# How technology drove the shale oil industry and what it means to Russia

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**Abstract.** In this article, we discuss the implications of development of extracting technology of shale gas. Declining natural gas reserves during the 1970s prompted the United States movement to fund research into, leading to many advances in technology including micro seismic imaging. Observed progress in extracting technology of shale gas has some implications for Russian gas industry. As long as Russia is dependent on oil for 70 percent of its exports, Russia's economy will be intrinsically linked to the fluctuation of world oil prices. Moreover, nations and energy industry were forced to consider what a future with dwindling fossil fuel supplies might look like, after the first global oil shock during the 1970s. One response was to look for new types of fossil fuel reserves and develop ways to reach them. It would be stressed that current crisis creates an opportunity for Russia to provide tax and financial incentives to encourage technological innovations such as Big Data Analytics.

**Keywords:** shale gas, micro seismic imaging, Russian gas industry, world oil price, world gas price.

# Как технологии стимулируют сланцевую индустрию и какое это имеет значение для России

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**Аннотация.** В статье обсуждается вопрос последствий развития технологий добычи сланцевого газа. Снижение резервов натурального газа в США в 70-х гг. вынудило государство и деловые круги США направить финансовые ресурсы на развитие технологий добычи сланцевого газа, в том числе технологий микросейсмических взрывов. Наблюдаемый прогресс технологий добычи сланцевого газа имеет также значение для российской газовой и нефтяной индустрии. Как долго 70% российского экспорта будет составлять нефть и газ, так долго российская экономика будет уязвимой из-за колебания цен на нефть. Общество, государство и представители нефтяной промышленности вынуждены были пересмотреть свои взгляды на будущее нефтяной промышленности после первого нефтяного шока в 70-х гг. Ответом на этот вызов был поиск новых типов резервов ископаемого топлива и развитие способов их добычи. Следует подчеркнуть, что современный кризис создает возможность проведения в России налоговой и финансовой реформы с целью стимулирования технологических инноваций, таких как аналитика больших данных.

**Ключевые слова:** сланцевый газ, технология микросейсмического взрыва, российская газовая промышленность, мировые цены на нефть, мировые цены на газ.

Nothing is more central to the Russian economy as the world oil price. A recent economic report indicates that a $1 decline in the price of oil entails annual losses to

the Russian budget of about $2 billion on an annual basis. So in recent weeks with oil price dropping from $43 to $31 per barrel the budget lost about $24 billion and the dollar exchange rate went from 65/$ to 77/$, demonstrating the linkage between the oil price and the rouble. Macroeconomic factors can influence the oil price, for example when the IMF lowered the world GDP forecast by.3% for 2015 the price of oil declined. When China lowered its 2015 GDP from 8% to 6.8% this also had a negative impact on the oil price and the 2016 decline in oil prices was attributed to economic uncertainty in China. Between 2003 and 2013, China accounted for 45% of the increase in world oil demand. Supply and demand are main drivers of oil price. World oil demand in 2015 was 94.6 million barrels a day while supply was 96.9 million barrels causing downward pressure on the oil price. The 3-billion barrels of worldwide oil inventory drives the price downward as it contributes to the glut in oil. The recent increase in US interest rates by the US Federal Reserve Bank created some downward pressure on the oil price as the dollar strengthened.

The most unpredictable driver of oil prices is geopolitical events. In the past 60 years, oil has spiked during the 1956 Suez crisis, the 1973 Yom Kipper war, the 1979 Iran Revolution and most recently, the war between Saudi Arabia and Yemen in April of 2015 caused the price of oil to increase to $65/b from $50. During the worldwide Financial Market meltdown in 2008, oil plummeted from $147 to $35 per barrel. The effect on Russia was devastating with a decline in GDP of 8%.

Nations and energy were forced to consider what a future with dwindling fossil fuel supplies might look like, after the first global oil shock during the 1970s. One response was to look for new types of fossil fuel reserves and develop ways to reach them. Over forty years later, these efforts are finally beginning to pay off. Horizontal drilling and hydraulic fracturing, the technologies for reaching "unconventional" reserves such as natural gas and light tight oil (LTO) trapped in rock formations (often shale) are now widely being used. These extraction techniques can to unlock both newly discovered reserves and previously known deposits that could not have been economically extracted using conventional methods.

As reserves that cannot be extracted by conventional drilling methods, unconventional oil and gas reserves are defined.

Oil or gas in these reserves are trapped in natural fractures in the rock or absorbed by nearly organic material. Besides shale gas and LTO, unconventional fossil fuel deposits include coal bed methane, tight sandstone and methane clathrates.

Declining natural gas reserves during the 1970s prompted the United States movement to fund research into extracting shale gas, leading to many advances in technology including micro seismic imaging. The government encouraged drilling for shale gas through tax credits, research dissemination, and industry support. In 1991, it supported the first horizontal drilling project, and in 1998, the first commercial shale fracture in the Barnett Shale basin in the state of Texas. The first combination of hydraulic fracturing and horizontal drilling followed in the Barnett basin in 2005.

The use of the latest drilling technologies generated productivity growth, as measured by initial production per rig of over 30% per year between 2007 and 2014. The "walking rig" or pad drilling is one technological advance that has contributed greatly to gains in rig productivity. Rather than a single well from a well pad, a walking rig can move around the pad, drilling multiple wells (sometimes dozens). Since 2006, the use of pad drilling has grown dramatically from a few percent to over 50 percent of new wells, with the potential to rise higher. This partially explains the disparity between the recent closing of 60 percent of rigs and a decline in production of only 3 percent. While the newer pad drilling rigs with multiple wells have remained active, the older less efficient rigs have been closed. Another innovation used extensively is 3D seismology that supports hydraulic fracturing by giving developers a better understanding of the geology of the reservoir and how best to stimulate it.

The single biggest advancement now coming to the shale industry is the use of big data for radically better asset optimization and operations. In every sector of the U. S. economy the availability and collection of data from machines, services and business operations is growing at an astonishing rate. Still a large

amount of data remains disparate and disordered. The use of big-data analytics offers nearly all industries the potential for unprecedented insight, efficiency and economic value. Big-data analytics can already optimize the surface mapping of the best drilling locations; indicate how and where to steer the drill bit; determine, section by section the best way to stimulate the shale; and ensure precise truck and rail operations. Mobile computing, using aap-centric analytics, can increase uptime, reduce maintenance, improve workforce productivity, reduce errors and rework, and enable low-cost compliance. Halliburton reports that its analytic tools achieved a 40 percent reduction in the cost of delivering a barrel of oil. Baker Hughes says that analytics helped it double output in older wells. Schlumberger announced a 50 percent gain in productivity thanks to the use of analytics. Conoco Phillips combined the latest sensors (which extract data by the minute rather than daily), wireless networks and big-data analytics to boost output by 30 percent in existing wells.

A key point is that the nature of fracking (also hydraulic fracturing, hydrofracturing, hydrofracking, or fraccing) is more like a standardized, repeated, manufacturing process, rather than the one-off, large scale engineering projects that characterize many conventional oil projects. While conventional projects might take 7 years to produce oil tight, oil projects can achieve production in 2 or 3 months. The U.S. has become the world leader in shale oil production because it has a long history of wildcat oil entrepreneurs and capital markets in addition to a legal system that allows any landowner to sell their mineral rights without government approval. Although Russia and China have huge shale deposits they lack a supportive environment to encourage the development of their shale resources.

Although U.S. shale production accounts for less than 5% of the global market, the rapid growth in U. S. shale oil was the key factor driving the collapse in oil prices during 2014. Since 2008, the U. S. has increased its shale production to 4.5 million barrels per day that has formerly imported from Saudi Arabia, Nigeria and other oil exporters. In November of 2014, OPEC led by Saudi Arabia maintained a production level of 30m/bd. This strategy has been primarily intended to maintain its market share by driving U. S. shale producers out of the market while also hurting Russia and Iran.

For the time being OPEC's strategy seems to be working as U. S. oil production is expected

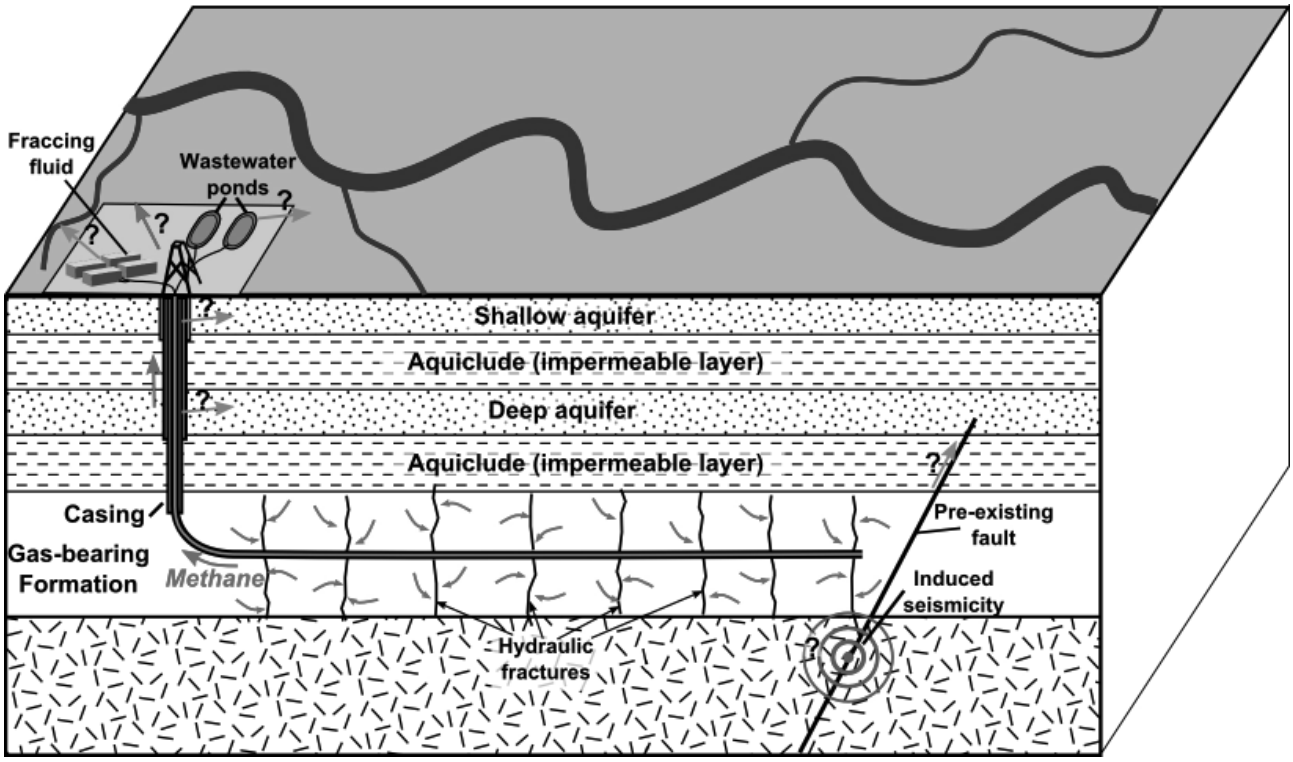


*Figure.* **Hydrofracturing**

to decline by around 1 million b/d in 2016 from its 2015 peak of 9.6 million bd. Many high cost shale producers are going bankrupt and "zombies" (companies that can afford only to pay interest and other expenses and cannot afford to drill for oil) becoming more common. This strategy has some risks for Saudi Arabia, for example, if the price of oil remains at $40 a barrel it has to use $10 billion a month from its currency reserves to maintain current budget spending levels. This is important because a significant portion of its budget goes to social spending that is needed to maintain political stability. Although the U. S. shale companies have significantly cut production they can quickly start producing when the oil price recovers in 2017 as Daniel Yergin and other analysts are forecasting.

As long as Russia is dependent on oil for 70 percent of its exports, Russia's economy will be intrinsically linked to the fluctuation of world oil prices. A main driver of oil prices is the Saudi/US shale conflict, which was a direct result of the advancement of shale extraction technologies employed in the United States. The current crisis creates an opportunity for Russia to provide tax and financial incentives to encourage technological innovations such as Big Data Analytics. These innovations can be applied not only to the development of Russia's massive shale reserves but also to the enhancement of productivity in other areas such as logistics and the localization of manufacturing. Improvement in these areas will help Russia to be competitive in a dynamic global environment.

## ABOUT BIG DATA ANALYTICS

Big data analytics examines large amounts of data to uncover hidden patterns, correlations and other insights. With today's technology, it is possible to analyze your data and get answers from it almost immediately–an effort that's slower and less efficient with more traditional business intelligence solutions.

*History and evolution of big data analytics*

The concept of big data has been around for years; most organizations now understand that if they capture all the data that streams into their businesses, they can apply analytics and get significant value from it. But even in the 1950s, decades before anyone uttered the term "big data," businesses were using basic analytics (essentially numbers in a spreadsheet that were manually examined) to uncover insights and trends.

The new benefits that big data analytics brings to the table, however, are speed and efficiency. Whereas a few years ago a business would have gathered information, run analytics and unearthed information that could be used for future decisions, today that business can identify insights for immediate decisions. The ability to work faster–and stay agile–gives organizations a competitive edge they did not have before.

*Why is big data analytics important?*

Big data analytics helps organizations harness their data and use it to identify new opportunities. That, in turn, leads to smarter business moves, operations that are more efficient, higher profits and happier customers. In his report Big Data in Big Companies, IIA Director of Research Tom Davenport interviewed more than 50 businesses to understand how they used big data. He found they got value in the following ways:

1. ***Cost reduction***. Big data technologies such as Hadoop and cloud-based analytics bring significant cost advantages when it comes to storing large amounts of data–plus they can identify more efficient ways of doing business.

2. ***Faster, better decision making***. With the speed of Hadoop and in-memory analytics, combined with the ability to analyze new sources of data, businesses are able to analyze information immediately — and make decisions based on what they have learned.

3. ***New products and services***. With the ability to gauge customer needs and satisfaction through analytics comes the power to give customers what they want. Davenport points out that with big data analytics, more companies are creating new products to meet customers' needs.

Organizations are inundated with data–terabytes and petabytes of it. This is not new. However, what is new is the velocity of growth, the diversity of the data and the imperative to make better use of information to transform your business.

*How it works and key technologies*

There's no single technology that encompasses big data analytics. Of course, there's advanced analytics that can be applied to big data, but in reality several types of technology work together to help you get the most value from your information. Here are the biggest players:

**Data management**. Data needs to be high quality and well governed before it can be reliably analyzed. With data constantly flowing in and out of an organization, it is important to establish repeatable processes to build and maintain standards for data quality. Once data is reliable, organizations should establish a master data management program that gets the entire enterprise on the same page.

**Data mining**. Data mining technology helps you examine large amounts of data to discover patterns in the data–and this information can be used for further analysis to help answer complex business questions. With data mining software, you can sift through all the chaotic and repetitive noise in data, pinpoint what is relevant, use that information to assess likely outcomes, and then accelerate the pace of making informed decisions.

**Hadoop**. This open source software framework can store large amounts of data and run applications on clusters of commodity hardware. It has become a key technology to doing business due to the constant increase of data volumes and varieties, and its distributed computing model processes big data fast. An additional benefit is that Hadoop's open source framework is free and uses commodity hardware to store large quantities of data.

**In-memory analytics**. By analyzing data from system memory (instead of from your hard disk drive), you can derive immediate insights from your data and act on them quickly. This technology is able to remove data prep and analytical processing latencies to test new scenarios and create models; it is not only an easy way for organizations to stay agile and make better business decisions, it also enables them to run iterative and interactive analytics scenarios.

**Predictive analytics**. Predictive analytics technology uses data, statistical algorithms and machine-learning techniques to identify the likelihood of future outcomes based on historical data. It is all about providing a best assessment on what will happen in the future, so organizations can feel more confident that they were making the best possible business decision. Some of the most common applications of predictive analytics include fraud detection, risk, operations and marketing.

**Text mining**. With text mining technology, you can analyze text data from the web, comment fields, books and other text-based sources to uncover insights you had not noticed before. Text mining uses machine learning or natural language processing technology to comb through documents–emails, blogs, Twitter feeds, surveys, competitive intelligence and more–to help you analyze large amounts of information and discover new topics and term relationships.