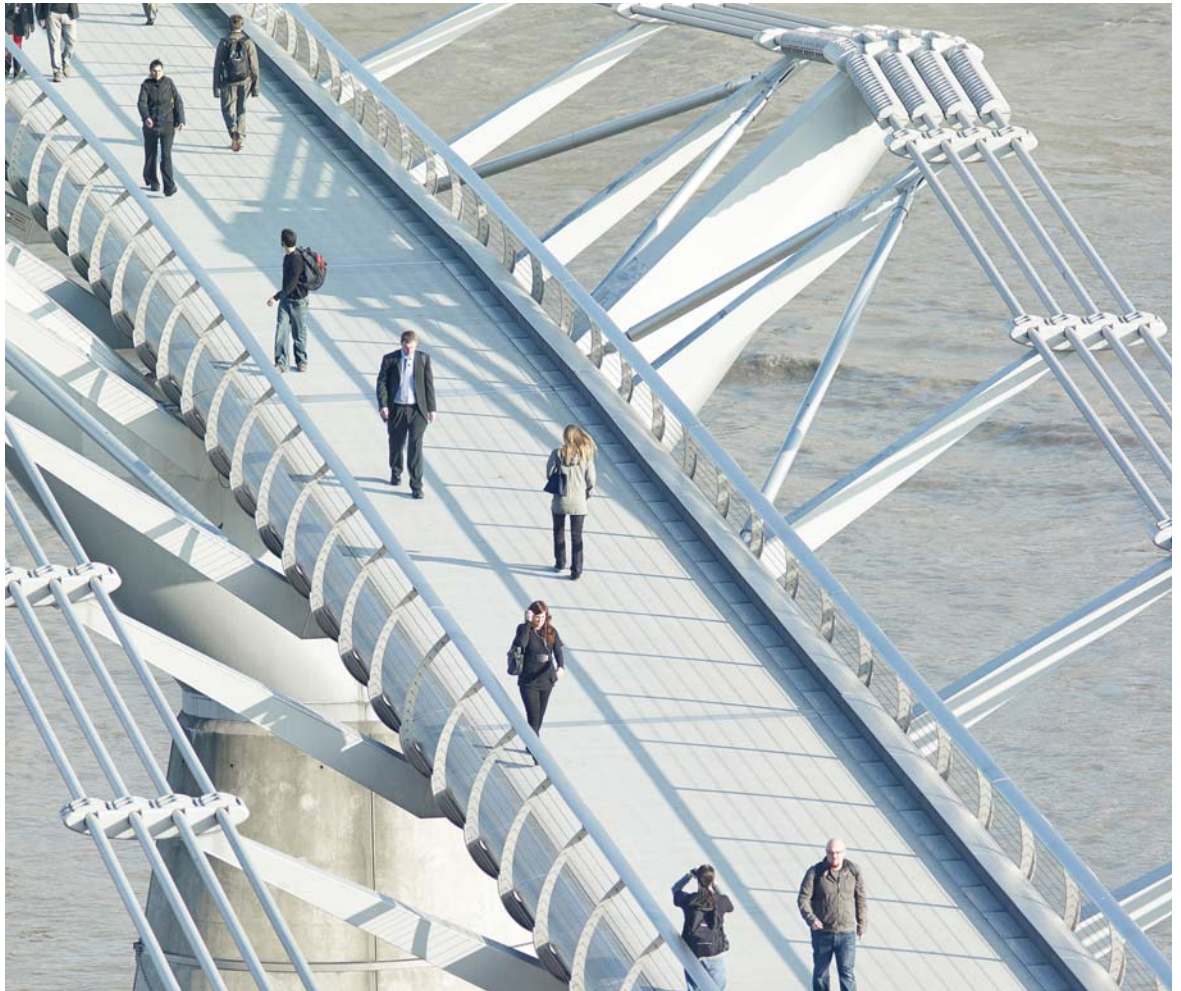


Gateway to growth: innovation in the oil and gas industry



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Foreword



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In our work with oil and gas companies we see the importance of innovation up close every day. It's one sector where process innovation has a dramatic impact on not just the bottom line of individual companies, but also on national economies.

For most of our clients, innovation is a core part of their internal culture and their company mission. There's no denying that the sector has made some amazing advances over the past decade, but there's still room to learn from other industries and the top innovators. That's where this paper comes in.

There are many challenges involved in creating an innovative culture, but the payoffs are high for those companies that make this a priority. Perhaps some of the biggest challenges for oil and gas companies lie in finding the right talent, pursuing the right partners, and getting the right metrics in place to measure their innovation progress. We look at these challenges, and what some of the largest and most innovative oil and gas companies are doing to pursue this Gateway to growth.

About this report

Gateway to growth: innovation in the oil and gas industry is a companion paper to PwC's comprehensive report, *Breakthrough innovation and growth*.

Breakthrough innovation and growth explores the impact that innovation has on growth and examines how leading companies are making innovation work for their organisations. The report explores three key questions:

1. How are companies using innovation to drive growth and what is the return on this investment?
2. How are approaches to innovation changing, particularly in light of a trend towards more disciplined innovation?
3. What are the best practices and critical success factors that deliver tangible business results?

To answer these questions we draw on insights obtained from interviews with the 1,757 C-suite and executive-level respondents, across more than 25 countries and 30 sectors, who are responsible for overseeing innovation within their company. Our sample included 66 respondents from the oil and gas sector in 18 countries.

Innovation leadership drives growth

We've found a clear correlation between innovation and success in growing revenues across industries. In *Breakthrough innovation and growth*, we report that over the past three years, the most innovative 20% in our study grew at a rate 16% higher than the least innovative. And in the space of only five years, the top innovators forecast that their rate of growth will further increase to almost double the global average, and over three times higher than the least innovative.

The oil and gas respondents in our survey anticipate faster revenue growth than nearly any other sector. Some of this growth may come from energy price increases. But for oil and gas, that is far from the whole story. The sector has been steadily redefining production possibilities. Technological innovation has made it possible to extract fossil fuels that weren't accessible just a decade or two ago. Oil from bituminous sands, gas from shale—these are resources that were considered too difficult or expensive to access in the past, but they're now transforming the marketplace in North America.

The increase in shale gas production is well-known, but it's not the only example. Oil recovery has been steadily increasing too. The Permian Basin, an area that covers 250 to 300 miles of west Texas and eastern New Mexico in the US, started producing oil in 1921. Ten years ago, its wells were no longer pumping. But the introduction of new drilling techniques (hydraulic fracturing or fracking) has created a resurgence of production over the past three years. Now 'the Basin' accounts for 14% of all US oil production.¹

Fracking isn't the only new drilling technique that's having an impact. Other advances in horizontal drilling like using a 'pad' to drill multiple wells from one site are contributing to increased productivity and reducing the sector's geographic footprint too.²

According to one estimate, in North America the typical oil and gas well has become four times more productive in just the last six years. That reflects decades of research happening across many fields.

Clearly oil and gas companies are already doing a lot of things right. Indeed, the number of patents related to extractive industries more than doubled from 2005 to 2010.³ Those with an edge in innovation will have a big advantage over their competitors.

And decisions on innovation now could have a big impact on results over the long-term. Take biofuels from algae. There's been research on the topic for many years. In Canada, a pilot project is being set up as part of the Canada Oil Sand Innovation Alliance (COSIA) programme. The bio-refinery will grow algae using the waste heat and byproducts of the drilling process.

1 <http://www.nasdaq.com/article/the-2nd-largest-oil-discovery-in-the-history-of-the-world-cm282232>

2 <http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/oil-and-gas-innovation-keeps-pace-with-high-tech-world/article12607183/>

3 <http://venturebeat.com/2012/03/28/5-trends-in-oil-gas-technology-and-why-you-should-care/>



Innovating for safety

Innovation in the oil and gas industry isn't only centered around increasing production. Making sure that operations run safely is another top priority. That can mean finding new ways to monitor the integrity of materials in changing environments or creating new systems for inspection, maintenance and repair. And as the industry enters more challenging environments, innovation to ensure safety is becoming more vital. Take deep-sea drilling. Anadarko's CEO has compared the techniques used to those needed to put a man on the moon. And some players in the industry are literally collaborating with NASA, for example to develop fiber optic sensing systems that will make off-shore drilling platforms safer.

A solid innovation strategy separates the best from the rest

Less than half of oil and gas executives say they have a well-defined innovation strategy, compared to 79% of the top innovators across industries.

We interviewed companies from throughout the oil and gas value chain, including both small companies and very large players, operating both upstream (including oil field services) and downstream. Around four-fifths of these oil and gas respondents say innovation is important to their business (see Figure 1). For 39% of the oil and gas executives we interviewed innovation is already a ‘competitive necessity. That figure jumps to 48% looking out five years, suggesting that innovation is vital for every segment of the industry.

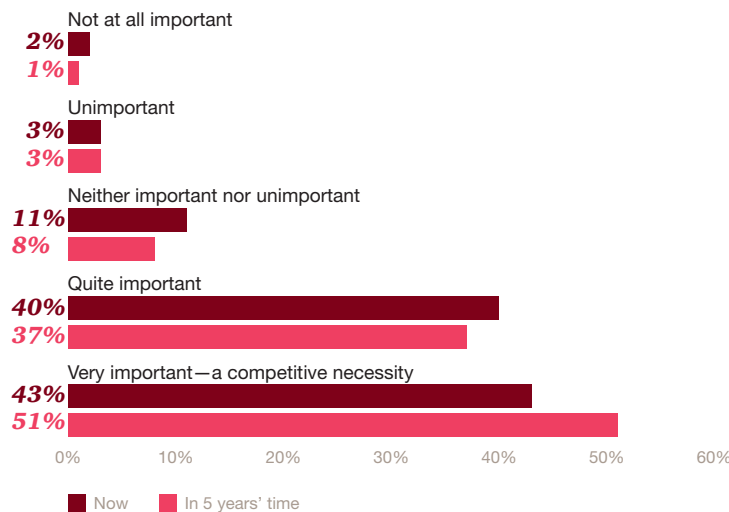
But only about half of these oil and gas companies say they have a well-defined strategy and that they are executing on it. That’s a serious problem for those without a clear vision, because execution starts with a sound strategy.

No matter how large or small your company, it’s critical to clearly define your goals for innovation. Where you’re operating in the value chain will have a big impact on what type of innovation makes the most sense. It’s important to know what level of innovation you’re shooting for. Too much innovation can be a drain on resources. Too little innovation and opportunities for growth are squandered. Once you’ve got a clear roadmap, it’s important to keep evaluating what’s working and what’s not—otherwise the competition may catch up faster than you think.

In our view, innovation crosses the entire enterprise, not just the R&D function. R&D around technology and business systems and processes for upstream companies, or products and services for downstream companies, is certainly vital. But it’s important to look for opportunities to grow in areas like business models and the supply chain too.

Figure 1: Oil and gas executives view innovation as vital to future success

How important is innovation is to the success of your company now? In 5 years time?



Source: PwC, Breakthrough innovation and growth. Base (oil and gas respondents): 66



We've identified some fundamental questions oil and gas executives need to ask themselves when taking a closer look at their company's innovation vision:

- 1. What balance of innovation do we need?** What ratio of incremental, breakthrough and radical? What kinds of innovation will deliver against the desired business goals? How should the different types of innovation be used across our portfolio?
- 2. Will our talent pipeline support future innovation?** Are we actively working to increase our candidate pool and position our company as a supportive environment for top talent? Can we look outside the sector and bring in creative thinkers from other industries?
- 3. Are we collaborating enough and with the right partners?** Do we have systems in place to evaluate the relevance of good ideas from other industries? How strong are our strategic partnerships?
- 4. Do we have strong enough innovation processes?** Are we making use of open innovation or other strategies like corporate venturing to identify and develop new relationships and ideas?
- 5. How will we know success when we see it?** What measurement systems for innovation are in place? How well are they working? Do they support innovation efforts or stifle them?

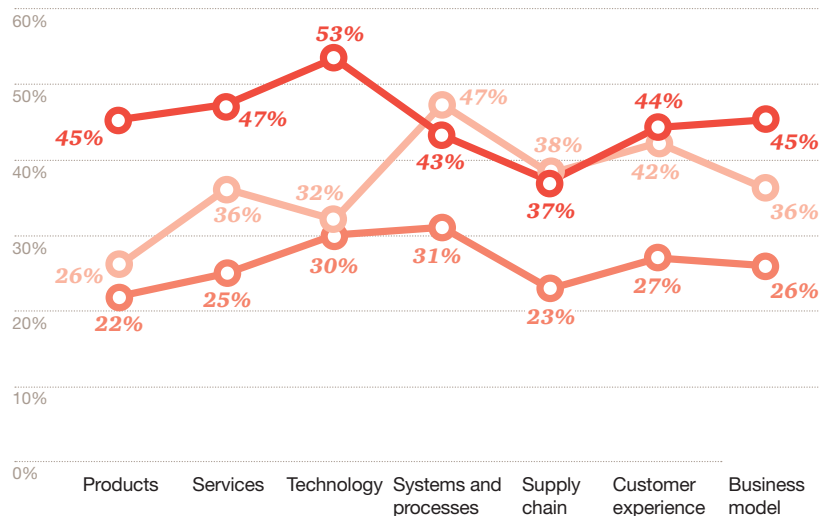
Balancing your innovation portfolio

We've found that one of the keys to driving growth is to focus on a balanced innovation portfolio. That means finding the right mix of investments in incremental, breakthrough and radical innovation across the whole range of innovation areas. The right mix for oil and gas companies will depend on where they are in the value chain.

The good news: oil and gas executives are already expecting between 32% and 47% of their innovations to be major advances in every area we looked at with the exception of products, where innovation primarily applies to companies operating downstream. These levels of breakthrough and radical innovation are a major departure from historic portfolios that generally contained 10%–20% breakthrough and radical innovations. This shift to higher levels of breakthrough and radical innovation is one of the important signals of the innovation transformation that is already underway across industries.

Figure 2: Oil and gas companies are focusing on radical and breakthrough innovation in a wide range

How significant will your innovations in the following areas be over the next 3 years?

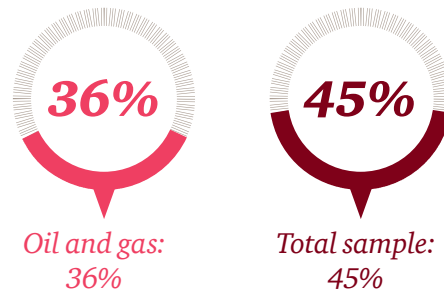


Source: PwC, Breakthrough innovation and growth. Base oil and gas: 66; top 20%, 359; bottom 20%: 395

Focusing on talent and culture

Nearly every company we spoke with found some aspects of innovation challenging. For the oil and gas sector, three are at the top of the list: measurement, talent, and finding the right partners. Around half of oil and gas executives find each of these areas challenging, and we'll talk more about each later in this report. But when it comes to innovation culture, oil and gas respondents are more confident. Only 36% see it as a challenge—well below the rate overall (45%). Is their culture as good as they think?

Proportion who see developing an innovation culture as a challenge.



India's Reliance Industries Limited takes strong leadership one step further. It's established the Reliance Innovation Council to "provide the vision to the innovation movement at RIL." The RIC includes the company's Chairman & Managing Director, Mukash Ambani, but it's actually headed up by an eminent professor, Dr. Raghunath Anant Mashelkar, and includes other business and science leaders, including 2 Nobel Prize winners in Chemistry.

Source: Reliance Industries Limited corporate website

Strong leadership and a healthy risk tolerance are top priorities

Innovation culture starts with 'tone from the top'—and that's clearly an area where the sector is strong. Nearly three-quarters of oil and gas executives (74%) say that senior executive participation in innovation projects is important (see Figure 3). And speeches by oil and gas executives frequently reference innovation and R&D.

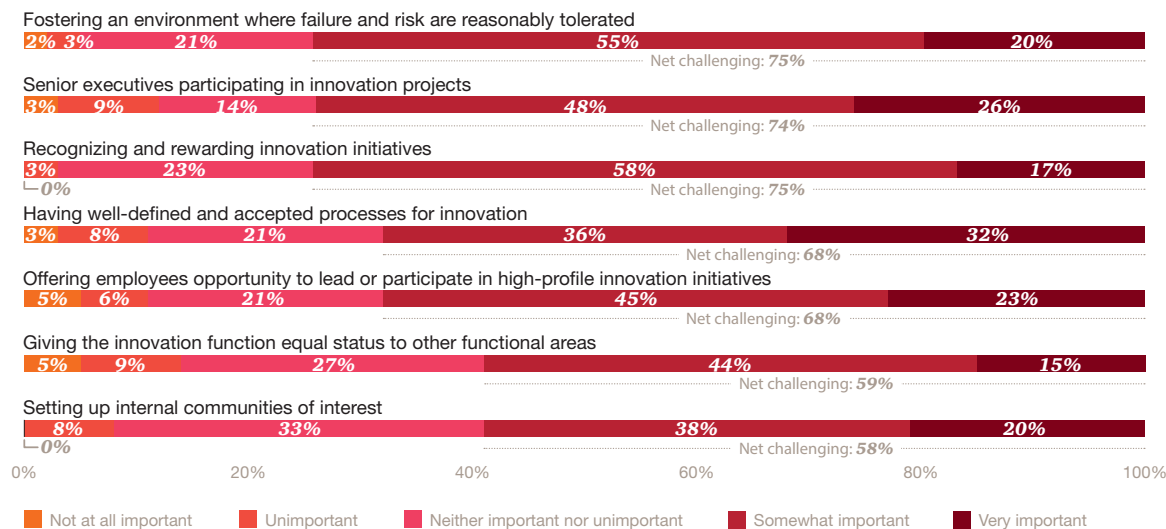
But a strong innovation culture goes well beyond just the C-suite. It means giving employees, not just senior managers, the opportunity to participate in high profile projects. Strong innovators recognise and reward their peoples' efforts. Here, too, most oil and gas executives are already convinced.

But the most important element of fostering an innovative culture? For oil and gas executives, it's developing a healthy tolerance for risk and failure.

That's not always easy in an industry with huge capital investments raising the stakes. But 'failures'—experiments that don't provide the expected results—are a natural part of the innovation process. Sometimes unexpected results can help show the way to bigger and better outcomes. Taking risks is especially important when it comes to ideas that may lead to breakthrough or radical change. In the oil and gas industry, taking risks and expecting some failures is just a part of everyday business. Every time a company drills a new well, there is a risk that the well will be dry.

Figure 3: Oil and gas executives believe the right risk environment, ‘tone from the top’ and recognition and rewards are the most important was to build a solid innovation culture

In your organisation, how important are each of the following to creating and fostering an innovative culture?



Source: PwC, Breakthrough innovation and growth. Base: oil and gas: 66; total sample: 1757

Finding today’s and tomorrow’s innovators

Nearly half of oil and gas executives say that talent poses a challenge to their innovation efforts. Finding today’s skilled innovators and bringing them on board is one aspect. In our experience, the best breakthrough innovators want to be recognised as somebody who makes a difference—to their profession, to the company, and sometimes to the world. That gives oil and gas companies with a strong innovation culture and commitment to corporate sustainability an edge.

“In order to progress into the unknown, we need people who are more transformational in their thinking, with backgrounds outside the industry, and who are not intent on maintaining the status quo”

Oil and Gas CEO

But today’s market isn’t the only challenge. Demographics are a factor too. There’s a current generation of researchers and engineering getting ready to retire—and not enough new graduates in math and sciences coming to take their places.

BP’s reaching out to students in the UK too with its Link Programme. And it’s working on showing young professionals the benefits of working in the industry. While giving the Fuellers Annual Energy Lecture 2013, the company’s CEO, Bob Dudley, summed it up this way: “while smart technology matters, smart people matter more. One absolute certainty is that the baby-boomer generation is now retiring and the growing industry will face a shortage of highly skilled engineers, technologists, geologists and other professionals. So we urgently need to show young people—around the world—that this is an industry with a great future as well as a great past. We have to demonstrate

that this is a high tech, high value industry which is bringing real benefits to people around the world. And we must show young people how exciting and fulfilling a career in energy can be.”

Another way to address the talent crunch is by looking outside of the industry’s traditional disciplines for candidates. That has another benefit: it helps bring fresh perspectives that can recharge innovation efforts. One CEO of an oil and gas business told us: “We are considering breakthrough and radical innovations, such as what our retail sites will look like in 20 years’ time,” he says. “We are asking ourselves all kinds of questions about the types of customer, products and services that should be on offer. This may lead to a totally different business model. In order to progress into the unknown, we need people who are more transformational in their thinking, with backgrounds outside the industry, and who are not intent on maintaining the status quo.”

Enhancing collaboration

Innovation doesn't just depend on how smart your people are. How well those smart people connect with other smart people is just as important. We've found that across all sectors, the most innovative companies collaborate far more often than the least innovative.

In the oil and gas sector collaboration is especially important due to the high cost and long lead times associated with oil and gas advancements. Joint projects between oil majors/super majors, oil field service operators and strategic partners, suppliers or universities are becoming the norm rather than the exception. And cooperation is spanning the globe.

Take Italy's Eni. The company has partnerships with local universities and the national research council in Italy. But it's collaborating with Stanford and MIT too.

Looking ahead over the next three years, respondents say they have plans to collaborate with a diverse range of partners from strategic partners and suppliers to academics and even competitors, although that's still a minority (see Figure 4).

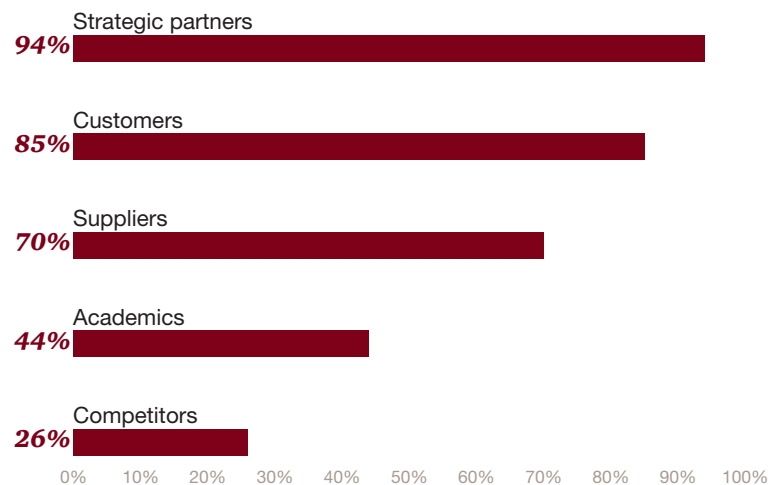
External partnerships can have huge benefits, but finding the right partner isn't always easy—nearly half of oil and gas executives see it as a challenge.

That's not surprising when you consider how often oil and gas companies are working together with partners outside of their own industry and core disciplines. Using nuclear magnetic resonance imaging—originally developed for medical applications—to map the amount of oil in rock is now commonplace. Shell is even working with one of the Hollywood companies behind the Shrek movies; the company hopes the collaboration will lead to better visualisation of seismic data.⁴

To solve some of the future challenges of maintaining aging deepwater facilities, Total is teaming up with French robotics engineering firm Cybernetix to develop a new Inspections, Maintenance, Repair (IMR) system called SWIMMER (for Subsea Works Inspection and Maintenance with Minimum Environment ROV)⁵. It's designed to stay underwater for three months and has a range of 50 km.

Figure 4: Oil and gas executives are planning a wide range of collaborations

With which of the following do you have a plan in place to collaborate over the next three years to deliver innovative products and services? Yes summary.



Source: PwC, Breakthrough innovation and growth. Base: oil and gas respondent: 66; total sample: 1757

⁴ <http://www.shell.com/global/products-services/solutions-for-businesses/globalsolutions/impact-online/read-full-issues/2011/issue-2/business-of-innovation.html>

⁵ <http://total.com/en/energies-expertise/oil-gas/exploration-production/strategic-sectors/deep-offshore/innovation/preparing-aging-facilities>



And oil services company Schlumberger is partnering with Saint-Gobain on crystallography and with Lockheed Martin on advanced computing, as just two examples of the company's many partnerships.

In Houston, Texas, the oil and gas Innovation Center, a subscriber service for petroleum companies, profiles technologies developed in other industries that have crossover applicability in the petroleum industry.

Highlighted technologies fit into the following categories:

- Coatings & Materials
- Communications & Power
- Filtration & Fluids
- Health, Safety & Environment
- Inspection & Monitoring
- Motion Control
- Security
- Sensors
- Software

In Brazil, the government is making billions of dollars of funding available to help promote research that will spur offshore oil exploration. The government is counting on developing a robust oilfield services industry locally. State-owned oil major Petrobras is playing a leading role. It has established a research center that's attracted participation from Baker Hughes, Schlumberger and Halliburton.⁶

⁶ <http://www.4-traders.com/PETROLEO-BRASILEIRO-SA-6496795/news/Petroleo-Brasileiro-SA-Petrobras--Brazil-Pushes-Innovation-As-Key-To-Offshore-Surge-Local-Conten-14217583/>

Strengthening innovation processes

Almost seven in ten (69%) of the oil and gas executives in our study believe that having well-defined innovation processes is important for establishing an innovative culture. But, what does a well-defined process look like?

Effective innovation processes are iterative, beginning with the collection of ideas and progressing through stages of idea prioritisation, experimentation and decision-making about which ideas should be commercialised and ending with the delivery and monetisation of the innovation. When it works well, this process allows for the rapid development of successful ideas, and the fast failure of bad ones.

For the upstream segment of the oil and gas sector, where capital investments are often long-term and some ideas take extensive research before they bring results, finding the right amount of “fast failure” gets more complicated. For many companies, partnering is an essential part of the process.

To make breakthrough innovations happen, companies are looking to a variety of innovation operating models such as open innovation (collaboration with outside partners), design thinking (looking at the need from an anthropologist’s perspective), corporate venturing and incubators (small groups of intrapreneurs that use rapid prototyping).

About a third of oil and gas respondents say that open innovation is the approach with the most potential to drive revenues. But what does open innovation really mean for oil and gas companies, where technology is often proprietary?

In some cases, companies are joining consortia to solve tough problems. In Canada, the Canada Oil Sands Innovation Alliance (COSIA) is a great example of a joint approach to improving the sector’s environmental impact. Launched in March, 2012, COSIA now includes 14 companies. Through COSIA, participating companies capture, develop and share the most innovative approaches and best thinking to improve environmental performance in the oil sands, focusing on tailings, water, land and greenhouse gases.

COSIA reports that to date, member companies have shared 446 distinct technologies and innovations that cost over \$700 Million to develop.⁷ And that’s increasing as the alliance matures. Some 180 projects are moving forward under the alliance, which has a staff of 20 engineers and scientists and acts as a planning hub.

And some companies are opening up their innovation process. Shell’s GameChanger programme which combines elements of open innovation, incubators and corporate venturing (see *Changing the innovation game at Shell*), is by far the best-known example.

Statoil has also launched an “Innovate” portal that hosts innovation challenges and also accepts free-form ideas. To help potential participants the company has set up a discussion group on Linked in. That’s helped improve both the quality and quantity of submissions.⁸

Schlumberger’s Executive Vice President of Technology, Ashok Belani, points to software platforms as one place where open innovation is already happening in the oil and gas industry. He says “For example, when we give a Petrel platform to Shell or Petrobras, our software platform has to provide not only the required functionality and user interface but also, more importantly, it has to have extensibility or interoperability with their systems, allowing new innovation to happen in that oil and gas company. It can also plug in applications from other vendors and companies. That is an example of open innovation.”⁹ Belani also believes the trend will soon extend to hardware. He sees a future where oil rigs themselves become open systems. Different suppliers will be able to plug in systems that work together seamlessly.

7 <http://www.conocophillips.com/who-we-are/our-company/spirit-values/teamwork/Pages/collaboration-in-the-oil-sands.aspx>

8 <http://innovateblog.statoil.com/2013/06/26/a-new-start-and-even-more-hard-work-ahead/#more-807>

9 http://www.sbc.slb.com/Our_Ideas/Energy_Perspectives/2nd%20Semester13_Content/2nd%20Semester%202013_Interview_Ashok.aspx

Changing the innovation game at Shell

Open innovation platform? ‘Angel investor’? Incubator? Shell’s renowned GameChanger programme combines elements of all three. GameChanger was born back in the mid 90’s, during a down cycle in the oil and gas industry. There was significant pressure on R&D costs—but Shell’s leadership wanted to make sure the company didn’t lose sight of ideas that would drive business over the long-term. GameChanger was modeled after the “Silicon Valley” ecosystem, for example by including peer review and early experimentation as an essential part of the process.

In 2002, Shell started establishing partnerships with universities in the US and Europe as part of the GameChanger programme. They started reaching out for ideas, instead of waiting for innovators to come

to them, including collaborating more with venture capital firms and conferences and special events to reach more Small-to-Medium enterprises.

Shortly after, they started organising ‘domains’ to give the process more structure. These were broadly conceived, using a variety of lenses. That helped the company increase the connection between the bottoms up ideas developed through GameChanger and the top down strategic intent of the firm. The result? Improved quality of projects in the portfolio.

Since 1996 the programme has invested over \$250 million in more than 3,000 ideas, turning around 300 into commercial projects that are helping Shell deliver more energy to customers today. One technology developed through GameChanger—swellable rubber seals—increased oil recovery by 1.5 million barrels within three years.

How does it work?

In its current incarnation, GameChanger is driven by a central team that crosses the whole business. Ideas are submitted either via the company’s web platform or internally and receive a sponsor. Members of the GameChanger team hear the idea and decide whether it should be developed into a formal proposal. At the next stage, the proposal goes to an extended panel that includes three members of the GameChanger team and three technical experts in relevant areas. They evaluate and decide on the proposal on the spot. If approved, the next step is funding the proof-of-concept experiment programme, where it gets periodically reviewed. And once the idea is shown to work, GameChanger will help commercialise the idea too.

Sources: Shell website, <http://www.managementexchange.com/story/shell-game-changer>

For the oil and gas sector, corporate venturing is another important trend. Chevron, BP, Shell, ConocoPhillips, and others all have major corporate venturing arms. Investing in small start-ups is another way that sector companies are hedging their bets and increasing their exposure to a wide range of technologies, across industries. And they’re also helping to balance the innovation portfolio for some companies. Small start-ups

offer a chance to invest in technologies which may radically disrupt the industry without committing extensive internal resources. Some of these companies are backing traditional cleantech or energy-focused venture funds too. It’s not just the IOCs that are using corporate venturing—NOCs like Eni SpA, SaudiAramco and Statoil are getting into the game too.

Measuring success

On average the oil and gas companies we interviewed actually spend a smaller percentage of their revenues on innovation than do companies across the sample as a whole. But according to R&D magazine, the energy industry will still spend nearly \$16 billion on R&D in 2013

Clearly, tracking success is critical. But what aspects of innovation need to be measured? What are reasonable targets? These are two questions that continue to perplex executives—half of oil and gas respondents say that having the right metrics is a challenge for their companies.

As innovation portfolios diversify, metrics for breakthrough and truly radical innovations need to change to reflect the new processes and types of value.

In our view, the true measure of innovation success cannot only be seen through a financial lens. Leading companies define measurements that go well beyond the traditional ROI. In oil and gas, tracking patents is one standard metric. Other qualitative approaches can be valuable too. Shell's VP for Technology Strategy says she views the ability to attract the best partners as the real measure of success.¹⁰

Italy's Eni has developed a comprehensive approach to measuring the effectiveness of their R&D programme.¹¹ Different business units focus on different types of innovation, and these are reflected in the company's KPI's. The company's metrics are divided into four categories—value generated (both tangible and intangible), portfolio efficiency and effectiveness, project efficiency and effectiveness, and strategic alignment. One example of tangible value is capex savings. This metric quantifies savings on capital costs (capex) achieved by applying the innovative technology instead of the best alternative technology available on the shelf. More intangible metrics include patents, publications, and transfer of know-how to other business units.

¹⁰ <http://www.shell.com/global/products-services/solutions-for-businesses/globalsolutions/impact-online/read-full-issues/2011/issue-2/business-of-innovation.html>

¹¹ http://www.eirma.org/sites/www.eirma.org/files/doc/members/recent/110318_MeasuringEffectivenessinRandD/lorenzo-siciliano_ENI.pdf/noproxy; <http://www.pmi-nic.org/public/digitalibrary/07.%20Gruppo%20ENI%20-%20R&D%20Portfolio%20Metrics.pdf>

Conclusions and key takeaways: where next for your business?

There's no disputing the fundamental role innovation has played in the oil and gas industry. Technological innovation has had a profound effect on all aspects of the supply chain. Advances ranging from 3-D and 4-D seismology to improvements in distillation and isomerization to liquefaction and regasification have had a profound impact on the way companies explore, drill, produce, process and distribute oil and gas. The future will hold many more advances, as energy companies begin to examine nanotechnology, biotechnology, and sustainable chemistry solutions.

Companies with an innovation edge will have a strong competitive advantage. What can you do to make sure your company is a leader and not a laggard?

- **Know where you want to go and how you'll get there.** Innovation in the oil and gas industry requires careful planning and a clearly defined strategy. According to our survey, the oil and gas industry lags the top innovators in terms of having a defined strategy.

What can you do to make sure your company is a leader and not a laggard?

- **Look beyond R&D.** Investing in research and development is an important part of innovation, but it's far from the whole story. The energy sector is leading when it comes to making big improvements in process and systems, but oil and gas companies need to make sure that they're paying attention to fostering innovation in areas like business models, products and customer experience (for downstream) and the supply chain too.
- **Focus on people.** The executives we surveyed say it can be hard to get and keep the right people on board to make innovation happen. To cope, oil and gas companies need to find creative ways to attract new recruits. And they need to make sure they have a strong innovation culture that supports top talent.
- **Work together with the right partners, across industries.** Finding the right external partners is a challenge for many of the executives we surveyed. But it's vital—particularly given the oil and gas industry's strong history as a 'technology integrator'. Drilling two miles down under the ocean requires as much technical sophistication as sending a man into space. Joint projects between oil majors/super majors, oil field service operators and strategic partners, suppliers or universities are becoming the norm rather than the exception. Often these are part of open innovation initiatives, but corporate venturing is having a renaissance too.
- **Carefully measure success.** That means developing the right KPI's for different types of innovation and business units. And while looking at innovation through a financial lens is important, so are other perspectives.

Want to find out more?

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