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Technology commercialization: Experience of the U.S. and Possibilities for Oil and Gas Industry in Russia

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Abstract
US are leading the way in technology commercialization, while Russia lags far behind. This paper discusses the best American practices, situation in Russia and technology commercialization in oil and gas complex. Technology commercialization in Russia struggles for several reasons. In this paper, we propose that Russia can improve its technology commercialization by studying the example of the US. The best practices of US universities cannot be exactly replicated. It is necessary therefore to create a Russian model of technology commercialization that, while drawing on the spirit and general features of technology commercialization in the United States, is adapted for the specific conditions in Russia. The important overarching point is that it is necessary to improve technology commercialization in oil and gas industry, because they are really crucial for Russian economy. Peculiarities of technology commercialization in oil and gas industry are revealed. Possibilities of the carbon capture and storage (CCS) and enhance oil recovery (EOR-CO2) technologies commercialization in oil and gas complex of Russia are presented. Carbon dioxide sequestration by means of capturing and injecting it into the underground reservoirs is a promising mechanism of reducing carbon dioxide concentration. And also CCS might be used to EOR-CO2 and production by means of oil extraction and decreasing oil viscosity.

Keywords: technology commercialization, the US experience, oil and gas industry, Russia, carbon dioxide, carbon capture and storage (CCS), oil recovery, EOR-CO2 technology

Introduction

US are leading the way in technology commercialization, while Russia lags far behind. US institutions have taken steps to encourage entrepreneurship, to promote regional development, and to engage in what is known as technology commercialization.

Technology commercialization means any form of commercial usage of intellectual property (IP), including a cession of the rights, licensing, and internal use of IP by think tanks, research universities, research centers and IP commercialization by specialized companies (venture companies).

Usually such departments as Offices of Technology Commercialization (Transfer) or Offices of Technology Licensing in US think tanks, research universities, and research centers are responsible for the protection and efficient transfer of institutions discoveries to the marketplace for the benefit of society.

In Russia, technology commercialization struggles for several reasons, in oil and gas industry too. Through recent policy initiatives, coupled with investment in physical infrastructure, Russia has built the components of an innovation ecosystem. But it lacks many things that would encourage technology commercialization such as an entrepreneurial culture and innovative environment, strong project teams and skilled inventors in business, and entrepreneurship education, etc.

We propose that Russia can improve its technology commercialization by studying the example of the US and implementing proper procedures. And the important overarching point is that it is necessary to improve technology commercialization in oil and gas industry, because they are really crucial for Russian economy.

Technology Commercialization in the United States

In the United States, the beginning of university entrepreneurship can be attributed to the passage of Bayh-Dole Act (1980), which enabled technology commercialization at US universities. This act is US legislation dealing with IP arising from federal government-funded research.

According to the act, a university became the legal owner of any IP that was created at that university as a result of publicly funded research [1]. The income earned by US universities from licensing increased from $7.3 million in 1981 to $3.4 billion in 2008 [2].

In Figure 1, we present the idealized process of technology commercialization at U.S. universities and other scientific institutions. Successful R&D begins the process of technology commercialization.

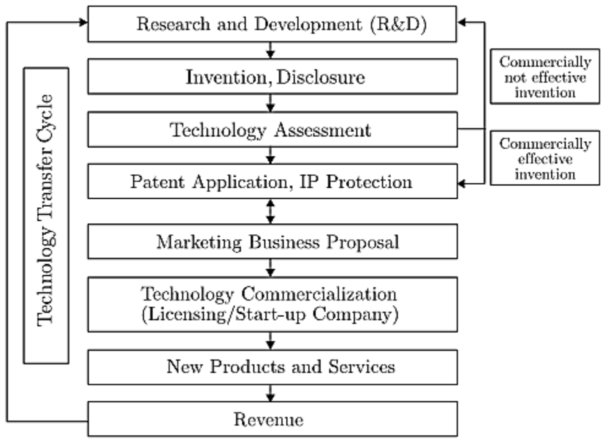

Figure 1: Technology commercialization stages at U.S. universities

Source: Adapted from Office of Technology Commercialization presentation, University of Maryland, College Park http://otc.umd.edu/sites/default/files/documents/about-otc-2010.pdf

The most important step of technology commercialization is technology assessment. If the assessment deems that the invention is not commercially viable, the invention is sent back to the R&D process for refinement; if the invention is, on the other hand, judged to be commercially viable, then the assessment determines what kind of IP protection will be sought and if a patent should be applied for, as well as establish the appropriate model of technological commercialization (licensing or start-up company). Because it costs about $15,000 to $30,000 to patent an invention in the US, universities and other research institutions patent only commercially advanced inventions. Thereafter market research is conducted, and a business proposal is prepared. Negotiations with companies interested in the new technology begin, and the commercialization model is completed [3].

In the United States, there are two basic models of technology commercialization [4]:

1. License agreement with an existing company that is interested in a new technology;
2. Start-up company using the research institution's (university's) IP (the institution can license with an existing company, or with a new company started with a technology license).

Licensors use license agreements to grant their licensees the right to use certain IP, including software, inventions, patents, etc.

In both cases, a license agreement between the university (think tanks, research centers, etc) and an existing or start-up company is concluded. According to the license agreement, the licensee (the company that obtained the license) pays the licensor (the university, think tanks, research centers) fixed payments-a royalty.

Royalties are typically agreed upon as a percentage of gross or net revenues derived from the use of IP or a fixed price per unit sold of an item of such, but there are also other modes and metrics of compensation.

Besides the IP being licensed and the royalty rates, license agreements can also include representations, warranties, termination provisions, terms of indemnification and dispute resolution clauses.

If the license agreement is concluded with a start-up company that cannot afford to pay a royalty, often the university (think tanks, research centers, etc) becomes the owner of a new company share.

According to American practices, around 80% of license agreements are concluded with a licensee who is familiar to the inventor [5].

So, the main tasks of technology commercialization and licensing at US universities can be identified as the following[1]:

- Accelerate the transfer of new technologies from universities to the marketplace.
- Provide services (training, counseling, and mentoring) for university researchers and potential business partners.
- Assess the fair market value of IP owned by the university, and determine and negotiate fair terms of transactions and agreements.
- Use best business practices while taking into account the interests of the general public.
- Resolve conflicts among groups of researchers, industrial partners, and the university.

So, technology commercialization in the US has been successful overall. The US affords an excellent example for Russia to follow.

Technology Commercialization in Russia

Russia is good at research, and her science and research fields remain world class. The Russian government has actively financed R&D in recent years: expenses for R&D were 1.48% of GDP in 2013 (see Figure 2), compared with 1.16% of GDP in 2010 (UNESCO Institute for Statistics 2012).

They are less than in the United States (2.66% of GDP in 2013), but for Russia they are considerable nonetheless, and the percentage is expected to reach 3% by 2020, according to the strategy of innovative development of Russia.

But Russia patents a large amount of IP without commercial potential and commercializes only 2.2% of inventions [6]. Most Russian R&D is carried out in public institutes that have weak commercial ties. Thus, Russia's biggest deficiencies are technology commercialization and practical application of inventions.

[1] Adapted from AUTM (Association of University Technology Managers) and OTC (Office of Technology Commercialization, University of Maryland) presentations and materials.

There are four main models of technology development in Russia:

1. government contracts and research grants;
2. business contracts;
3. university-based start-ups (Federal Law 217 (2009), "Law on Small Enterprises near Universities");
4. licensing.

Russian universities are focused on models 1 and 2 of technology development and have historically not been concerned about the practical use of scientific results. But models 3 and 4 are where technology commercialization is really at, and they represent new trends for Russian universities.
Models 3 and 4 demand inventions (IP) with the potential for commercialization, support organizations (structure) and resources, and the promotion of team (especially model 3) and entrepreneurial skills. These aspects are missing at Russian universities. Universities are not ready to pursue these models of commercialization. Therefore it is precisely models 3 and 4 that need to be developed.

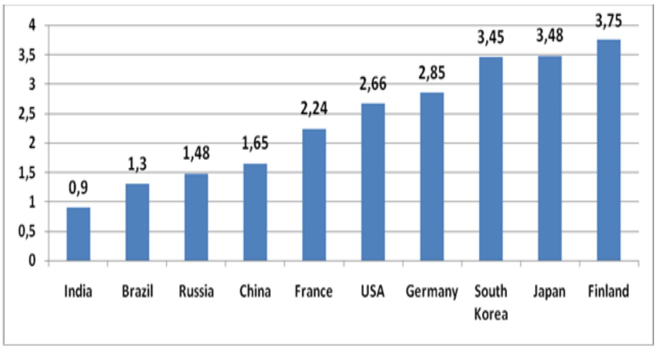

Figure 2: Expenses for R&D as a % of GDP, 2013

Source: Global R&B funding forecast 2013, Battelle R&D Magazine (http://www.battelle.org/docs/default-document-library/2013-R-and-D-Funding-Forecast.pdf?sfvrsn=4).

Technology Commercialization in Oil &Gas Industry

Technology commercialization in oil and gas industry has a number of features connected first with specifics and peculiarities of the industry. The authors highlighted the following features of oil and gas industry in Russia:

- Institutional regulation of subsoil usage;
- High capital intensity of the oil and gas production;
- Unique character of mineral deposits;
- High level of entrance barriers into industry;
- High level of transaction costs;
- High degree of the assets specificity;
- High strategic and social value of oil and gas companies;
- Lack of opportunities to reduce risks by product diversification (monoproduct companies).

So, scientific inventions and technologies can't be practically introduced in production without close cooperation with oil and gas companies. Besides, many technologies and inventions are developed in compliance with mining and geological conditions of a concrete oil and gas deposit. Therefore, a key factor of successful technology commercialization in oil and gas industry is mutually beneficial cooperation between universities (think tanks, research centers, etc) and oil and gas companies. Technology commercialization and implementation of innovative projects in oil and gas industry allow to increase economic efficiency of the oil and gas production, to reduce production costs, to improve oil recovery, to reduce ecological risk of oil and gas production.

Possibilities of the CCS and EOR-CO2 Technologies Commercialization

The principles of Russian oil and gas companies operation in the modern economic conditions may and should provide for a use of sets of organizational and technical, economic solutions targeted on the adoption, implementation and commercialization of environmental and nature conservation related technologies. That makes it possible to use the options of greenhouse gas reduction that are widespread in the Western countries in order to ensure energy-efficient development and rational usage of natural resources [7].
Commercialization of technology of carbon dioxide sequestration by means of capturing and injecting it into the underground reservoirs is a promising mechanism of reducing carbon dioxide (CO2) concentration. And also carbon capture and storage technologies (CCS) might be used to enhance oil recovery (EOR-CO2) and production by means of oil extraction and decreasing oil viscosity.
The proportion of the CCS technologies in reduction of the global emission is estimated to be from 20 to 28 percent, which indicates the prospects of development and vast adoption of such technologies [8,9]. CCS technologies include the following technological processes: capturing, transportation and geological storage. These processes (stages) differ from each other considerably in terms of technical and technological practicability and have different experience of practical application. Geological storage is linked with the possibility of injecting CO2 into saline formations (water-bearing strata), oil and gas fields, and coalbeds.
It was noted that CO2 storage in oil and gas fields that are at the final production stage might be used to enhance oil recovery (EOR-CO2) and production by means of oil extraction and decreasing oil viscosity [10,11].
Enhancing oil recovery by the EOR-CO2 method may be characterized by the added value by usage of anthropogenic CO2, captured at power plants and industrial enterprises. Studies conducted by American experts showed that the worldwide potential of the EOR-CO2 is 340 billion barrels of technically recoverable oil resources and the capacitive potential of CO2 storage is 120,000 million tons. Large volumes of potential carbon dioxide storage in the oil reservoirs underline the interest in the EOR-CO2 technologies commercialization [12].
Currently, most of the CCS projects serve the demonstration purpose, therefore, there is no definite way to evaluate the costs of CCS technology commercialization. The implementation costs of the CCS technology depend on

particular project, technological features of capturing industrial enterprises, mining and geological conditions of fields, distance of transportation etc.

It has to be mentioned that the CO2 sequestration costs will differ at different stages of the technology development. Thus, at the demo stage (currently) projects are minor and focused on drawing attention of all the stakeholders to this technology in order to prove its efficiency and safety. At this stage, the cost of such projects remains rather high, especially at the CO2 capturing stage [7].

The majority of Russian oil and gas fields (Western Siberia) are located in the areas that are remoted from the main industrial CO2 emission sources. The old oil and gas production areas, such as Tatarstan and Bashkiria, the Northwestern region (including Kaliningrad oblast) are the most suitable for the EOR-CO2 methods usage. It is important to evaluate the geological and technical potential of the EOR-CO2 technology, the CO2 storage for the old oil production areas in the first place.

Reasonability of the effective and stimulating state policy for the large-scale CCS projects adoption and EOR-CO2 technology commercialization is conditional on the demo stage and high capital intensity of such technologies, as wells as the uncertainty about the future world carbon market development. Therefore, incentives and the support of oil and gas companies' strategic initiatives in the resource-saving and environmental areas, one of which is the commercialization of CCS and EOR-CO2 technologies, are necessary.

Conclusion

Generalizing from what we have noted above, we can propose the following recommendations for Russian universities (think tanks, research centers, etc) to improve technology commercialization:

- Develop an integrated ecosystem, one that brings together science, entrepreneurship education, innovation, and collaboration (like in the U.S. universities and institutions).
- Generate IP with commercial potential; analyze, screen, and "package" innovation projects.
- Develop an entrepreneurial culture among employees and students; popularize innovations, and improve IP management and entrepreneurship.
- Create entrepreneurship education opportunities (programs, speaker series, open hours) to educate innovators with strong entrepreneurial skills.
- Connect with industrial sector and particular companies to collaboratively use resources and pursue opportunities.
- Facilitate university-industry collaboration.
- Focus on the real requirements of business.

We began this paper by proposing that Russia can benefit a great deal from the US when it comes to technology commercialization. Needless to say, the way in which US universities have promoted technology commercialization cannot be copied detail for detail, because the situation in Russia is not exactly like the situation in the United States. We can observe the best practices of US universities, but they cannot be exactly replicated. It is necessary therefore to create a Russian model of technology commercialization that, while drawing on the spirit and general features of technology commercialization in the United States, is adapted for the specific conditions in Russia.

And the important overarching point is that it is necessary to improve technology commercialization in oil and gas industry, because they are really crucial for Russian economy.

Technology commercialization in oil and gas industry has a number of features connected first with specifics and peculiarities of the industry.

One of the perspective directions in oil and gas complex is CCS and EOR-CO2 technology commercialization. Carbon dioxide sequestration by means of capturing and injecting it into the underground reservoirs is a promising mechanism of reducing carbon dioxide concentration. And also carbon capture and storage technologies (CCS) might be used to enhance oil recovery (EOR-CO2) and production by means of oil extraction and decreasing oil viscosity.

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