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Mariana Y. Villanueva González

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By: Mariana Y. Villanueva González*

SHALE GAS: OPPORTUNITIES AND CHALLENGES BETWEEN MEXICO AND THE UNITED STATES

ABSTRACT

Would it be better for Mexico to remain a net importing partner of natural gas from the United States or to encourage its own Mexican Gas Revolution? Mexico has an estimate 545 trillion cubic feet (Tcf) of shale natural gas reserves, and trillions of additional cubic feet of conventional reserves. Nevertheless, the country has remained a net importer of natural gas due to underdevelopment. Meanwhile, shale gas production on the other side of the border has increased significantly over the past decade, causing United States gas prices to drop. Due to its close proximity to the major shale field development in South and West Texas, Mexico is particularly well-positioned to take advantage of unconventional extraction techniques and apply them in Mexico. This article examines the legal, economic, and environmental challenges and opportunities of the unconventional production landscape in Mexico in order to propose effective solutions by which Mexico can take advantage of its own resources.

I. INTRODUCTION

Today, natural gas plays a fundamental role in every nation's economy. It is an alternative fuel that can provide any country, with enough reserves, the energy security necessary to fuel economic development. Natural gas, formed hundreds of millions of years ago, is one of the cleanest,¹ safest, most useful and abundant² energy sources in the modern world. This reality is thanks to the shale gas discovered and developed in the United States' (U.S.) 137 shale formations in 41 other countries, representing 32% of the world's natural gas technically recoverable resources.³

* Mariana Y. Villanueva González obtained a Law and Finance Degree (JD) from the Tecnológico de Monterrey and is currently pursuing a Master's Degree (LLM) in Energy Law and Sustainable Development at the Universidad Autónoma de Nuevo León. She is an associate of the law firm Peña Mouret Abogados, S.C. in México, where she works within the energy and corporate practice of the Firm. mariana.villanuevagzz@gmail.com. The author thanks the support provided by Oscar Lugo and Pilar Rodríguez from the Universidad Autónoma de Nuevo León, Julian Cárdenas from the University of Houston, Alejandra Bueno and Jorge Canavati from the AEM Bi-National Energy Committee, and Gabriel Peña from Peña Mouret Abogados.

1. *Environmental Benefits of Natural Gas*, AMERICAN GAS ASSOCIATION, <https://www.aga.org/environmental-benefits-natural-gas> (last visited Mar. 6, 2016).

2. *Natural Gas and the Environment*, NATIONAL FUEL, http://www.nationalfuelgas.com/natural_gas_environment.aspx (last visited Mar. 6, 2016).

3. "Technically recoverable" resources are those that can be produced using current technology without reference to economic profitability. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY,

Curiously, although Mexico has an estimated 545 trillion cubic feet (Tcf) of shale natural gas reserves, and additional trillions of cubic feet of conventional reserves,⁴ the country has remained a net importer of natural gas. This is because unconventional gas production in Mexico poses many interesting challenges in the wake of the recently enacted Energy Reform.⁵ Most of Mexico's shale is in the north and northeast, where there are yet unresolved problems of infrastructure, technology, skilled labor, suitable regulations, and environmental concerns. The basins of Sabinas, Burgos, Veracruz and Tampico-Misantla, specifically, have great potential for development. This means that in order to tap into the country's bounty of shale gas, these tasks will need to be addressed.

On the other side of the border, U.S. gas production has been increasing significantly over the past decade: from 19,974,360 MMcf⁶ in 2003 to 25,562,232 MMcf in 2013.⁷ Due to increased production, U.S. gas prices have dropped from \$5.47 in 2003⁸ to \$3.73 in 2013.⁹ The U.S. is expected to go from a net importer of natural gas to a net exporter by 2018, when U.S. production is projected to exceed domestic consumption.¹⁰ With natural gas prices relatively low compared to global prices and historically low for the U.S., American producers are looking for new markets for their natural gas¹¹—primarily Mexico, due to its close geographical proximity to the major shale field development in South and West Texas.

This article discusses the shale gas landscape between Mexico and the U.S. in two parts: Part I, a historical background describing the reforms that led to the current state of natural gas regulation in Mexico, and Part II, discussing legal, economic and environmental opportunities and challenges. Each part is intended to ultimately answer the main question: whether Mexico is better positioned to continue as a net importer of cheap natural gas from their neighbor, or to encourage Mexican producers to implement unconventional extraction techniques.

II. HISTORICAL BACKGROUND

A. Reforms in Mexico

Natural gas production depends on the necessities of crude oil production. Since 1938, the supply of oil and natural gas has been determined by Pemex's

TECHNICALLY RECOVERABLE SHALE OIL AND SHALE GAS RESOURCES: AN ASSESSMENT OF 137 SHALE FORMATIONS IN 41 COUNTRIES OUTSIDE THE UNITED STATES 2, 3, 10 (2013), http://www.eia.gov/analysis/studies/worldshalegas/archive/2013/pdf/fullreport_2013.pdf.

4. *Id.* at 6, II-2.

5. *Infra* Part III.

6. Equivalent to the volume of 1,000,000 cubic feet (cf) of natural gas.

7. *U.S. Natural Gas Marketed Production*, U.S. ENERGY INFO. ADMIN., <http://www.eia.gov/dnav/ng/hist/n9050us2A.htm> (last visited Mar. 6, 2016).

8. Prices are in Dollars per Million Btu.

9. *Henry Hub Natural Gas Spot Price*, U.S. ENERGY INFO. ADMIN., <http://www.eia.gov/dnav/ng/hist/rngwhhdA.htm> (last visited Mar. 6, 2016).

10. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, DOE/EIA-0383(2014), ANNUAL ENERGY OUTLOOK MT-22, MT-24 (2014), [http://www.eia.gov/forecasts/archive/aeo14/pdf/0383\(2014\).pdf](http://www.eia.gov/forecasts/archive/aeo14/pdf/0383(2014).pdf).

11. MICHAEL RATNER ET AL., CONG. RESEARCH SERV., R42074, U.S. NATURAL GAS EXPORTS: NEW OPPORTUNITIES, UNCERTAIN OUTCOMES (2015).

strategies.¹² Pemex's strategies were influenced by the Ministry of Finance, as oil was the principal source of tax revenue for the government.¹³ More specifically, Pemex¹⁴ has been the main player in Mexico's hydrocarbon sector since the nationalization of the oil industry in 1938 and the most important Mexican oil company today. Consequently, the supply of oil and natural gas has been determined by Pemex, which has been strongly influenced by the Ministry of Finance.¹⁵ In this scenario, it was more profitable to produce oil than to develop natural gas infrastructure. This is because the difference (profit) between the extraction cost and the final price was higher than the cost of developing natural gas infrastructure (extraction cost) and the final price, particularly because of the low gas prices.

Between 1988 and 1994, Mexico's national energy policy promoted the consumption of natural gas due to environmental issues posed by the excessive use of carbon to produce energy. The government instructed the Federal Electricity Commission ("CFE")¹⁶ and Pemex (which represented the 73 percent of the consumption of carbon and natural gas)¹⁷ to oversee an increase in the participation of natural gas and reduce the production of carbon. Also, the government directed the industrial sector to adopt new natural gas technologies through incentives to use this fuel. The proposal was unsuccessful due to Pemex's insufficient financial resources and the impossibility of opening the sector to private investment because hydrocarbons had always been a controversial topic since the nationalization of the sector.¹⁸

With this scenario and external pressures—primarily from the U.S.—to privatize strategic sectors, including hydrocarbons, the Mexican government introduced the first important natural gas reform in 1995, during the administration of President Ernesto Zedillo.¹⁹ The reform introduced a new regulatory institution, the Energy Regulatory Commission ("CRE"),²⁰ to regulate and provide permits to the private investors in the activities of transportation, distribution, and storage of natural gas. Nevertheless, these modifications had a small impact since Article 27 of the Mexican Constitution still reserved the exploration and production of natural gas

12. PETRÓLEOS MEXICANOS [Pemex], <http://www.pemex.com/en/Paginas/default.aspx> (last visited April 24, 2016).

13. JUAN ROSELLON & JONATHAN HALPERN, WORLD BANK PUBLICATIONS, VOL. 194, REGULATORY REFORM IN MEXICO'S NATURAL GAS INDUSTRY: LIBERALIZATION IN THE CONTEXT OF A DOMINANT UPSTREAM INCUMBENT, VOL. 194 (2001), http://www.hks.harvard.edu/hepg/Papers/Rosellon_reg_reform_gas_industry_1-01.pdf.

14. *Supra* note 12.

15. Rosellon, *supra* note 13.

16. COMISIÓN REGULADORA DE ELECTRICIDAD [CFE] (Federal Commission of Electricity), <http://www.cfe.gob.mx/paginas/home.aspx> (last visited May 1, 2016).

17. Victor Rodríguez-Padilla & Rosio Vargas, *El Comercio de Gas Natural con Canadá y Estados Unidos. Una Mirada al Futuro*, COMERCIO EXTERIOR (March, 1997), <http://revistas.bancomext.gob.mx/rce/magazines/333/6/RCE6.pdf> (Natural Gas Commerce with Canada and the United States. A look to the Future).

18. Rosellon, *supra* note 13.

19. *Id.*

20. COMISIÓN REGULADORA DE ENERGÍA [CRE] (Federal Commission of Electricity), <http://www.cre.gob.mx> (last visited April 24, 2016).

exclusively to Pemex.²¹ Thus, the reforms of the 1990s were insufficient to prevent the deterioration of the hydrocarbon industry, and specifically, the spur of the gas market.²²

It was not until 2008, during President Felipe Calderon's administration, that a new reform was enacted to promote competition in the hydrocarbon sector.²³ This reform presented the creation of "incentive contracts" called Exploration and Production Integrated Contracts ("CIEPS"), a type of service contracts with a spice of competitiveness.²⁴ However, the reform did not prosper because the new contract did not allow private investment to share the profit, as the constitutional prohibition on private investment in "upstream" activities (Exploration and Production activities, or "E&P") continued in force by the Mexican Constitution.²⁵

The current President of Mexico, Enrique Peña Nieto, conducted a campaign of economic reform after the elections in 2012. His political party worked with other parties to create a "Pact for Mexico," including reforms in the sectors of energy, finance, education, telecommunications, among others. The Energy Reform was approved by the administration in December 2013 and passed secondary legislation in August 2014. The State continues to maintain ownership of subsurface hydrocarbons under the new reforms; however, it has opened the possibility for domestic and foreign private companies to participate in the exploration and production of hydrocarbons through contracts and the opportunity to participate in refining, transportation, storage, and processing of natural gas in 2016.

The reform transformed the natural gas model with the intent to enhance energy security, promote infrastructure development, open access to producers and users, and provide for competitive gas pricing.²⁶ The first key goal of this new model is to conduct importation and production through a contract scheme between three main players: the private sector, Pemex and CFE.²⁷ In addition, an independent gas operator, the National Natural Gas Control Center ("CENAGAS"),²⁸ will have the control over the National Natural Gas System, which includes transportation and

21. CONSTITUCIÓN POLÍTICA DE LOS ESTADOS UNIDOS MEXICANOS [C.P.], art. 27, Diario Oficial de la Federación [DO] (Official Journal of the Federation), 5 de febrero de 1917 (Feb. 5, 1917) (Mex.) (Const. of Mexico).

22. *Id.*

23. *Id.*

24. Verónica Baz et al., 3 *Dilemas: Un diagnóstico para el futuro energético de México*, RED MEXICANA PARA LA COMPETENCIA Y REGULACIÓN, CENTRO DE INVESTIGACIÓN PARA EL DESARROLLO [CIDAC] (2013), http://cidac.org/esp/uploads/1/3Dilemas_FuturoEnergetico16.pdf (last visited April 15, 2016) (3 Dilemmas: A Diagnostic of the Energy Future of Mexico).

25. C.P., *as amended*, art. 27, DO, 29 de enero de 2016 (Jan. 29, 2016), http://www.diputados.gob.mx/LeyesBiblio/pdf/1_29ene16.pdf.

26. *Id.*

27. Duncan Wood, et al., *Economic Impact and Legal Analysis of the Shale Oil and Gas Activities in Mexico*, 10–11 (2015), WILSON CTR.: MEXICO INST., ASOCIACIÓN DE EMPRESARIOS MEXICANOS [AEM], UNIV. OF TEXAS AT SAN ANTONIO [UTSA], UNIV. AUTÓNOMA DE NUEVO LEÓN [UANL], https://www.wilsoncenter.org/sites/default/files/Economic_Impact_Legal_Analysis_Shale_Oil_Gas_Activities_Mexico.pdf (last visited April 24, 2016).

28. *See generally* SECRETARÍA DE ENERGÍA [SENER] (Secretariat of Energy), CENTRO NACIONAL DE CONTROL DEL GAS NATURAL [CENEGAS] (Nat'l Natural Gas Control Ctr.), <http://www.cenagas.gob.mx> (last visited April 15, 2016).

system operations. Finally, the midstream and downstream activities, storage, distribution, and commercialization will be again in control of the three players.

III. OPPORTUNITIES AND CHALLENGES

A. Legal

For the gas sector to function successfully, Mexico needs a strong regulatory scheme with an effective institutional framework guaranteeing enforcement. The recently-enacted Energy Reform provides Mexico with new institutions and regulations that must work together for the transformation of the gas industry in the country. To determine the potential for unconventional production in Mexico, the challenges and opportunities facing the new regulatory and institutional scheme must be described and analyzed.

1. Mexican Institutional Framework

The main institution created to improve, operate, manage, administer and guarantee the continuity and security of the National Integrated Transportation and Storage System of Natural Gas is the National Center of Natural Gas Control (“CENEGAS”). CENEGAS is not only in charge of the supply, infrastructure, transportation and storage of natural gas, but also authorizes permits and develops clear rules of pricing in order to be attractive to the gas industry.²⁹ Because CENAGAS has only recently begun to formally operate the natural gas system, the capacity of the regulator to administer the regulatory framework is difficult to judge. However, CENEGAS will eventually handle the very important task of breaking up the monopoly of gas transportation, management and commercialization, and opening the system to private companies.

The Ministry of Energy (“SENER”)³⁰ will have the important role of providing Mexico with an effective and applicable upstream policy (E&P activities) to ensure the sector possesses enough resources to supply the demand. SENER will also determine the available areas for development of E & P activities, schedule the dates for the public bidding, choose the model for each contract, and approve the non-fiscal terms of the contract. The SENER will have to work closely with the Ministry of Finance (“SHCP”),³¹ which will approve the fiscal terms that apply to each contract.

Another important institution is the CRE,³² which will grant permits for transportation, storage, distribution, compression, liquefaction, decompression, regasification, marketing, and sales of natural gas.³³ The new market structure will be enforced through new regulations prepared by the CRE in a way that investments

29. Estatuto Orgánico del Centro Nacional de Control del Gas Natural (CENAGAS Organic Statute), art. 35, §§ I-II, art. 38, § V, DO 13-04-2015.

30. SENER, <http://www.gob.mx/sener> (last visited April 24, 2016).

31. SECRETARÍA DE HACIENDA Y CRÉDITO PÚBLICO [SHCP] (Secretariat of Finance and Public Credit), <http://www.gob.mx/hacienda> (last visited April 24, 2016).

32. CRE, *supra* note 20.

33. Estatuto Orgánico del Centro Nacional de Control de Energía (Organic Statute of CRE), DO 09-03-2015.

in new capacity will be aligned with the public interest and avoid market dominance situations.³⁴ It will be interesting to analyze the effectiveness of the CRE's permits and whether they adequately fulfill the natural gas reform strategy.

A new institution created with the reform is the National Agency for Industrial Safety and Environmental Protection from the Hydrocarbon Sector ("ASEA"),³⁵ which is responsible for the regulation and supervision of the industrial safety, operational safety and environmental protection of the hydrocarbon sector activities. It is important to mention that this activity has been carried out by various federal agencies such as the Secretariat of Labor and Social Welfare ("STPS"),³⁶ the Secretariat of Environment and Natural Resources ("SEMARNAT"),³⁷ and the Federal Attorney for Environmental Protection ("PROFEPA").³⁸ Before the reform, each agency sanctioned the breach of their own regulations, but now the ASEA unifies the hydrocarbon-related activities within these agencies, and it will sanction any participant in the event of non-compliance. In short, it is important that the legal framework provides the ASEA with enough power to regulate the environmental and safety issues, and addresses them effectively.³⁹

The institutional framework has changed in order to cope with the task of regulating the new markets and to meet the demand created in the market. The challenge will be in how the different institutions will work together to transform the natural gas industry. It is important to consider that many of them are of new creation and/or have new responsibilities. As they grow into their new faculties, these institutions face the challenge of guaranteeing the security that the industry needs.

2. Mexican Federal and Local Regulations

After describing the institutional framework, it is important to analyze the opportunities and challenges presented by the new natural gas regulations. First, while the constitutional reforms broadly outlined the gas reform, many details were left to the secondary laws—regulations. These regulations have to create a strong legal framework in line with market demands.⁴⁰ Second, Mexico's legal scheme in natural resources issues tend to be regulated at the federal level.⁴¹ The federal government issues federal legislation, and local authorities (in states and municipalities) must coordinate their own local regulations to comply with the

34. Guillermo Zuñiga Martinez, *Reform of the Mexican Energy Sector*, CRE (Oct., 2015), <https://www.lbcg.com/media/downloads/events/519/efm15-day-1-9-50-guillermo-zuniga-cre.8887.pdf>.

35. AGENCIA NACIONAL DE SEGURIDAD INDUSTRIAL Y DE PROTECCIÓN AL MEDIO AMBIENTE DEL SECTOR HIDROCARBUROS [ASEA], <http://www.asea.gob.mx>.

36. SECRETARÍA DEL TRABAJO Y PREVISIÓN SOCIAL [STPS], <http://www.gob.mx/stps/> (last visited April 24, 2016).

37. SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES [SEMARNAT], <http://www.gob.mx/semarnat> (last visited April 24, 2016).

38. PROCURADURÍA FEDERAL DE PROTECCIÓN AL AMBIENTE [PROFEPA], <http://www.profepa.gob.mx/> (last visited April 24, 2016).

39. Wood et al., *supra* note 27.

40. Zuñiga, *supra* note 34.

41. Erik Lee and Christopher Wilson, *The U.S.-Mexico Border Economy in Transition*, WILSON CTR.: MEXICO INST., N. AMERICAN RESEARCH P'SHIP [NARP], W. LEGISLATIVE ACAD. [WLA], BORDER LEGIS. CONF., 130 (2015) https://www.wilsoncenter.org/sites/default/files/Border_Economy_Transition_Wilson_Lee.pdf.

federal regulations. Local policymakers and legislators have to ensure that local regulations comply and implement the conditions contemplated in federal regulations. The different federal institutions are working to establish unique agreements with the states and municipalities that will simply regulate procedures and foster public awareness of the natural gas industry.⁴²

With respect to upstream activities, the new regulation scheme provides the opportunity for private investment to participate in the biddings for gas extraction by E&P Contracts. Even though the constitutional amendment still prohibits private concessions, the federal laws allow four types of contractual arrangements through which the private parties can participate (service, profit, production sharing and license contracts). These contracts contain many factors to be worked out among the new players and the institutions in charge of the abandonment, fiscal terms, and guarantees.

Midstream and downstream regulations will pose a major challenge, which will be discussed in the next section.⁴³ Midstream assets, along with all other existing state assets, were deemed off-limits for privatization.⁴⁴ Many believe this issue posed a serious obstacle to overall energy reform, as the midstream market has faced chronic underinvestment under state control. Fortunately, transportation of gas through pipelines and supply contracts, now transferred to CENAGAS jurisdiction, can be held by private investors and will be subject to open access discipline. There are still many questions regarding the necessary permits and authorizations, and the way the institutions will control and regulate the activities.

Mexico does not have any federal regulations on hydraulic fracturing, an unconventional extraction technique. The lack of regulations is an evident challenge, as it provides no legal certainty to the new players in the energy sector. However, the SEMARNAT—the federal agency responsible for the protection, restoration, and conservation of ecosystems and natural resources—has taken an important and positive step by issuing the Environmental Guideline for Shale E&P Activities.⁴⁵ The SEMARNAT guide provides environmental recommendations that oil operators (private companies and productive state enterprises) should follow in E&P activities in the different shale fields in order to effectively protect the environment. The guide introduces the process of hydraulic fracturing, detailing the environmental impacts that may result from inefficient operating conditions.

Under current U.S. policy, natural gas can be freely exported to any country that has a free-trade agreement with the U.S.—presenting an opportunity for Mexico. In 2013, for example, the U.S. exported over 650 billion cubic feet (bcf) of natural gas to Mexico. Even though Mexico has no experience and unresolved regulations to apply hydraulic fracturing, there is an open door to import the natural resource

42. *Id.*

43. *Infra* Part B-2.

44. SECRETARÍA DE GOBERNACIÓN (Secretariat of the Interior), DO, <http://www.dof.gob.mx/> (last visited April 15, 2015).

45. SEMARNAT, DIRECCIÓN GENERAL DE ENERGÍA Y ACTIVIDADES EXTRACTIVAS (DIR. GENERAL FOR ENERGY AND EXTRACTIVE ACTIVITIES), GUIDE FOR THE ENVIRONMENTAL CRITERIA FOR HYDROCARBON EXPLORATION AND EXTRACTION 5–6 (2015), http://inecc.gob.mx/descargas/difusion/2015_guia_criterios_ambientales_lutitas.pdf (Guía de Criterios Ambientales para la Exploración y Extracción de Hidrocarburos Contenidos en Lutitas, DO, 2015) (Mex.).

from the U.S. taking advantage of their low prices, instead of supporting the high cost of national production.⁴⁶

These are issues that the reform solely cannot solve, but they must be considered during the lawmaking process due to the potential impact of unconventional techniques and resources for Mexico's economic development. The legislators must account for all of the factors mentioned above in order to develop regulations that will encourage the sector to nourish and produce the beneficial impacts that the country needs.

B. Economics

The Mexican legal framework is vested with relevant regulatory powers in the natural gas industry, which is likely to gain more economic importance due to the increasing demand of natural gas. The economic environment must be adequate for the entry of new competitors and capacity development. In addition, the policy that determines the amount of natural gas that will be extracted, imported, or exported is measured by the economic variables such as pricing, production costs, demand, and supply. Today, even though Mexico is the sixth-largest country in the world with shale gas reserves, it depends on the U.S. gas supply. This situation is due to a series of factors abetting this trend to continue, which will be discussed in the following paragraphs.

1. Trade

To analyze the Mexican market, it is essential to note a geographical variable that directly influences the policies adopted throughout the country: the 2,000-mile border that it shares with the U.S. This proximity to the world's largest producer of natural gas⁴⁷ gives Mexico an opportunity to import and export natural gas from and to its neighbor. Much of the production is taking place in South and West Texas, a region with important shale formations that continue into Mexico and represent a growing market for additional U.S. natural gas exports.

The bilateral economic relationship with Mexico plays a major interest in the U.S. agenda, creating a strong trade relationship. Mexico is the U.S.'s third-largest trade partner in total trade after China and Canada, second-largest export market after Canada, and ranks third as a supplier of U.S. imports.⁴⁸ Also, Mexico has significantly increased natural gas imports from the U.S., and Mexican energy policymakers are contemplating this phenomenon will increase for the next five years.

46. Tom Tunstall, et al., *Economic Impact of the Eagle Ford Shale*, UNIV. OF SAN ANTONIO, INST. FOR ECON. DEVELOPMENT, CTR. FOR CMTY. AND BUS. RESEARCH [UTSA], 14–15 (Sept. 2014), http://iedtexas.org/wp-content/uploads/2014/09/2014_EFS_Release_Oct.pdf.

47. Linda Doman, U.S. ENERGY INFORMATION ADMIN., *U.S. Remained World's Largest Producer of Petroleum and Natural Gas Hydrocarbons in 2014*, TODAY IN ENERGY (April 7, 2015), <https://www.eia.gov/todayinenergy/detail.cfm?id=20692>.

48. SEELKE, CLAIRE ET AL. MEXICO'S OIL AND GAS SECTOR: BACKGROUND, REFORM EFFORTS, AND IMPLICATIONS FOR THE UNITED STATES (Sept. 28, 2015) <https://www.fas.org/sgp/crs/row/R43313.pdf>.

Therefore, despite Mexico having one of the world's largest natural gas reserves (the sixth-highest, globally),⁴⁹ it seems that the Mexican government will focus its attention only on the development of a pipeline system with national coverage to enhance U.S. cheap natural gas imports without considering increments in production. This is the trend. For example, Mexico imported 333 bcf of natural gas from the U.S. in 2010.⁵⁰ Imports spiked to 650 bcf of natural gas from the U.S. in 2013.⁵¹ By 2014, Mexico imported a total of 1,052 bcf of natural gas; 729 bcf came from the U.S., an increase of nearly 120% from 2010.⁵² U.S. natural gas exports to Mexico account for nearly half of total U.S. natural gas exports and approximately 69% of Mexico's natural gas imports in 2014.⁵³ All of this happens while Mexico sits on top of huge untapped reserves of oil and natural gas.⁵⁴

The U.S. imports a very small amount of natural gas from Mexico. Mexico has been trading oil and natural gas with the U.S. since the turn of the last century. It is typically among the top three exporters of oil to the U.S. As previously mentioned, Mexico's natural gas production has failed to keep pace with rising domestic demand, making U.S. gas exports an important source of energy. The value of Mexico's natural gas imports increased from \$995.7 million in 2007 to \$2.5 billion in 2013. The surplus in natural gas trade with Mexico is expected to widen as recent supply and demand trends in both countries are expected to continue.

2. Infrastructure and Technology

As we have seen, if the current trends continue unabated, Mexico will likely become a net importer of gas in a few years.⁵⁵ In addition, Mexico will have to carry out significant infrastructure and technology investments in upstream, midstream, and downstream activities to meet the demand of natural gas. It is almost certain that infrastructure and technology in Mexico is not as well developed as in the U.S.; as we have seen, U.S.-Mexico trade in natural gas is done exclusively via pipeline. This means that the gas sector will need to invest in infrastructure, efficient extraction, exploration, transportation, storage and distribution processes with the use of technological advances in order to enable this resource to be produced and transferred.

Regarding the upstream activities for unconventional production, hydraulic fracturing is the technology that will have to be implemented to extract the resource. The challenges in relation to its implementation will be discussed in Part C.1. Also, a recent study by the Bi-national Center Library at Texas A&M International University suggested that capital investments in Mexico's midstream and

49. TUNSTALL, *supra* note 45.

50. U.S. ENERGY INFO. ADMIN., MEXICO INTERNATIONAL ENERGY DATA AND ANALYSIS 9 (2015), https://www.eia.gov/beta/international/analysis_includes/countries_long/Mexico/mexico.pdf.

51. *Id.*

52. *Id.*

53. *Id.*

54. *Id.* at 7–8.

55. Tunstall, *supra* note 46, at 14.

downstream segment could total US \$17 billion over the next five years.⁵⁶ The Federal Government will need to attract private investment to make the sector competitive. Port facilities, terminals, storage capacity, and gas product pipelines will have to be built. The natural gas pipeline construction program must advance rapidly, as well as their interconnection facilities in order to appropriate U.S. hubs. This will allow Mexico to fully benefit from an available low-cost supply of natural gas, while utilizing unique logistical and technological advantages.

One of the most recent changes is that the Federal Government just published the Five-Year Plan for the Expansion of the National Integrated Transportation and Storage System of Natural Gas 2015–2019.⁵⁷ The Five-Year Plan contemplates the duplication of the Mexican pipelines in 2018 to ensure the efficient imports from the U.S. As the gasification program advances, natural gas will fully replace fuel oil and coal in power generation.⁵⁸ The government should take into account that the pipeline construction is moving ahead much faster than the installation of refinery units. Therefore, Mexico should participate with American gas companies to construct new natural gas-fired power plants along with natural gas pipelines across the country to meet increasing electricity demands and import larger amounts of natural gas from the U.S.

Pipeline flows from the U.S. into Mexico averaged two bcf/d in 2014. Projects to increase pipeline capacity are underway across the northern part of Mexico and are projected to import more than five bcf/d of natural gas by 2020. One of the goals of CENAGAS is to improve the existing infrastructure, which currently is composed of 9,343 kilometers of gas transportation ducts.⁵⁹ In addition, there are 15 compression stations with a total capacity of 431,630 HP,⁶⁰ from which 293,650 HP correspond to Pemex Gas and the remaining 137,510 HP correspond to private initiatives. There is a transportation capacity of 5,012 MMpcd⁶¹ substitutes natural gas (SNG) and 90 MMpcd in the Naco-Hermosillo Duct. Additionally, there are 28 injection points, 7 processing plants and 8 importation points.⁶²

As said before, one third of the domestic requirements of dry gas are imported. This share will continue to grow in the short- and medium-terms, given the construction of new pipeline capacity,⁶³ the implementation of technologic advanced, and the development of under-served and new, emerging local markets. Growth of industrial and electricity demands will accelerate, due to lower prices.

56. Ernst & Young, *Mexico's Emerging Infrastructure Opportunity*, 2 (2014), [http://www.ey.com/Publication/vwLUAssets/EY-mexicos-emerging-infrastructure-opportunity/\\$FILE/EY-mexicos-emerging-infrastructure-opportunity.pdf](http://www.ey.com/Publication/vwLUAssets/EY-mexicos-emerging-infrastructure-opportunity/$FILE/EY-mexicos-emerging-infrastructure-opportunity.pdf).

57. See generally CENEGAS, FIVE YEAR PLAN FOR NATURAL GAS, 2015–2019 (2015), <http://www.gob.mx/sener/acciones-y-programas/plan-quinquenal-de-gas-natural-2015-2019> (Plan Quinquenal de Expansión del Sistema de Transporte y Almacenamiento Nacional, Integrado de Gas Natural, DO, 2015) (Mex.).

58. Adrian Lajous, *Mexican Energy Reform*, COLUMBIA UNIV., CTR. ON GLOBAL ENERGY POLICY, 14 (June, 2014), <http://www.goldmansachs.com/our-thinking/pages/north-american-energy-summit/reports/cgep-mexican-energy-reform.pdf>.

59. Wood, et al., *supra* note 27.

60. Horsepower.

61. Million cubic feet per day.

62. Tunstall, et al., *supra* note 46.

63. Lajous, *supra* note, at 58.

This means that Mexico will need to implement the mentioned actions in order to achieve their goals of supplying the increasing demands.

3. Human Resources

Mexico's gas sector presents both challenges and opportunities for the country's labor markets. Over the next ten years, at least 20,000 Pemex workers will retire, creating a need for new generations to take their place.⁶⁴ Private gas companies and government agencies will need skilled professionals to enter the sector with the new reforms. Today, the country has a shortage of qualified workers who are adequately prepared to attend advanced training on the new regulations.⁶⁵ In addition, half of Pemex's employees will be near the retirement age within a decade and there are not enough young professionals to replace them. Public and private educational institutions absorb the challenge of implementing and adapting their programs to cover this demand. On the other hand, current students now have a new opportunity to develop an expertise in a sector that will be providing new employment possibilities. The future will depend on the educational institutions and energy companies preparing students and future workers with the necessary skills in order for Mexico to have the necessary human resources to transform its gas sector.

C. Environmental

Last but not least, protecting the natural environment while developing energy projects should be the first priority. The recent development of gas from low-permeability shale, made possible by new technology for horizontal drilling and hydraulic fracturing, has fundamentally transformed the world's immediate energy future by turning vast unconventional gas resources into reserves.⁶⁶ Many believe that shale gas production is and will be the main resource for natural gas in coming years and represents a critically important transitional fuel on the path to a decarbonized future.⁶⁷ Therefore, producers will have to strictly implement the environmental regulations, hoping that the government issues them before the producers start their work, during the E&P activities.

1. Hydraulic Fracturing

Shale gas is extracted by a unique technique widely used in the U.S. called hydraulic fracturing.⁶⁸ Hydraulic fracturing produces fractures in the rock formation that stimulate the flow of natural gas, increasing the volumes that can be recovered. The technique consists of wells that are vertically drilled hundreds to thousands of feet below the land surface and then the pipe bends in a horizontal section extending

64. *The Lack of Human Capital in the Energy Reform*, CIDAC (May 26, 2014), <http://cidac.org/eng/the-lack-of-human-capital-in-the-energy-reform/>.

65. *Id.*

66. Mark Zoback & Douglas Arendt, *The Opportunities and Challenges of Sustainable Shale Gas Development*, *ELEMENTS*, 251 (Aug. 2014), http://www.elementsmagazine.org/archives/e10_4/e10_4_de p_perspective2.pdf.

67. *Id.*

68. Tunstall, et al., *supra* note 46.

thousands of feet. Fractures are created by pumping large quantities of fluids at high pressure down a wellbore and into the target rock formation.⁶⁹

The gas extracted by this technique is used for electricity generation to reduce CO₂ emissions, which mitigates air pollution and helps minimize climate change issues. Over the years, many have debated the impacts of this technique on environmental and human health due to the chemicals injected into the water used to make the fracture. Many also debate over the opportunities from it, such as direct economic benefit of jobs created, taxes paid, stimulus and royalty payments to landowners.⁷⁰ Regardless, hydraulic fracturing has presented many benefits but remains highly controversial with many unanswered questions.

Regarding unconventional production in Mexico, the country has taken preliminary steps to explore and produce shale gas, but as said before, the country currently lacks the infrastructure and technology necessary to truly develop natural gas. Pemex produced its first shale gas in early 2011 from an exploratory well in northern Mexico.⁷¹ Later that year, the government announced a significant discovery in the same region, which could significantly increase the country's proven natural gas reserves.⁷² Pemex announced in early 2014 that it planned on drilling ten shale test wells, bringing Mexico's total to 175 wells, a small figure compared with the more than 27,000 wells drilled across the border in Texas in 2014.⁷³

There are many environmental opportunities resulting from shale gas extraction. One of the largest benefits is using gas for electricity power because it replaces the CO₂ emissions by more than 50 percent—thus helping to combat climate change. Also, increased natural gas use mitigates air pollution thanks to the absence of mercury and particulate matter in fuel gas, as well as significantly reduced sulphur content.⁷⁴ It also significantly reduces emissions of NO_x, approximately 70% of which are from oxidation of the nitrogen in the coal. Hence, switching from coal to natural gas would lead to significant health and quality-of-life improvements, especially in large urban centers in the developing world and in coal mining communities.⁷⁵

The main environmental issues concern the contamination resulting from spills and leaks to surface and the subsurface aquifers. Hydraulic fracturing fluid commonly consists of water, proppants⁷⁶ and chemical additives that open and enlarge fractures within the rock formation. These fractures can extend several hundred feet away from the wellbore. Once the injection process is completed, the internal pressure of the rock formation causes fluid to return to the surface through the wellbore. This fluid is known as “flowback” and may contain the injected chemicals plus naturally occurring materials such as brines, metals, radionuclides, and hydrocarbons. The flowback and produced water is typically stored on site in

69. *The Process of Hydraulic Fracturing*, ENVT. PROT. AGENCY (last updated Oct. 16, 2015), <https://www.epa.gov/hydraulicfracturing/process-hydraulic-fracturing> (U.S.).

70. Zback, *supra* note 66.

71. Tunstall, et al., *supra* note 46, at 38.

72. *Id.*

73. U.S. ENERGY INFO. ADMIN., *supra* note 50, at 12.

74. *Id.*

75. *Id.*

76. For example, sand, ceramic pellets or other small incompressible particles.

tanks or pits before treatment, disposal or recycling. In many cases, it is injected underground for disposal. In areas where that is not an option, it may be treated and reused or processed by a wastewater treatment facility and then discharged to surface water.⁷⁷

Other issues related to hydraulic fracturing are traffic contamination and land disturbance from the locations of the wells can affect the communities near the process. These are the factors that influenced governments to issue environmental regulations that will be described in the next section.

2. Environmental Regulations

The U.S. has done a great job creating and enforcing new rules for safe and responsible hydraulic fracturing, which will be applicable to federal and tribal lands.⁷⁸ Currently, there are more than 100,000 oil wells or boreholes located on land managed by the Federal Government. The Bureau of Land Management has set new requirements to ensure the integrity of wells, protect water quality, and improve the process of public disclosure of the chemicals and other details of hydraulic fracturing operations.⁷⁹

Another long-term issue will eventually arise regarding the consumption of natural gas. In 2012, the use of natural gas in electricity generation passed the 50% threshold and this share will continue to expand rapidly as the pipeline grid is extended and new power plants are built. Initially, the increased use of natural gas both as a base load fuel and in support of wind power generation cut carbon emissions.⁸⁰ Eventually, however, new technology will be required to eliminate lower emissions from natural gas, given the overriding need to reduce the carbon intensity of the Mexican economy.

In Mexico, following the passing of the Energy Reform, many have raised concerns about the environmental effects of hydraulic fracturing, especially in the states with vast resources of unconventional hydrocarbons (such as Coahuila, Nuevo León, Tamaulipas and Veracruz).⁸¹ Mexico's agenda includes regulating fracking, and as mentioned before, the SEMARNAT published the Environmental Guideline for Shale E&P Activities that introduces the process of hydraulic fracturing, detailing the environmental impacts that may result from inefficient operating conditions.⁸² There are also a series of Mexico's official standards on environmental matters to be considered by operators in the gas sector that contain general criteria with specific recommendations for oil operators during exploration, drilling and well completion, extraction, closure and abandonment of the well.

Mexico also has the ASEA for environmental enforcement. The ASEA is a newly-created regulatory unit responsible for regulating and supervising industrial safety, operational safety, and environmental protection of the hydrocarbon sector

77. EPA, *supra* note 69.

78. 43 C.F.R. § 3160.0 (2016); Oil and Gas; Hydraulic Fracturing on Federal and Indian Lands, 80 Fed. Reg. 16,128 (Mar. 26, 2015) (to be codified at 43 C.F.R. pt. 3160).

79. *Id.*

80. Lajous, *supra* note 58.

81. Tunstall, et al., *supra* note 46.

82. *Id.*

activities.⁸³ The ASEA shall participate in the design, regulation, and supervision of industrial and operational safety; the decommissioning and abandonment of facilities; and the integral control of waste and emissions.⁸⁴

The ASEA is divided in many units. One will be the supervision, inspection, and industrial surveillance unit, responsible for making inspections and verification of compliance with regulations on industrial safety and environmental protection. The ASEA now unifies the hydrocarbon-related activities of those agencies and their sanction in the event of non-compliance. The ASEA will work with the STPS, which is the agency that is responsible for the safety and health of workers and the workplace.⁸⁵ The ASEA will oversee three critical areas, which are the management systems for industrial safety, operational safety, and the environmental protection and safety measures.⁸⁶

IV. ANALYSIS

A. Mexico should continue importing natural gas from the U.S. while investing in national infrastructure.

Since the last decade, hydraulic fracturing and horizontal drilling have transformed the U.S. gas industry through the shale gas discoveries. This situation has been a major game changer in U.S. energy policy. As the excess of gas causes prices to drop, U.S. gas producers are looking for ways to discharge their supply in order to stabilize prices. Evidently, the most strategic partner is their southern neighbor, Mexico.⁸⁷ This section explains why the aforementioned factors support the idea that Mexico should continue importing gas from the U.S. while investing in its own infrastructure.

Legally speaking, Mexico has made significant advances in the gas sector by implementing the new Energy Reform. The new package of regulations creates new institutions and possibilities for new players in the sector, providing a welcoming panorama for American companies to either invest in the development of gas infrastructure within Mexico for their natural gas to go through the pipelines or participate in E&P Activities. Also, the regulations provide certainty: legal security that their investment will be secured by strong institutions. For these reasons, it would be beneficial for Mexico to attract foreign companies to invest in the gas production and infrastructure for the development of this sector in Mexico.

Economic factors are also beneficial for the U.S.-Mexico gas trade relationship. Affordable U.S. shale gas ensures that Mexico's world-class light industry and manufacturing sectors enjoy competitively priced energy and electricity supplies. In return, the Mexican demand for U.S. gas helps relieve the pressure of gas supply saturation for shale drillers in the U.S. domestic market. Therefore, given

83. Ley de la Agencia Nacional de Seguridad Industrial y de Protección al Medio Ambiente del Sector Hidrocarburo [ASEA] [Law of the National Agency Safety and Protection Environment Hydrocarbon Sector], DO, 11 de agosto de 2014 [Aug. 11, 2014] (Mex.), <http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFsr/DO3425.pdf>.

84. *Id.*

85. Tunstall, et al., *supra* note 46.

86. *Id.*

87. Doman, *supra* note 47.

the actual economical conditions of natural gas, it is beneficial for Mexico to continue importing the gas, but without forgetting about the investment for the development of the gas sector in Mexico.⁸⁸

Mexico has always imported natural gas from the U.S. in small quantities, but since the implementation of several reforms in Mexico due to environmental issues because of the high emissions of carbon dioxide, natural gas proved that it has a lower carbon footprint,⁸⁹ restraining the growth of greenhouse gases. Therefore, Mexico has significantly incremented the demand for natural gas. Also, Mexico's power sector gas demand is expected to climb from 3.5 bcf/d in 2014 to 5.4 bcf/d by 2024, as electricity demand rises and gas-fired plants' share of total power generation in Mexico increases from less than 50% now to nearly 70% by 2027, according to the Mexican Ministry of Energy.⁹⁰

As Mexico's gas demand climbs, it will continue to favor low-cost U.S. shale gas supplies. While Mexico is moving to stimulate private and foreign investment in gas development, established U.S. shale gas producers will likely remain Mexico's core gas suppliers for at least the next decade as low-cost U.S. supplies flood in through cross-border pipelines. For the next several years, at least, growing cross-border pipeline capacity will make Mexico the largest and steadiest customer for U.S. gas exports. The pipelines will open Mexico to the flood of cheap natural gas coming out of Texas and other shale regions since the hydraulic fracturing boom began a decade ago. In anticipation of future increases in price, Mexico should push for investment in infrastructure, and development of technology and human resources to spur the shale gas production within the country.

V. CONCLUSION

Natural gas—shale gas, specifically—is an alternative fuel that presents many opportunities and challenges for Mexican economic development. Mexico sits on top of a gigantic quantity of shale gas reserves, but there are some issues that need to be addressed before reaching an auto sufficient production. This article examined the historical, legal, economic and environmental considerations in order to answer the main question: whether Mexico is particularly well positioned to either continue being a net importer of cheap gas from their neighbor or encourage Mexican producers to implement unconventional extraction techniques.

Historically, the Mexican gas sector was controlled by a monopoly that made investment complicated, and as a result, the sector did not develop compared to other countries. It was not until 2013 and 2014 that the Federal Government enacted much-needed market reforms, which have already been enforced in all levels of legal instruments and have imposed a new government structure. This will give

88. Gabriel Collins, *Mexico Is Becoming the Single-Largest U.S. Shale Gas Export Customer*, NORTH AMERICA SHALE BLOG (Jan. 5, 2015), http://www.northamericashaleblog.com/2015/01/05/mexico-is-becoming-the-single-largest-u-s-shale-gas-export-customer/?utm_source=Mondaq&utm_medium=syndication&utm_campaign=View-Original.

89. AGA, *supra* note 1.

90. SENER, OUTLOOK FOR THE ELECTRICITY SECTOR 2013–2027 163 (2013), <http://www.smartgridmexico.org/es/documentos/documentos-rectores-sener/2-prospectiva-del-sector-electrico-2013-2027/file> (Prospectiva Del Sector Eléctrico 2013–2027, DO, 2013) (Mex.).

the country the necessary institutional and legal framework to attract private investment and transform the sector. Although, there remain pending challenges regarding the functionality of the institutions and regulations, and the way they will adapt to the demanding energy market.

An evident opportunity is the geographical position of Mexico to the U.S., making the outlook for the production of shale gas in Mexico an integral part in this scenario. The proximity of some formations in northern Mexico, Sabinas, Burgos, and Tampico-Misantla to U.S. developments and the low cost of this resource due to the excess of supply it has in the U.S. translates to easy importation of natural gas from one country to another. Therefore, the challenge for Mexico is drawing important investment for upstream, midstream, and downstream infrastructure and technology to meet the demand. This means that in order to tap into the country's bounty of shale gas, infrastructure such as roads, rails, and pipelines will have to be built out first. Additionally, the ability to develop a suitably skilled workforce and apply new technology within the actual legal framework will be key to long-term success.

Although Pemex has allocated a small share of its budget to shale gas development, the sector is unlikely to grow rapidly, but new rules set by the energy reform allow entry of foreign firms to initiate significant development of Mexico's shale gas resources. This could result in many benefits to direct employment, payment of taxes by new incorporated companies, royalties to landowners, and new technology. But to realize the many benefits of enhanced natural gas use, it is critically important for shale gas resources to be developed safely and in an environmentally responsible and socially acceptable manner.

New energy policy for the development and modernization of the natural gas industry should have the main objective of offering enough supply in order to meet with the gas demand, taking into account legal, economic, and environmental considerations. In conclusion, Mexico should take advantage and continue importing cheap gas from the U.S. while investing in infrastructure and learning from the technology of hydraulic fracturing implemented in southern U.S. In the near future, with a strong legal and environmental framework in conjunction with good economic conditions, Mexico should implement and transform the gas sector with the help of shale gas.