



**The New Energy
Landscape
Shale Gas in Latin America**

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Abstract¹

This paper examines the potential for shale gas in Latin America, and the technical and institutional obstacles to the industry's development. The first part of the paper analyzes the characteristics of the shale gas revolution that developed in the U.S. and highlights its precarious nature, the requirements for its initial development, and future prospects. The second part turns to the Latin American context – with a focus on Argentina and México -- drawing on the lessons from the U.S. experience to postulate where the significant obstacles to shale gas production in the region lie, why successfully addressing those challenges is problematic in key countries, in which countries the challenges are likely to be successfully engaged, and what it all means for how markets and trade in shale gas will evolve. The paper concludes that while Latin America's abundance of shale gas reserves could well prove a boom for the region, the myriad political and institutional obstacles faced by national governments mean that a shale gas revolution of the nature seen in the US remains a distant prospect.²

¹ “The New Energy Landscape: Shale Gas in Latin America” by David R. Mares for the Inter-American Development Bank and the Inter-American Dialogue Energy Working Papers Series

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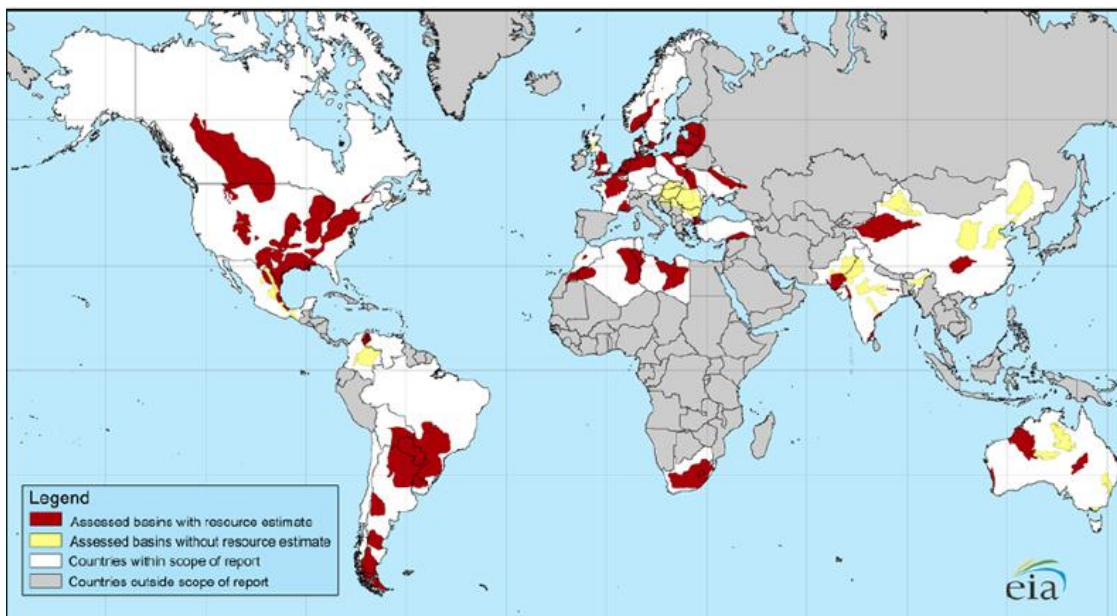
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Introduction

Recent discussions of world energy markets have enthusiastically forecast a shift in the geopolitical center of energy back to the Western Hemisphere by as early as the 2020s.³ The region had previously dominated oil markets up to WWII after which the cheap, plentiful, and high quality Middle Eastern oil became the epicenter of the geopolitics of energy. Though oil (tar sands in Canada, heavy oil in Venezuela, pre-salt oil in Brazil and shale oil in the U.S.) continues to lead the discussion, the share of natural gas in total energy is projected to equal that of oil by 2030, at 28 percent.⁴ The dramatic turnaround in the U.S. natural gas market as a result of the ‘shale gas revolution’, which is transforming the country from a net importer into a net exporter of natural gas, is an important factor in the discussion.

Latin America appears to be rich in shale gas, according to a study commissioned by the U.S. Energy Information Administration (EIA)⁵. The maroon colors in Figure 1 are preliminary indicators of the location of major basins with shale gas potential that were examined in the study. One can see the unique situation of the Western Hemisphere (though most of the basins in the world have not yet been explored), and within Latin America of Argentina, Mexico, Brazil and Paraguay.

Figure 1: Global Shale Reserves



Source: The Oil Drum

³ . cf., Daniel Yergin, “Oil’s New World Order” *Washington Post*, October 28, 2011; Amy Meyers Jaffe, The Americas, Not the Middle East, Will Be the World Capital of Energy” *Foreign Policy*, September/October 2011

⁴ . British Petroleum, *BP Energy Outlook 2030*, London, January 2011 p. 18 http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/2030_energy_outlook_booklet.pdf

⁵ . Vello Kuuskraa, et. al., ”World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States” Arlington, VA: Advanced Resources International, Inc. April 2011

Table 1 presents a deeper cut into Latin America’s natural gas potential with figures on proven conventional natural gas reserves and the estimated technically recoverable shale gas,⁶ organized by major countries. Venezuela, with 179 trillion cubic feet (tcf) of proven conventional gas, ranks second in the Western Hemisphere after the U.S. and eighth in the world. No other Latin American country holds major reserves of conventional gas. When we turn to shale gas the picture is dramatically different. Column four in the table shows Argentina with 774 tcf of technically recoverable gas from its shale deposits, far outdistancing Venezuela and second amongst potential shale gas reserves in the Advanced Resources International (ARI) study, now that U.S. reserves have been re-evaluated significantly downward. Mexico also dwarfs Venezuela and ranks third with 681 tcf of technically recoverable gas. Brazil also has the potential to become a major player in gas in addition to its likely weight in oil markets once the pre-salt fields begin producing; its technically recoverable shale gas reserves are estimated at 226 tcf . More potential good news is that Chile, which has virtually no hydrocarbon reserves to date to fuel its dynamic economy, is estimated to have important shale gas reserves. Paraguay, with minimal internal demand, could also produce significant quantities of shale gas and generate significant exports. In short, Latin America has the potential to be floating in a vast supply of natural gas.

Table 1: Natural Gas Potential in Latin America 2011 (tcf)

| Country | Conventional | Potential Shale | Technically-Recoverable Shale |
|-----------|--------------|-----------------|-------------------------------|
| Mexico | 12 | 2,366 | 681 |
| Colombia | 4 | 78 | 19 |
| Venezuela | 178.9 | 42 | 11 |
| Bolivia | 26.5 | 192 | 48 |
| Brazil | 12.9 | 906 | 226 |
| Paraguay | ... | 249 | 62 |
| Uruguay | ... | 83 | 21 |
| Argentina | 13.4 | 2,732 | 774 |
| Chile | 3.5 | 287 | 64 |

Source: Jeremy Martin and Vanessa Orco, “Shale Gas en America Latina” <http://energiaadebate.com/shale-gas-en-america-latina/>

⁶ . According to the Energy Information Agency (EIA), “The estimates of technically recoverable shale gas resources for the 32 countries outside of the United States represents a moderately conservative ‘risky’ resource for the basins reviewed. These estimates are uncertain given the relatively sparse data that currently exist and the approach the consultant has employed would likely result in a higher estimate once better information is available. The methodology is outlined below and described in more detail within the attached report, and is not directly comparable to more detailed resource assessments that result in a probabilistic range of the technically recoverable resource.” World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States” April 5, 2011 <http://www.eia.gov/analysis/studies/worldshalegas/>

Nevertheless, until significant exploration is undertaken one cannot know how much shale gas exists and is potentially recoverable under current economic and technological conditions. Even in the US, where shale gas exploration and production has been underway for a number of years, estimated reserves have been revised down quite dramatically: in 2012 the EIA reduced the total estimated shale gas reserves from 827 trillion cubic feet (tcf) to 482 tcf; in the prolific Marcellus Shale basin it reduced the reserves by 66 percent, from 410 tcf to 141 tcf.⁷ In Europe, Exxon has cautioned against expecting a shale gas ‘revolution’ after drilling two wells in Poland that found no commercially viable gas, and warned any production is likely to still be five years out.⁸

The pace of exploration in Latin America, as well as subsequent production and development of the required infrastructure to deliver the gas to the market, will be significantly influenced by politics and public policies in each country addressing the domestic energy market, the environment, and indigenous rights. The experience of the past decade suggests that the conditions for the shale gas revolution to take off in Latin America will vary by country; unfortunately, in two of the three potentially largest producers (Argentina and Mexico), the outlook is extremely problematic and in the third (Brazil), recent events suggest the risks for foreign investors are on the rise.

This paper is organized into two parts. The first part examines the characteristics of the shale gas revolution that developed in the U.S. and highlights its precarious nature, the requirements for its initial development, and future prospects. The second part turns to the Latin American context, drawing on the lessons from the U.S. experience to postulate where the significant obstacles to shale gas production in the region lie, why successfully addressing those challenges is problematic in key countries, in which countries the challenges are likely to be successfully engaged, and what it all means for how markets and trade in shale gas will evolve.

I. The Shale Gas Revolution: Technological Innovation and Economic Incentives

The existence of natural gas in shale has long been known but technology could not develop those resources at economically viable costs. Drilling technology and procedures has made significant jumps beginning in the 1980s with coil-tubing, steerable drill bits, downhole telemetry equipment and, in this

⁷ . *AEO2012* Early Release Overview [http://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2012\).pdf](http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2012).pdf)

⁸ . Tom Bergin, “Exxon tempers European shale gas enthusiasm” *Reuters* February 20, 2012 <http://af.reuters.com/article/commoditiesNews/idAFL5E8DK6TJ20120220?pageNumber=1&virtualBrandChannel=0> ; see also, International Gas Union, *World LNG Report 2010* pp. 20-24 <http://www.igu.org/igu-publications/IGU%20World%20LNG%20Report%202010.pdf>

third generation of horizontal drilling, the ability to place multiple horizontal well bores over longer distances, deeper and with more accuracy. For the specific case of shale gas, hydraulic fracturing techniques (aka ‘fracking’) were developed in which a mixture of water, chemicals, and sand is pumped into the well to crack open the rock and release the natural gas into the well.⁹ (See Appendix)

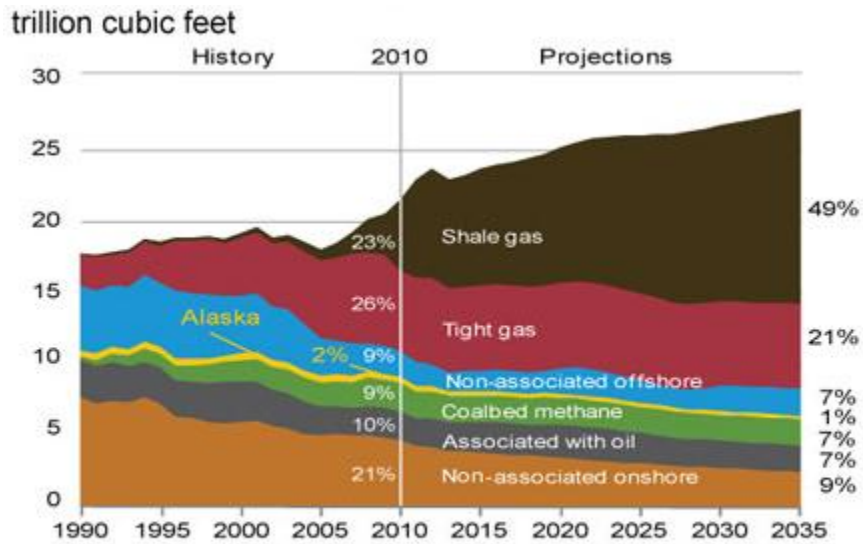
The point about the technological innovations is that they were costly to develop and remain costly to use. Major oil and gas companies perceived the opportunity costs of developing the required new technologies to be too great, given their access to conventional oil and gas reserves across the globe. It was small domestic companies in the US market that took the lead in developing the technology and using it.

These innovators were helped in efforts by three important elements in the domestic legal environment within which shale E&P could develop and two factors in the domestic energy market (all of which are problematic in Latin America as we will see in Part II). First, in the U.S. access to resource basins was initially relatively cheap given that US laws that provide subsoil property rights to surface property owners rather than to the state; the high costs of technology and equipment were thus offset to an important degree by the initially low cost of purchasing the resource. A second factor is the sanctity of contracts. Leasing contracts signed with individual property owners or states were not easily overturned when the lessees discovered that the value of the gas was significantly higher than they believed at the time shale E&P was in its infancy. Though the costs of purchasing subsequent shale deposits increased, the costs of technology and equipment declined, thus still providing a stimulus to investment. The third legal factor promoting the shale revolution in the US was a decentralized and difficult to revise regulatory context that has limited the impact of environmental concerns on shale E&P.

The factors in the domestic energy market were low barriers to entry and high prices for natural gas. Deregulation of the natural gas industry that began in the 1980s and picked up speed in the 1990s opened access to the extensive US pipeline system and created a competitive market for natural gas. Returns were initially high, despite the fact that shale gas wells’ depletion rates are higher than for conventional gas, because market determined gas prices were high (peaking at more than \$13 thousand cubic feet in 2008).

⁹ . Lynn Helms “Horizontal Drilling” *DMR Newsletter* 35:1 pp. 1-3 <https://www.dmr.nd.gov/ndgs/newsletter/NL0308/pdfs/Horizontal.pdf> ; EIA, “What is shale gas and why is it important?” *Energy in Brief* http://www.eia.gov/energy_in_brief/about_shale_gas.cfm

**Figure 2 illustrates the rise in shale gas production and optimistic expectations for the future.
Figure 2: US Natural Gas Production**



Source: U.S. Energy Information Administration, AEO2012 Early Release Overview, January 23, 2012.

There is no doubt that shale gas has experienced a phenomenal growth period. But all is not rosy for its short to medium term future. Some of its challenges come from the characteristics of production, others from its very success and still others from increased conventional supplies and the developing global LNG market.

Given the costs of production and the steep decline curves for shale gas wells (ranging from 65% in the first year in the Barnett shale to 85% in the Haynesville shale) producers in the US are moving from a bonanza period to an uncertain short term future. US gas prices are extremely low today (under \$3.00 per thousand cubic feet, compared to the high of just over \$13 in 2008) because so much gas is available in the market and the 2012 winter was unseasonably warm, contributing to reduced demand. To make matters more pressing for shale gas producers, global supplies of conventional gas are plentiful, making LNG imports quite competitive with shale gas production in many areas.¹⁰

Some analysts are suggesting that shale gas production in the US is being driven by liquids rather than by the demand for gas itself; the appropriate focus for investors therefore should be specifically on liquids rich shale gas, rather than on the gas itself. Of course, if the gas markets tighten, price would go up, attracting new investment for gas.

¹⁰ . Dave Summers, "Tech Talk - the new EIA Shale gas report" *The Oil Drum* April 17, 2011 <http://www.theoil Drum.com/node/7802> accessed February 18, 2012

The quantities needed for investment are thus large and sensitive to risk. One study analyzing the 34 largest U.S. publically traded producers determined that \$22 billion needed to be invested per quarter to maintain current production levels, of which only \$12 billion came from cash flow – meaning that \$10 billion every quarter needed to be raised through a combination of debt, share offerings, and joint venture agreements.¹¹ Even Chesapeake, one of the largest producers of shale gas, has found it difficult to service its debt and had to sell off significant assets.¹²

Environmental Questions

Environmental issues should ideally be weighed against the benefits of shale gas production, then debated in the political process, and trade-offs among these costs and benefits made through the democratic process. The decision making process, however, is made problematic to the degree that scientific evaluation of the risks is weak, the public is largely uninformed about the scientific state of the debates, and the political process for making the trade-offs is considered illegitimate by significant sectors of society. Partly because the fracking process used in shale gas E&P is relatively new there is no scientific consensus on the degree of associated risks (though the fact that we are still debating the scientific merits of oil related E&P proves that time itself may be only partly to blame). The politicized public policy context in the U.S. diverts the attention of the general public from the pursuit of knowledge about the topic to validating already held biases about environmental issues. And since both sides of the debate believe that the other side controls the legislative process through its lobbying, the political process in the U.S. is decreasingly able to serve as the legitimate forum for making the trade-offs between protecting the environment, public health, and promoting economic activity.

Nevertheless, we do know that fracturing of wells requires large amounts of water, generating opportunity costs for the use of that water. The water used in fracking contains potentially hazardous chemicals and its use must be managed properly. Large amounts of toxic wastewater must be treated and disposed of. Disposal of such wastewater into deep wells (in Ohio the threshold is speculated to be 4,000 feet) can cause noticeable earthquakes and damage, as a study by the US Geological Survey strongly suggested.¹³ Consequently, the regulations governing risk tradeoffs will have a fundamental impact on the future of shale gas. Chevron's huge liability in an environmental case in Ecuador may have a region-wide

¹¹ Arthur Berman, "After The Gold Rush: A Perspective on Future U.S. Natural Gas Supply and Price" *The Oil Drum* February 8, 2012 <http://www.theoil Drum.com/node/8914> referring to a study by ARC Financial Research

¹² . Michael Drost, "Forced to pay off its debt, Chesapeake sells \$6.9 billion in assets" *Energize Weekly* Wednesday, September 19, 2012 / Volume 5 Issue 38 http://www.euci.com/energize/9-19-12_Chesapeake_selloff.pdf accessed September 19, 2012

¹³ . Ajay Makan, "Fracking water linked to earthquakes" *Financial Times* April 14, 2012

impact as well, especially since the Ecuadorean plaintiffs are seeking confiscation of the company's assets in other countries to force Chevron to accept the verdict.¹⁴

Table 2 lists the risks associated with shale gas exploration and production (E&P) and the advantages of shale gas supply.

Table 2: The Environmental Trade-Offs Associated with Shale Gas

Environmental Risks

- Competition for water affects drinking water, wildlife habitat, recreation, agriculture, industrial or other uses
- Air emissions, including NO_x (mono-nitrogen oxides), volatile organic compounds, particulate matter, SO₂ (sulphur dioxide), and methane, commonly occur during exploration and production activities
- Normally occurring radioactive material may be brought to the surface during shale gas drilling and production operations, in the rock pieces of the drill cuttings, in solution with produced water, or precipitates out in scales or sludges.
- Methane leakage into groundwater
- Pollution from produced frackwater disposal on the surface
- Induced earthquakes from frackwater injection into disposal wells
- Environmental footprint of industrialized landscapes as new wells are constantly being drilled

Environmental Benefits

- Natural gas combustion in efficient combined-cycle power plants emits less than half the CO₂ (carbon dioxide) as coal combustion
- Natural gas combustion emits significantly lower levels of sulfur dioxide than combustion of coal or oil
- Horizontal drilling significantly reduces the number of well pads, access roads, pipeline routes, and production facilities required for vertical drilling, thus minimizing disturbance to habitat and the public

Source: *Modern Shale Gas Development In The United States: A Primer* ES-4; EIA, "What is Shale Gas..."; US Geological Service, "FAQ: Earthquakes Induced by Fluid Injection"
<http://earthquake.usgs.gov/learn/faq/?faqID=357>

II. Will Latin American Countries Create a Favorable Investment Climate for Shale Gas?

Latin America has great potential in the area of shale gas but it faces a number of challenges in developing its reserves. For example, human capital is limited¹⁵ and environmental regulations to address the trade-offs involved in shale gas production have not been debated and adopted. But rather than think

¹⁴ . "Ecuadoreans seeking Chevron's Argentine assets to enforce \$19 billion oil spills judgment" Associated Press November 01, 2012

¹⁵ . "The region's looming gap in human capital - Milton Costa" *Business News Americas* November 4, 2011

about specific needs in an ad hoc fashion, it is better to develop a general picture of the incentives and disincentives in each country and evaluate the way in which the government is proceeding with respect to shale gas development. The main issues that will determine which Latin American countries become part of the shale gas revolution revolve around the needs of investors, the state of the environmental debate, and the ability of the state to provide security for E&P operations.

As demonstrated by the US experience, significant investment is required to develop shale gas, and the willingness of investors to come to the region will depend on the rates of return and levels of political risk. The level of risk will also be influenced by the manner and content of the environmental framework within which shale gas can be developed, the ability of the government to provide security for investments and operations in the face of potential public demand for contract revisions once reserve levels are confirmed in a basin, criminal activity to extort payment from companies engaged in E&P, and environmentalists/indigenous peoples who disagree with development of the resources at all. Table 3 outlines five specific areas constitute challenges for development of Latin American shale.

Table 3: Issues to be addressed in Latin American Shale Gas

| Area | Issues |
|-------------------|---|
| Finance – | local sourcing, FDI, portfolio, state investment, state loans; terms |
| Contracts – | Security of the terms of contracts; if weak, what are the components that could likely be forcibly modified; can the projects remain profitable under altered terms |
| Domestic market – | does a local supply have to be guaranteed; profitability; credibility of government to maintaining local returns that do not undermine shale gas projects |
| Export market – | potential; government regulation of those exports via tax, quantitative restrictions and repatriation of profits |
| Environmental – | what will regulations be, how independent is the judiciary in enforcing them, and what types of political risks do they entail |

Argentina

With the third largest shale gas reserves in the ARI study, as well as a developed domestic gas market and export infrastructure, among Latin American countries Argentina is attracting the most attention. Preliminary estimates indicate that only 20 percent of the prime Vaca Muerta shale basin has liquids, but in the context of the gas shortage in Argentina the dry versus wet gas issue should not be as pressing as it

is in the U.S., *ceteris paribus*. A great deal of exploration lies ahead to confirm the level and characteristics of Argentina's potential.¹⁶

Figure 3: Shale Gas Basins of Southern South America



Source: Advanced Resources International, *World Shale Gas Resources: An Initial Assessment*, February 17, 2011, p. IV-1

A number of companies have already begun exploring in Argentina, (Repsol/YPF, Total, Apache and Exxon) with Repsol/YPF coming up with a significant discovery in December 2011 before it was nationalized in April 2012. YPF, now a National Oil Company (NOC), has the largest lease for shale gas

¹⁶ . Abigail Wilkinson, “Argentina's subsidy cuts a small step to deregulation - Michael Lynch” *Business News Americas* November 18, 2011

and has signed an unspecified agreement with Chevron to explore for both shale gas and shale oil.¹⁷ The current pace of 5-20 exploratory wells should be seen as efforts by companies to gauge the country's potential, establish a basis for attracting farm-out deals with other companies, and beef up market valuation, but not as a guarantee that the hundreds of wells costing billions of dollars will inevitably develop.¹⁸

Exploration is going to require investment in the logistics and infrastructure necessary to support it. This lack of investment is what some analysts blame for the differential cost of a shale well in the US and Argentina (\$3 million, compared to \$7-8 million, respectively);¹⁹ YPF's own drilling program for shale gas and shale oil is projected to be \$3 billion in 2012.²⁰ The government is expecting an influx of foreign capital from companies and other governments interested in Argentina's hydrocarbon resources and is willing to combine that carrot with the stick: not only was Repsol/YPF nationalized for allegedly underinvesting in Argentina, the Brazilian NOC Petrobras lost its lease in Neuquen province for the same reason.²¹

Nevertheless, the investment climate in Argentina is problematic for large investments as current government policy is at best and indicative of unilateral government behavior. The government had offered oil and mining companies tax breaks amounting to US\$461 million in 2011 but withdrew them in early 2012, ordering the companies to repatriate export revenue from the prior year and convert it to Argentine pesos. The government manipulates inflation figures and has passed a law penalizing anyone who publishes their own figures that contradict official ones. This manipulation of inflation rates defrauds investors in government bonds of millions of dollars and the IMF has warned Argentina that it faces sanctions unless it improves the quality of its economic data.

The government has nationalized pension funds, the airline Aerolineas Argentinas and now YPF. The government has also increasingly restricted the circulation of US dollars in Argentina and out of the country, including by companies seeking to repatriate profits. And there is the continuing saga regarding the country's default on its international debt, which has flared up again with bondholders successfully impounding an Argentine naval ship in Ghana.²² Financial markets and international oil and gas companies are thus unlikely to provide the billions of dollars necessary for the large scale development of shale gas in Argentina. The government has expressed confidence that China could provide significant sources of capital to develop Argentina's gas potential, and the Chinese already have investments in Argentine oil and gas (CNOOC owns 40% of Bridas Energy Holdings, Ltd., and through it 16% of Pan

¹⁷ . "YPF/Chevron signed an understanding to explore for shale gas and oil in Neuquen" *MercoPress*, September 15, 2012

¹⁸ . BNA, *Shale Resources in Latin America* October 2012 p. 7

¹⁹ . BNA, *Energy Intelligence Service: Argentina* August 2012 p. 13

²⁰ . "YPF/ Chevron signed..." *MercoPress*, September 15, 2012

²¹ . "Argentina's Neuquen considers returning E&P license to Petrobras, others" *Platts* September 25, 2012

²² . "NML-Capital targeting second Argentine navy vessel docked in South Africa" *MercoPress*, October 25 2012

American Energy, while Sinopec has significant holdings of oil and gas in southern Argentina²³). But one can deduce from the fact that Chinese affiliated companies have not announced major production increases that they have been as reticent as the other companies to invest significantly in Argentina's oil and gas under the current policy environment.

The history of Argentine gas policy with respect to the domestic and external markets over the past decade has favored the domestic consumer at the expense of foreign consumers, companies and their shareholders throughout the value chain, and the national treasury. The country had been an important regional exporter, supplying Chile, Brazil, and Uruguay. But in response to the economic collapse of 2000-2001 the governments of first Nestor Kirchner (2003-2007) and then Cristina Fernández de Kirchner (2007– present) imposed price caps on the domestic market that were devastating to investors. In response, companies diverted domestic supplies to exports.

The government, however first increased export taxes and when that did not deter the companies, restricted exports in an effort to keep the domestic market supplied. The government also broke contracts but to no avail. With the export market significantly reduced and the domestic market unprofitable, companies dramatically cut back on E&P in Argentina. According to a report by Barclays Capital, between 2003-2010 energy prices declined by almost 30 percent while oil and gas production fell by 12 percent and 2.3 percent, respectively.²⁴ The EIA reports that gas production fell ten percent in 2011 from its peak in 2006.²⁵ Meanwhile, energy subsidies totaled US\$10 billion in 2011 alone.²⁶

Domestic stimulus policies and the commodity boom affected the country's major exports, chiefly soya, and fueled high levels of GDP growth, boosting incomes. But because the government had kept consumer prices for gas low, gas shortages ensued. To maintain its domestic popularity the government continued to keep prices uneconomically low in the domestic market and had to shut down industry for days in the winter months (supply shortages have reached 40% of demand) to keep homes heated; even in the summer, industry is closed when home air conditioning demand soars.²⁷

Domestic gas policy affects both producers and distributors. Gas distributor Metrogas (owned by Consorcio Gas Argentino made up of BG 54.67% and YPF 45.33%) has been temporarily taken over by the government in the wake of the company's decision to open insolvency proceedings after years of

²³ . Ian James, "China on Latin American buying spree to lock in long-term needs in oil, minerals, food" Associated Press, June 5, 2011 accessed via <http://economything.blogspot.com/2011/06/china-on-latin-american-buying-spreeto.html>

²⁴ . Abigail Wilkinson "Government will up sector intervention" - analyst – Argentina" *Business News Americas* February 8, 2012

²⁵ . EIA, "Argentina" July 14, 2012 p. 5

²⁶ . Abigail Wilkinson, "The winners and losers in Argentina's subsidy story - Emilio Apud" *Business News Americas* January 20, 2012

²⁷ . EIA, "Argentina" 2011

rising costs and stable low prices.²⁸ The government has made some timid efforts to encourage E&P. In 2008 it instituted the Gas Plus program which paid higher prices for gas produced from either new wells or wells that had not been producing since 2004, but the incentives were too small to significantly alter the economics of production. In November 2011 after her re-election, the Fernández government began reducing energy subsidies,²⁹ and raised well-head prices 300 percent in August 2012.

The government expected intermediaries to absorb the cost, not the consumer,³⁰ which will certainly generate conflict with the intermediaries and keep gas demand at high levels. When Repsol/YPF balked at paying the rescinded US\$8 million export tax break in early 2012 the government banned the company's exports. The company claimed that these government actions led eight potential partners in its Argentine shale operations to terminate their interest.³¹ The company was nationalized a few months later. Government pressure on the industry increased in July when it required companies to submit annual investment plans in order to generate reference prices that would permit recovery of costs and a 'reasonable' profit.³²

The Argentine gas industry is further negatively affected by the government's labor policies, which promote the ubiquity of strikes and work slowdowns. For long term projects this labor situation may be less pressing, but since shale gas requires consistent and expensive drilling (around US\$7 million in Argentina) work stoppages can significantly affect the profitability of a project. Argentina's industrial policy, which promotes domestic manufacturing, will increase costs and delays as it is not in condition to produce the requisite quantity of specialized equipment. This is despite having manufactured and exported some fracking equipment to the U.S. in the past.

Domestic market policies negatively affect Argentine gas E&P in another important way. For political reasons the government emphasizes its nationalist credentials by paying higher prices for imports of gas than it would take to stimulate the production of more Argentine gas. The country became a net importer of gas in 2008 and in 2011 LNG imports probably doubled to over their volume in 2010, to 100 Bcf.³³ The government has signed a contract with Qatar to supply it with 5.4 million tons of LNG, which also requires the construction of a third LNG terminal.³⁴ The political logic created by the Kirchners means that it is better to pay more money to Chevron and Qatar for LNG imports than to raise prices

²⁸ . "Enargas once again extends control over Metrogas – Argentina" *Business News Americas* February 9, 2012

²⁹ . Abigail Wilkinson, "Argentina's subsidy cuts a small step to deregulation - Michael Lynch" *Business News Americas* November 18, 2011

³⁰ . Taos Turner, "Argentina to Raise Gas Wellhead Prices by 300%" *Wall Street Journal Online* August 9, 2012

³¹ . "Argentine Government Steps Up Pressure, Bans YPF Exports" *Latin America Energy Advisor*, February 13-17, 2012 p. 2

³² . Shane Romig, "Argentina shale gas investment hinges on stable regulations" *Dow Jones Newswires*, October 19, 2012 accessed October 24, 2012

http://www.latinpetroleum.com/new/newsdetail.php?cid=34&art_id=11363&content=F&aid=11363

³³ . EIA "Argentina" 2012 p. 8

³⁴ . "Qatargas will provide Argentina with LNG on a 20 year supply agreement" *MercoPress*, July 1, 2011

offered to companies developing Argentine natural resources, since subsoil gas resources belong to the nation and not to private companies. Apart from the budgetary impact that such a policy creates, subsidizing external supplies for the domestic market will create problems for shale gas producers because it artificially increases supply in the domestic market.

Regarding environmental issues, Argentina starts out with an advantage in that the shale gas reserves are largely in the sparsely populated regions of Patagonia and Neuquen, making environmental issues less pressing. Nevertheless, there is a growing NGO movement in the country that is focusing on fracking issues, including Coordinadora de Comunicacion Audiovisual Indigena Argentina (CCAIA), Grupo Ambiental Nogoyasero, ONG Ambiente Comarca, Coalicion Civica ARI Mendoza & Instituto de Formacion Transformar, Asamblea Ambiental Ciudadana (AAC) of Rios Gallegos, and Mesa Entre Rios Libre de Fracking. The growing opposition has the potential to link environmental issues to those of indigenous rights to create significant obstacles to shale gas development.³⁵

Mexico

The ARI study estimates that Mexico has the second largest technically recoverable shale gas deposits in Latin America, which makes it the third largest in the world (remembering that ARI did not assess every basin in the world). Mexico's national oil company (NOC) Pemex drilled its first well in the Burgos region across the border from Texas, but it cost almost five times that of those drilled on the Texas side, and came up dry. Pemex produced shale gas for the first time in March 2011 in Coahuila state, in a formation that is part of the prolific Eagle Ford area across the border in Texas.³⁶ 150 wells are planned for drilling up through 2016,³⁷ and the NOC has budgeted \$200 million for shale gas development.³⁸ At the optimistic end, one analyst believes Mexico could fully develop its shale resources within seven years and not only become self-sufficient but export as well.³⁹

³⁵ . "UN calls on Argentina to stop eviction of indigenous peoples from their lands" *MercoPress*, September 19, 2012

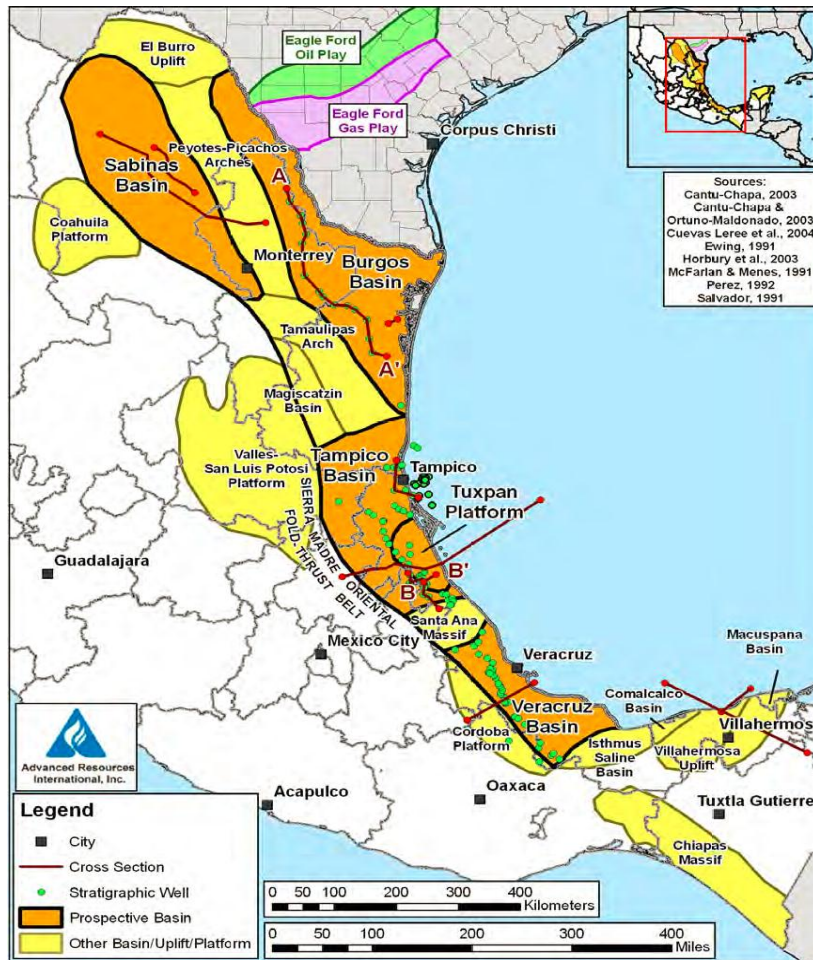
³⁶ . "Unconventional Resources of Mexico: Opportunities and Challenges" presented at the Canadian Society for Unconventional Resources (CSUR) Technical Lunch, September 12, 2012 http://www.csur.com/sites/default/files/September%20Technical%20Luncheon%20Presentation_0.pdf accessed November 10, 2012; EIA, "*Mexico*" July 2011

³⁷ . Martin, "Mexico: Shale Gas Becomes Priority"

³⁸ . EIA, "*Mexico*", October 2012 p. 11

³⁹ . David Biller, "Pemex's shale prospects" *Business News Americas* July 18, 2011, citing Alvaro Ríos of Gas Energy Latin America

Figure 4: Onshore Shale Gas Basins of Eastern Mexico's Gulf of Mexico Basin



Source: Advanced Research Initiative, *World Shale Gas Resources: An Initial Assessment*, February 17, 2011 p. II-2

Mexico faces a different set of challenges than Argentina in developing its shale gas potential. The government has estimated that development of shale gas resources will require \$7-10 billion per year⁴⁰ and that full development will take 5-8 years.⁴¹ But raising this capital, and the associated human capital and technology required, is difficult because of restrictions on foreign investment in the energy sector and domestic pricing issues.

With regards to foreign investment, the Mexican constitution forbids anyone but the state from having an equity share in oil or gas. Reforms of the gas sector began in 1995 and created a service contract mechanism in 2003 to permit companies other than Pemex to explore and produce non-

⁴⁰ . Jeremy Martin, "Mexico: Shale Gas Becomes Priority" *Latinvex*, October 23, 2012 <http://latinvex.com/app/article.aspx?id=312> accessed October 31, 2012

⁴¹ . Laurence Iliff, "Pemex to Spend \$200 Million Looking for Shale Gas" *Dow Jones Newswires*, September 11, 2012 as cited in *Rigzone* http://www.rigzone.com/news/oil_gas/a/120634/Pemex_to_Spend_200_Million_Looking_for_Shale_Gas accessed October 31, 2012

associated gas.⁴² A number of small companies as well as Petrobras and Repsol signed on to exploit the northern Burgos Basin conventional gas blocks.⁴³ But a comparison of the number of wells operating on the Texas versus Mexican sides of the border (in roughly the same size basins, there are more than 83,000 gas wells in south Texas, compared to just over 4,800 in the Burgos)⁴⁴ reveals that the multiple service contracts have not been sufficiently attractive for the private sector to become the significant partner envisioned by the reformers – largely because the contracts pay for services, rather than permit equity shares. Given that the shale blocks are even riskier than the conventional gas blocks in the Burgos, service contracts are unlikely to attract the requisite investment to develop shale gas.

Can the state via its NOC Pemex provide the requisite investment? Though it has a monopoly over oil and natural gas exploration and production, gas takes a back seat to oil in the company's operations. Given the NOC's poor E&P performance in oil, the national demands that it improve its efforts in oil, and the greater value of oil over gas, Pemex can hardly be expected to make the necessary investments in equipment, personnel, and capital to undertake the levels of exploration necessary to assess the extent and quality of the country's shale reserves and develop them. In fact, conventional natural gas production fell in 2011 and early 2012.⁴⁵ In September 2012, Pemex announced that it would invest \$200 million over three years assessing the country's shale gas reserves⁴⁶ – far short of the aforementioned \$7-10 billion required for full development.

Mexican production of shale gas faces serious market problems as well, despite the fact that demand is booming. Growth in Mexican demand has outstripped that of production over the past decade; 70 percent compared to 46percent.⁴⁷ Pemex consumes 40 percent of the total for its oil wells, refineries and petrochemical plants, with the power sector using another third of the total, and state-owned electricity monopoly Comisión Federal de Electricidad (CFE) accounting for 3/4 of that total.⁴⁸

⁴² . Juan Rosellón and Jonathan Halpern, "Regulatory Reform in Mexico's Natural Gas Industry: Liberalization in the Context of a Dominant Upstream Incumbent" World Bank, Latin America and the Caribbean Region Finance, Private Sector, and Infrastructure Sector Unit, 2000 http://www.hks.harvard.edu/hepg/Papers/Rosellon_reg_reform_gas_industry_1-01.pdf ; Francisco X. Salazar Diez de Sollano, "Natural Gas in Mexico: Current trends and alternate scenarios" The Geopolitics of Natural Gas, The James A. Baker III Institute for Public Policy, Rice University, Houston, Texas May 27, 2004 http://bakerinstitute.org/programs/energy-forum/publications/presentations/GAS_Salazar_05_27_04%20.pdf

⁴³ . Starr Spencer, "Pemex details plan for several 2011 licensing rounds" *The Americas* Vol. 89 No. 48 March 9, 2011

⁴⁴ . Diez de Sollano, "Natural Gas in Mexico" figures are for December 2002 for Texas and December 2003 for Mexico

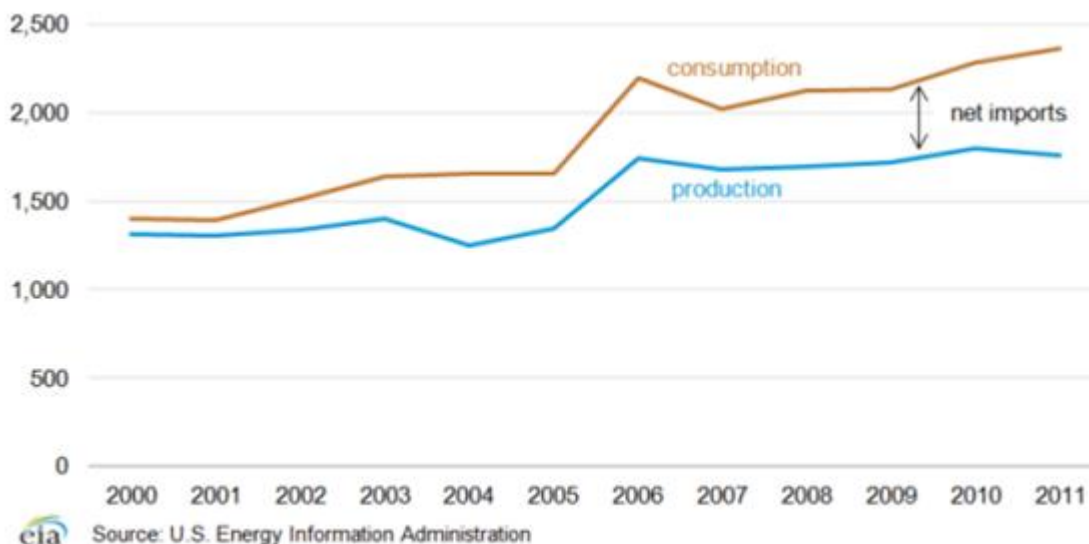
⁴⁵ . EIA, Profile: Mexico October 2012 pp. 10-11

⁴⁶ . Iiff, "Pemex to Spend \$200 Million Looking for Shale Gas"

⁴⁷ . Martin, "Mexico: Shale Gas Becomes Priority"

⁴⁸ . EIA, Profile: Mexico, October 2012, pp. 13-14

Figure 5: Mexico's Dry Natural Gas Production and Consumption (billion cubic feet)



There is plentiful and cheap gas next door in the United States. Pipeline gas imports from the US as a result of falling prices there grew by 50 percent in 2011 (Mexico receives 1/3 of US gas exports, and the US, accounts for ¾ of Mexico’s gas imports), and displaced 20 percent of Mexico’s LNG imports, which originate largely from Qatar, Nigeria, and Peru. Four proposed LNG projects have been cancelled in light of US supply, though there is still some consideration of expanding LNG import capacity.⁴⁹ The US Energy Information Administration (EIA) expects US exports to Mexico to increase 440 percent by 2025 over 2011 volumes.⁵⁰ Low priced gas from the US thus has an important distorting impact on Mexico’s production and supply of natural gas.

The manner in which gas prices are set in the Mexican market creates a disincentive to invest in Mexican production. Gas prices are linked to U.S. prices, generally the Henry Hub price at the border plus transportation costs. The problem is that the gas glut in the US has driven Mexican prices down, dropping 32percent in 2011 alone. The low price stimulates an increase in domestic demand, both industrial and from the power sector, with CFE planning to build 27GW of natural gas-fired thermo plants by 2026.⁵¹ Pipeline limitations, in this context, result in supply shortages rather than price increases that could balance supply and demand. Though the government has offered to seek increased LNG supplies, domestic industry refuses to pay the higher cost of LNG. Moreover, it is unclear whether Mexico could increase imports given Peru is its main source, and Peruvians have expressed a desire to divert exports to

⁴⁹ . EIA, Country Profile: Mexico July 2011; EIA, Profile: Mexico, October 2012, pp. 11-12

⁵⁰ . Rodriguez, “U.S. Shale Glut Means Gas Shortage for Mexican Industry”

⁵¹ . Rodriguez, “U.S. Shale Glut Means Gas Shortage for Mexican Industry”

the domestic market and avoid the low prices paid in Mexico.⁵² As such, Mexico's low gas prices are seeing the diversion of contracted LNG to more lucrative markets.

The supply picture is theoretically further enhanced by the future of conventional gas in Mexico and the existence of three LNG import terminals. Domestic supply of conventional gas may increase significantly as 60 percent of production is associated gas and in 2011 250 billion cubic meters (bcm) was flared; the government has plans to capture and transport that gas to the domestic market.⁵³ The Altamira LNG terminal supplies CFE with up to 500 million cubic feet per day (MMcfd) of gas via a 15 year contract with Shell's Gas del Litoral that expires in 2018. The Manzanillo LNG terminal supplies a CFE power plant through a 15 year LNG contract with Repsol, guaranteeing a minimum annual volume of 67 bcm from Peru's Camisea project.⁵⁴

The future of LNG is not clear, regardless of what happens with Mexico's shale gas. Peru has been considering renegotiating the contract to divert supply to its own domestic market. The Costa Azul terminal is supplied via a long-term LNG contract with Indonesia's Tangguh LNG, but Sempra Energy, operator of the terminal, renegotiated its contract to permit the diversion of up to 80 percent of supply to higher paying markets.⁵⁵ Mexican LNG facilities are thus operating at low levels and will likely remain so in the future, unless they become export terminals in the wake of Mexico's shale gas revolution.⁵⁶

Another challenge for Mexico is transporting increasing volumes of gas. Mexico's gas pipeline system is overloaded and unable to transport the requisite supplies, even where they do materialize. Pemex still dominates the pipeline system despite the 1995 reforms which fractured its monopoly on pipelines, and that has restricted expansion. In 2011, the government announced that it would seek investments of US\$8bn in natural gas transport from 2012 to 2018, under the supervision of CFE and Pemex's gas and petrochemical subsidiary PGPB.⁵⁷ A year after the declaration, Pemex was still looking for the financial and construction capabilities to undertake the \$3bn Los Ramones pipeline project from Monterrey to central Mexico -- the key north-south line of the proposed new national system.⁵⁸ CFE has

⁵² . Rodriguez, "U.S. Shale Glut Means Gas Shortage for Mexican Industry"; James Fredrick, "Mexico's natural gas conundrum" *Business News Americas*, October 9, 2012

⁵³ . EIA, Mexico, October 2012 p. 11

⁵⁴ . Repsol, Press Release, 24 June 2010 http://www.repsol.com/es_en/corporacion/prensa/notas-de-prensa/ultimas-notas/24062010-repsol-primer-cargamento-gnl-peru.aspx accessed October 27, 2012

⁵⁵ . *Platts LNG Daily*, "Sempra Renegotiates Indonesian LNG Supply Contract to Allow More Cargo Diversions" accessed via *Southerland* <http://www.lnqlawblog.com/02062012costaazullng/> February 6, 2012

⁵⁶ . Carlos Manuel Rodriguez, "U.S. Shale Glut Means Gas Shortage for Mexican Industry" *Bloomberg* September 4, 2012 <http://www.bloomberg.com/news/2012-09-03/u-s-shale-glut-means-gas-shortage-for-mexican-industry-energy.html>

⁵⁷ . "More gas for Mexico: Interview with Eugenio Laris Director of financed investment projects, CFE" *Business News Americas* December 2, 2011

⁵⁸ . James Fredrick, "Mexico's natural gas conundrum" *Business News Americas* October 9, 2012

performed better, with bids accepted for five sections of pipeline in the northwest that are to be completed by 2016.⁵⁹

At the present time, the external market is a supplier of gas to Mexico, via pipeline from the US and LNG from around the globe. Yet if Mexico were to develop its shale potential it would have sufficient supply to become an exporter of LNG without the domestic-external market tradeoffs that countries such as Peru are confronting. The three LNG import terminals, and the expanded pipeline infrastructure with links to the US, could be reconfigured into export terminals, as is currently happening in the US. Exporting US and northeast Mexican gas to high-priced Asian markets from the Mexican Pacific coast rather than via the Panama Canal would be attractive.

Investors in Mexican shale gas, unlike those in Argentine energy, would not have to worry about the security of their contracts vis-à-vis the Mexican government. But they would encounter the security concerns faced by conventional gas producers, since Mexico's shale gas potential is largely located in the coastal zones in which Drug Trafficking Organizations (DTOs) have engaged in large scale violence to dispute control over trade routes and are branching out into other illegal activities such as kidnapping and oil theft. Pemex is concentrating its efforts outside those corridors in Coahuila, but these are not the sites where Mexico's major shale gas potential is located.

The main environmental obstacle for development of shale gas in Mexico is water – not so much the fear of contaminating aquifers in the sparsely populated arid north where most of the country's shale gas potential is found, but the absolute shortage of it.

The future of shale gas in Mexico, like that of oil, is thus likely to have to wait for the details of the next energy reform. Mexico's limitation on foreign investment in the sector to service contracts is not likely to generate the level of profits required. Should the incoming government of Enrique Peña Nieto be successful in reforming the hydrocarbon sector to permit greater participation by the private sector throughout the value chain, domestic production of conventional gas could increase. But at least over the next decade, Mexican shale gas would still likely be overpriced in a market supplied by Mexican conventional gas and cheap imports from the US.

Other potential shale gas producers

Four other countries in Latin America have interesting shale gas prospects: Brazil, Colombia, Paraguay and Chile.

Brazil is pre-occupied with the development and promise of the hydrocarbon reserves in the offshore pre-salt basins, and little discussion has occurred to date regarding shale gas development. Nevertheless, given the large potential of shale gas development in Brazil and the growing energy needs

⁵⁹ . James Fredrick, "More interest shown in CFE's natural gas pipelines" *Business News Americas* July 4, 2012; James Fredrick, "Natural gas to fuel Sinaloa development" *Business News Americas* October 10, 2012

of the country, we can expect it to become an area of interest to the country after the pre-salt developments are under way, perhaps in the mid-2020s.

The Brazilian response to significant hydrocarbon discoveries in its pre-salt offshore basins provides the context for thinking about shale gas development in the country. Brazil had significantly liberalized the oil and gas sector in the 1990s, attracting investments from IOCs and NOCs from throughout the world. Those reforms permitted concession contracts to be allocated and projects to be 100 percent owned by foreign and private investors; Brazil was only one of three countries in the world to offer pure concession contracts, the other two being Canada and the U.S. In response to the significant hydrocarbon discoveries in the pre-salt areas, Lula's administration then halted auctions of blocks in these areas in 2008. Private companies worried that an oil reform would force them out of Brazil. The reform did limit private and foreign participation in new E&P projects to less than 50 percent, created a separate state entity to oversee the basins, made the NOC Petrobras the operator of all pre-salt projects, and increased domestic content requirements for these projects.

IOCs failed in their attempts to modify the legislation although the Lula government was aware of their concerns. In the interest of maintaining its reputation for respecting contracts, the government did not seek retroactivity for the provisions of this reform, arguing that forced contract renegotiation contravene Article 5 of the constitution. This sent an important significant signal to foreign investors as 28 percent of the deep water acreage had already been allocated under the prior concession system.

The reform appears to have been broadly acceptable to foreign investors. Only one (South Korean) company left Brazil after selling its pre-reform stake, and while there has been speculation that they were unhappy, the company made no statements to that effect after leaving. The true indicator of acceptance will be once the new blocks are auctioned, though the fact that existing projects are not being unloaded and the few sales draw significant bids suggests that there are few worries they will be nationalized with unprofitable results.

Environmental considerations could also play an important role in the willingness of investors and companies to move into Brazilian shale. Brazil's experience in deepwater E&P might provide insights here as well, given a current controversy over a Chevron operated field that leaked a small amount of crude (3.7 thousand barrels) into the Atlantic Ocean in November 2011. Chevron and its drilling partner Transocean faced a series of charges at the state and federal levels not only regarding its operational responsibilities (including poor contingency planning) for the spill, but also civil and criminal charges. Although Chevron paid a fine of \$14 million and Transocean was able to get a ban on its operations throughout the country overturned, the both still face \$20 billion in civil and criminal charges associated with the spill.⁶⁰ Given the current controversies regarding the environmental impact of shale

⁶⁰ . Samantha Pearson, "Brazil court relaxes ban on Transocean" *Financial Times* October 4, 2012

gas extraction, the development of regulations specific to the characteristics of the fracking process is likely to be necessary for significant exploration to occur.

Domestic content regulations are particularly significant in Brazil. The demands for equipment, people, and local companies to meet those requirements in the pre-salt E&P are greater than Brazilian companies can meet, and thus slowing development of Brazil's oil bonanza. If Brazil adopts similar regulations for the development of its shale gas resources the development of shale gas will be pushed further into the future, given the priority of oil.

The ARI study did not expect *Colombia* to be an important source of shale gas, since it is speculated to have only 19 tcf of technically recoverable shale gas. But the Colombian government does not accept these figures and is following the strategy it has used successfully in oil -- provide an attractive environment for investment and they will find reserves and produce. The government is thus pursuing shale via auctions of blocks⁶¹ and setting royalty levels at 40 percent below those for conventional crude oil.⁶² Development of a domestic market for gas is necessary, particularly in the power sector⁶³ and could be supplemented by development of the heavy oil projects in the Colombian section of the Orinoco Belt which require gas for upgrading facilities.

Chile is estimated to have a non-negligible 64 tcf of technically recoverable shale gas, credible government policies and an ability to attract financing for large natural resource projects. Chile has a developed domestic gas market in the central part of the country, which developed thanks to the integration projects with Argentina and suffered when that government's domestic gas policies dried up exports. The copper industry in the north needs power and has funded development of LNG import facilities, but finds itself in conflict with the energy companies over electricity prices. In line with its general approach to the economy, the government is leaving development of its shale gas potential to the market, and the market is looking to US exports of gas for its supply.⁶⁴

Paraguay has a potential 61 tcf of technically recoverable shale gas but there seems to be no interest on the part of government or the private sector to develop either a domestic gas market or its shale gas potential. The domestic market for power is saturated by electricity from the binational Itaipú dam with Brazil: Paraguay sells up to 90% of its share of electricity to Brazil because it cannot use it at home. Regional export potential is low since Paraguay is surrounded by countries with far more potential in conventional and shale gas (Bolivia, Argentina and Brazil), as long as its neighbors develop some of their reserves. A pipeline connection to the copper mines in northern Chile via Argentina makes sense only if

⁶¹ . Heather Walsh, "Shell, Repsol win oil blocks at Colombian auction" *Bloomberg* October 17, 2012

⁶² . Laszlo Palotas, "Colombia quiere consolidarse como país exportador energético" presentation at the Mesa Redonda sobre Energía en Colombia 2012, organized by the Institute of the Americas, February 9, 2012 Bogotá http://www.iamericas.org/documents/energy/Colombia_psg.pdf

⁶³ . *Colombian energy futures: The dawn of a new market* Business News Americas, September 2012

⁶⁴ . Valeria Ibarra, "El revival del gas desata guerra entre empresas en Chile" *El Mercurio*, May 6, 2012

Bolivia, Argentina, and Peru stay out of that market -- meaning that development costs in Paraguay could fall enough to be competitive with US LNG imports -- which is not likely.

Conclusion: The Politics of Hydrocarbon Production

Hydrocarbons will remain an important source of energy for decades to come, with the cleaner burning natural gas increasing its role as coal and oil succumb to environmental pressures to lower emissions. The developing world energy scenario could be extremely favorable for Latin America. The region is potentially rich in shale gas resources, with country endowments spanning an impressive spectrum from multiple hundreds of tcf (Argentina, Mexico and Brazil) to still-significant reserves in the tens of tcf (Chile and Paraguay). These resources can fuel domestic growth, lower costs, and have an impact on poverty through boosting power generation and employment, and making national economies more cost competitive. The world as a whole will benefit as the importance of oil resources in the volatile Middle East declines -- U.S. and Canadian production of conventional and non-conventional oil and gas contribute importantly to the shift -- leading to a restructuring of the geopolitics of energy.

Yet Latin America faces significant challenges regarding its shale gas potential, and it is not clear whether it will successfully address them. To varying degrees, the politics of hydrocarbon production is problematic in the major Latin American countries. Though Latin America is diverse, and some smaller potential producers (Colombia and perhaps Peru which has not yet been assessed) may be more conducive to shale gas E&P, the situation in the big three raises significant obstacles to achieving the levels of production that would usher in this new regional and global scenario. The challenge for shale gas in Latin America is in crafting domestic market policies and incentives for foreign investors to bring the requisite capital, skill, and technology to the region; the same challenge the region faces in exploiting its significant oil resources. Historically, Latin America does not have a stellar record in providing such incentives, particularly when it perceives it has an asset that others desire. Unless resource nationalism can be made compatible with incentivizing significant foreign participation, it may be too early to start trumpeting a bonanza for Latin American shale, and the resulting shift in the geopolitical center of energy towards the Western Hemisphere.

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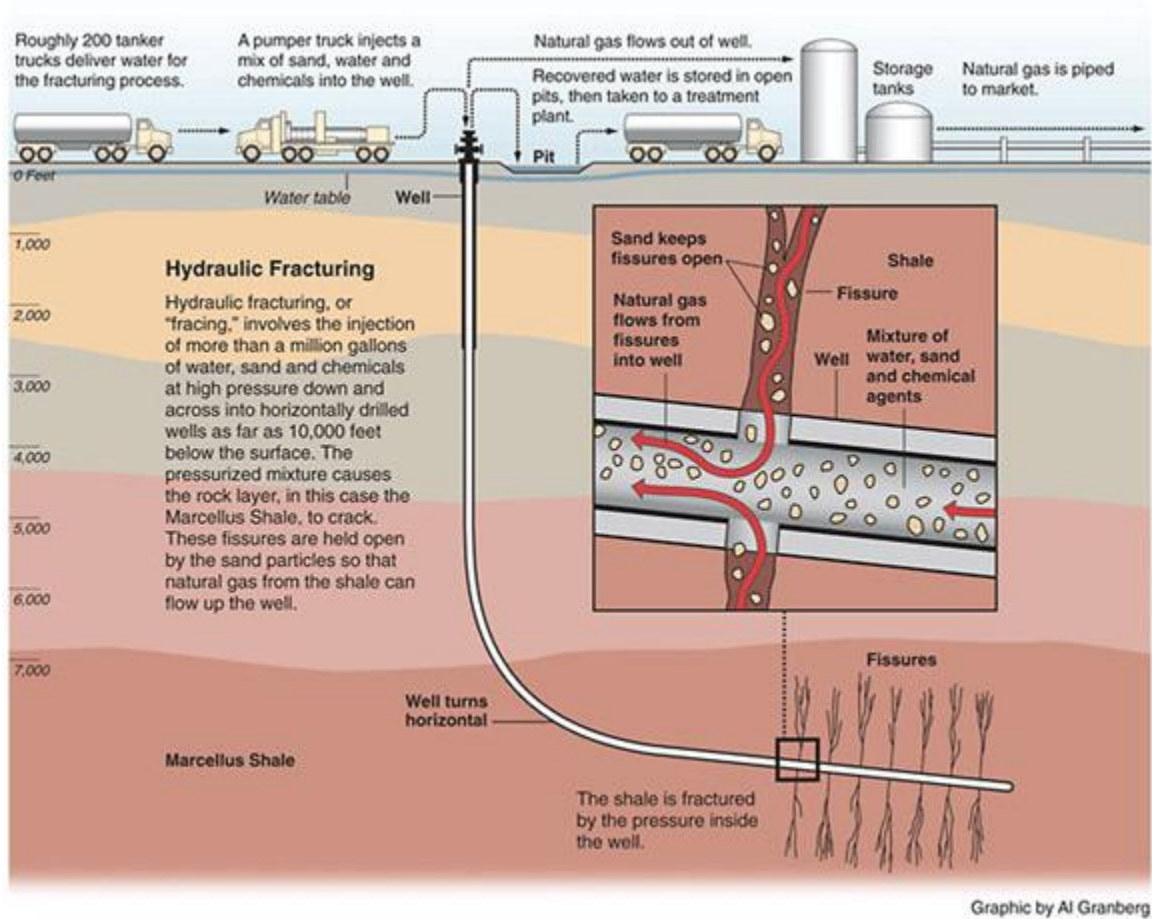
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Appendix



Source: ProPublica, <http://www.propublica.org/special/hydraulic-fracturing-national>, as cited in EIA "What is Shale Gas..."