tons by 2035.

**Bazhenov formation oil production forecast, million tons**

![Graph showing oil production forecast from 2018 to 2035 for Evolution, Climate, and Equal opportunities scenarios.](image-url)
6.4. ORF IMPROVEMENT OPPORTUNITIES

The oil recovery factor in Russia is lower than in many oil-producing countries. So far, Russia has only been able to achieve a 22% ORF, while in Norway and USA this figure is much higher: 45–50%. Low ORF is largely a result of insufficient use of enhanced oil recovery techniques (EOR), such as injection of CO₂, methane, water and steam into formations, and the use of polymers and alkalis.

Only a few projects using EOR are being implemented in Russia, since, in most cases, oil companies lack the economic incentives to execute such projects. Operating expenses associated with the use of tertiary production techniques are much higher than those required for conventional production. In addition, the existing tax regime doesn't provide any benefits for EOR projects.

Russia may improve its ORF by focusing on the use of digital oil production technologies. The integration of digital technologies into field development processes may help to reduce equipment downtime, minimize workovers and reduce oil production losses.

Under the existing tax regime, we have estimated that the project ORF for Russia is 38%. In the case of additional tax incentives from the state, the ORF may increase to 45%, which is comparable to that of the US and Norway. According to our estimates, increasing the ORF from the current 38% up to 45% will result in a 10 billion tons increment in recoverable ABC1+C2 oil reserves.

Achieved and potential ORF at conventional Russian fields, %

- Achieved ORF: 22%
- Project ORF: 38%
- Potential ORF: 45%

*+10 billion tons of reserves*
6.5. OFFSHORE DEVELOPMENT

Russian offshore fields account for only 4% of ABC1+C2 reserves. Little information is available about offshore resources and over time the estimate of offshore reserves is likely to increase. This, however, requires exploration activities involving significant costs. For many years, no more than 10 offshore exploration wells were drilled each year. Within the last 10 years, most drilling was carried out in the Sea of Okhotsk, the Caspian Sea, and the Baltic Sea. Between 2009 and 2018, a total of 8 offshore wells were drilled in the Arctic shelf, while during the same period, 14 wells were drilled in the Caspian Sea, and 25 in the Sea of Okhotsk.

Currently, several offshore projects are realized in Russia with a total production of about 24 million tons. Those are Sakhalin-1 in the Sea of Okhotsk, the Prirazlomnoye field in the Barents Sea, as well as the Y. Korchagin field, the V. Filanovsky field in the Caspian Sea, and several other fields in the Baltic Sea. At this point, the Prirazlomnoye field is the only Russian Arctic offshore project where commercial production is underway.

Following the imposition of sectoral sanctions by the US and EU that prohibit supplies of offshore equipment to Russia, companies had to adjust their offshore development plans. The shortage of Russian equipment for construction of offshore platforms may prove to be a serious constraint for offshore development in Russia. Nevertheless, Russian companies and the government are undertaking activities towards the development of Russian offshore production technologies.

Number of exploration offshore wells in Russia
Currently, the Arctic shelf is one of the most expensive oil production locations in Russia. Arctic projects require specialized equipment and the construction of new infrastructure. Considering that Russian companies currently have more attractive investment opportunities, we estimate that the launch of new Arctic production projects should not be expected before 2030.

According to current legislation, only state-owned companies are permitted to develop Russian offshore fields. Private companies operate offshore projects only under licenses obtained prior to the imposition of legislative restrictions. The removal of administrative barriers to allow private companies access offshore projects could contribute to more active implementation of offshore projects in Russia.

### 6.6. THE IMPACT OF INTERNATIONAL SANCTIONS ON RUSSIAN OIL PRODUCTION

In 2014, the USA and the EU imposed sectoral sanctions against Russia that set limitations on the cooperation between Russia and western countries in financial and energy sectors. In particular, the sectoral sanctions actually impose a ban on the supply of deepwater production equipment, equipment for Arctic offshore projects and for shale oil development. In addition, sanctions impose limitations on the cooperation between Russian and western companies. With the imposition of sanctions, virtually all the joint projects for development of unconventional reserves and development of Russian offshore fields were suspended.

The restrictions introduced are mainly aimed at reducing the long-term potential of Russian oil production and are unlikely to significantly affect the level of production in the coming years. However, in the longer term the damage done by the sectoral sanctions to the country’s oil production may prove to be tangible. The success of the Russian oil industry will depend on whether Russia can create its own technologies for offshore operations and development of unconventional reserves.

Over the past decade, growth was driven by the start of production at major greenfield projects that made up for the natural production decline at mature fields. According to our estimates, oil production at new fields will stabilize in the coming years. In the years following 2022, production may fall unless ORF is raised at mature fields and the development of HRR accelerates.

Hydraulic fracturing technology (Fracking) is actively used in Russia at conventional fields to intensify production. The same technology is one of the best
candidates for the development of shale formations. According to the Russian Ministry of Energy, in 2014 more than 80% of all the fracking equipment used in Russia was imported from other countries. It is especially relevant for underground completion equipment used in hydraulic fracturing operations (95% share of imports), drilling equipment (83% share of imports), high-pressure fracking pumps (80% share of imports), and software (90% share of imports).

The imposition of sectoral sanctions significantly slowed down the implementation of new offshore projects, many of which were planned to be implemented with the involvement of western partners. A number of projects were suspended for an indefinite period. (Universitetskaya-1, Barents Sea blocks). Prior to the imposition of sanctions, companies mostly used western technologies in offshore drilling and platform construction.

In cooperation with business, the Russian government is now undertaking measures to reduce dependence on imports in critical areas of economy. In 2015, a five-year plan of import substitution measures for the oil and gas engineering sector was approved. The plan provides for a significant increase in the production of domestic equipment for hydraulic fracturing. A certain amount of success has been achieved in offshore equipment production. Cooperation is underway with Asian equipment manufacturers. According to the draft Energy Strategy of the Russian Federation to 2035, the share of high-end technologies developed and localized in Russia for the energy sector by the year 2035 must be 70–80%. Our estimate is that as early as 2030, Russia will be able to significantly reduce its dependence on imports in all areas critical to the efficient development of the oil industry.

**Forecast of the import share in key offshore and HRR development technologies, %**
6.7. EVOLUTION OF TAX REGIME IN UPSTREAM

Despite regular single-point changes, the overall configuration of the Russian tax system has remained unchanged since the 2000s. The main amount of taxes is withdrawn in the form of taxes on revenue: mineral extraction tax and export duty. This approach means that the costs actually incurred by the subsoil user are never taken into account in the determination of the tax base.

In terms of taxation of oil production, we are seeing a trend towards more oil production for which various tax reliefs are available. As of 2018, about a half of all oil produced in Russia was from fields with tax incentives.

The scale of tax incentive varies depending on the type of reserve. At some fields, the incentives are sufficient to facilitate the cost-effective development of the field, while at other fields they are insufficient. Fore example, the existing framework of tax incentives does not promote the active application of EOR techniques to maintain production at mature fields. The Russian government was instructed to develop common criteria and procedures for the provision of government support to the development of Russian oil fields by the end of 2019. This effort will possibly help to improve the performance of the existing framework for the provision of tax incentives. At the same time, however, it doesn’t mean that the country no longer requires an integrated solution to the problem oil production taxation.

An important development for the Russian oil industry was the introduction in test mode the excess profit tax (EPT) at the beginning of 2019. Unlike the existing tax system, the tax is levied on the financial result rather than each ton of oil produced. Transferring the main tax burden to the later stages of field development allows to significantly increase production by developing previously unprofitable areas, and to thus increase government revenues. The EPT applies to both greenfield projects and mature fields. According to the Russian Federal Revenue Service for quarter 3 of 2019 this tax treatment is already applied at 135 subsoil blocks.

According to the Russian Government’s roadmap to develop oil fields and increase in oil production in the Russian Federation, the impact of the EPT on production performance will be assessed in May 2020. The roadmap also stipulates that a decision will be made in 2020 as to whether it is reasonable to expand the application of the EPT to the whole of Western Siberia, while in 2022 it will be decided whether this taxation system can be applied to the whole industry.
### Key changes in taxation for the Russian upstream sector

<table>
<thead>
<tr>
<th>Tax burden reduction</th>
<th>Tax burden growth</th>
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<tbody>
<tr>
<td>Depletion benefits for MET</td>
<td>2007 MET growth rate</td>
</tr>
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<td>MET holiday by regions</td>
<td>2008 MET growth rate</td>
</tr>
<tr>
<td>Expansion of the MET holiday by regions</td>
<td>2009 MET growth rate</td>
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<tr>
<td>Higher deductions in the MET formula</td>
<td>2010 MET growth rate</td>
</tr>
<tr>
<td>Export duty benefits for Eastern Siberia</td>
<td>2011 MET growth rate</td>
</tr>
<tr>
<td>Lowering the factor used in the export duty formula to 0.6</td>
<td>2012 Freezing the factor used in the export duty formula at 0.42</td>
</tr>
<tr>
<td>Export duty benefits for the Caspian Region</td>
<td>2013 Introduction of the MET markup</td>
</tr>
<tr>
<td>Lower MET for smaller fields</td>
<td>2014 MET growth rate</td>
</tr>
<tr>
<td>Incentives for HRR and offshore reserves</td>
<td>2015 MET growth rate</td>
</tr>
<tr>
<td>Prolongation of the regional MET benefits</td>
<td>2016 Making the gasoline and diesel markup part of the MET calculations</td>
</tr>
<tr>
<td>Lowering the factor used in the export duty formula to 0.3</td>
<td>2017 Introduction of the MET markup</td>
</tr>
<tr>
<td>Benefits for Samotlor</td>
<td>2018 MET growth rate</td>
</tr>
<tr>
<td>Introduction of the excess petroleum revenue tax for pilot projects</td>
<td>2019 MET growth rate</td>
</tr>
</tbody>
</table>

### Share of production from the fields with MET incentives in the total Russian oil production, %

![Graph showing the share of production from fields with MET incentives in Russian oil production, increasing from 2006 to 2018.](image-url)
6.8. OIL AND CONDENSATE PRODUCTION SCENARIOS FOR RUSSIA

There's a lot of uncertainty regarding longterm oil production in Russia. On the one hand, Russia has sufficient resources to maintain stable oil production for at least several decades. On the other hand, adverse factors such as depletion of mature fields, lack of technology to complete new complex projects, a suboptimal tax policy and a shortage of financial resources pose risks for long-term production stability.

In projecting oil production in Russia, we have adopted a scenario-based approach. One of the oil production scenarios for Russia lines up with the Evolution scenario that assumes the ongoing development of global energy in the framework of the current international energy policy. Evolution also assumes a gradual transition from the existing tax system that is based on the taxation of revenue, to a system that is based on the taxation of oil production profits. Another assumption made in the Evolution scenario is that the sanctions against Russia will continue throughout the forecast period. We assume that no new restrictions will be imposed on the oil and gas sector, however, the existing ones will continue for a long time. Moreover, Evolution assumes that by 2030 the lack of technology to develop HRR and implement offshore projects will be fully addressed.

The Climate scenario is based on an assumption that the global demand for oil will shrink due to the tightening of the climate policies of the leading economies, including Russia. This scenario also assumes an increase in the tax burden for the oil industry which will adversely impact investment into oil production. In the Climate scenario, oil and condensate production in Russia will fall below 400 million tons by 2035.

In the Equal Opportunities scenario, the level of oil production is calculated based on the premise that the global demand for liquid hydrocarbons will increase. In this scenario, oil and condensate production in Russia has an upward trend until 2030. According to our estimates, given the current level of technological development and infrastructural constraints, Russia can maintain its annual production at a level above 600 million tons for a long time.
Scenarios of oil and condensate production in Russia

Projected oil production in Russia by main sources, mb/d
6.9. PROJECTED CONSUMPTION OF MAJOR PETROLEUM PRODUCTS IN RUSSIA

In the last five years, the growth of motor fuel consumption in Russia experienced a dramatic slowdown. Between 2010 and 2014, the consumption of motor gasoline grew by 11%. However, since 2014, the average annual consumption of gasoline stabilized at 36 million tons and has remained practically unchanged. This trend is due to simultaneous action of multiple factors. Firstly, in the last few years, Russia has demonstrated a relatively low rate of economic growth, which negatively affects the disposable income of the population. As a result of the decline in the purchasing power of the population, sales of new passenger cars have significantly decreased. In 2018, sales of new passenger vehicles in Russia were down by 35% from 2013. Secondly, in large Russian cities the demand for personal vehicles is about to reach the maximum saturation level due to the capacity of the transportation infrastructure. Large Russian cities are becoming similar to Asian cities with high-density housing. The level of vehicles per thousand people in Asian countries is generally lower than in Europe. Thirdly, the fuel efficiency of motor vehicles is improving. This is primarily because new cars are getting more efficient. And finally, the introduction of paid parking in cities like Moscow and St. Petersburg have forced many motorists to chose public transport over their personal vehicles, which has had a negative impact on the average annual mileage.

The pattern of new car sales in Russia has remained relatively stable for years. Of the total passenger vehicle sales, about 90% are gasoline engine vehicles. We do not expect a vehicle electrification boom in Russia. As of 2019, the Russian fleet of electric vehicles is up to 4,000 vehicles (less than 0.01% of the overall passen-
ger vehicle fleet). The price premium for electric vehicles in Russia is way higher than in the US, Europe, or China. A foreign-made electric car is going to be on average twice as expensive as a conventional vehicle in the same class, and 40% more expensive than an electric vehicle in the US or Europe. The charging infrastructure is in its inception phase. Current measures of state support for electric transport are insufficient to create a mass demand for electric vehicles. This said, we do not expect that extensive use of electric vehicles is going to materially affect the demand for gasoline until 2035. We estimate the fleet of electric vehicles in Russia to be between 0.5 – 1 million vehicles by 2035. (1–2% of the total car fleet). Development of other alternative forms of transportation will go even slower. We anticipate that by 2035 the fleet of passenger vehicles powered by natural gas will be several times smaller than that of electric cars.

The growing consumption of diesel in the past few years is associated with construction, commercial transport, and the gradual transition of light commercial vehicles from gasoline to diesel. Following its sharp drop in 2015, the diesel demand is gradually regaining ground. The diesel demand is more responsive to changes in economic activity than that for gasoline. In the long term, the demand for diesel fuel will to a great extent depend on the pace of Russian economic growth. Other than economic activity, the demand for diesel is driven by the fuel efficiency of diesel vehicles and composition of the commercial vehicle fleet. We estimate that in the long term, NGV fuel could provide can seriously compete with diesel in the commercial transport sector, given that Russia has an effective support program for the development of NGV vehicles. In the near future, the NGV vehicle fleet is set to grow, primarily through conversion of public transportation vehicles, light commercial vehicles, and fleets of state-owned companies.

**Projected motor fuel demand in Russia, million tons**

<table>
<thead>
<tr>
<th>Gasoline</th>
<th>Diesel fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>2010</td>
</tr>
<tr>
<td>2015</td>
<td>2015</td>
</tr>
<tr>
<td>2020</td>
<td>2020</td>
</tr>
<tr>
<td>2025</td>
<td>2025</td>
</tr>
<tr>
<td>2030</td>
<td>2030</td>
</tr>
<tr>
<td>2035</td>
<td>2035</td>
</tr>
</tbody>
</table>

- **Actual**
- **Climate**
- **Evolution**
- **Equal opportunities**
6.10. REFINERY MODERNIZATION IN RUSSIA

Regardless of a slight slowdown in the growth of motor fuel consumption, Russia continues to upgrade its refineries. Due to various governmental incentives, 78 secondary distillation units were modernized or put into operation between 2011 and 2018. According to the Russian Ministry of Energy, the industry conversion rate over the same period went up from 70.5% to 83.4%. Completed projects resulted in a substantial increase in the output of Euro 5 fuels.

We anticipate the trend to upgrade refineries will continue to at least 2025-2027. Most of the projects are carried out by large Russian vertically integrated oil companies and are not expected to experience any substantial financing difficulties. However, it is possible that some projects by independent companies could experience a funding shortfall. Moreover, amendments to the tax laws enacted in 2018 suggest a substantial deterioration of the economics of simple refineries. It should be noted that in 2019 a number of Russian refineries entered into an agreement with the Russian Ministry of Energy, according to which they undertook to invest into refinery upgrades in exchange for benefits in the form of a reverse excise tax on crude oil. There's also ongoing debate over additional measures to encourage investment in refinery modernization in the form of a higher excise tax on crude oil. These initiatives indicate that the development of the refining industry is a strategic goal of the Government and will continue in the medium term.

Projected output of main petroleum products in Russia, million tons

<table>
<thead>
<tr>
<th>Product</th>
<th>2018</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Diesel fuel</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
We estimate that, when implemented, the companies’ refinery modernization plans will increase the conversion rate of Russian refineries to 92% by 2035. We anticipate that until 2035, the output of gasoline will grow by 6 million tons, that of diesel by 28 million tons, while fuel oil production is expected to decrease by 28 million tons.

6.11. THE BALANCE OF SUPPLY AND DEMAND IN THE PETROLEUM PRODUCTS MARKET

The growth in the production of motor fuels given low growth in domestic demand creates the conditions for the rise of light petroleum products export. We anticipate that in the Evolution scenario, the oversupply of the Russian gasoline market is set to reach 7 million tons in 2035. The market will remain oversupplied even in the scenario of high demand growth. In the Climate scenario, the gasoline market will be oversupplied by 10 million tons by 2035. Therefore, we do not anticipate any major problems associated with the supply of gasoline to the domestic market, regardless of the gasoline demand scenario.

The projected balance of the Russian motor gasoline market is highly sensitive to adjustments in the tax regulation of the industry as many refineries, even following their modernization, will still economically inefficient without subsidies. The lower cost of oil exports compared to that of petroleum product exports results in a “logistical lag” that keeps the Russian refineries behind the European ones. If the subsidies to the Russian refining industry were to be cancelled or considerably reduced, the gasoline market could become undersupplied.

The diesel fuel market has been oversupplied for many years and the implementation of refinery modernization plans will only increase the oversupply. By 2035, we anticipate a diesel fuel market oversupply of 64–70 million tons, depending on the demand growth scenario. This assessment assumes an almost twofold growth of diesel fuel exports from Russia. Our thinking is that such a considerable increase in diesel exports could have a negative impact on diesel fuel quotes in Europe. However, as is the case with the gasoline market, the diesel fuel market balance is highly sensitive to the refining support policy pursued by the government.
6.12. TAX REGIME OF RUSSIAN REFINING

Over the past decade, Russian oil refining sector has experienced several tax reforms. The main goal behind these reforms was to encourage investment in the modernization of oil refineries. To achieve this goal, export duties on light petroleum products were gradually reduced and export duties on fuel oil were increased. This resulted in the widening of the spread between dark and light petroleum products, making the economics of the construction of conversion facilities more appealing to investors.

Despite the availability of investment incentives, the current Russian taxation system implies a high dependence of the refining economics in Russia on the oil prices. The high cost of shipping refined products to the export markets is cancelled out by a difference in oil and petroleum products customs duties i.e. the customs subsidy. While the customs duties charged on oil and petroleum products depend on oil prices, lower oil prices mean a reduction in customs subsidy. A similar situation occurred in 2015–2017. For lots of refineries, the customs subsidy fell short of what was required to overcome the logistical lag from the export markets.

In 2018, amendments were made to the tax and customs laws. Starting from 2019, the scheme of indirect subsidization of refineries through export duties
will be gradually replaced with direct subsidies through refunds of crude feed-stock excise. The procedure for calculating crude oil excise tax assumes that such payment will fully compensate for any reduction of the customs subsidy. However, unlike the customs subsidy, refunds of the crude oil excise are contingent on a number of conditions. Crude oil excise tax will be automatically refunded to the refineries supplying motor gasoline and naphtha to the domestic market and refineries operated by sanctioned companies. In order to receive payments from the budget, all other refineries (export-oriented simple refineries) will have to sign a refinery upgrade contract with the government for the amount of at least 60 billion RUB. At the time of preparation of this Report, 11 refineries have signed such investment agreements.

Yet another innovation in the refining regulation was the emergence of the damping allowance scheme in 2019, designed to smooth out global wholesale price fluctuations affecting domestic motor fuel prices.

Previously, it was the RUB/USD exchange rate that acted as a natural damp-er i.e. the cost of oil and fuels denominated in RUB was approximately constant. After the connection between oil and the exchange rate was disrupted, the economics of the Russian refineries that are fuel suppliers to the domestic market became much more susceptible to external volatility, resulting in an abrupt increase of wholesale oil prices in early 2018. The damping allowance was introduced to avoid future crises. The essence of the scheme is the following: wholesale prices in the Russian market are approximate-

**Subsidizing a typical refinery in European part of Russia*, $/barrel**

![Graph showing subsidy changes from 2015 to 2024](image)

* Forecast is based on the $60 per barrel oil price.
ly constant; if they are exceeded by export prices, i.e. the refinery margin decreases, the government refunds the refineries part of the difference out of the Budget; if the export prices are lower than the domestic ones, the refinery margin increases, and the refinery gets to pay some of the difference to the Budget. This results in the all-round margin from sales of motor fuels in Russia being maintained at a level sufficient for operating efficiency and business development within a wide range of macro-parameters.

6.13. REGULATION OF THE RUSSIAN RETAIL PETROLEUM PRODUCT MARKET

The sharp increase in retail prices for motor fuels in 2018 occurred as a result of a combination of factors: the growth of world gasoline and diesel quotes, the weakening of the rouble against the dollar and the increase in excise taxes on fuel. At the beginning of 2018, gasoline export prices soared and the domestic wholesale and retail prices followed suit. However, the wholesale prices grew faster than the retail prices, causing the margin from sales of petroleum products through gas stations to shrink. This situation threatened independent players, which account for about 50% of retail sales of petroleum products in Russia, and could lead to an undersupply of the domestic motor fuel market.

Seeking to stabilize the domestic fuel supplies and reduce inflationary pressure, the Russian Government concluded an agreement with the major oil companies, valid till March 31 2019, to freeze wholesale gasoline and diesel prices and establish domestic fuel supply obligations. In addition, in the second half of 2018, excise tax rates on fuel were reduced. Such measures made it possible for retail players to generate sufficient revenue to cover their OPEX. However, frozen domestic prices had a negative impact on the profitability of Russian refineries.

The growth of excises and VAT in early 2019 translated into losses for the refining industry. According to our estimates, the share of taxes in the price of gasoline rose from 52% in the first half of 2016 to 64% in the first half of 2019. The high tax burden is putting pressure on the retail price of fuel and controlling prices causes the refineries to incur losses.

In an attempt to balance out the interests of consumers and producers, in 2019 the country introduced a damping allowance scheme, designed to smooth out the fluctuations of wholesale gasoline and diesel prices on the do-
mestic market through budget subsidies. The first months of using the damp-
er revealed the scheme's imperfections. The damper caused refineries to
suffer even more losses from the supply of petroleum products to the domes-
tic market. This prompted an adjustment of the damping allowance calcula-
tion formula. The adjusted damper made the economics of petroleum prod-
uct supplies to the domestic market more attractive and also contributed to
the stabilization of domestic retail sales margin. However, given the high vol-
atility of the global oil and petroleum products market, we do not exclude
the need for further adjustments to the mechanisms used to regulate the do-
mestic motor fuel market.
FORECASTS COMPARISON

This section compares the individual forecasts presented in this Report with our previous estimates and forecasts of international institutions such as OPEC and the International Energy Agency.

The fuel structure of primary energy consumption for 2030 in the Evolution scenario is close to the IEA Stated Policy Scenario (SPS) and the OPEC baseline scenario from the World Oil Outlook 2019 report. However, if we compare the fuel structure in the Climate scenario and in the IEA Sustainable development scenario (SDS), the divergence of forecasts will be significant. The main difference is that the absolute level of energy consumption in the Climate scenario is higher than in the Sustainable development scenario. Therefore, despite the fact that the share of oil in the structure of primary energy consumption in the Sustainable development scenario is higher than in the Climate scenario, the Sustainable development scenario assumes a more conservative forecast of demand for liquid hydrocarbons than the Climate scenario.

Shale oil production in the US and electrification of road transport are, in our view, key risks to the long-term dynamics of oil prices. Since the publication of the previous Report in 2016, we have revised up the long-term level of shale oil production in the United States. Our updated forecast for shale oil production is generally comparable to those of OPEC and the IEA, while being slightly more conservative.

The forecast of the electric vehicle fleet for 2030 in the Evolution scenario is between the forecasts of the IEA and OPEC. The forecast of the electric vehicle fleet in the Climate scenario exceeds the forecast of the IEA Stated policy, but lags behind the optimistic scenario of the IEA for the electrification of transport-EV 30@30.
The structure of primary energy consumption in 2030, %

Forecast of demand for liquid hydrocarbons, Mbd

US shale oil production in 2030, Mbd

Global EV fleet* in 2030, mln

*includes passenger and commercial BEV, PHEV and FCEV
ABBREVIATIONS

AP  Asia-Pacific
b/d  barrels a day
BECCS  Bioenergy Carbon Capture and Storage
BEV  Battery Electric Vehicle
CCUS  Carbon Capture, Utilization and Storage
CNG  compressed natural gas
CTL  coal-to-liquids
DAC  Direct Air Capture
EOR  enhanced oil recovery techniques
EPT  excess profit tax
FCEV  Fuel Cell Electric Vehicle
GDP  gross domestic product
GTL  gas-to-liquids
HRR  hard-to-recover reserves
ICE  internal combustion engine
IMO  International Maritime Organization (UN)
IPCC  Intergovernmental Panel on Climate Change
kW*h  kilowatts per hour
LNG  liquefied natural gas
LPG  liquefied petroleum gas
MARPOL  International Convention for the Prevention of Pollution from Ships
mb/d  million barrels per day
MET  mineral extraction tax
NDCs  National Determined Contributions
NEDC  New European Driving Cycle
NGL  natural gas liquids
OECD  Organisation for Economic Co-operation and Development
ORF  oil recovery factor
PHEV  Plug-in Hybrid Electric Vehicle
WLTP  World Harmonized Light-Duty Vehicles Test Procedure
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