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**Innovations in oil & gas upstream – break-through
technologies and required acceleration framework**

Parallel Session 1

The impact of technology - Embracing innovation

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Executive summary

Bridging the gap between idea and successful hi-tech business is an extremely challenging task in any technology area. However each area has its own peculiarities in terms of the main tasks to be solved and the competences to be developed. For upstream technologies the most challenging specific task is to validate the technology through full-scale field tests and then find early adopters to make first sales. This task is a typical chicken-and-egg problem: how to perform a full-scale field test if only a thoroughly validated technology can grant access to the field. The primary goal of Skolkovo Oil & Gas Center is to facilitate the development of Russian oil & gas startups from the stage of proven concept or tested prototype to first commercial sales. This paper focuses on the key initiatives and mechanisms implemented by the Center to reach this goal and some successful cases of their implementation.

Oil and Gas Technology Development and Deployment in Russia: an Overview

Russia being one of the largest oil and gas producers in the world whose budget is by 50% formed by incomes from oil & gas industry has a strategic interest in developing and implementing most efficient technologies for exploration and production. Key technological challenges which Russian oil & gas industry is facing now and will be facing in long term perspective (at least for twenty years) are:

- Prolonging the lifetime of brownfields by reducing lifting costs and by broad implementation of EOR methods;
- Developing greenfields in extreme environment (e.g. arctic offshore);
- Finding keys to economically feasible production from hard-to-recover reserves (extremely low permeability, heavy oil, carbonates reservoirs etc.);
- And finally, developing new technologies and approaches to explore hydrocarbons and to obtain more knowledge about existing provinces.

Innovation in these areas is driven by all involved parties and each has its role to play. Oilfield service companies and equipment producers (both international and domestic) execute huge R&D programs striving to be the first to offer best solutions to the customers. Major oil & gas producers perform in-house R&D, participate in R&D consortiums and provide opportunities for testing external developments on their assets. Government introduces different tax benefits for companies developing hard-to-recover reserves and implementing innovative technologies. Startups are working in tight cooperation with development institutions to provide break-through and truly innovative solutions to the market.

However, until recent years major international service companies like Schlumberger were seen as almost the only contributors to a process of technological development of Russian oil & gas industry. A role of oil & gas producers was at best expected to be a smart buyer whose only contribution is to pick right technology among those presented in the market. Fortunately, the situation is changing a lot and the industry observes shifts in several directions:

- Most of major Russian oil & gas producers consistently increase investments in in-house R&D and external R&D consortiums;
- Cooperation activity in R&D between oil & gas producers and technology providers (especially domestic) is rising as producers are looking for cheaper, customized for their needs and localized technologies;
- Overall activity of technological startups and development institutions has risen drastically in the last 5 years.

Skolkovo Innovation Center (hereinafter referred to as Skolkovo) is one of the most known contributors to the abovementioned rise of startups activity in Russia. Skolkovo is a development institution started in 2010 by Russian government and is composed of start-ups developing innovative technologies (currently numbering over 1,000), industrial partners (e.g. Honeywell, Rosneft, General Electric etc.) implementing new technologies in industries, the Skolkovo Institute of Science and Technology (Skoltech), and a Technopark in Skolkovo city, located near Moscow. Together these entities established a vibrant ecosystem of technology innovation and entrepreneurship focused on five directions: Nuclear, Biomed, Space, IT and Energy. Skolkovo already became a community of likeminded talented people capable to develop new multidisciplinary technologies.

As of May 2015 Skolkovo hosts over 50 startups developing and commercializing new technologies for oil & gas industry and this number is expected to grow up to 100 startups by 2017. Current R&D portfolio of these startups covers wide range of technological areas and in total could address almost all key technological challenges of the industry. Of course there are some technological areas hard to be addressed by startups.

For example it is hard to expect that a solution for deep water drilling in Arctic will be developed by small innovative company. However one could expect that a startup will develop for example an underwater robot for equipment inspection, solution for flow assurance etc. So eventually there is a place for startups in almost any stage of exploration and production. Among technological areas in which Skolkovo startups are most active are:

- Geophysics: e.g. spectral noise logging or acoustic tomography;
- Submersible pumps especially for wells with low productivity;
- Physical EOR approaches e.g. ultrasonic or plasma pulse treatment;
- Oil and gas treatment e.g. catalytic desulphurization and supersonic gas separation;
- And finally IT solutions for all kind of tasks from seismic interpretation to smart field solutions.

Some the Skolkovo startups have already passed the stage of field-testing and can be seen as a commercial success story. However, most of them are facing or will face in the near future the problem of finding a way to test their technology on the field and then find early adopters to make first sales.

Oil and Gas Technology Acceptance: Why it is so slow and How to Accelerate It

The topic of Oil and gas technology development and acceptance is often addressed by researchers, government entities and the industry¹²³. Most of the usually named key reasons for the slow acceptance of new technologies in oil and gas industry all over the world are also true for Russian oil and gas industry:

- Major operators have become increasingly risk-averse as new projects have become more costly, less economical, and technically more challenging. The potential harm and losses from technical malfunctions in oil and gas industry are far beyond those for the most of the other capital-intensive industries. The extreme example of the negative outcome from a malfunction in just a small element of a huge oil producing facility is BP oil disaster in Gulf of Mexico. However, even a single onshore well breakdown leads to notable economic losses for operator.
- High level of asymmetry in expertise, competences and problem understanding between operators, service companies, entrepreneurs and research institutions. The industry knows quite a few examples of a tight, effective and sustainable cooperation between operators, service companies and research institutions in pulling new technologies from fundamental stage to wide market implementation.

Even if the operating company has a strong will to develop and implement some game-changing technology it can take decades to get from laboratory stage to wide implementation. For example, Shell has started laboratory studies of Alkaline surfactant polymer (ASP) enhanced oil recovery technology in mid-90's⁴. Nowadays several full-scale pilot projects are being executed and are planned to be finished only by 2018-2020. Of course this is also an extreme case, but for example, a full-scale field test program for a new type of submersible pump will usually take a two year testing in at least 10 wells. Thus, typical time-to-market for even simple equipment which submersible pump actually is will be 3 to 5 years.

1. Rao V and Rodriguez R: "Accelerating Technology Acceptance: Hypotheses and Remedies for Risk-Averse Behavior in Technology Acceptance," paper SPE 98511 Society of Petroleum Engineers (2005)

2. Bakewell C and Horsely C: "Innovation Lacking in High-Tech World of Oil," Oil & Gas Journal online article. http://www.ogj.com/articles/article_display.cfm?Article_ID=229822.

3. NPC Committee On Global Oil And Gas: "Oil and Gas Technology Development", Topic Paper #26 of the NPC Global Oil & Gas Study. http://www.npc.org/study_topic_papers/26-ttg-ogtechdevelopment.pdf

4. <http://www.shell.com/content/dam/shell/static/future-energy/downloads/eor/eor-brochure-2012.pdf>

Naturally, a lot of different and effective mechanisms were introduced in past two decades all over the industry to make the path from concept to market implementation faster and smoother:

- Technology facilitators like ITF⁵ and TNO⁶
- Specialized testing facilities like Rocky Mountain Oilfield Testing Center⁷ and Ullrig Drilling and Well Center⁸
- Fully centralized technology development strategies in countries with one dominating state-owned NOC like in Saudi Arabia⁹
- Intensive state-driven programs in countries with high level of state control over the industry like DEMO 2000¹⁰ program in Norway
- Special divisions in IOCs tailored to seek and implement new external technologies in this IOCs like Chevron Technology Ventures¹¹ and BP Ventures.

Returning back to Russian oil and gas industry it is clear that it now lacks such mechanisms. After almost 15 years of drastic perturbations in economy, politics and society it is only several years ago then Russian state, major oil and gas and service companies became practically aware of the need to develop of such cooperation and technology acceleration mechanisms. By 2015 several effective mechanism and programs to foster innovation in Russian economy are already established. However, there are not focused on oil and gas industry and its peculiar needs. Therefore, Skolkovo as a major development institution in an area of new technologies in Russia have to develop its own set of best practices and mechanisms to help its startups to successfully demonstrate their technologies in real conditions and commercialize them. Among the key of these practices and mechanisms are:

- Oil and gas acceleration program for early stage startups to develop their business skill and to shape their technology, business model and marketing strategy so that they will meet the needs of the customers in the best possible way
- Cooperation and communication models with key oil and gas companies to meet potential early adopters and relative startups in right time
- Cooperation with oilfield service companies and equipment producers who can act as technology aggregators and potential business partners or next stage investors for startups
- Cooperation with international business accelerators and technology facilitators to provide startups easy ways to enter international markets
- Development of specialized testing areas on brownfields to provide cheap and guaranteed access to the field for startups

Acceleration Program: Meeting Needs of Customers with Capabilities of Startups

In overall oil and gas acceleration program in Skolkovo is constructed as many typical business acceleration programs which are presented in any industry all over the world. However, it includes some specific elements and priorities.

As it was stated earlier the gap between the real problems of oil and gas companies, their demand for new technologies from one side and the understanding of these problems by startups from other side is one of the

5. <http://www.oil-itf.com/>

6. <https://www.tno.nl/>

7. <http://www.rmotc.doe.gov/>

8. <http://ullrigg.no/>

9. <http://www.kacst.edu.sa/en/research/Documents/OilAndGas.pdf>

10. http://www.forskningsradet.no/prognett-demo2000/Programme_description/1228296565509

11. <http://www.chevron.com/ctv/>

main factors hindering the fast development and adoption of new technologies. Thus, it is extremely important to establish effective communication between potential customers and startups on the early stage of their development. Skolkovo performs this task by arranging regular meetings of startups with a panel of subject matter experts and business representatives. Usually each startup participating in the acceleration program gets through 3 to 5 of such meetings linked to key milestones of a startup development plan.

As an example of startup benefited from an early communication with the customers is Laser Solutions¹² could be named. In 2012 it started to develop a set of fiber optic monitoring systems for distributed temperature, pressure and acoustic sensing in oil and gas wells. The initial plan was just to sell these systems to oil and gas companies. However, after several discussions with experts and potential customers the company realized that the real demand is for a turn-key solution which includes not only equipment but also consulting services, data interpretations methods and software. This insight allowed them to timely change their development plan so that by the time the monitoring systems were developed the company had a team, expertise and partners ready to provide turn-key services.

Cooperation with Oil and Gas Companies: Meeting Early Adopters with Right startups Just-in-Time

Getting deep and detailed knowledge of customer needs before attracting investments and diving into a 2-3 year R&D project is not an only advantage of close and regular communication with potential customers. It is a usual case for oil and gas technology startups to get stuck in their development even after successful field testing. That is because the majority of big oil and gas companies choose to work only with those technology providers who have a long history of their technology implementation and market track. Of course there is a possibility to have a first commercial implementation in a small-scale oil and gas producer who is less risk-averse and not tied with long term contracts with major technology providers. But it is almost impossible to find such a customer in Russia and it is not a simple task to get to the US market with thousands of small independent oil and gas producers. From the other side in oil and gas industry due to its intrinsic incomplete knowledge of the oil and gas fields being developed it is a usual case that an urgent need to solve an unexpected technical challenge arises. Thus, Skolkovo manages to keep in touch with all its partner oil and gas companies to catch such challenges and find an appropriate and most effective solution among those presented by Skolkovo startups.

The best illustration for this idea is a case occurred just in the beginning of 2015. An oil producing company RITEK¹³ which is a partner of Skolkovo has unexpectedly faced a problem of very high sulfur dioxide content in the associated petroleum gas on one of their greenfields. As there were both no time to negotiate with major desulfurization technologies providers and actually no place to integrate typical equipment to the already being under construction gas treatment plant, RITEK asked to find compact, effective and fast to implement technology. A solution developed by a Skolkovo startup Start-Catalyst has met all the needs perfectly and the contract to supply the equipment was negotiated and signed in a couple of months. In addition to this Skolkovo have provided Start-Catalyst with a grant financing which allowed it to make engineering and order equipment without attracting additional investments.

12. http://lscom.ru/en_oil.html

13. <http://www.ritek.ru/>

Cooperation with Successful Technology Providers: Finding Best Partner to Tunnel a Way to a Customer

Again it should be noted that in any industry it is a good practice for startup to cooperate with successful company working on a relevant market. Such partner already has a wide network of business contacts, marketing resources and sustainable reputation. But for the oil and gas industry it is often not just a good but almost the only way for startup to get to the market in a reasonable time. The reason is that oil and gas industry is highly specialized meaning that oil and gas producers are mostly only operators and the vast majority of technologies are developed and produced by technology providers. That is why Skolkovo constantly develops cooperation with middle sized international and local service providers and equipment producers.

This cooperation can take different forms and there is an example of Skolkovo partner participating in such cooperation in almost all possible ways. Targin¹⁴ is a middle sized (comparing to Schlumberger) diversified oilfield service provider hosted in Bashkortostan Republic of Russia. Its strategy is not only performing in-house R&D but also to seek for startups and small-sized technology company to integrate them to Targin's business as subcontractors or through acquisitions. Growth through acquisitions is a typical strategy for oilfield service companies: Schlumberger have acquired more than a dozen of technology providers for the last 15 years. The essential difference is that Schlumberger acquires only successful small and mid-scale companies and almost never attracts startups as subcontractors. That is why Targin is a kind of best partner for Skolkovo among service companies. Getting down to the practical aspects of this cooperation, Targin:

- and its CEO personally¹⁵ are active participants of Skolkovo mentor program
- is an investor for a couple of Skolkovo startups
- attracts Skolkovo startups as subcontractors to meet particular needs of its customers
- helps Skolkovo to find and evaluate new startups with high potential

An example of cooperation with equipment producer is a partnership with OMZ¹⁶ - Russia's only heavy machine-building company with experience fulfilling EPC contracts, primarily in the oil and gas sector. OMZ maintains its own small business accelerator¹⁷ in which some of Skolkovo startups have already successfully participated. Furthermore, OMZ leverages development of Skolkovo startups by offering them a possibility to order equipment for their first field-testing or commercial projects without requiring prepayment.

Cooperation with International Accelerators: Grounding to the Best Markets to Start Business

Since Skolkovo mission is not only to fonder innovative development of Russian oil and gas industry but also to help Russia becoming an active technology provider on international level, Skolkovo also promote its startups development on the international markets. The most effective way to do it is basically cooperate with local technology accelerators and facilitators. As it is well-known that in the oil and gas industry the best region to test and first implement new technology is North America and US especially Skolkovo is focused to develop partnerships with accelerators in this region. First and most productive partnership was established

14. <http://targin.ru/>

15. http://sk.ru/foundation/mentor/mentor/b/mentors_applications/archive/2014/10/28/mentor-kamil-zakirov.aspx

16. <http://omz.ru/en/>

17. <http://www.tstart.ru/>

in 2014 with Houston Technology Center¹⁸ to assist in commercializing energy related Skolkovo startups, with the goal for those companies to launch in Houston and grow in US.

Novas Energy¹⁹ is an example of Skolkovo startup that one of the first saw the advantages of launching business in US and already realized them in practice. With the help of Skolkovo it not only found a partner²⁰ to start business in Houston but also attracted investment for the development of new technologies²¹. This allowed Novas that was performing without commercial gain small-scale field tests in Russia since 2009 to pass to the next stage of development just in one year – as in the end of 2014 it attracted next round of funding in the amount of \$15mln.

Creating specialized testing areas: personal playgrounds for startups

The last in this paper but one of the most promising Skolkovo initiatives which is now being intensely discussed with Russian government and potential involved parties is a creation of testing areas on a real oil and gas fields. Such fields should be dedicated only for testing new technologies and not for commercial oil and gas production. Also the testing area should be independent from major oil and gas producers or service companies so that it could be equally opened to any startup or technology provider and will provide independent and trustful appraisal of technology testing results. However a business model of a company owning and operating such a field should be economically feasible. For example, its income could be formed by providing R&D services, access to facilities and, the last but not least, it could also act as a venture investor for startups that get access to the testing area. A couple of investment funds specializing in oil and gas technology have already expressed a certain interest to participate in such business. Skolkovo expects that first testing facility on a real oilfield will be started in the middle of 2016 and it will greatly urge the development of many startups and new technologies in upstream.

18. <http://www.houstontech.org/articles/grohouston/>

19. <http://www.novasenergy.com/>

20. <http://www.propell.com/>

21. <http://technovita.ca/projects.html>