

Shale Gas in Latin America: Opportunities and Challenges*

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Introduction

Recent discussions¹ 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. The region had dominated oil markets up to World War II, after which the Middle East—with its cheap, plentiful, and high-quality 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 United States) 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.² The dramatic turnaround in the US natural gas market, a result of the “shale gas revolution” that is transforming the country from a net importer of natural gas to a net exporter, is an important factor in the discussion.

Latin America appears to be rich in shale gas, according to a study commissioned by the US Energy Information

Administration (EIA) and prepared by Advanced Resources International (ARI).³ The ARI study presents preliminary indicators of the location of major basins with shale gas potential that were examined. The Western Hemisphere’s unique situation is evident (though most of the world’s basins have yet to be explored), as are the positions of Argentina, Mexico, Brazil and Paraguay within Latin America.

Table 1 provides detail on Latin America’s natural gas potential, with data on proven conventional natural gas reserves and the estimated technically recoverable⁴ shale gas, organized by major countries. Venezuela, with 179 trillion cubic feet (tcf) of proven conventional gas, ranks second to the United States

¹ See 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.

² 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/STAG-ING/local_assets/pdf/2030_energy_outlook_booklet.pdf.

³ 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.

⁴ According to the Energy Information Agency (EIA), “The estimates of technically recoverable shale gas resources for the 32 countries outside of the United States represent a moderately conservative ‘risked’ 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.” US Energy Information Administration, “World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States,” April 5, 2011: <http://www.eia.gov/analysis/studies/worldshalegas/archive/2011/pdf/fullreport.pdf?zscb=55469097>.

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FOREWORD

The Inter-American Dialogue is pleased to present another working paper of the Inter-American Dialogue's Energy Policy Group. This paper was prepared by David Mares, an expert on energy and scholar at the Institute of the Americas, Rice University, and the University of California, San Diego. Our aim is to inform and shape national and regional policy debates on the energy challenges confronting the countries of Latin America, improve the quality of attention to those challenges, and encourage multilateral cooperation to address them.

In this working paper, Mares draws on lessons from the United States and analyzes challenges facing Latin America's natural gas potential. He examines the legal environment, domestic market, and technological innovations that brought on the US shale gas revolution. Mares then provides an overview of Latin America's vast supply of natural gas. He reviews the associated problems in terms of investment, security, and human capital, and examines the environmental risks and benefits. He analyzes the prospects for addressing these challenges successfully in several countries, including Argentina, Mexico, Brazil, Colombia, Chile, and Paraguay. Mares concludes that shale gas will remain important for the region, both because of its abundance and cost-effectiveness, and its usefulness as a tool to fight poverty and enhance geopolitical stability. Still, the politics of hydrocarbon production remain problematic.

This working paper is part of a series of studies carried out through the Dialogue's initiative on energy policy in the Americas. Previous papers have dealt with a diverse set of energy policy issues, including Latin America's energy future, social conflicts over energy development, the prospects for nuclear power, and the management of Brazil's national oil company Petrobras.

The Dialogue established its Energy Policy Group in 2009 with the generous support and cooperation of the Inter-American Development Bank. Led by Dialogue senior fellow Genaro Arriagada, a distinguished Chilean analyst and former minister of state, the group consists of a professionally and politically diverse membership of some 20 energy analysts, corporate leaders, and policymakers.

Michael Shifter
President

in the Western Hemisphere and eighth in the world. No other Latin American country holds major reserves of conventional gas.

As regards shale gas, the picture is dramatically different. The fourth column in Table 1 shows that Argentina has 774 tcf of technically recoverable gas from its shale deposits, far outstripping Venezuela and placing Argentina second among potential shale gas reserves in the ARI study, now that US reserves have been revised 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 to date has virtually no hydrocarbon reserves to fuel its dynamic economy, is estimated to have substantial shale gas reserves. Paraguay, with minimal internal demand, could also produce significant quantities of shale gas and generate substantial exports. In short, Latin America potentially has a vast supply of natural gas.

Table 1. Natural Gas Potential in Latin America, 2011 trillion cubic feet (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 América Latina": <http://energiaadefebate.com/shale-gas-en-america-latina/>.

Until significant exploration is undertaken, however, it remains unknown how much shale gas exists and is potentially recoverable under current economic and technological conditions. Even in the United States, where shale gas exploration and production have been underway for several years, estimates of reserves have been revised downward dramatically: in 2012 the EIA's estimate of shale gas reserves

was cut from 827 tcf to 482 tcf, and in the prolific Marcellus Shale basin the EIA revised the estimated reserves downward by 66 percent, from 410 tcf to 141 tcf.⁵ In Europe, Exxon has cautioned about expectations of a shale gas "revolution" after drilling two wells in Poland that found no commercially viable gas. The company said that any production is likely to be five years away.⁶

The pace of exploration in Latin America, as well as subsequent production and development of the infrastructure needed to deliver the gas to the market, will be influenced significantly by each country's politics and its public policies on the domestic energy market, the environment, and indigenous rights. The experience of the past decade suggests that the conditions needed 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 that the risks for foreign investors are increasing.

This paper has two parts. The first examines the characteristics of the shale gas revolution that developed in the United States, with a view to highlighting its precarious nature, the requirements for its initial development, and its future prospects. The second part turns to Latin America, drawing on lessons from the US experience to suggest where the significant obstacles to shale gas production in the region lie, why it is problematic to address those challenges successfully in key countries, in which countries the challenges are likely to be successfully tackled, and what all this means for how markets and trade in shale gas will evolve.

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

The presence of natural gas in shale has long been known, but technology could not develop those resources at economically viable costs. Drilling technology and procedures

⁵ US Energy Information Administration, *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).

⁶ Tom Bergin, "Exxon Tempers European Shale Gas Enthusiasm," *Reuters*, February 20, 2012: <http://af.reuters.com/article/commodities-News/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>.

have made significant advances, beginning in the 1980s, with coil-tubing, steerable drill bits, downhole telemetry equipment, and—in this third generation of horizontal drilling—the ability to place multiple horizontal well bores over longer distances, deeper, and with greater accuracy. For the specific case of shale gas, hydraulic fracturing techniques (“fracking”) were developed, whereby a mixture of water, chemicals, and sand is pumped into the well to crack open the rock and release the natural gas into the well⁷ (see Appendix).

The technological innovations 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. Small domestic companies in the US market thus took the lead in developing and using the technology.

These innovators were helped by three important elements in the domestic legal environment within which shale exploration and production (E&P) would develop, and by two factors in the domestic energy market (all of these are problematic in Latin America, as we will see in Part II). First, access to resource basins in the United States was initially relatively cheap, given that US laws grant subsoil property rights to surface property owners rather than to the state. The high costs of technology and equipment were thus offset to a substantial degree by the initially low cost of purchasing the resource. A second factor was 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 shale deposits subsequently increased, the costs of technology and equipment declined, and thus there was still a stimulus to investment. The third legal factor in promoting the shale revolution in the United States was a decentralized regulatory context that was difficult to revise, a circumstance that has limited the impact of environmental concerns on shale E&P.

⁷ Lynn Helms “Horizontal Drilling,” *DMR Newsletter* 35:1, pp. 1–3: <https://www.dmr.nd.gov/ndgs/newsletter/NL0308/pdfs/Horizontal.pdf>; US Energy Information Administration, “What Is Shale Gas and Why Is It Important?” *Energy in Brief*: http://www.eia.gov/energy_in_brief/about_shale_gas.cfm.

The factors in the domestic energy market were low barriers to entry and high prices for natural gas. Deregulation of the natural gas industry, which 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 US\$13 per Mcf [thousand cubic feet] in 2008). Figure 1 illustrates the rise in shale gas production and optimistic expectations for the future.

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

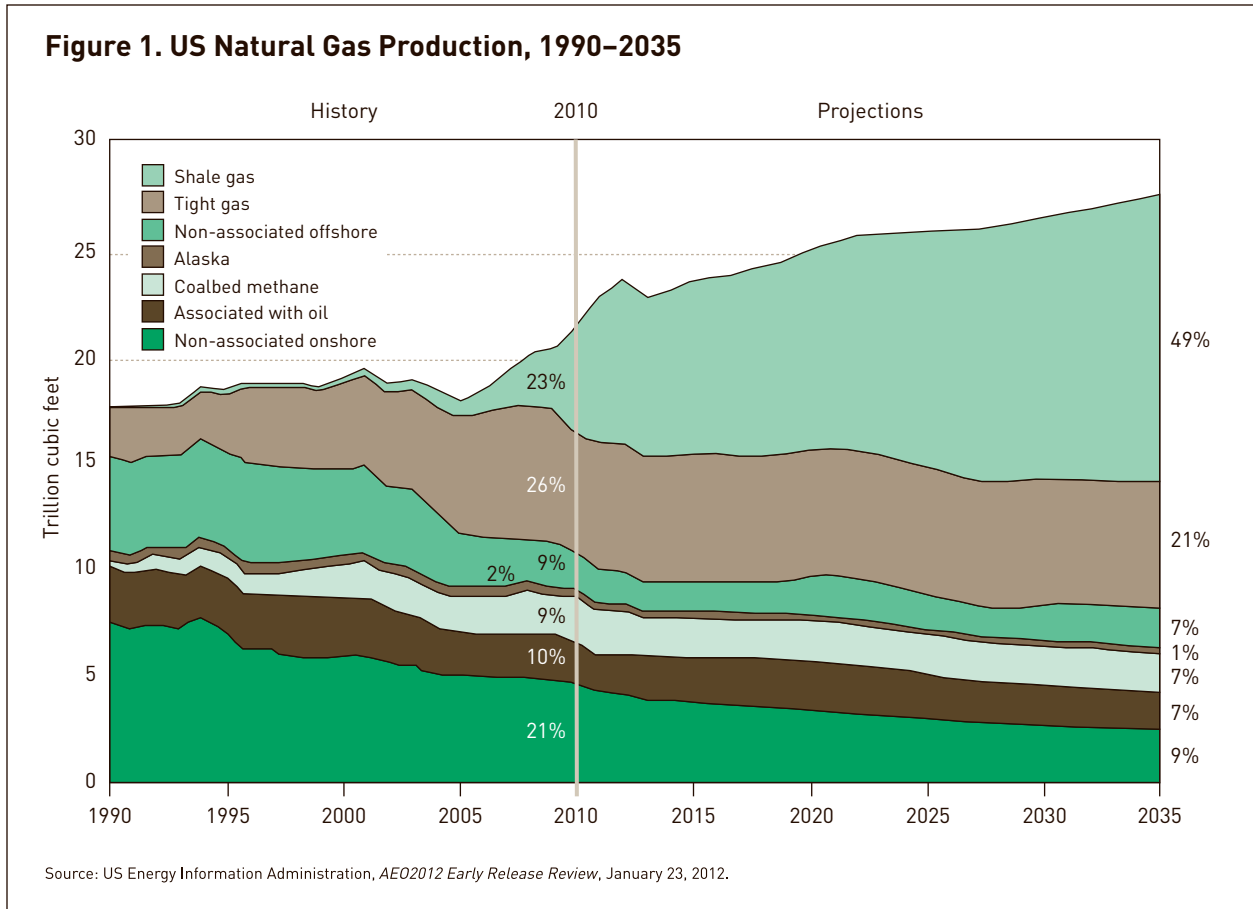
Given the costs of production and the steep decline curves for shale gas wells (ranging from 65 percent in the first year in the Barnett shale to 85 percent in the Haynesville shale), producers in the United States are moving from a bonanza period to an uncertain short-term future. US gas prices have been extremely low recently (less than US\$3 per Mcf in 2012, compared to the high of just over US\$13 in 2008) because so much gas is available in the market and the 2012 winter was unseasonably warm, lowering 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.⁸

Some analysts are suggesting that shale gas production in the United States is being driven by liquids rather than by the demand for gas itself; the appropriate focus for investors therefore should be on liquids-rich shale gas rather than on the gas itself. Of course, if the gas markets tighten, the price would rise and thereby attract new investment for gas.

The quantities needed for investment are thus large and sensitive to risk. One study analyzing the 34 largest US publicly traded producers determined that US\$22 billion had to be invested every quarter to maintain current production levels, of which only US\$12 billion came from cash flow—meaning that US\$10 billion every quarter had to be raised

⁸ 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.

Figure 1. US Natural Gas Production, 1990–2035



through a combination of debt, share offerings, and joint venture agreements.⁹ Even Chesapeake, one of the largest producers of shale gas, has found it difficult to service its debt and has had to sell off significant assets.¹⁰

Environmental Questions

Ideally, environmental issues should be weighed against the benefits of shale gas production and debated in the political process, and then the trade-offs among these costs and benefits should be made through the democratic process. The decision-making process, however, is problematic inasmuch as 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 United States diverts the public’s attention away from the pursuit of knowledge about the topic and toward 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 is ever less able to serve as the legitimate forum in which to make the trade-offs between protecting the environment and 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

⁹ Arthur Berman, “After The Gold Rush: A Perspective on Future US 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).

¹⁰ Steven Mufson, “Debt-plagued Chesapeake Energy to sell \$6.9 billion worth of its holdings” *Washington Post*, September 12, 2012.

potentially hazardous chemicals and its use must be managed properly. Large amounts of toxic wastewater must be treated and disposed of. Though industry is pursuing means of reusing this wastewater, the technology is sufficiently expensive that recycling is not usually the economic option.¹¹ Disposal of this 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 has strongly suggested.¹² Consequently, the regulations governing how risk trade-offs are resolved 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 impact as well, especially since the Ecuadoran plaintiffs are seeking confiscation of the company’s assets in other countries to force Chevron to accept the verdict.¹³ Table 2¹⁴ lists the risks associated with shale gas E&P and the advantages of shale gas supply.

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 faces a number of challenges to developing it. 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. Rather than think about specific needs in an ad hoc fashion, however, it is better to develop a general picture of the incentives and disincentives

¹¹ Alison Sider, Russell Gold and Ben Lefebvre, “Drillers Begin Reusing ‘Frack Water,’ *Online Wall Street Journal*, November 20, 2012: <http://online.wsj.com/article/SB10001424052970203937004578077183112409260.html>.

¹² Ajay Makan, “Fracking Water Linked to Earthquakes,” *Financial Times*, April 14, 2012.

¹³ “Ecuadoreans Seeking Chevron’s Argentine Assets to Enforce \$19 Billion Oil Spills Judgment,” *Associated Press*, November 1, 2012.

¹⁴ *US Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, Modern Shale Gas Development in the United States: A Primer*. Washington, DC, 2009: http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf; US Energy Information Administration, “What Is Shale Gas and Why Is It Important?” *Energy in Brief*: http://www.eia.gov/energy_in_brief/about_shale_gas.cfm; US Geological Service, “FAQ: Earthquakes Induced by Fluid Injection”: <http://earthquake.usgs.gov/learn/faq/?faqID=357>.

¹⁵ David Biller, “The Region’s Looming Gap in Human Capital,” *Business News Americas*. November 4, 2011.

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

Environmental risks
<ul style="list-style-type: none"> • Competition for water affects drinking water, wildlife habitat, recreation, agriculture, industrial, or other uses. • Air emissions, including nitrogen oxides, volatile organic compounds, particulate matter, sulfur dioxide, and methane, commonly occur during exploration and production activities. Recent studies suggest methane leakage from fracked wells can have a larger carbon footprint than coal.* • Normally occurring radioactive material (NORM) 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 precipitating 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. • Pollution and traffic-accident risks associated with the fleet of trucks (up to 200—see Appendix) required to deliver fresh water and retrieve toxic water.
Environmental benefits
<ul style="list-style-type: none"> • Natural gas combustion in efficient combined-cycle power plants emits less than half the CO₂ of coal combustion, but only if methane leakage is controlled (perhaps at less than 3 percent). • 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.

* Robert Bowen, “Methane Leaking From Fracking Wells in Colorado and Utah Raising Concerns,” *Examiner.com*, January 7, 2013: <http://www.examiner.com/article/methane-leaking-from-fracking-wells-colorado-and-utah-raising-concerns>.

in each country, and evaluate how the government is proceeding with 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.

The US experience demonstrates that significant investment is required to develop shale gas, and that the willingness of investors to come to the region will depend on the rates of return and the levels of political risk. The nature and substance of the environmental framework within which shale gas can be developed will affect both the rates of return and political risk. So too will the government's ability to provide security for investments and operations in the face of potential public demand to revise contracts once reserve levels are confirmed in a basin, criminal activity to extort payment from E&P companies, and environmentalists/indigenous peoples who disagree with development of the resources at all. Table 3 outlines five areas that pose challenges to the 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, which components could 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 maintain local returns that do not undermine shale gas projects.
Export market	Potential: government regulation of exports via tax, quantitative restrictions, and repatriation of profits.
Environmental	What will the regulations be? How independent is the judiciary in enforcing them? 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, Argentina is attracting the most attention among Latin American countries. Preliminary estimates indicate that only 20 percent of the prime Vaca Muerta shale basin has liquids, but given the gas shortage in Argentina the dry versus wet gas issue should not be as pressing as it is in the United States, all other things being equal. A great deal of

Figure 2. Shale Gas Basins of Southern South America



exploration lies ahead to confirm the level and characteristics of Argentina's potential.¹⁶

Several companies have already begun exploring (Repsol/YPF, Total, Apache, and Exxon), and Repsol/YPF made a significant discovery in December 2011 before the company was nationalized in April 2012. YPF, now a national oil company (NOC), has the largest lease for shale gas and 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 hundreds of wells costing billions of dollars will inevitably be developed.¹⁸

¹⁶ Abigail Wilkinson, "Argentina's Subsidy Cuts a Small Step to Deregulation," *Business News Americas*, November 18, 2011.
¹⁷ "YPF/Chevron Signed an Understanding to Explore for Shale Gas and Oil in Neuquen," *MercoPress*, September 15, 2012.
¹⁸ Idriss Hadj-Nacer, "Shale Resources in Latin America, Intelligence Series," *Business News America*, October 2012, p. 7.

Exploration will require investment in supporting logistics and infrastructure. Some analysts blame the lack of such investment for the differential between the cost of a shale well in the United States and Argentina (US\$3 million and US\$7–8 million, respectively).¹⁹ YPF's own drilling program for shale gas and shale oil was projected to amount to US\$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 a stick: not only was Repsol/YPF nationalized for allegedly underinvesting in Argentina, but the Brazilian NOC Petrobras lost its lease in Argentina's Neuquen province for the same reason.²¹

Nevertheless, the investment climate in Argentina is problematic for large investments, since current government policy continues to be erratic at best and reflects the government's unilateralism. The government had offered oil and mining companies tax breaks amounting to US\$461 million in 2011, but withdrew them in early 2012 and ordered the companies to repatriate export revenue from the previous 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 data. This manipulation of inflation rates defrauds investors in government bonds of millions of dollars, and the International Monetary Fund (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 Aerolíneas Argentinas, and now YPF. In 2012 it increasingly restricted the movement of US dollars in and out of Argentina, including transfers by companies seeking to repatriate profits. And there is the continuing saga of the country's default on its international debt, which flared up again when bondholders temporarily secured the impounding of an Argentine naval ship in Ghana,²² and in a New York court case that could favor those holdout bondholders that

did not accept Argentina's forced renegotiation of its debt.²³ 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 amounts of capital to develop Argentina's gas potential, and indeed the Chinese already have investments in Argentine oil and gas: the China National Offshore Oil Corporation (CNOOC) owns 40 percent of Bidas Energy Holdings, Ltd., and through it 16 percent of Pan American Energy; and the China Petroleum and Chemical Corporation (Sinopec) has significant holdings of oil and gas in the southern part of the country.²⁴ But the fact that China-affiliated companies have not announced major production increases suggests that they have been as reticent as other firms about investing significantly in Argentina's oil and gas sector, given the current policy environment.

Over the past decade, Argentine gas policy toward the domestic and external markets has favored domestic consumers over foreign consumers, companies and their shareholders throughout the value chain, as well as the national treasury. The country had been an important regional exporter, supplying gas to Chile, Brazil, and Uruguay. In response to the economic collapse of 2000–2001, however, the governments of Néstor Kirchner (2003–2007) and then Cristina Fernández de Kirchner (2007–) imposed price caps on the domestic market that were devastating to investors. In response, companies diverted domestic supplies to exports, but the government first increased export taxes and, when that did not deter exports, imposed quantitative limits in an effort to keep the domestic market supplied. The government broke contracts, to no avail. With the export market significantly reduced and the domestic market unprofitable, companies dramatically cut back on E&P. According to a Barclays Capital report, between 2003 and 2010, energy prices declined by almost 30 percent while oil and gas production fell by 12 percent and 2.3 percent, respectively.²⁵ The EIA reports that gas production fell by 10

¹⁹ Gustavo Stok, "Energy in Argentina: In step with the new YPF, Intelligence Series," *Business News America*, August 2012, p. 13.

²⁰ "YPF/Chevron Signed an Understanding to Explore for Shale Gas and Oil in Neuquen," *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.

²³ Nate Raymond, "US Appeals Court Declines to Rehear Argentina Bond Case," *Reuters*, March 26, 2013.

²⁴ Ian James, "China on Latin American Buying Spree to Lock in Long-Term Needs in Oil, Minerals, Food," *Associated Press*, June 5, 2011, accessed at <http://economything.blogspot.com/2011/06/china-on-latin-american-buying-sprees-to.html>.

²⁵ Abigail Wilkinson "Government Will Up Sector Intervention—Analyst," *Business News Americas*, February 8, 2012.

percent in 2011 from its peak in 2006.²⁶ Meanwhile, energy subsidies totaled US\$10 billion in 2011 alone.²⁷

Domestic stimulus policies and the commodity boom affecting the country's major exports, chiefly soya, fueled high GDP growth, thereby causing incomes to rise. But because the government has 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 has had to shut down industry for days in the winter months (supply shortages have reached 40 percent of demand) to keep homes heated. Even in the summer, industry is closed when home air conditioning demand soars.²⁸

Domestic gas policy affects both producers and distributors. The government has temporarily taken over Gas Distributor Metrogas (owned by Consorcio Gas Argentino and comprising BG at 54.67 percent and YPF at 45.33 percent) in the wake of the company's decision to open insolvency proceedings after years of rising costs and stable low prices.²⁹ The government has made 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 have a significant impact on the economics of production.

In November 2011, after the re-election of Cristina Fernández, the government began reducing energy subsidies,³⁰ and in August 2012 it raised well-head prices by 300 percent. But the government expected intermediaries to absorb the cost, not the consumer,³¹ which would certainly generate conflict with the intermediaries and keep gas demand at high levels. The government announced a plan to raise well-head prices up to US\$7.50 MMBtu (million British thermal units) last fall, but clarified in early 2013 that the price would be offered only to companies that were

committed to increasing output, and that if the increases did not materialize the companies would be penalized.³²

When Repsol/YPF balked at paying the rescinded US\$8 million export tax break in early 2012, the government banned the company's exports. Repsol/YPF claimed that the government's actions caused eight potential partners in its Argentine shale operations to terminate their interest,³³ but to no avail since the company was nationalized a few months later. Government pressure on the industry increased in July 2012 when it required that companies submit annual investment plans so that it could generate reference prices allowing for recovery of costs and a "reasonable" profit.³⁴

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 (about US\$7 million in Argentina), work stoppages can significantly affect the profitability of a project. Argentina's industrial policy of fostering domestic manufacturing will increase costs and delays because the country is unable to produce the required amount of specialized equipment, even though Argentina has exported some fracking equipment to the United States 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 more for gas imports than it would take to stimulate the further production of Argentine gas. The country became a net importer of gas in 2008, and LNG imports in 2011 were probably double their 2010 volume at 100 billion cubic feet.³⁵ The government has signed a contract with Qatar to supply Argentina with 5.4 million tons of LNG, requiring the construction of a third LNG terminal.³⁶ Because of the political logic created by the Kirchners, it is better to

²⁶ US Energy Information Administration, "Argentina," July 14, 2012, p. 5.

²⁷ Abigail Wilkinson, "The Winners and Losers in Argentina's Subsidy Story," *Business News Americas*, January 20, 2012.

²⁸ US Energy Information Administration, "Argentina," 2011.

²⁹ "Enargas Once Again Extends Control over Metrogas—Argentina," *Business News Americas*, February 9, 2012.

³⁰ Abigail Wilkinson, "Argentina's Subsidy Cuts a Small Step to De-regulation," *Business News Americas*, November 18, 2011.

³¹ Taos Turner, "Argentina to Raise Gas Wellhead Prices by 300%—President," *Wall Street Journal Online*, August 9, 2012.

³² John Wills, "Argentina Presents Plan to Increase Wellhead Price for Private Producers," *Business News Americas*, February 15, 2013.

³³ "Argentine Government Steps Up Pressure, Bans YPF Exports," *Latin American Advisor—Energy*, Inter-American Dialogue, February 13–17, 2012, p. 2.

³⁴ Shane Romig, "Argentina Shale Gas Investment Hinges on Stable Regulations," *Dow Jones Newswires*, October 19, 2012: http://www.latinpetroleum.com/new/newsdetail.php?cid=34&art_id=11363&content=F&aid=11363, accessed October 24, 2012.

³⁵ US Energy Information Administration, "Argentina," 2012, p. 8.

³⁶ "Qatargas Will Provide Argentina with LNG on a 20 Year Supply Agreement," *MercoPress*, July 1, 2011.

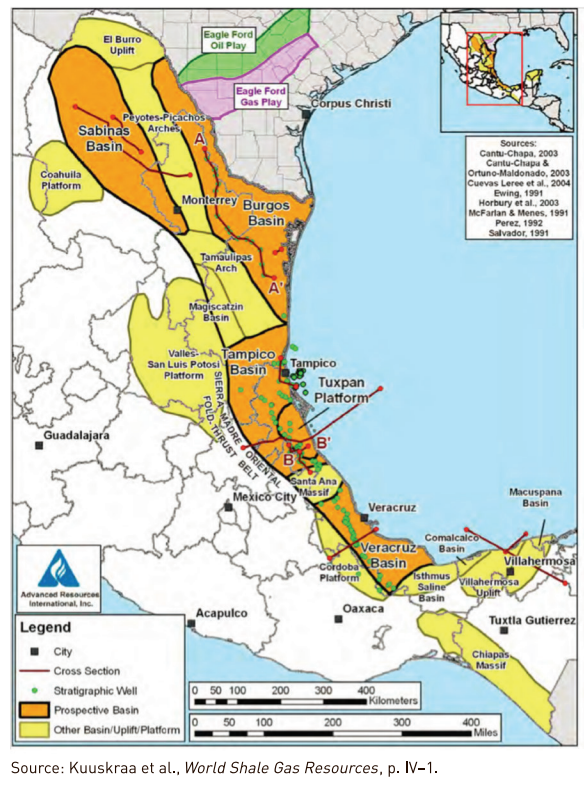
pay more money to Chevron and Qatar for LNG imports than to raise the prices offered to the companies developing Argentine natural resources, since subsoil gas resources belong to the nation and not to private companies. Apart from the budgetary impact of such a policy, subsidizing external supplies for the domestic market will create problems for shale gas producers because it artificially increases supply in the domestic market.

As regards environmental issues, Argentina starts with an advantage in that the shale gas reserves are largely in sparsely populated Patagonia and Neuquen, and thus environmental concerns are less pressing. Nevertheless, a growing movement of non-governmental organizations (NGOs) is focusing on fracking, including the Coordinadora de Comunicación Audiovisual Indígena Argentina (CCAIA), Grupo Ambiental Nogoyasero, ONG Ambiente Comarca, Coalición Cívica ARI Mendoza, Asamblea Ambiental Ciudadana (AAC) in Río Gallegos, and Mesa Entre Ríos Libre de Fracking. The growing opposition has the potential to link environmental issues to those of indigenous rights, and thus create significant obstacles to shale gas development.³⁷

Mexico

The ARI study estimates that Mexico has the second largest technically recoverable shale gas deposits in Latin America, making it the third largest source in the world (remembering that ARI did not assess all the world's basins). The NOC Pemex drilled its first well in the Burgos region across the border from Texas, but it cost almost five times more than those 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.³⁸ There are plans to drill 150 wells through 2016,³⁹ and the NOC has budgeted US\$200

Figure 3. Onshore Shale Gas Basins of Eastern Mexico's Gulf of Mexico Basin



Source: Kuuskraa et al., *World Shale Gas Resources*, p. IV-1.

million for shale gas development.⁴⁰ One optimistic analyst believes that Mexico could fully develop its shale resources within seven years, becoming not only self-sufficient but an exporter.⁴¹

In developing its shale gas potential, Mexico's challenges differ from those of Argentina. The Mexican government has estimated that development of shale gas resources will require US\$7–10 billion per year⁴² and that full development will take 5–8 years.⁴³ But raising this capital, and the associated human capital and technology required, is

³⁷ "UN calls on Argentina to Stop Eviction of Indigenous Peoples from Their Lands," *MercoPress*, September 19, 2012.

³⁸ "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; US Energy Information Administration, "Mexico," July 2011.

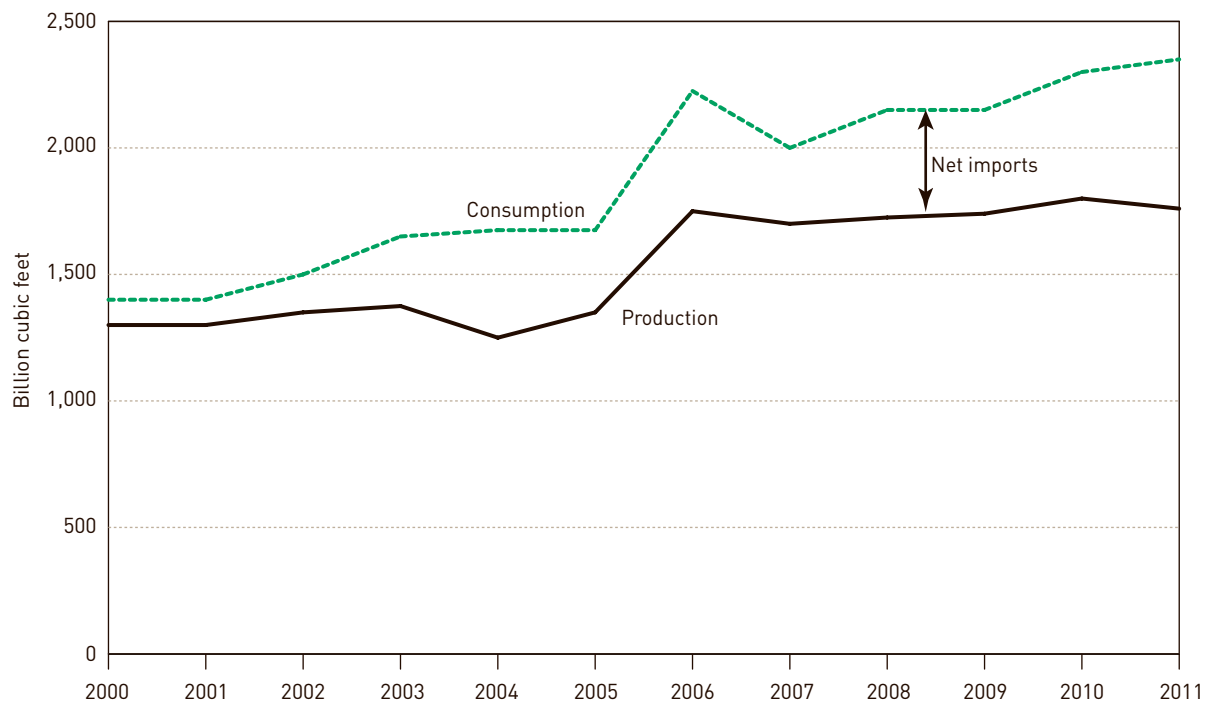
³⁹ Jeremy Martin, "Mexico: Shale Gas Becomes Priority," *Latinvex*, October 23, 2012: <http://latinvex.com/app/article.aspx?id=312>, accessed October 31, 2012.

⁴⁰ US Energy Information Administration, "Mexico," October 2012, p. 11.

⁴¹ David Biller, "Pemex's Shale Prospects," *Business News Americas*, July 18, 2011 (citing Alvaro Ríos of Gas Energy Latin America).

⁴² Jeremy Martin, "Mexico: Shale Gas Becomes Priority," *Latinvex*, October 23, 2012: <http://latinvex.com/app/article.aspx?id=312>, accessed October 31, 2012.

⁴³ Laurence Iloff, "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.

Figure 4. Mexico's Dry Natural Gas Production and Consumption, 2000–2011

Source: US Energy Information Administration

difficult because of restrictions on foreign investment in the energy sector and domestic pricing issues.

As regards 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-associated gas.⁴⁴ Several small companies, as well as Petrobras and Repsol, signed on to exploit the northern Burgos Basin's conventional gas blocks.⁴⁵ But a comparison

of the number of wells operating on the Texan and Mexican sides of the border (in similar-sized basins, there are more than 83,000 gas wells in south Texas compared to just over 4,800 in the Burgos Basin)⁴⁶ reveals that the multiple service contracts have not been attractive enough to induce 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 these conventional gas blocks in the Burgos Basin, service contracts are unlikely to attract the requisite investment to develop shale gas.

Can the state provide the required investment through its NOC Pemex? Though it has a monopoly over oil and natural gas E&P, gas is subordinate to oil in the company's operations. Given Pemex'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, the company can hardly

⁴⁴ 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, James A. Baker III Institute for Public Policy, Rice University, Houston, Texas, May 27, 2004: http://bakereinstitute.org/programs/energy-forum/publications/presentations/GAS_Salazar_05_27_04%20.pdf.

⁴⁵ Starr Spencer, "Pemex Details Plan for Several 2011 Licensing Rounds," *The Americas* 89: 48, March 9, 2011.

⁴⁶ Francisco X. Salazar Diez de Sollano, "Natural Gas in Mexico." Figures are for December 2002 for Texas, and December 2003 for Mexico.

be expected to make the necessary investments in equipment, personnel, and capital to undertake the levels of exploration needed 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 2012.⁴⁷ Pemex announced that it would invest US\$200 million over three years assessing the country's shale gas reserves,⁴⁸ far short of the aforementioned US\$7–10 billion required for full development.

Mexican production of shale gas also faces serious market problems, even though demand is booming. Growth in Mexican demand has outstripped that of production over the past decade by 70 percent to 46 percent.⁴⁹ Pemex consumes 40 percent of the total for its oil wells, refineries, and petrochemical plants while the power sector uses another third of the total, with the state-owned electricity monopoly Comisión Federal de Electricidad (CFE) accounting for three-quarters of that latter share.⁵⁰

Gas is plentiful and cheap next door in the United States. Pipeline gas imports from the United States as a result of falling prices there grew by 50 percent in 2011 (Mexico receives one-third of US gas exports, and the United States accounts for three-quarters of Mexico's gas imports), displacing 20 percent of Mexico's LNG imports that largely originate in Qatar, Nigeria, and Peru. Four proposed LNG projects have been cancelled in light of US supply, though some consideration is still being given to expanding LNG import capacity.⁵¹ The EIA expects the volume of US exports to Mexico to increase by 440 percent between 2011 and 2025.⁵² That low-priced gas from the United States,

however, substantially distorts Mexico's production and supply of natural gas.

The way in which gas prices are set in the Mexican market is a disincentive to invest in Mexican production. Gas prices are linked to US prices, generally the Henry Hub price (a price established at the Louisiana distribution hub, which is used as a reference for natural gas futures contracts traded at the New York Mercantile Exchange) at the border with transportation costs added. The problem is that the gas glut in the United States has driven Mexican prices down, causing a 32 percent price decline in 2011 alone. The low price stimulates an increase in domestic demand, from both industry and the power sector, and the electricity monopoly CFE is planning to build 27 GW of natural gas-fired thermo plants by 2026.⁵³ Low prices are thus a disincentive to invest in Mexican production.

In this context, pipeline limitations lead to supply shortages rather than increased prices to balance supply and demand. Though the government has offered to seek more LNG to boost supply, domestic industry refuses to pay the higher cost of LNG and it is not even clear that Mexico could increase such imports, given Peru's desire to divert exports to its own domestic market and the low prices paid in Mexico.⁵⁴ In fact, Mexico's low price is stimulating diversion of contracted LNG to more lucrative markets, as evidenced by Sempra Energy's behavior at the Costa Azul terminal (see below).⁵⁵

In theory the supply outlook is brightened further 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 a total of 250 billion cubic meters (bcm) was flared in 2011; the government has plans to capture and transport that gas to the domestic market.⁵⁶ The Altamira LNG terminal supplies CFE with up to 500 million cubic feet per day of gas under a 15-year

⁴⁷ US Energy Information Administration, "Profile: Mexico," October 2012, pp. 10–11.

⁴⁸ Laurence Iloff, "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.

⁴⁹ Jeremy Martin, "Mexico: Shale Gas Becomes Priority," *Latinvex*, October 23, 2012: <http://latinvex.com/app/article.aspx?id=312>, accessed October 31, 2012.

⁵⁰ US Energy Information Administration, "Profile: Mexico," October 2012, pp. 13–14.

⁵¹ US Energy Information Administration, "Country Profile: Mexico," July 2011; US Energy Information Administration, "Profile: Mexico," October 2012, pp. 11–12.

⁵² Carlos Manuel Rodriguez, "US 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>.

⁵³ *Ibid.*

⁵⁴ *Ibid.*; James Fredrick, "Mexico's Natural Gas Conundrum," *Business News Americas*, October 9, 2012.

⁵⁵ "Sempra Renegotiates Indonesian LNG Supply Contract to Allow More Cargo Diversions," posted on February 6, 2012 from *Platts LNG Daily* at Southerland: <http://www.lnglawblog.com/02062012costaazullng/>, accessed October 27, 2012; David Biller, "Sempra Evaluating LNG Exports from Costa Azul," *Business News Americas*, May 4, 2012.

⁵⁶ US Energy Information Administration, "Mexico," October 2012, p. 11.

contract with Shell's Gas del Litoral that expires in 2018.⁵⁷ 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.⁵⁸

The future of LNG is not clear, however, no matter 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 under a long-term LNG contract with Indonesia's Tangguh LNG, but Semptra Energy, operator of the terminal, renegotiated its contract to permit the diversion of up to 80 percent of supply to higher paying markets.⁵⁹ Mexican LNG facilities are thus operating at low levels and are likely to remain so in the future unless they become export terminals in the wake of Mexico's shale gas revolution.⁶⁰

Another challenge for Mexico is transporting increasing volumes of gas. Mexico's gas pipeline system is overloaded and is unable to transport the requisite supplies, even were they to materialize. Pemex still dominates the pipeline system despite the 1995 reforms that fractured its monopoly on pipelines, and that circumstance has restricted expansion. The government announced that it would seek investments of US\$8 billion in natural gas transport from 2012 to 2018, under the supervision of CFE and Pemex's gas and petrochemical subsidiary Pemex Gas y Petroquímica Básica (PGPB).⁶¹ A year after the declaration, Pemex was still looking for the financial and construction capacity to undertake the US\$3 billion Los Ramones pipeline project from Monterrey to central Mexico that is the key north-south line of the proposed new national system.⁶² CFE has performed

better: bids have been accepted for five sections of pipeline in the northwest that are to be completed by 2016.⁶³

Currently, the external market is a supplier of gas to Mexico by pipeline from the United States and LNG from around the globe. But if Mexico were to develop its shale potential it would have sufficient supply to become an exporter of LNG without the domestic-external market trade-offs that Peru is confronting. The three LNG import terminals, and the expanded pipeline infrastructure with links to the United States, could be reconfigured into export terminals, as the United States is currently doing. It would be attractive to export US and northeast Mexican gas to high-priced Asian markets from the Mexican Pacific coast rather than via the Panama Canal.

Investors in Mexican shale gas, unlike those in Argentine energy, would not have to worry about the security of their contracts with the 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 where drug-trafficking organizations have engaged in large-scale violence to gain control of 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 the main potential for Mexican shale gas is not there.

The principal environmental obstacle to the 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.

A determination of the future of shale gas in Mexico, like that of oil, is thus likely to have to await the details of the next energy reform. Limiting foreign investment in the sector to service contracts, as Mexico does, is unlikely to generate the level of profits required. Should the new 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 is still likely to be

⁵⁷ "Shell to Start Altamira LNG Terminal Construction This Year," *Business News Americas*, September 12, 2003.

⁵⁸ "Repsol Delivers Its First Cargo from the Peru LNG Plant," press release, June 24, 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.

⁵⁹ "Semptra Renegotiates Indonesian LNG Supply Contract to Allow More Cargo Diversions," *Platts LNG Daily*, accessed via *Southerland*: <http://www.lnglawblog.com/02062012costaazullng/>, February 6, 2012.

⁶⁰ Carlos Manuel Rodríguez, "US 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>.

⁶¹ David Biller "More Gas for Mexico: Eugenio Laris, Director of Financed Investment Projects, CFE," *Business News Americas*, December 2, 2011.

⁶² James Fredrick, "Mexico's Natural Gas Conundrum," *Business News Americas*, October 9, 2012.

⁶³ 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.

overpriced in a market supplied by Mexican conventional gas and cheap imports from the United States.

Other potential shale gas producers

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

Brazil has been preoccupied with the development and promise of the hydrocarbon reserves in the offshore pre-salt basins, and there has been little discussion of shale gas development. But in early 2013 the hydrocarbons regulator, the Agência Nacional do Petróleo (ANP), suddenly announced that the country's shale gas reserves could be greater than its pre-salt oil reserves⁶⁴ and potentially almost double the shale gas potential suggested in the ARI study (to about a technically recoverable 425 tcf). The ARI study had looked at one rather than the four basins analyzed by the ANP.⁶⁵ Given the large potential of shale gas development in Brazil, the country's growing energy needs, and rising concern over inflation, the government has decided to stimulate shale gas exploration now and is putting onshore shale gas blocks up for auction at the end of 2013.

Brazil's response to significant hydrocarbon discoveries in its pre-salt offshore basins provides a context for thinking about the potential obstacles to shale gas development in the country. Brazil had significantly liberalized the oil and gas sector in the 1990s, attracting investments from international and national oil companies from throughout the world. Those reforms allowed concession contracts to be allocated (Brazil was only one of three countries in the world to offer pure concession contracts, the other two being Canada and the United States), and projects could be 100 percent owned by foreign and private investors. In response to the significant hydrocarbon discoveries in the pre-salt areas, the Lula da Silva administration 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.

International oil companies failed in their attempts to modify the legislation, but the Lula government was aware of their concerns. In the interest of maintaining its reputation for respecting contracts, the government did not seek to enforce the provisions of this reform retroactively, arguing that forced contract renegotiation would contravene Article 5 of the constitution. This is a significant signal to foreign investors, since 28 percent of the deep-water acreage had already been allocated under the previous concession system.

The reform appears to have been broadly acceptable to foreign investors. One South Korean company left Brazil after selling its pre-reform stake, and there has been speculation that it was unhappy, but the company made no complaints after leaving. The true indicator of acceptance will be apparent once new pre-salt blocks are auctioned (10 are scheduled for 2013), 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 the controversy last year over a Chevron-operated field that leaked a small amount of crude (3,700 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 US\$14 million and Transocean was able to get a ban on its operations throughout the country overturned, both still face civil charges associated with the spill.⁶⁶ Given the current controversies surrounding the environmental impact of shale gas development, regulations specific to the characteristics of fracking are likely to be needed before there is significant exploration.

⁶⁴ Michael Place, "Brazilian Shale Bigger than Pre-Salt, Says Regulator," *Business News Americas*, January 17, 2013.

⁶⁵ "Brazil Prepares to Surprise Drillers This Time With Gas," *Bloomberg*, February 8, 2013.

⁶⁶ Samantha Pearson, "Brazil Court Relaxes Ban on Transocean," *Financial Times*, October 4, 2012; Samantha Pearson, "Brazil Drops Criminal Charges over Spill," *Financial Times*, February 21, 2013.

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

The ARI study did not expect *Colombia* to be an important source of shale gas, since it is estimated 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 the oil sector: provide an attractive environment for investors and they will find reserves and produce. The government is thus pursuing shale gas development by auctioning blocks⁶⁷ and setting royalty levels at 40 percent below those for conventional crude oil.⁶⁸ A domestic market for gas has to be developed, particularly in the power sector,⁶⁹ and could be supplemented by development of the heavy oil projects in the Colombian section of the Orinoco Belt, which require gas to upgrade facilities.

Chile is estimated to have a non-negligible 64 tcf of technically recoverable shale gas. It also has credible government policies and can attract financing for large natural-resource projects. There is a developed domestic gas market in central Chile, which advanced thanks to the integration projects with Argentina and suffered when the Argentine government's domestic gas policies dried up exports. The copper industry in the north needs power and has financed the development of LNG import facilities, but it is in dispute 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.⁷⁰

⁶⁷ Heather Walsh, "Shell, Repsol Win Oil Blocks at Colombian Auction," *Bloomberg*, October 17, 2012.

⁶⁸ 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.

⁶⁹ "Colombian Energy Futures: The Dawn of a New Market," *Business News Americas*, September 2012.

⁷⁰ Valeria Ibarra, "El revival del gas desata guerra entre empresas en Chile," *El Mercurio*, May 6, 2012.

Paraguay has a potential 61 tcf of technically recoverable shale gas but there seems to be no interest on the part of the government or the private sector to develop either a domestic gas market or the country's shale gas potential. The domestic market for power is saturated by electricity from the binational Itaipú dam with Brazil: Paraguay sells up to 90 percent 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 Bolivia, Argentina, and Peru stay out of that market and if development costs in Paraguay fall enough to be competitive with US LNG imports, neither of which is likely.

Conclusion: The Politics of Hydrocarbon Production

Hydrocarbon energy resources will remain important sources of energy for decades to come, and the role of cleaner-burning natural gas will increase as coal and oil succumb to environmental pressures for lower emissions. This developing-world energy scenario can be extremely favorable for Latin America and the world. The region is potentially rich in shale gas resources, with country endowments spanning an impressive spectrum from several hundred tcf (Argentina, Mexico, and Brazil) to still significant volumes in the tens of tcf (Chile and Paraguay). These resources can fuel domestic growth because of their abundance, their lower cost, and their ability to have a significant impact on poverty by boosting power generation and employment and by making national economies more cost competitive. The world will also benefit as the significance of oil resources in the volatile Middle East declines (US and Canadian production of conventional and non-conventional oil and gas also contribute substantially to this shift), leading to a restructuring of the geopolitics of energy.

The development of Latin America's shale gas potential, however, faces significant challenges, and it is not clear that the region will address them successfully. To varying degrees, the politics of hydrocarbon production is problematic in the major Latin American countries. Though Latin America is quite 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, conditions in the big three countries raise significant obstacles to achieving the levels of production that would usher in this new regional and global context. The essential challenge for shale gas in Latin America is 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 developing its significant

oil resources. Historically, Latin American countries do not have a stellar record in providing such incentives when they perceive that they have an asset that others desire. Unless resource nationalism can be made compatible with providing incentives for significant foreign participation, it may be far too early to start trumpeting a bonanza for Latin America and a shift in the geopolitical center of energy towards the Western Hemisphere.

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