Reimagining Argentina
An unconventional look towards 2035
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A conservative model of technically recoverable reserves at Vaca Muerta implies approximately:

- **+50 years** of Argentina’s current natural gas consumption
- **+46 years** of Argentina’s current oil consumption
- **2.7** times Argentina’s 2013 GDP
- **+80 years** of soybean exports

With a potential impact of Vaca Muerta Play development across the economy of:

- **$2.1** dollars of GDP increase for each dollar invested in shale extraction
- **$368 billion dollars** of CapEx invested up to 2035
- **3x** times bigger contribution of the mining, oil and gas sector to the total economy, moving from representing 3% to 9% of the overall GDP by 2035
- **0.5%** additional annual GDP growth up to 2035
- **22,000** jobs created yearly during the next two decades
- **80 years** of soybean exports
- **46 years** of Argentina’s current oil consumption
- **2.7** times Argentina’s 2013 GDP
- **+80 years** of soybean exports

22,000 jobs created yearly during the next two decades
Prologue

In the year 2011, when the first US Energy Information Agency (EIA) report about Global Shale Resources was published, Argentina began to see a new development opportunity emerging from the depths of Vaca Muerta and other unconventional resources. At that time, Accenture was involved with US and Australian companies collaborating on how to best develop their unconventional assets. Such assets—specifically shale gas, tight gas, shale oil and tight oil—are revolutionizing the energy landscape in the USA and there have been numerous studies looking at the impact of these assets on the economy of the USA. Now, Accenture is aiming to understand how Vaca Muerta can contribute to Argentina’s regional and national development.
Introduction

This Accenture study aims to propose a valid framework to understand a potential Vaca Muerta field development plan and how this development would impact Argentina’s regional and national economies, as well as the implications and challenges that the development of these shale assets will require in the years to come. A specific methodology was created in collaboration with GiGa Consulting: a Vaca Muerta Field development model with oil and gas production forecasts, investments, and data on infrastructure and capital and operating expenses required. The model developed jointly by GiGa and Accenture considers the impact of the oil, wet gas and dry gas already appraised on the Vaca Muerta field. The model was constructed based on the current operational assumptions, and some considerations of the Eagle Ford field in Texas, USA were also extrapolated.

The Vaca Muerta field development plan then served as input for the Argentina Input Output Matrix, helping to understand direct, indirect and induced effects on the Argentina Gross Domestic Product (GDP) as well as the industries which would be most impacted by the developments. The model also includes some considerations to reflect the particularities of the shale oil & gas development and production.

This is not a technical paper for the hydrocarbon reservoir; instead it describes one unique resource development approach. The intention is to understand the orders of magnitude of the socio-economic impacts and use this as a catalyst for discussion to consider the challenges and see what is required to achieve those benefits.

What has become clear is that the resource is out there for Argentina to take advantage of it. This unconventional resource is significant. Despite the challenge being daunting, the economic and social benefits will be well worth the effort.
Reimagining Argentina

Unconventional resources—specifically shale gas, tight gas, shale oil and tight oil—are revolutionizing the energy landscape in the USA, and now other countries with large unconventional reserves are keen to start their own revolution. The success of the USA in developing its unconventional resources, using new technologies such as horizontal drilling and fracking (hydraulic fracturing) to access previously unavailable reserves, has prompted the questions: Which other countries can also be successful? and How quickly will they succeed?

Accenture believes that Argentina is one of the front runners. According to recent analysis by EIA and Advanced Resources International, Argentina has 802 Trillion cubic feet (tcf) of technically recoverable shale gas resources (308 Tcf only in Vaca Muerta); the world’s second largest resource behind only China and above the United States, and 27 billion barrels of unconventional oil reserves.1 Shale activity is already ramping up in Argentina, for example, the international oil company Chevron having signed a partnership in 2013. Other international oil companies, including ExxonMobil, Shell and Total all now hold interests in shale exploration and development in Argentina. YPF also recently signed a major deal with Petronas, the national oil company of Malaysia, to develop the Amarga Chica field in Vaca Muerta requiring an initial investment of up to $550 million, of which Petronas will contribute $475 million.2 As a result of these investments, shale drilling in Argentina has now started to increase. For example, Chevron and YPF plan to drill 170 wells on their Vaca Muerta acreage in 2014.3 Along with Dow, YPF announced a project to develop “El Orejano” field for shale gas production, marking the entry of the American petrochemical company in the Argentine shale arena. This year, YPF contracted 15 new drilling rigs for its own Vaca Muerta shale operations, nearly doubling its existing rig count in the area.4 According to its own data, YPF spent around $1.12 billion on activity in Vaca Muerta in 2013 (a big increase from $380 million in 2012)5 and has around 198 unconventional wells currently in production from its Loma Campana block.6

Shale development provides Argentina with the possibility of becoming a potentially important player in the global gas market. In the past, Argentina has been a major supplier of natural gas to neighboring countries; today Argentina’s domestic gas demand is enough to see it importing significant quantities of natural gas. A shale revolution in Argentina has the potential to see the country becoming a net exporter of gas and a significant producer of oil, reducing imports and becoming self-sufficient in both, which has important implications for the country’s GDP. Argentina’s gas demand is also expected to increase with more gas use by power generation and energy-intensive industries. For Argentina to reach its full potential in terms of its shale industry, it requires not only substantial up-front investment but support from a whole host of other areas. Some of these enablers have already been identified in Accenture’s 2014 study “The International Development of Unconventional Resources: If, where and how fast?” The study reveals that not only is the size and quality of the shale resource important, but considerations like the fiscal and pricing regime, access to the shale acreage, its operability, Argentina’s skill base and the existing infrastructure in the shale region/s are all crucial to the successful exploitation of its unconventional resources.

If Argentina can make a success of harnessing its shale assets from Vaca Muerta, Accenture estimates that by 2035 (under an optimized development model for Vaca Muerta) the development of Argentina’s oil and gas shale resources could see an average contribution to Argentina’s annual GDP of between $62.2-$67.8 billion. This translates into an additional GDP growth of 0.5% per year and the creation of 20,000-22,000 new jobs each year to 2035.7

In terms of Vaca Muerta reservoir potential and after initial well testing, one international oil company CEO commented a couple of years ago “We think it could be bigger than the Eagle Ford field “. (Mark Papa – former CEO EOG Resources).8 Another oil company spokesman recently made similar comments “The Vaca Muerta shale in Argentina is unique because of the rock thickness. Argentina has kind of won the geological lottery (Kent Robertson, Chevron)9. Regarding the above, industry insiders firmly believe that indications show Vaca Muerta to be bigger than the Bakken or the Eagleford fields in the USA with its development set to have an immediate and lasting impact on the growth of Argentina’s economy.
The following methodological note intends to describe the conceptual framework that underlies the impact analysis developed in this study. In order to quantify the impact of the shale industry across the Argentine economy, a timing estimate of shale oil & gas expected production levels was required. Because Accenture considered this input as critical to build a robust model, we leveraged the shale oil & gas conceptual model developed by GiGa Consulting to estimate VMUT (Vaca Muerta) shale oil and gas production volumes through an extensive time horizon.

The model developed by GiGa Consulting considers a total of 112 current concession areas that overlap within the VMUT resource play. It was assumed also that each geographic area will be partially developed, and with a predetermined timing sequence. The development is based on a standard development cluster of 160 acres, with average production, drilling and lifting costs (compatible with the VMUT geology and local production environment), and always keeping a commercial and business viability. Finally, different zones where dry gas, wet gas and oil predominated were considered for each area of development, along with their costs and production assumptions.

By taking all these elements into consideration, the model estimates oil and gas production over the unconventional Vaca Muerta field life cycle, followed with an infill second development “wave” to be occurred 12 years after start-up of the initial development phase. The model assumes a similar performance to the ones observed in other US unconventional plays. The model also forecasts ranges for total number of wells drilled, drilling rigs over time, investment requirements in terms of Capex and Opex, federal and local taxes and royalty generation.

Potential production, production forecast and wells’ performance were assumed to follow patterns shown by analogous US shale plays. The model assumes as well a gradual predominance of horizontal wells over a period of time, following the approach taken in other shale basins.

In order to ensure reliable results, the model combines VMUT raw data, local oil & gas industry statistics, lessons learned and benchmarking with other US shale plays, assembled with GiGa and Accenture the consultants’ expertise in the oil and gas sector. Under this model, production estimates take a reasonable optimistic perspective, but feasible nevertheless under favorable conditions in terms of wells productivity, available funding, favorable regulatory environment, as well as oil and gas prices.

The shale oil and gas expected production volumes obtained with this model were leveraged by Accenture to then quantify the economic contribution and impact of the shale industry on the national economy in terms of GDP and jobs creation.

The Argentine input-output matrix was used to quantify the direct, indirect and induced impact of the shale industry on all sectors of the Argentine economy as well as the sectors that benefitted the most. As the most recent I-O table for Argentina relates to year 1997, we leveraged the latest available Use and Supply Requirements Tables published by INDEC in 2004 to build a more up-to-date national input-output table. For this reason, the model estimates are consistent with requirements and imported components of investment which are reflected in the 2004 I-O table. As investment requirements for shale are greater than that of conventional, resources the estimated impact on GDP becomes more conservative. By using the national I-O table and capturing all the supply-chain effects associated with the shale industry, a set of multipliers were obtained that describe the change of output in every industry caused by a marginal change in the production of the shale industry. Since the “extraction of shale gas/oil” sector is not disaggregated in the 2004 I-O table, its multiplier was assumed to be equal to the one shown by the “extraction of oil and gas” sector.

The obtained multipliers were adjusted to increase the accuracy of results. This adjustment was made assuming that the surge in shale gas/oil is now 20% more intensive (compared to conventional energy) in the use of the following related industries: Oil and gas activities, Construction, Transport (water, rail and ground passenger), Pipelines, Extraction of sand stone and clay; and Professional services. At the same time, and in order to provide ranges for the different multipliers, each multiplier was adjusted by historical sector’s volatility.

Likewise, the modified 2004 I-O table does not contemplate adjustments to other industrial sectors non-related to shale gas & oil. In that sense, it was assumed that interrelationships among industrial sectors will remain constant.

As a final step, Accenture leveraged shale’s expected production estimated by GiGa Consulting under three different development stages:

1. Vaca Muerta Initial development: Argentina develops shale gas/oil production from Vaca Muerta formation.

2. Optimized Vaca Muerta play development: Argentina optimizes shale gas/oil extraction in Vaca Muerta by infill drilling increasing the number of wells by cluster.

3. Vaca Muerta Play and Other Basins: Argentina not only develops Vaca Muerta formation, but also other basins (San Jorge and Austral primarily).

A rise in production in one selected development stage produces an impact on GDP and jobs creation (direct, indirect and induced effects) via the multipliers obtained from the adjusted 2004 I/O table.
Evolution of Well Production according to the methodology applied

2015

2025

2035

Añelo - Province of Neuquen
Shale in Argentina

Unconventional Resources and the GDP
Argentina has a complex economic history. This has been exacerbated in recent years by the global economic recession which has seen many countries struggling with lack of growth and unemployment. In its latest “World Economic Outlook” (July 2014), the International Monetary Fund (IMF) has again lowered its estimate for global GDP growth in 2014 (down by 0.3 percent to 3.4 percent) reflecting the continued weak performance of some mature economies like the USA and a less optimistic outlook for several emerging markets. With somewhat stronger growth expected in some advanced economies next year, the IMF’s global economic growth projection for 2015 remains at 4 percent.\textsuperscript{11}

In Argentina, after a decade of high growth, the Argentinean government reported GDP growth of only 3% in 2013, a figure that is lower than the average from past years. In turn, some analysts have reviewed their growth expectations for 2014.\textsuperscript{12} The increased competition and the macroeconomic stability appear as the main challenges that Argentina must face in the short term.

The local economy is emphatically trying to attract new investments to strategic sectors, such as energy and infrastructure. At the close of this publication a new Hydrocarbon Bill is being proposed and one of the provisions discussed is that the national state may increase control of key oil and gas provinces like Neuquén (which has been dealing with international oil companies directly through its own oil company), in an effort to speed up shale exploration. Just the fact that a new hydrocarbon law is being considered and discussed, aiming to incentivize and speed up shale development, is a very good sign for Argentina’s economy.

### Figure 1

**Average annual addition to GDP by 2035: Vaca Muerta Play (in billions of US dollars)**

<table>
<thead>
<tr>
<th>High Estimate\textsuperscript{2}</th>
<th>Low Estimate\textsuperscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP 0.3%</td>
<td>GDP 0.1%</td>
</tr>
<tr>
<td>(31.6 - 34.3)</td>
<td>(15.1 - 16.7)</td>
</tr>
<tr>
<td>Oil and Gas Extraction</td>
<td>Top 10 industries\textsuperscript{1}</td>
</tr>
<tr>
<td>(-600)</td>
<td>(7,600-8,200)</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Includes Other support activities for mining; Water, transit and ground passenger transportation; Pipelines transportation; Real estate and construction; Iron and steel product manufacturing; Professional services; Refinery products; Utilities; Other product manufacturing; Plastics products

\textsuperscript{2} High and low estimations are based on multipliers’ ranges, which were set according to each industry’s historical volatility

\textsuperscript{3} The annual average GDP growth rate without shale for the period 2014-2035 is 3.6%. In terms of production, it was assumed a WTI at $85 per barrel and a BTU at $7.5

Source: Accenture Research, EIU and INDEC

Under the Vaca Muerta Play optimized development stage – with infill drilling – Accenture estimates that by 2035 the development of Argentina’s oil and gas shale resources could see an average contribution to Argentina’s annual GDP of between $62.2-$67.8 billion. Comparatively, the average annual contribution to GDP equals:

- 3.3 times soybean exports\textsuperscript{13}
- 3 times YPF’s market capitalization\textsuperscript{14}
- 54% of Argentina’s foreign debt\textsuperscript{15}

Moreover, the Vaca Muerta Play development stage could potentially create roughly 20 to 22 thousand new jobs in the economy each year to 2035, in a country where, for instance, total job creation was estimated to be around 150,000 in 2013.
Shale in Argentina

Impact on Argentina’s Industry Sectors
In 2013, according to the World Bank, Argentina’s GDP stood at around $612 billion (US dollar/c current prices). Today, Argentina is a services-led economy with manufacturing and agriculture being also dominant sectors and with the shale oil and gas industry having the potential to accelerate growth across multiple sectors. For example, the shale boom could see the Mining, Oil & Gas sector potentially representing 9% of the overall economy by 2035 (these sectors currently account for around 3%) and in the future, they could even show a higher contribution to Argentina’s economy than the agriculture sector.

**Figure 2**
Argentina’s GDP 2013 vs 2035: by Sector ($ billion and percent)

<table>
<thead>
<tr>
<th>2013 GDP (US$ current prices)</th>
<th>2035 GDP (US$ current prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$611,755</td>
<td>$1,468,405</td>
</tr>
</tbody>
</table>

- **Agriculture**: 16%
- **Electricity, Gas & Water**: 9%
- **Mining, Oil & Gas**: 15%
- **Construction**: 6%
- **Retail, Wholesale & Hospitality**: 16%
- **Transportation and Comms**: 6%
- **Financial Services and Real Estate**: 8%
- **Manufacturing**: 20%
- **Government, Health and Education**: 3%

Source: World Bank; CEPAL; EIU
The economic growth and positive impact on the various industry sectors in Argentina is largely driven by its rising shale oil and gas production. The economic impact is primarily an effect of GDP growth, supported by factors like increasing energy demand, falling energy imports and job creation and rising productivity. There are also likely to be social benefits from job creation and higher wages leading to increasing competition and innovation as well as the direct effect on local communities through increased investment and local content initiatives.

Thus, Argentina’s shale revolution is a key opportunity to generate a structural change in the current context. How quickly these developments materialize will determine how quickly Argentina’s economy will grow. Under Accenture’s Vaca Muerta Play development stage, Accenture expects the impact of shale oil and gas development on Argentina’s annual average economic growth to be 0.5% in the period from 2013 to 2035. Under this development stage, the $62.2–$67.8 billion average annual total GDP impact would largely be driven by the oil and gas sector, that will contribute with over $31.6–$34.3 billion (over 50% of the total impact). According to the multipliers used, the oil and gas sector alone is expected to create 13,000 new direct jobs between 2013 and 2035 (an average of around 600 new jobs per year). Accenture considers that this is a very conservative estimate given the characteristics of the I-O table used in the methodology and comparing similar experiences in other geographies with unconventional developments.

To illustrate job creation just for oil and gas drilling, Accenture estimates that each drilling team could employ around 30 people for direct operation. Additionally, some 30 ancillary services including environmental care, medical care, transportation support and mechanics, catering, transportation, etc., are required, totaling about 200 people per team. Other services such as security, geological control, trials, etc. are also necessary. This is approximately twice the estimate per rig in Argentina in the ‘90s, and it sounds reasonable due to higher environmental, regulatory and security pressures.

The potential impact of shale gas development in Argentina is also relevant if seen in comparison with the impact that unconventional resources development has had on the economy of the USA over the past few years. Here, the development of unconventional resources has not only been transformational but is also leading the USA down a path toward energy self-sufficiency. It has been estimated in various studies done by I.H.S analysts, that the unconventional gas industry contributed to the creation of 2.1 million jobs in the USA and that the impact of new activity in the unconventional and shale gas sector will increase that contribution to 3.3 million by the end of the decade (and almost 3.9 million by 2025). I.H.S analysis also shows that by 2015, 3.2% of all US manufacturing jobs will be linked to unconventional development but by 2025, this share will jump to 4.2%. (This means that unconventional development will support close to 400,000 manufacturing jobs in 2015 and just over 500,000 in 2025). The overall contribution to the GDP of the USA of unconventional activity is estimated by I.H.S to double from $284 billion in 2012 to $533 billion in 2025.16
Similar to the development of the shale gas industry in the USA and its impact on that economy, the Input-Output matrix results obtained for the local economy show the development of the shale gas industry to have a stronger impact on extraction-related industries; therefore we expect to see a correlation between the growth of these economic sectors and the development of the shale gas industry in Argentina:

- Support activities for mining (services related to oil and gas extraction; extraction of sand stone and clay and others)
- Water transit and ground passenger transportation
- Iron and steel product manufacturing
- Infrastructure (including pipelines and other transportation)
- Real estate and construction
- Professional services
- Oil refinery products
- Water, gas and energy supply
- Other manufacturing products
- Plastic products manufacturing

The impact of raising shale production on the energy sector, as well as energy-intensive industries, and even on infrastructure like roads, railroads, pipelines, and others, will generate sectorial growth with associated rises in expenditure and job creation. Such jobs would be directly and indirectly related to the energy sector such as engineers, geologists, drilling contractors, construction workers, truck drivers, as well as project managers and logistics and supply chain experts.

The spillover effects and implications of this potential shale revolution is also likely to have an important social and local community impact. This is expected to be largely positive through increased expenditure by direct and indirect employees of the energy industry benefiting local businesses, including hotels, restaurants, and shops. However, there is also the likelihood of negative external factors, both in environmental terms and insufficient public services (for example, health and education) to efficiently meet a higher demand resulting from a growing workforce, as well as labor transfer towards the higher income oil sector as a result of an increased demand.

**Figure 4**
Most impacted industries, average annual addition to GDP
Vaca Muerta Play – US$ billion

<table>
<thead>
<tr>
<th>Industry</th>
<th>High Estimate</th>
<th>Low Estimate</th>
<th>Annual Average Jobs Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support activities for mining</td>
<td>4.3-4.6</td>
<td>1.6-1.8</td>
<td>(1,500-1,600)</td>
</tr>
<tr>
<td>Water, transit and ground passenger</td>
<td>1.9-2.1</td>
<td>1.5-1.7</td>
<td>(1,100-1,200)</td>
</tr>
<tr>
<td>Pipelines transportation</td>
<td>1.6-1.8</td>
<td>1.4-1.5</td>
<td>(-100)</td>
</tr>
<tr>
<td>Real estate and construction</td>
<td>1.5-1.6</td>
<td>1.2-1.3</td>
<td>(-200)</td>
</tr>
<tr>
<td>Iron and steel product manufacturing</td>
<td>1.4-1.7</td>
<td>0.8-0.9</td>
<td>(2,700-2,900)</td>
</tr>
<tr>
<td>Professional services</td>
<td>0.7</td>
<td>0.7</td>
<td>(-50)</td>
</tr>
<tr>
<td>Refinery products</td>
<td>0.7</td>
<td>0.7</td>
<td>(-200)</td>
</tr>
<tr>
<td>Utilities</td>
<td>15.1-16.6</td>
<td>15.1-16.6</td>
<td>(-300)</td>
</tr>
<tr>
<td>Other products manufacturing</td>
<td></td>
<td></td>
<td>(-300)</td>
</tr>
<tr>
<td>Plastic products</td>
<td></td>
<td></td>
<td>(7,600-8,200)</td>
</tr>
<tr>
<td>Total gain</td>
<td></td>
<td></td>
<td>(-100)</td>
</tr>
</tbody>
</table>

¹ High and low estimations are based on multipliers’ ranges, which were set according to each industry’s historical volatility
² Support activities for mining include services related to oil and gas extraction; extraction of sand stone and clay and others

Source: Accenture Research and INDEC
Impact on manufacturing

Increased shale activity is expected to drive growth in other gas-intensive industries, such as refining, petrochemical and power generation as well as iron and steel industries. Under the same development stage, the GDP impact from increasing iron and steel production alone is expected to be nearly $1.7 billion on average per year to 2035.

Likewise, a nascent re-industrialization process based on lower gas prices could potentially take off, transforming the industrial map of Argentina, and reviving some energy-intensive industries by making them more competitive while also creating new ones. “By industrializing primary production thanks to the shale activity, Argentina might open up to new markets” Martin Picón, the director of the Chemicals Chamber of Commerce, commented recently.

However, even without looking into the future, there is evidence that substantial changes are already happening. New and strategic industries like frac sand production are emerging locally thanks to the shale boom (though still most of the current supply is higher-cost ceramic proppant sourced from Brazil, China and Mexico). With local sourcing options in Argentina still in the early stages of exploration, access to the global logistics and supply chain markets will be key and remains a concern during the short term. Demand is going up quickly, however, as global service company Halliburton recently inaugurated frac sand storage and treatment plant in Neuquén (near the Vaca Muerta play) demonstrates. Likewise Compañía de Inversiones Mineras (CIMSA) is currently undergoing a frac sand production and treatment effort in quarries near the location of Gaimán, in the province of Chubut.

A similar situation is developing for the chemicals used as stimulants during the drilling process for shale wells. Generally unconventional wells require the injection of a wide variety of chemicals such as diesel fuel, methanol, formaldehyde, ethylene, hydrochloric acid, and sodium hydroxide. Today Argentina has virtually no local production capability to obtain large quantities of such chemicals, although efforts are underway to start the development of in-country production capacity.

Impact on infrastructure and services

Argentina’s transportation sector is also expected to be highly impacted by rising shale activity. Here the total combined impact of new infrastructure for water and other materials as well as new oil and gas pipelines is expected to be around $3.8 billion per year on average.

Estimates made by GiGa indicate that over 4,000 km of trunk pipelines are necessary to transport oil and gas from development areas to major transportation or injection nodes (Oldelval, TGS, Pacifico). In addition, a high level estimate indicates that 10 times more internal pipelines will be necessary to work as internal field collecting systems with the associated design engineering, construction and maintenance requirements.

In addition, strong infrastructure investments will be required to expand the rail network and give support to Vaca Muerta logistics requirements. In the meantime, most supplies will continue to be transported via truck, which is a less cost efficient alternative. Today, around 3,000 trucks move in and out of the Vaca Muerta play on a daily basis to transport water, frac sand, chemicals and other supplies showing an exponential growth since shale drilling began.

The majority of roads in Neuquén Province that serve current oil and gas locations are currently unpaved, and new drilling activity will necessitate investment in this infrastructure as well. New infrastructure will also be required indeed to bring supplies in and out of the shale region (and intensely maintain the existing infrastructure), as well as new pipelines being built for rising oil and gas production.

Likewise, new investments are expected to stimulate professional services; construction; power, water and gas supply; and commerce sectors, with professional services alone expected to drive an impact on GDP of $1.5 billion on average per year to 2035. Besides, in Añelo, the urban area nearest to the Vaca Muerta play, construction is booming today. The municipality is working on a master plan for year 2030 which would imply building the necessary infrastructure, health, educational and housing services to cater for an estimated population that will reach 30,000 inhabitants in the next 15 years.
This is not a minor challenge, considering that the town counts with 5,000 inhabitants today and already duplicated its size in less than 3 years.\textsuperscript{21}

There is no doubt that rising shale activity will bring a myriad of opportunities to Argentina. However, some questions are still waiting to be answered. New and cheaper energy sources could raise Argentina’s competitive advantage and lead to a revival of the energy-intensive manufacturing sector; but the country’s ability to create broader effects across the economy will require new regulations and policies to be in place. Both the local and federal government will need to work hand in hand to transform Argentina’s shale revolution into a reality, by setting economic incentives, investing in public infrastructure, regulating and protecting the environment and also coordinating a common policy that can help to reverse the skills gap and more specifically the deficit of engineers. Today only 300 new engineers graduate in Argentina in comparison to a thousand new lawyers, setting up a rising challenge to increasing market demand.\textsuperscript{22}

Figure 5
Average annual addition to GDP by 2035
Including all development stages (upper ranges) – US$ billion

<table>
<thead>
<tr>
<th>Billions of US$</th>
<th>% annual average GDP boost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial development</td>
<td>52.3</td>
</tr>
<tr>
<td>Vaca Muerta play</td>
<td>67.8</td>
</tr>
<tr>
<td>Vaca Muerta play and other basins</td>
<td>75.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total number of jobs created by 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial development</td>
</tr>
<tr>
<td>Vaca Muerta play</td>
</tr>
<tr>
<td>Vaca Muerta play and other basins</td>
</tr>
</tbody>
</table>

Source: Accenture Research
Shale in Argentina

Higher Domestic Oil and Gas Production

By 2035, as a result of successful shale exploration and development in the Vaca Muerta area, Accenture projects that Argentina’s oil production will have increased to over 1.8 million barrels per day (b/d) with natural gas production projected to rise to over 317 million cubic meters per day. The projection for oil production is positive in that Argentina is forecast to become self-sufficient in oil between 2020 and 2025. For natural gas, self-sufficiency also kicks in in the early 2020’s under the assumptions considered.

Oil production in Argentina is currently around 550,000 b/d and demand continues to outstrip supply; the story is the same for natural gas. To date, nearly all of Argentina’s oil production has been conventional, and this is now expected to change as the Vaca Muerta begins to ramp up. Oil production from the Neuquén basin was around 224,000 b/d in 2013, more than a third of the country’s production, and the basin produced 2.2 billion cubic feet per day of natural gas also (according to the regional government’s figures). Currently Argentina produces around 100 million cubic meters per day (mmcm/d) of gas, mostly from conventional fields, and imports significant quantities of natural gas (over 11.8 bcm in 2013) to meet demand from power generation and industry.

It is worth mentioning that Argentina has a number of basins which also hold unconventional resources. The largest is the Neuquén Basin (home to the Vaca Muerta formation). The other basins are smaller and relatively unexplored, and include the Paraná Basin to the north, and the San Jorge and the Austral-Magallanes basins to the south. Most of the activity related to unconventional in Argentina is likely to be focused on the Neuquén region initially with oil and gas production here projected to increase significantly in the near future.
Figure 6
Argentina's Oil Production (Conventional and Unconventional) to 2035 (kbbl/d)

Figure 7
Argentina's Natural Gas Production and Consumption to 2035 (MMm3/d)

Source: GiGa Consulting and Accenture Research
After 20 years of shale activity, Accenture forecasts that the cumulative effect of shale development in Argentina up to 2035 will result in approximately:

<table>
<thead>
<tr>
<th>Rigs</th>
<th>$ in Federal Taxes</th>
<th>$ in CapEx</th>
</tr>
</thead>
<tbody>
<tr>
<td>227</td>
<td>$128 billion</td>
<td>$368 billion</td>
</tr>
<tr>
<td>35,238</td>
<td>Wells drilled</td>
<td></td>
</tr>
</tbody>
</table>

In contrast to many other countries with large unconventional reserves (with the exception of the USA) Argentina’s services supply is favorable in that there is already oil and gas industry activity ongoing near the large shale deposits (this is particularly true for the Neuquén region). This means that there is an Oil Services industry locally developed; and there are oil, water and gas pipelines and other supporting infrastructure already set up there. This is being seen as a big advantage to shale gas extraction which, combined with the size and quality of the formation, makes the Vaca Muerta field in the Neuquén region particularly attractive and relatively direct to develop.

GiGa Consulting Development Model

Development Stages for the Vaca Muerta and Other Shale Basins:

1. Initial Development: In this initial development stage, Argentina develops shale gas/oil production only from Vaca Muerta formation. Here the GDP impact in total for the period from 2013 to 2035 will be around $52 billion, representing an additional GDP growth rate of 0.2% per year led by shale (on top of the country’s estimated 3.6% annual growth). This development stage estimates that between 10,000–11,000 jobs will be created per year in all sectors.

2. Optimized Development: Under this stage, Argentina improves shale gas/oil extraction in the Vaca Muerta by infill drilling, (and because we consider this scenario to be the most representative, Accenture is referencing this development stage throughout this point of view). Here the GDP impact in total for the period from 2013 to 2035 will be roughly $65 billion, which means an additional GDP growth rate of 0.5% per year led by shale (on top of Argentina’s estimated 3.6% annual growth). This development stage estimates that between 20,000–22,000 jobs will be created per year in all sectors.

3. Vaca Muerta and Other Basins: In this final development stage, Argentina develops not only Vaca Muerta intensely but also other basins (Cuyana, D129 and Austral primarily). Here the GDP impact in total for the period from 2013 to 2035 will be around $75 billion, representing an additional GDP growth rate of 0.7% per year (on top of the country’s estimated 3.6% annual growth). This development stage estimates that between 23,000–25,000 jobs will be created per year in all sectors.
Capturing the shale opportunity

Lessons for Vaca Muerta: The Eagle Ford Field in Texas, USA.

The Vaca Muerta play shares many of the characteristics that made the Bakken, Eagle Ford and Marcellus shales in the United States so successful: rich shales with low clay content, high organic content with existing infrastructure, and an active oilfield services sector. What makes the US unconventional story even more compelling is that before unconventional activity started ramping up, only the Permian basin was a producing basin, with no production in the Bakken and Eagle Ford plays.26 The Vaca Muerta play also has the additional bonus that the shale is particularly thick (according to YPF data ~ 300-450 meters thick in some places) which promises good permeability and production rates.26

YPF is already evaluating three core areas on its Vaca Muerta acreage to determine not only hydrocarbons in place but also quality of the rock and the performance of its vertical (and horizontal) wells. YPF has been drilling vertical wells in this early development phase of Vaca Muerta which can also be profiled and logged over the entire formation providing useful data over the vertical interval.27

Most US shale plays like the Eagle Ford field intensively use horizontal drilling to boost production flow rates and some fields like the Barnett have made a transition from drilling primarily vertical wells to horizontal wells. Accenture and Giga expect that despite of the thickness of the Vaca Muerta formation, companies will also make a similar transition to using more horizontal wells at Vaca Muerta*. The transition of the Barnett shale to horizontal drilling showed impressive results. Many of the operators in the US tight and shale plays have also increased drilling and well efficiency by using pad drilling and more frac stages per well. For example, the impressive production rises in the Eagle Ford field are due to a combination of good geology, near field exploration techniques, well spacing, fracturing design, proppant use and focusing on the overall operating business model – there are a few companies who have become expert in combining these operational and technical techniques. In 2007, total Eagle Ford field liquids production (crude oil and condensate) was less than 21,000 barrels. By 2010, production averaged nearly 29,000 barrels per day (b/d), and was approaching 60,000 b/d by year’s end; all from horizontal wells. Currently the Eagle Ford produces around 1.4 MM b/d.

Operators in the Eagle Ford have been very focused on and open to operational changes and new technologies. Some companies active in the area state that they “benchmark constantly” to make every well drilling better and more cost effective than the previous one. EOG Resources, the largest oil producer in the Eagle Ford Shale, has achieved sustained operational improvements by adopting a manufacturing style approach to drilling and production operations. It recorded a 36 percent reduction in completed well costs and a 43 percent reduction in drilling time for its Eagle Ford operations in the five-year period from 2008 to 201328 as a result. Another Eagle Ford operator, BHP Billiton reported in 2014 that it has been able to reduce drilling time in the Eagle Ford by 20% and costs by 24%, using models to diagnose performance issues (primarily a proppant placement model which showed that only 38% of the vertical frac height was being propped).29 Petrohawk (now part of BHP Billiton) has found that by using a new fracturing technique in twelve of its Eagle Ford wells compared to nine other wells (fractured using a hybrid design), the wells using this new technology had 32% higher flow rates and 42% higher pressure after 90 days of production.26 The Eagle Ford play is also just one of the shale regions in the USA which has benefited from government programs to support the development of shale gas in the USA which have included: supporting R & D programs on unconventional natural gas, offering tax credit for unconventional natural gas production, and deregulating wellhead prices of natural gas, as well as mandating open access to natural gas pipelines.

Operators in the Eagle Ford play have not only been quick to try out new technologies and more innovative operating practices but have also focused on good environmental and regulatory practices; many are part of the Eagle Ford Shale Consortium which focuses on better collaboration with local communities and regulators.31 Today many Eagle Ford operators use no emission or low-emission controls for various operations (which are now being mandated by the US Environment Protection Agency or EPA) and have a good track record of working with various regulatory agencies like the Texas Railroad Commission (RRC) and Texas Commission on Environmental Quality (TCEQ).

Today, the Eagle Ford is one of the largest producing oil and gas fields in North America, producing 1.4 million b/d of oil and 6 billion cubic feet of natural gas per day in late 2013. The Eagle Ford basin currently ranks as the largest oil and gas development in the world in terms of capital invested and industry activity (estimates indicate $30 billion was spent developing the play in 2013 and there are over 200 operators and 266 active rigs currently on the site).32

*The GIGa model included a progressive transition from vertical to horizontal well drilling in unconventional plays in Argentina.
The fact that there is already existing oil and gas industry activity around fields like the Vaca Muerta is expected to accelerate the development of shale production and therefore its impact on Argentina’s economy. There is the potential to scale up activity very quickly (as was evident in the Eagle Ford field in the USA – see inset) although rig and the availability of oil field services for key services like pressure pumping and completions generally could be a constraint. Rig activity is already scaling up with data showing in June 2014, an average of 107 rigs drilling for oil or gas in Argentina, the highest number operating since records began in 1982.33

YPF has recently reported that its production of unconventional oil and gas reached 25,000 barrels per day from around 244 wells in Vaca Muerta. (15,000 bpd of crude, 46 MMcfd of gas).34 The company currently has over 20 active rigs in the area as well as 8 work-over rigs, and it expects to drill 140 wells in the Vaca Muerta in 2014; (YPF also drilled 10 wells for tight gas resources in Lajas play in the first quarter of 2014). YPF also plans to increase its drilling rig fleet to 75 by the end of 2014, up from 63 in the third quarter of this year. YPF plans to spend $15 billion in a decade on shale extraction, drilling estimated 1,500-2,000 wells.35

International oil companies are also drilling in the Vaca Muerta and other unconventional basins in Argentina. As of August 2014, Total has the largest number of wells following YPF with 11 wells (3 in Aguada Pichana, 4 in San Roque, 3 in Rincón de la Ceniza y 1 in Pampa Las Yeguas). ExxonMobil drilled five wells there in 2013 and it announced in May 2014, success with its horizontal well in the Bajo del Choique Block (which tested oil at an average rate of 770 barrels per day (b/d). Shell has six producing oil wells in Vaca Muerta. Pluspetrol has already drilled 10 wells. Americas Petrogas, like Chevron in El Trapial field has drilled 4 wells each and Medanito y Roch 3 wells each. YPF has also recorded drilling success with its well in the Agrio formation in south-western Patagonia (August 2014), also in the Neuquén region (but in a separate formation to the Vaca Muerta). This shale deposit is the third significant shale discovery in Argentina in just four years.36

Figure 8
Oil Companies – Who is who in Vaca Muerta (August 2014)

<table>
<thead>
<tr>
<th>Oil Companies</th>
<th>Concession Area</th>
<th>%</th>
<th>Develop Area (Working Interest)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>YPF SA</td>
<td>16,054</td>
<td>36%</td>
<td>4,791</td>
<td>39%</td>
</tr>
<tr>
<td>Wintershall Energía SA</td>
<td>2,877</td>
<td>6%</td>
<td>1,187</td>
<td>10%</td>
</tr>
<tr>
<td>Total Austral SA</td>
<td>2,781</td>
<td>6%</td>
<td>1,101</td>
<td>9%</td>
</tr>
<tr>
<td>Apache Energia Argentina SRL</td>
<td>2,375</td>
<td>5%</td>
<td>856</td>
<td>7%</td>
</tr>
<tr>
<td>G&amp;P Neuquen SAPEM</td>
<td>4,725</td>
<td>11%</td>
<td>792</td>
<td>6%</td>
</tr>
<tr>
<td>Petrobras Argentina SA</td>
<td>2,228</td>
<td>5%</td>
<td>703</td>
<td>6%</td>
</tr>
<tr>
<td>Pan American Energy LLC</td>
<td>823</td>
<td>2%</td>
<td>467</td>
<td>4%</td>
</tr>
<tr>
<td>ExxonMobil Exploration Argentina SRL</td>
<td>1,275</td>
<td>3%</td>
<td>569</td>
<td>5%</td>
</tr>
<tr>
<td>Chevron Argentina SRL</td>
<td>579</td>
<td>1%</td>
<td>312</td>
<td>3%</td>
</tr>
<tr>
<td>Americas Petrogas Argentina SA</td>
<td>795</td>
<td>2%</td>
<td>243</td>
<td>2%</td>
</tr>
<tr>
<td>Pluspetrol SA</td>
<td>2,850</td>
<td>7%</td>
<td>189</td>
<td>3%</td>
</tr>
<tr>
<td>Other operators</td>
<td>7,070</td>
<td>16%</td>
<td>1,152</td>
<td>9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44,533</strong></td>
<td><strong>100%</strong></td>
<td><strong>12,362</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Fuente: GiGa Consulting
Argentina Shale Enablers

Today Argentina is trying to overcome obstacles, improve the performance of its energy sector and abandon its condition as energy importer. In 2014, Argentina is expected to post an energy deficit of more than $9 billion, and import significant quantities of natural gas.  

Accenture has identified a number of key enablers which will facilitate the development of shale reserves in Argentina and help achieve a sustained GDP growth through unconventional hydrocarbon production.

With up to 30 active sites drilling for shale oil and gas today in Argentina and confirmed plans for additional rigs, progress toward successful development is heading in the right direction. But to achieve the scale of production required, much more investment is needed and quickly. The shift from conventional to unconventional production will require a complete transformation of the traditional energy sector in Argentina. Not only are the drilling techniques very different, such as hydraulic fracking, a greater use of horizontal wells, and higher numbers of wells under a "drilling factory" approach which has an impact on the land area, but new and existing infrastructure will be needed (for example shale extraction uses high volumes of water and also produces a lot of water) as well as a new skill base. Upfront planning, scheduling and widespread coordination will be required for all these areas and more.

Creating new infrastructure and managing the logistics to achieve the required scale and efficiency of unconventional production is a huge undertaking. Hundreds of truck trips are involved in the drilling, fracturing and completion of a single well. In 2013 alone, total truck trips required for all current shale drilling would equal more than 300 round trips from London to New York.
### Market attractiveness

<table>
<thead>
<tr>
<th>Size of potential resources</th>
<th>Neuquén Basin is a key focal point for unconventionals by major exploration and production companies and national oil companies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>583 tcf shale gas and 20bn bbl of shale oil</td>
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<table>
<thead>
<tr>
<th>Enabling fiscal regime</th>
<th>Investment promotion regime</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exemptions from export tax for up to 20 percent of production after five years from the project start.</td>
</tr>
</tbody>
</table>

### Ease of implementation

<table>
<thead>
<tr>
<th>Geology</th>
<th>Depth 2,500 m–3,000 m and thickness 150–250m sharp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good rocks and high total organic content (TOC), data available</td>
</tr>
<tr>
<td></td>
<td>&gt;300 wells drilled</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land access and operability</th>
<th>Existing oil and gas production basin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good road and infrastructure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unconventional services sector</th>
<th>More than 50 operators and service suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Immature unconventional supply chain (e.g. logistical challenges for sand and water, need to import fracturing chemicals)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oil and gas distribution network</th>
<th>Complete regional connectivity: open access pipelines and well-connected electricity network</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One of the most extensive pipeline system in Latin America</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conventional and other competitors</th>
<th>Declining production from conventional resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Almost 70% of YPF’s oil and gas project portfolio are unconventional resources (shale and tight gas and oil)</td>
</tr>
</tbody>
</table>

| Skilled workforce | Insufficient skilled labor for the oil and gas sector to address the upcoming boom |

Source: Accenture Research
Fiscal and pricing regime

A well-developed, stable regulatory regime, predictable access and distribution of permits and licenses as well as Argentine government incentives for exploration and development are all crucial to develop Argentina’s shale production capacity.

By October 2014, Argentina’s federal government was working on a legal and regulatory overhaul for the oil and gas sector to spur the development of the country’s large shale resources. Accenture estimates that under current royalty rates of 12%, the Argentinian provinces are set to earn an annual average of over $3.9 billion in new royalties alone in total to 2035 from shale developments (around 40% of total export taxes in 2013), and around $5.9 billion in total over the same period from a Federal corporate income tax of 35% (around 34% of total income tax collection in 2013).39

One of the areas, which many investors are looking for Argentina to reform, is the area of export taxation for key commodities like grains and crude oil. Additional mechanisms to stimulate unconventional development activity are currently expected through changes to tax and exports regulations.

Argentina’s government is now looking to pass a new hydrocarbons law increasing federal control over the oil and gas sector, limiting royalties, and expanding financial incentives for shale investment which includes changes to its export tax. One incentive now being considered by the government provides for any producer that invests at least $1 billion over five years in developing unconventional resources to be able to export up to 20% of the production tax free and keep the foreign exchange proceeds outside of the country, considerably altering the export tax situation. The new law could also require provinces to change the way they partner with companies to develop oil and gas reservoirs as some provinces have required a stake in concessions without investing in them. 40

Arguably as important as an enabler is a competitive gas price environment. Argentina’s policy on natural gas prices will be very important for the development of unconventional gas reserves (the deregulation of natural gas prices has often been mentioned as one of the turning points for the successful development and scaling of shale gas in the USA). In 2012, Argentina renewed the Gas Plus program and announced that oil and gas companies will be able to secure a wellhead price of $7.5/mmbtu (+44% from the previous regulated price level) for new gas production in the country, as an effort to encourage the exploration and production of natural gas. This represents a substantial increase on previous gas prices (In February 2013, the Argentine government raised the natural gas price paid to producers from $2.50/mmbtu to $7.50/mmbtu). As a result, Argentina will start to reduce its natural gas imports in 2015 thanks to agreements with major gas producers, such as YPF, Pan American Energy, Wintershall, Total and Tecpetrol, all now taking steps to increase their conventional gas production.41 Today, Argentina pays a high price for its energy and its gas imports and the cost is expected to continue to rise until shale gas production comes on stream in significant volumes.
Much of Argentina’s current account deficit is due to the cost of natural gas imports. Argentina became a net gas importer in 2008, after having been a net exporter since 1999. To meet rising demand, Argentina now imports over 11.8 bcm of natural gas annually and this volume is rising year on year (in 2010, the country only imported 3.6 bcm of natural gas). Today, Argentina regularly reduces supplies to large industrial users each winter, at times of peak demand. Earlier in 2014, Argentina announced that it would start to cut natural gas subsidies for residential and commercial users only (effective 1st April 2014) to reduce consumption and try to encourage energy efficiency. Subsidies for natural gas used in heavy industry have not however been reduced so far.

Argentina’s gas demand is expected to increase as a result of its shale developments. Argentina has always had a very gas intensive economy. In the 1990’s natural gas made up over 40% of the country’s primary energy demand supported by increasing production from new exploration. At this time the Neuquén basin accounted for almost 60% of current gas production and 50% of Argentina’s proved reserves. The increase in gas production in the 1990’s saw analysts projecting an increase in demand for gas use in power generation and for compressed natural gas, with actual gas demand for Argentina growing from 90 bcf in 1995 to a peak of 1500 bcf in 2006.

Based on past trends, Argentina’s gas demand is expected to show similar growth from today over the next two decades. As shale gas production increases, there is expected to be corresponding increase in gas demand as more gas is used in power generation and industry. Accenture projects that gas demand will increase from around 134 mmcm/d in 2014 to 236 mmcm/d by 2035.

Figure 10
Argentina, historical gas production and consumption, 1990-2011

Source: Energy Information Administration, International Energy Statistics
Other critical factors important in determining the viability of unconventional resources in Argentina are the availability of road and rail infrastructure and, probably more importantly, water. The Neuquén region is also fortunate in that it has a relatively well-developed road system meaning that oil companies will find it relatively easy to access potential shale drilling sites with heavy equipment, as well as facilitating exports to markets.

While water is not expected to be a major constraint to shale development as there is water available, there is expected to be some challenges with regard to water regulations and logistics. Several rivers, including the Limay and Neuquén rivers, are close enough to the Neuquén Basin to provide the requisite fresh water for hydraulic fracturing. This means that there is not expected to be an issue with the availability of water for the increasing shale industry in Argentina nor is major competition with agriculture or human use expected.

A previous study by Accenture called "Water and Shale Gas Development" looked at the issue of water as it relates to shale exploration and development. The shale industry is a significant user of water and efficient water movements continue to provide a competitive advantage in the industry. Water is used both in the drilling and operational phases of shale drilling as well and the industry creates substantial amounts of waste water. As such the regulatory process and good logistics for water are very important for successful shale industry development

In Argentina, onshore oil and gas resources are governed by provincial governments in their own territory (although this might change under a new energy law, see above). Therefore, currently, exploration permits are granted by provincial states. Operators are also regulated by environmental regulations issued by the Federal Secretary of Energy and more stringent rules at the provincial level. For oil and gas operations, environmental impact studies are required by Resolution 105/92 and Resolution 340/93 requires annual environmental audit studies to be prepared by consulting firms registered with the Secretary of Energy. Water is also primarily regulated by the provincial governments. Oil companies need to therefore develop a good understanding of both provincial and federal rulings for

*A typical shale well requires around 7,500 cubic meters of water to drill and fracture, depending on the basin and geological formation. The vast majority of this water is used during the fracturing process, with large volumes of water pumped into the well with sand and chemicals to facilitate the extraction of the gas; the remainder is used in the drilling stage, with water being the major component of the drilling fluids. Relatively small amounts of water are also used for dust suppression on site, and for the cleaning and flushing of drilling equipment. Although increasing volumes of water are being recycled and reused, freshwater is still required in high quantities for the drilling operations as brackish water is more likely to damage the equipment and result in formation damage that reduces the chance of a successful well.
not only oil and gas operations but also for water use and access.

In the Neuquén province, for example, the General Water Resource Office (DGRH) is responsible for applying the water code in the province. Considering the amount of water consumed by the shale gas industry, conflicts in water demand with other users could occur. A recent study by the Argentinean Institute of Oil and Gas has indicated that shale operations in the Neuquén province will consume around one percent of all water available within that province (see Figure 11).46

Within the province, a user community has been created to resolve water demand conflicts, which has been regarded as good practice. Due to a lack of a national water law, inter-provincial water conflicts are more difficult to resolve and a River Basin Water Management model has been used by Neuquén and neighboring provinces. The AIC River Basin Authority was introduced in 1985 to act as the water management authority for Rio Negro, Neuquén and Limay rivers.

Managing water quality for shale operations in Argentina is also within the scope of provincial water laws. There is growing demand in Argentina for more stringent flow back and wastewater discharge regulations to improve widespread surface water pollution. However, with the complexity of varying environmental/water regulations in different provinces, progress is relatively slow. Similar to other countries, there are also already concerns in Argentina over the use of chemicals in the fracking process; so far the disclosure of details in fracking fluid is not mandatory in Argentina (as it is now in many states in the USA).

Finally, as in other countries, there is the challenge of the prevalence and power of unions in Argentina which will be relevant across all aspects of the shale operation—from transport to fracturing services—and is likely to be a key factor contributing to the cost and complexity of developments.

Figure 11
Province of Neuquén – Water use by sector

Argentina has a well-developed oilfield services sector which to date has been focused primarily on conventional operations. The country also has another advantage in that while much of its unconventional drilling activity is new, it is taking place in areas which are not that remote, with most drilling locations not more than a few hours’ drive from a town or some kind of development. Currently the country has few domestic service company players and even fewer who have unconventional drilling and production expertise. While some of the same service companies operating in the unconventional sector in the USA will also be contracted for shale opportunities in Argentina, it is likely that in the short term, services will be provided by the larger, global service companies.

This means that there is a large opportunity for the oilfield services sector generally in Argentina but the concentration of players is likely to put pressure on pricing for exploration and production players. This will make the shale sector in Argentina very different to the USA for example, in terms of equipment and services. In the USA there has been an extremely competitive pricing environment for key services and products, due to the sheer number of service companies operating in this highly fragmented sector.

In other key demand areas, analysts are estimating that North American frac sand demand is expected to increase by nearly 30% in 2014, compared to 2013. This has resulted in logistics constraints in both rail and trucking capacity and price increases across the sand value chain.47

Argentina is also likely to see strong competition for services for key processes in shale operations such as pressure pumping and completions. Lack of equipment is also likely to be a bottleneck, and rigs with top drives in global short supply also. Some of these likely shortages are already starting to be addressed. In 2013, the Neuquén Governor Jorge Sapag announced that the province will be setting up a specialized industrial park to develop support demand for equipment and services for the unconventional industry in the region. Eight service companies have agreed to invest around (and an airport) in the town of Añelo, near the Vaca Muerta formation. The Neuquén region saw $4.1 billion of oil industry investment in 2013 alone, as shale industry activity in the province starts to scale.48
Argentina has one of the most extensive oil and gas distribution networks in Latin America. The country’s pipeline network comprises 6,248 km of oil pipelines; 3,631 km of refined product pipelines and 29,930 km of gas pipelines (predominant gas pipelines include Neuba I, Neuba II, and San Martin) which connect producing provinces in the Neuquén, San Jorge, and Austral basins with Buenos Aires and other demand centers. The Neuquén province currently accounts for almost half of the country’s natural gas production with an established pipeline infrastructure to process and transport gas to the markets.

New natural gas pipelines are already being built as shale activity starts to ramp up in Argentina. In July 2014, YPF started operating a new $75 million, 55km natural gas pipeline in Neuquén province, which connects the Rincón del Mangrullo block to the Loma La Lata separation plant. The pipeline, which has a transport capacity of 5 million cubic meters per day, is part of a $400mn joint investment in tight gas development at the site with fellow operator Petrolera Pampa. In 2013, YPF also connected around 50 unconventional wells to the national trunk oil pipeline network.

Up to now, the focus of new pipeline infrastructure in Argentina has been on gas pipelines to import gas from Bolivia. The contracts for the first stage of the future Gasoducto del Nordeste pipeline for further Bolivian imports were signed in early August 2014 with first stage expected to cost around $600 million. The government has also called for proposals for the second stage that will run across Formosa, Chaco and Santa Fe. When finalized, the new pipeline will connect Bolivia’s gas system with Argentina’s Northeast region providing natural gas to 3.5mn residents in Santa Fe, Corrientes, Misiones, Formosa, Chaco and Salta.
Before the focus switched to unconventional plays in Argentina, the majority of upstream activity was focused on the Neuquén and Golfo San Jorge basins—which still comprise the vast majority of Argentine crude oil production, each accounting for slightly more than 40 percent of national output. Chubut (Golfo San Jorge basin) is the most prolific oil province, followed by Neuquén, Santa Cruz, and Mendoza.

Conventional oil production is currently around 550,000 b/d from these basins, which Accenture forecasts to decline to 421,000 b/d by 2035. Today, all of Argentina’s natural gas production comes from conventional fields (around 94 mcm/d) and unconventional gas production is only just starting. However as unconventional gas production ramps up quickly, it is expected to overtake conventional production in the early 2020s, when gas production from unconventional fields reaches over 80 mcm/d.

Over the past few years, Argentina also launched an offshore exploration program that was undertaken by a consortium led by YPF, PAE, and Petrobras in Argentina’s south Atlantic offshore region but commercial hydrocarbons were not found. Other offshore exploration in Argentina has been limited and the government cancelled plans to tender new deepwater offshore exploration contracts in 2011, claiming that market conditions were not conducive to successful exploration. Consequently, there has been little oil exploration offshore and new discoveries in the offshore San Jorge basin have been disappointing.52

Declining conventional production and growing dependence on imports make the economic boost from unconventional resources at the potential scale an extremely attractive prospect for Argentina, as well as the development of the tight gas resources already identified. Even though conventional production is in decline, Argentina can benefit from a services and supply chain which has already been well developed to support conventional operations.

Another factor to consider is that, in the early days, unconventional reserves will generally be more expensive to exploit than conventional reserves in Argentina. In the USA today, there are companies that have already become expert in the unconventional and particularly shale, exploration and production process with associated cost benefits. Additionally, in the USA, it has arguably been a longer process for the large, integrated oil companies to adapt to unconventional operations which requires both a change in mind-set (factory approach) and a new cost structure, and operating model. For Argentina, there are also likely to be added capital costs in the form of new or expanded infrastructure to move production to supply domestic markets; with rising production possibly requiring the construction of new LNG plants to export gas or new oil terminals for storage and even exports.

Skilled Labor

The operating model for unconventional energy resources is very different from conventional operations. The process requires production closer to a “factory or manufacturing model,” with the scale and speed of operations quite unlike conventional exploration and drilling. The fracking process itself requires a high number of wells, often drilling quite close together, with a typical feature of shale wells being their high decline rates, meaning more and more wells are needed to sustain production levels. This means that the existing oil and gas workforce in Argentina will need to be reskilled to work effectively on unconventional drilling and production.

Argentina’s oil industry already has a skills gap. Currently it is estimated that there are shortages for engineering graduates (as well as geologists and geophysicists) with the number of graduates per year being lower than the demand from oil companies and even with the cannibalization of resources among such companies.

Today, Argentina, a country with around 42 million inhabitants, only has roughly 100,000 engineers graduating each year. It has been estimated that in 2003 there was an engineering graduate for every 8,000 inhabitants, a figure that dropped to 6,700 in 2009 and about 5,700 in 2013. To size the dimension of the problem we can look at the situation of other countries such as China, where there is one engineer every 2,000 people, or Germany that has one every 2,300. Argentina is struggling to reduce the current figure of one engineer every 6,600 inhabitants to one every 4,000.53

According to the latest available data from the Education Ministry, in 2011 only 4,550 students graduated from public and private engineering schools. The total number was above 5,000 in 2009, which indicates that the deficit of engineers could even be getting worse.

As a result, today, there is ‘zero unemployment’ for engineers in Argentina. Clearly demand exceeds supply and the new graduates can choose where to start their professional careers. For geophysicists it’s even worse, as oil companies are queuing to get fresh graduates, and sometimes they are even hired before finishing university. The market is hot for a discipline that produces an average of 2 graduates per year in a country where the oil and gas sector is booming.
Even with reskilling the available workforce, there will likely be a shortfall in the required labor needed to fully develop unconventional resources in Argentina. The boost to jobs in the oil and gas sector in Argentina is considerable under all of the development stages Accenture has modeled. For the base scenario considered, we estimate roughly 600 new direct jobs will be created each year as a result of increasing unconventional activity. Argentina already has open immigration policies which are encouraging talent to find its way into the country. However, as other booming oil locations have shown, this influx of talent is not a sustainable solution to workforce challenges. At best it is a short term solution, at worst, it serves to push up labor costs and thus the overall costs of new projects and distorts local economies (for example, industry players and associations in Australia are warning, in 2014, that up to $180 billion worth of investment could be lost without urgent workplace reform as high labor costs and competition for talent are pushing up project costs in the country). In the USA, shale and tight oil and gas development has, for example, shown that for some fields like the Eagle Ford, the challenge is often around the availability of drilling or fracking crews rather than equipment availability and this is likely to be a similar story for the most active plays in Argentina. Effective negotiations and developing relationships with unions will therefore also be important, as the economics of unconventional production are closely related to continuing operations, as close to 24/7 as possible to ensure maximum rig utilization.
Conclusions

The purpose of this study was to develop a technically informed view on the potential benefits for Argentina’s economy and social structure of the development of shale oil and gas industry in Vaca Muerta. Accenture’s analysis shows that opportunities are out there ready to be sized and that the impact on Argentina’s economy could be substantial.

There is little doubt that the decisions being made today to develop shale gas reserves could be among the most important in Argentina’s economic history. Accenture’s analysis shows that the Vaca Muerta has enough traction to add 0.5% to Argentina’s annual GDP growth and to create 22,000 jobs every year for the next two decades. In addition, because the Vaca Muerta holds much more gas “than Argentina could ever burn”, natural gas exports should be the way forward, with neighboring countries that have no gas or those experiencing energy shortages are among the natural customers. Shale gas development can also alleviate (and even solve) Argentina’s chronic balance of payments bottleneck.

The conclusions of Accenture’s analysis should, however, be met with caution and taken as a measure of the potentially great economic and social development opportunity that Argentina is facing today. As shown by similar international experiences (as well as Argentina’s) natural resources booms only become a blessing and aspirational if they are managed correctly. Lessons learned point to a number of “things to get right” for Argentina to fully profit from Vaca Muerta development.

The development scale of Vaca Muerta generates several challenges that must be overcome. Around the world, natural resources booms have generated, on occasions, an excessive concentration of production and export structure and high fiscal revenue dependence which can act as amplifiers of commodity price shocks. In view of the high international price volatility which characterizes the commodities being extracted, resource booms can have positive effects if combined with an adequate institutional framework, the right distribution of economic incentives and an intelligent implementation of industrial and macroeconomic policies.

Other countries have put in place a number of economic management mechanisms (stabilization and sovereign wealth funds, fiscal rules, fiscal responsibility legislation, etc.) as well as a flexible and cautious exchange rate and monetary policy schemes, which limit exposure and hedge against unexpected downturns of the global economy and price shocks.

Also, to think that the Vaca Muerta can act as a self-sustained engine for economic growth in Argentina (as might be the case in highly technical innovation centers such as you see in the USA like the Silicon Valley) is a mistake. Long term growth experiences based solely on resource extraction have recurrently proved unsustainable. A success story would require the economic benefits to outlast the initial period of high activity and a careful integrated planning and coordination upfront with tested views on what might be sustainable long term. In addition to guaranteeing macroeconomic stability, success would also require careful planning with the development of economic instruments (i.e. industrial development and export promotion programs) to support and diversify the industrial net in a way that economic activities remain strong even after the initial exploration and production activity starts to weaken.

Governments can also play a key role in accelerating the positive effects of the rising resources activity to the rest of the economy and the social structure. Increases in tax collection can generate enough resources to produce substantial social improvements (education, health, transportation, infrastructure, etc.). The challenge, however, is to administrate expenditure in such a way that does not compromise the financial and macroeconomic stability.

Accenture has identified that there are a number of key enablers which can facilitate the development of shale reserves in Argentina and move the country toward the aspirational average annual $65
billion GDP benefit of higher shale oil and gas production. The main challenges for Argentina are around the generation of fiscal and regulatory incentives, the development of its oil field services and workforce sectors, both of which need greater technical expertise and scale to fully develop Argentina’s shale resources.

However, it is likely that barriers will arise due to the fact, for example, that domestic propane and chemical production capacity and storage facilities are insufficient. While water sourcing and wastewater disposal capacity is enough for current activity levels, it will likely become a challenge as activity increases in the future. Also, roads need to be paved and even constructed. All these investments need a huge deal of private sector coordination and financing which can only be achieved if the government is fully committed to that role.

Another potential barrier is that of the availability of human capital. Finding workers with highly specialized skill sets, as well as less qualified workers with general experience, mechanical and engineering skills, and technological know-how will be hard. This shortage calls for immediate action to promote education and talent in science, technology, engineering and mathematics. The talent shortage may be solved in this highly globalized and interconnected world but Argentina should focus on creating additional value by developing local skills. Unions must also rise to the challenge, cooperating with operators and contributing to the global efficiency of the development that will allow it to achieve its fullest potential.

Argentina should also aim to preempt social conflicts which might arise out of the impact of rising shale activities. Natural resource dependent industries tend to impose social and environmental burdens on the surrounding local industries and populations which may lead to conflicts as the industry develops.

Also, deterioration and damage of existing public infrastructure (i.e. roads) due to the intensive use of the new industry has been sometimes another source of conflict. In each of these cases, to avoid this, the government should set up adequate environmental regulations and policies to ensure compliance, and a more sustainable approach to rapid shale and economic development.

Relationships with native communities living in productive areas must also be organized to allow for their social development under a framework of mutual respect and promoting an efficient field development.

The development of Argentina’s unconventional resources is a unique opportunity for Argentina. The transformational effect which the development of the Argentina’s Vaca Muerta (and potentially other basins) shale resources will have on Argentina’s economy is now rapidly becoming a reality. The size and the quality of the Vaca Muerta shale have already attracted a significant amount of new investment into Argentina and over the next few decades there will be a substantial increase. The development of Argentina’s shale resources is also estimated to reverse the trend that turned the country into a net importer, with oil and gas self-sufficiency also on the horizon.

Accenture estimates that the potential addition of $65 billion per year will have a significant impact on key sectors of Argentina’s economy. The new wealth will boost Argentina’s GDP growth and the welfare of its people. This value, however, will only be realized through new policies to support this activity, increasing collaboration between the public and private sectors and widespread sharing of technology and know-how. Argentina may rise to the challenge and embrace the contribution that Vaca Muerta can make toward a potential trillion dollar economy.

The key to success of the unconventional sector in Argentina is for those involved to work with this goal in mind, before they commit large amounts of time and money. Only time will tell.
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Finance for Unconventional Resources Management
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IT for Unconventional Resources Management
Development of IT strategies to manage unconventional resources, design and implementation of systems and solutions of specific data for unconventional resource development (including selection of software packages).

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