



Building momentum – oil and gas in Latin America

Development of unconventional oil and gas resources

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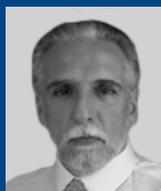
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Executive summary

Unconventional oil production has grown these past few years despite low oil prices since 2014. Although production in the US decreased in 2015, stabilization of prices and improvements in several operational areas allowed unconvensionals to maintain a relevant role in the global supply. Last year, Arthur D. Little published a viewpoint analyzing the perspectives for unconventional resources in selected Latin American countries. While our outlook for Latin American opportunities remains positive, there are new factors to consider. The key shale players have stayed strongly focused on the US, the moderate oil price recovery expectations persist, and concerns about fracking operations are increasing. Therefore, host countries, especially in Latin America, are now under greater pressure to create conditions that favor the development of these resources.

In recent years, countries such as Mexico, Colombia and Chile with potential in unconventional hydrocarbons have been evaluating their prospective resources. However, these activities have not been enough to build momentum and attract resources to speed up the de-risking process for unconventional hydrocarbons. Building momentum requires a strategy for aligning technical, regulatory, and economic conditions to boost the de-risking process of the greenfield plays prior to the take-off of massive developments. Two major forces can, in our opinion, help build momentum: national oil company leadership and/or government promotion & incentives. Besides these levers, a deeper understanding of the local conditions of the oil & gas industry is fundamental for defining the strategy and tactics for building momentum.

In our view, the development of unconventional hydrocarbons in different geographies will continue shaping the global oil and natural gas markets. Countries with high potential and interest in expanding their production, such as Mexico, Colombia, and Chile, still need to build momentum to ensure the inflow of capital investments to speed up the exploration/evaluation phases. Although there is still uncertainty regarding the feasibility of large developments, the growing demand for hydrocarbons presents an opportunity for oil companies.

As the energy industry continues evolving, trends in supply and demand could change the incentives to develop the unconventional plays (growing share of renewable, peak of oil demand, etc.). Therefore, there is a closing window of opportunity for adopting a strategy to provide the required support to oil & gas players and take advantage of unconventional developments.

1. Introduction

Unconventional oil production has grown these past few years despite low oil prices since 2014. Although production in the US decreased in 2015, stabilization of prices and improvements in several operational areas allowed unconvensionals to maintain a relevant role in the global supply, adding more than one mmbboed in 2017.

The oil and gas industry downturn forced oil companies to change their production strategies in order to mitigate the negative impact on their financial results. Most of the companies, including Majors, withdrew or delayed costly long-term projects to focus on opportunities that offered shorter development cycles and lower investment requirements. Among the latter type of opportunities were many unconventional developments in North America.

In this scenario, the Permian Basin positioned itself as the “sweet spot” of the US unconventional oil and gas developments. Attractive economics are the result of privileged geology that features multiple stacked plays – more than 1,000 feet thick each – and could hold vast reserves. The existing infrastructure and minimal needs for equipment displacement due to the stacked plays have decreased the break-even price significantly. Nowadays, this play is the largest producer of liquid hydrocarbons and the second-largest producer of natural gas in the United States. Permian has attracted investment from several Major oil companies, such as Chevron and ExxonMobil, as well as independents such as Pioneer and EOG. The increasing attention to domestic shale opportunities has resulted in lower levels of international activity for North American companies.

The fast-paced investment activity in the Permian Basin for asset transactions in 2017 reached more than 45 deals altogether, amounting close to USD 23 billion. Due to its success and relatively low risks, this world-class shale play has set expectations at too a high level, making it more difficult for overseas shale opportunities to attract international investors. Although several countries have confirmed their potential for unconventional production, development has not progressed at the same pace as it did in the United States, which offered the perfect ecosystem for shale development: prolific shales, light regulation, shale in sparsely populated areas with few environmental issues, water availability, multiple service providers and preexisting infrastructure. It will require a lot of effort for host countries with shale opportunities to achieve competitive conditions similar to those offered by the key US shale basins. National and local authorities, together with domestic industry participants such as NOCs, will play a key role in building the proper conditions for such developments to materialize.

In 2017, Arthur D. Little published a viewpoint analyzing the perspectives for unconventional resources in selected Latin American countries and the challenges those countries faced to stimulate these types of developments. While our outlook for Latin American opportunities remains positive, there are new factors to consider. The key shale players have stayed strongly focused on the US, the moderate oil price recovery expectations persist, and concerns about fracking operations are increasing in many places. Therefore, host countries, especially in Latin America, are now under greater pressure to create conditions that significantly favor the development of these resources.

Key improvements in unconventional operations

The US unconventional industry was able to maintain its growing production trend, aided by operational and technical improvements in a variety of areas:

- **Targeting:** Multiple methods have been developed to optimize the positioning of a horizontal wellbore in order to maximize reservoir exposure. Well placement success is often associated with the technologies of geosteering, which have been recently improved with the use of 3D seismic and real-time monitoring tools. These tools allow for timely reactions in order to best navigate the most prospective horizons.
- **Drilling and completion:** Drilling technologies are always evolving from play to play and adapting to the specific conditions of each formation; therefore, the improvements in drilling vary by play and even within the same play. Some of the most important efficiency breakthroughs include increased length of laterals, the ability to drill multilaterals to allow access to multiple zones and reduce costs, multi-pad drilling to optimize the use of space, pad drilling with hydraulic walking or skidding systems to optimize rigs movement, and improvement of reservoir characterization and completion techniques to allow differentiated treatments of fractures by well and by stage.
- **Logistics and operations:** Centralized developments have improved the economics and logistics of the

drilling site by reducing the surface impact and traffic for operations, as well as through concentration of facilities, compressors, tanks, separators, etc. This also results in smaller requirements for pipelines and access roads. Some players have also been acquiring specialized services companies integrating own sand and equipment to ensure competitive supplies for the operations.

- **Well productivity:** There have been many efforts to improve well productivity in different shale plays. The best-known innovations are in the area of artificial lift systems that help to maximize recovery, reduce costs and increase pumps' life and efficiency. A few operators have also adopted new techniques to improve productivity, such as EOR methods using gas injection. This method has been pioneered by EOG Resources for the Eagle Ford and it has been tested in the Bakken with positive results, however there is still more testing to do to prove the benefits of EOR in shale.

Digital technologies: The use of "big data" approaches combined with powerful software has played a key role in the optimization of E&P operations, especially for improving the identification of sweet spots. The industry shift to improve efficiency with data crunching and predictive analytics allows for significant reductions in cost and uncertainty.



2. How to create momentum for unconventional developments in new countries?

In recent years, most of the countries with potential in unconventional hydrocarbons have been evaluating the resource potential in prospective areas and, in some cases, drilling a few wells to validate the different characterization models. However, these activities have not been enough to build momentum and attract resources to speed up the assessment and development of unconventional hydrocarbons.

Building momentum requires a strategy for aligning technical, regulatory, and economic conditions to speed up the process of evaluation and confirmation of the commercial and technical feasibility prior to the take-off of massive developments. Two major forces can, in our opinion, help build momentum:

National oil company leadership

The national oil company could take the lead, assuming the role of “starter engine” to attract other players looking for unconventional opportunities. The NOC is usually best positioned to naturally become the pioneer in its own country’s shale plays due to its geological knowledge of the basins, its first-hand information to evaluate the prospective areas, its pre-existing relationship with the country’s regulators, its mission to follow national strategic initiatives, its close involvement with the communities. Therefore, the NOC can become the first mover and a key player in de-risking the unconventional plays.

Government promotion & incentives

The authorities can create the conditions to improve the sector’s attractiveness. Providing incentives to attract the most experienced companies, adjusting the fiscal and contractual terms to improve the risk-reward value proposition, and working with local stakeholders and communities to demystify beliefs about the negative impact of fracking operations, are some of the most critical steps to build momentum.

Besides these levers, which might in essence seem very simple, a deeper understanding of the local conditions of the oil & gas industry is fundamental for defining the strategy and tactics for building momentum in a particular country. Specific regulations, investment climate, domestic market factors and local context have resulted in varied paces of progress in un-

conventional resource development around the world. Only a few countries have been able to build momentum and move forward from the early stages of evaluation and piloting to massive commercial developments. Outstanding examples are Argentina, China and Canada, as we describe hereafter:

Argentina

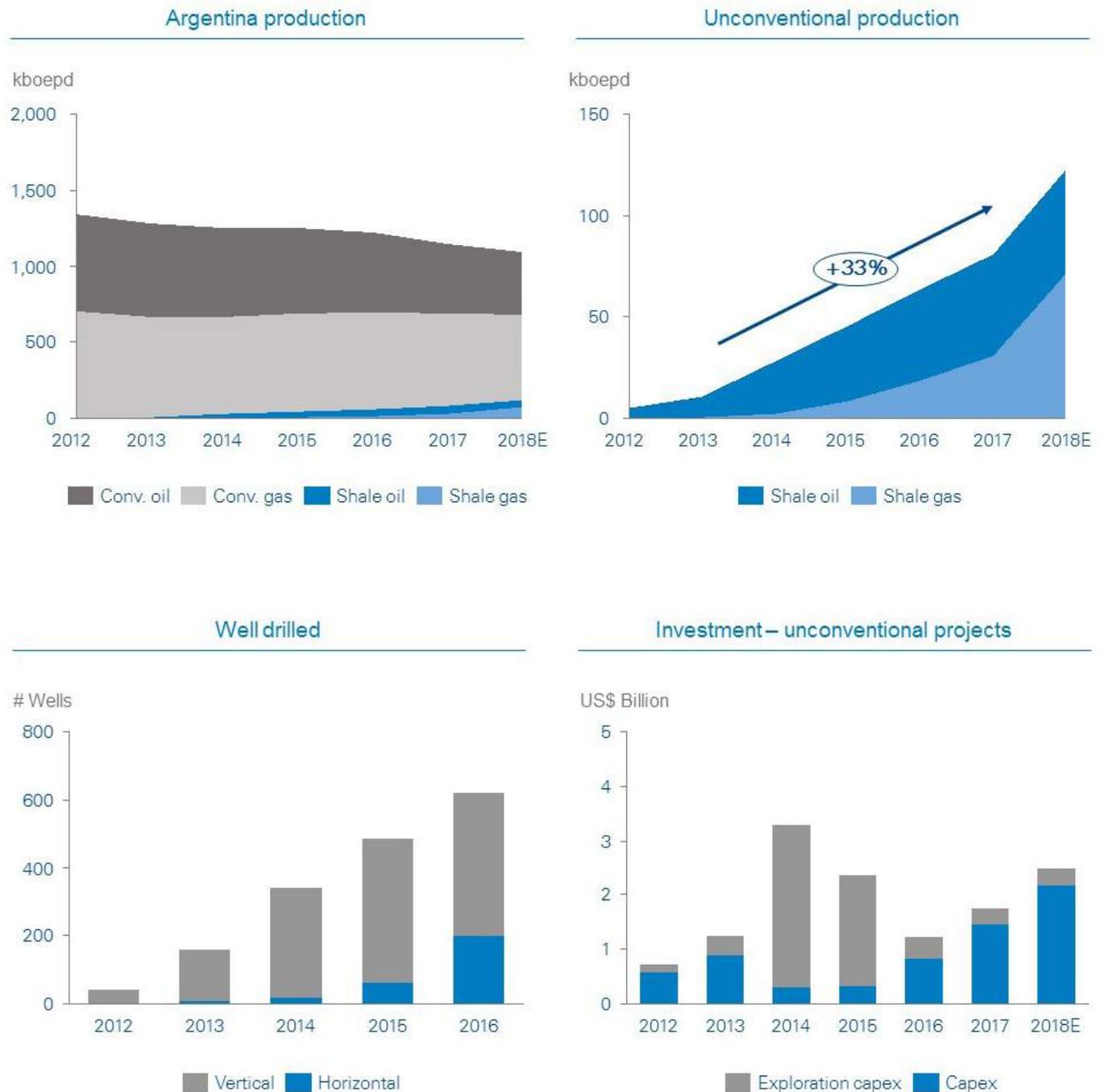
So far, Argentina is the only Latin American country in which unconventional production has reached commercial scale, though it is still small relative to its potential. Argentina has been successful in building momentum because YPF, the NOC, took a leading role in investing to improve the knowledge and characterization of the Vaca Muerta formation. Key accomplishments of YPF with the support of the government include:

- Acquired extensive knowledge and proved the concept of development in the basin by investing more than 6 billion USD
- Drilled nearly 700 unconventional wells in different blocks
- Adopted a strategy to build alliances with several international players
- Developed pilots with extended production tests to demonstrate technical and economic feasibility In addition, the government, at both national and local levels, has strongly supported the industry by:
- Maintaining higher domestic prices for unconventional gas developments
- Facilitating the process for licensing the unconventional prospective areas through reclassification of former conventional licenses, provincial bidding rounds, direct negotiations, and facilitating transactions in the traditionally active secondary market of petroleum interests
- Promoting infrastructure projects to facilitate project developments

Furthermore, the growing supply-demand gaps in the Argentinean oil and, particularly, natural gas markets have provided additional life-cycle incentives for investors and producers.

Argentina reached total unconventional production of 80 kboepd in 2017, which represents accumulated growth of 33 percent from the 2015 level. (See figure 1)

Figure 1: Argentina’s activity in unconventional developments



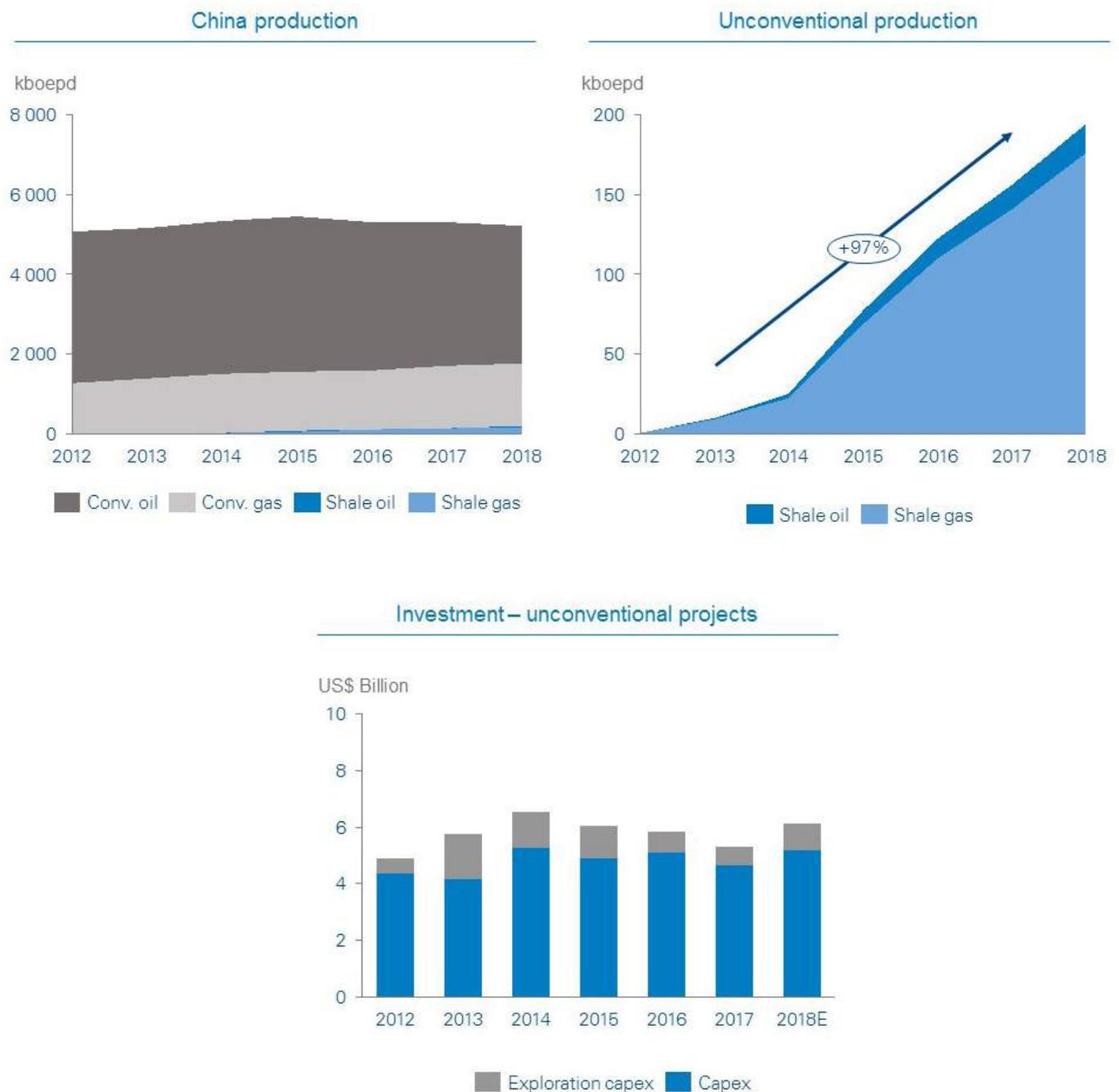
Source: Rystad, ogfi, GiGa, Arthur D. Little Analysis

China

China's first shale gas commercial production program was launched in 2014 in the Fuling field operated by Sinopec, which is one of the largest state-owned oil and gas companies

worldwide. Currently, China ranks as the world's third-largest shale gas producer, with production of approximately 10 Bcm (353 Bcf) in 2017, and this is expected to keep growing.

Figure 2: China's activity in unconventional developments



Source: Rystad, Arthur D. Little Analysis

China has been successful in building momentum because the NOCs, mainly Sinopec and PetroChina, took a leading role in investing to improve the knowledge and characterization of their domestic basins. Key accomplishments include:

- Developing a strategy to acquire know-how. China's national oil companies have been investing aggressively in the United States to acquire shale acreage, and this has allowed for an accelerated learning curve. For example, Sinopec paid USD 1 billion for properties owned by Chesapeake Energy, one of the US pioneers in shale gas development
- Acquisition of knowledge and proving the concept of development in domestic basins by investing more than USD 5 billion
- Drilling more than 600 unconventional wells in different domestic basins
- The Chinese authorities have strongly supported the industry by:
 - Providing production subsidies up to 2020
 - Providing waivers of price controls and fees
 - Granting tax concessions, committing research funds, and promoting price reforms

Furthermore, the growing demand for natural gas and increasing imports by pipeline and LNG are positive signals to investors that foresee a secure market for shale production.

It is fair to point out that there is still some skepticism around China's ability to keep up with unconventional developments. The main challenges are related to water availability, complex geology of the formations, and lack of adequate infrastructure, which will affect the economics of the operations.

Canada

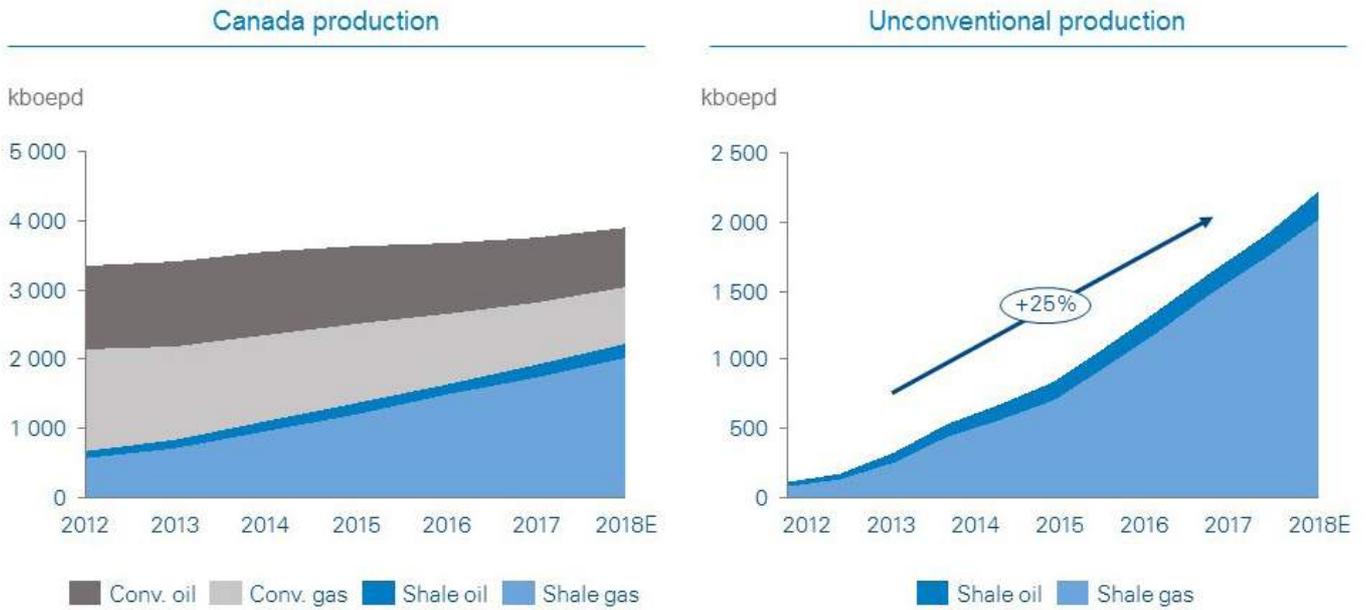
Canada is the second largest producer of unconventional hydrocarbons globally. In 2017 the production of shale reservoirs reached 170 mbpd of oil and 10,400 Mpcd of natural gas. (See Figure 3.) The Duvernay and Montney formations in Alberta and British Columbia have attracted the attention of national and international oil companies.

While Argentina and China have developed unconventional hydrocarbons under the leadership of their NOCs, Canada adopted a different strategy led by the government, which was concerned about the declining investments in oil sands projects. The strategy included enhancing the technical information base, flexibilizing fiscal terms, and simplifying the regulatory framework for permits. Some of the key adjustments included:

- The government keeps records of the different technologies applied to drilled unconventional wells and their results, to be shared with potential investors
- The environmental permitting was simplified to support unconventional operations applying area-based regulation (ABR reduced the permits and authorizations from more than 60 to one per block)
- Definition of a new royalty framework to harmonize the royalty rate with the product type and the feasibility of optimal development in each unconventional area

As a result, majors including Shell and Conoco are investing in unconventional after their setback in oil sands, while independents such as Encana and Seven Generations are the leading producers in both basins.

Figure 3: Canada’s activity in unconventional developments



Source: Rystad, Arthur D. Little Analysis

3. Are other Latin American countries building momentum?

Mexico, Colombia, and Chile are the countries in the region that have expressed the strongest interest in developing their unconventional resource potential. However, they still need to build momentum to accelerate the development of their resources:

EIA Technically Recoverable shale resources		
Country	Trillion Cubic Feet	Billion Barrels
Argentina	802	27.0
Mexico	545	13.1
Colombia	54.7	7.4
Chile	48.5	2.3

Mexico

Mexican resources are concentrated in three major basins: Sabina-Burro-Picachos (SBP), Burgos and Tampico-Misantla (T-M). So far, Pemex has conducted the exploration and analysis of these unconventional plays exclusively. In round zero, Pemex was awarded nine blocks with unconventional potential, and the company holds rights in five other promising areas, with partners under the incentivized service contract framework (CIEPs).

Pemex has been leading the exploration of unconventional resources in Mexico, through the acquisition of technical information and the drilling of more than 20 unconventional wells in the last few years. In 2017, the authorities defined the environmental and operational regulation for unconventional operations and announced a bidding round for unconventional areas.

However, conditions for Round 3.3 were not defined until February 2018, including nine unconventional blocks in Burgos Basin. Many challenges remain to build momentum for unconventional resources:

- Negative perception and fear of public opinion about the impact of fracking operations on seismic activity could have increased after the recent earthquakes in the country

- The change of administration could lead to energy policy changes and different views from new authorities about the need to support unconventional developments
- Limitations in Pemex’s exploration budget, combined with a diverse portfolio of opportunities, make it difficult to secure financial resources to de-risk unconventional plays
- Growing demand for natural gas is supplied by imports from the United States at very competitive prices. The Mexican’s gas-prone shale will compete with the gas price set by Marcellus / Eagle Ford / Bakken shales and the gas prices at the Houston ship channel

Although the development of unconventional resources could help offset oil production declines in Mexico’s oil, the support of the authorities will be essential to build momentum and ensure the required investment conditions to attract both national and international players into this segment.

Colombia

Colombia pioneered the promotion of unconventional resources in Latin America and, in 2012, adopted a special regime to improve the economics of these types of resources. In early 2018 there were seven unconventional blocks contracted by ANH to Ecopetrol, Exxon, ConocoPhillips and other companies. However, the development plans suffered the double setback of the price downturn and intense domestic environmental controversy around the potential impact of fracking activity.

Ecopetrol has estimated potential in the Middle Magdalena Valley (MMV) basin of between 2.4 and 7.4 billion barrels of oil recoverable, and is waiting for the environmental permit approval to conduct a pilot project in an unconventional block. This pilot is targeting shale oil opportunities in the Luna formation in the mature MMV basin, where the availability of oil-related infrastructure and abundance of water resources provide attractive conditions.



To accelerate the pace of shale oil developments, Colombia still needs to overcome some serious challenges and prove that:

- There will be sufficient government support and commitment from authorities and regulators to promote the development of unconventional, even after the presidential elections of 2018
- Ecopetrol and other players can conduct pilots and initial evaluation studies to demonstrate the technical and economic feasibility of the opportunities, in spite of apparent community resistance to fracking
- Regulators can implement an efficient and agile environmental and social-permitting process
- Government can keep the peace deal and support agreements with militant communities to increase the Operation's security for oil and gas companies

Meanwhile, the oil reserves of Colombia have been declining, and concerns regarding the security of supply have grown. Commercial feasibility of large discoveries of natural gas in the Caribbean offshore has yet to be proved. Therefore, the country is in desperate need to incorporate new hydrocarbon reserves, and attention is increasingly shifting to the promising unconventional potential in the MMV basin.

Chile

Chile's national oil company, ENAP, announced in 2016 its intention to team up with ConocoPhillips to explore shale gas opportunities in the Magallanes region. The increasing gas demand in Chile has been one of the main motivations for the government and ENAP to consider shale exploration. Although ENAP announced the first horizontal drilling in a tight play in 2017, no wells have yet been drilled, and the first one is expected to be conducted in 2018.

Investments under the ENAP-ConocoPhillips agreement are expected to amount to USD 100 million across the first four years of the project. This partnership with one of the world's top shale producers might accelerate the learning curve during the exploration phase and help improve productivity by reducing drilling costs.

By the end of 2017 the Magallanes region is estimated to hold eight TCF of tight gas resources (source: USGS). However, drilling activity is likely to take off in this area if the concept is to be proved and the economic feasibility of forthcoming massive shale gas extraction in the basin validated. It is important to highlight that the price of shale gas in Chile will compete with the imported LNG prices, which could have a positive impact on the attractiveness for shale developments.

Conclusions

The development of unconventional hydrocarbons in different geographies will continue shaping the global oil and natural gas markets. Canada, Argentina and China are the countries with the highest unconventional productions after the United States. Other countries with high potential and interest in expanding their production, such as Mexico, Colombia, and Chile, still need to build momentum and align the technical factors with economic and regulatory incentives to ensure the inflow of capital investments to speed up the exploration/evaluation phases.

As the energy industry continues evolving, trends in supply and demand could change the incentives to develop the unconventional plays (growing share of renewables, peak of oil demand, etc.). Therefore, there is a closing window of opportunity for adopting a strategy to provide the required support to oil & gas players and take advantage of unconventional developments.

The downturn of prices, combined with the growing opportunities in United States basins, have reduced the interest of international companies in expanding their shale operations into new markets, but the coordinated efforts of NOCs and local authorities can help improve the attractiveness of Latin American unconventional plays. NOCs could play an essential role as pioneers willing to invest, reducing the risk of unconventional plays and leveraging their knowledge of geology, experience with local communities and privileged access to infrastructure in order to attract qualified international partners.

Insight for oil companies

- Latin American countries such as Mexico, Colombia and Chile have interesting potential in unconventional resources. Although there is still uncertainty regarding the feasibility of large developments, the growing demand for hydrocarbons presents an opportunity to supply the domestic markets.
- NOCs such as Ecopetrol and Pemex have been acquiring technical information to better understand their unconventional opportunities. Their knowledge of local conditions can also help mitigate the surface risks for new entrants and potential partners.
- The price of acreage in the US has been growing, as the productivity of key basins keeps attracting investors. First movers in new shale basins outside the US will have the opportunity to acquire positions in high-potential areas at lower cost.
- Since in many countries public opinion is still very sensitive to the environmental impact of fracking operations, strong alignment of stakeholders and government support will be key to ensuring the proper conditions for massive unconventional developments.
- Oil price recovery and a supportive domestic gas price would facilitate de-risking greenfield plays in Latin America

Notes



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Building momentum for development of unconventional oil and gas resources in Latin America

Stabilization of prices and improvements in several operational areas allowed unconventional oil production to maintain a relevant role in the global supply.

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Arthur D. Little

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