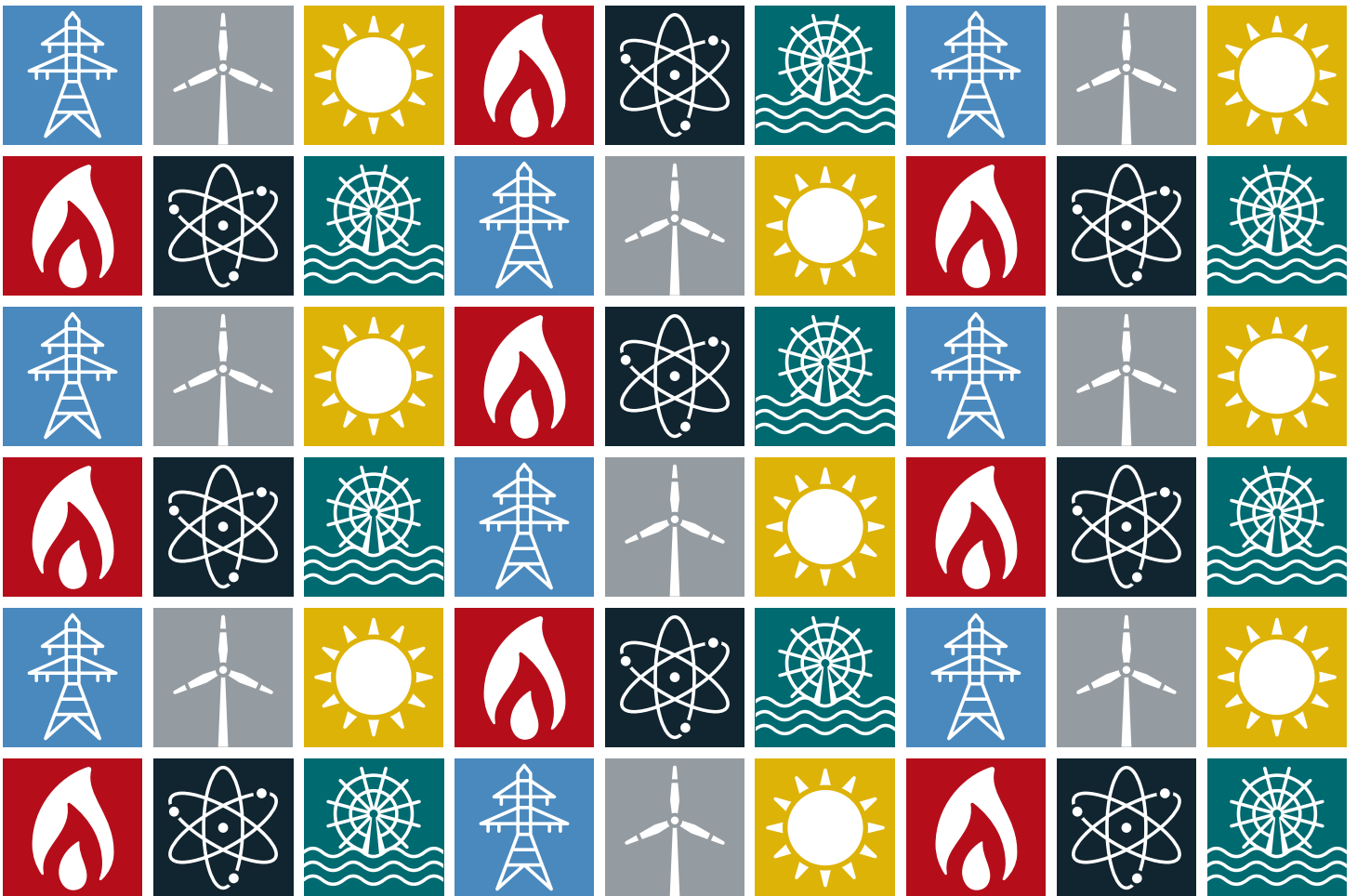


Shale Gas Development in Latin America



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Published by the Americas Society and Council of the Americas
September 2014

SHALE GAS DEVELOPMENT IN LATIN AMERICA

Shale gas is revolutionizing the global energy landscape and the impressive size of proven reserves puts the Western Hemisphere in an enviable position to capitalize on new realities. In addition to the United States and Canada, Argentina, Brazil, and Mexico all rank within the top 10 countries worldwide with technically recoverable shale gas resources; together, they make up approximately 40 percent of the world's total supply.¹ Additionally, Colombia has significant potential.

Nonetheless, while the existence and recoverability of these resources is apparent, the economic viability of extracting them is unclear, given production costs, volumes, and wellhead prices. Beyond purely economic considerations, a variety of factors including the regulatory framework, infrastructure, access to capital, and environmental and other political considerations could potentially retard development of the sector, especially as the pace of shale gas development quickens and investors concentrate elsewhere.

The primary point of comparison within the Western Hemisphere is the United States where, in 2014, over 20,000 horizontal wells are expected to be drilled. This compares with 250 unconventional wells in Argentina and just 10 in Colombia during the same time period.² Investors spent \$90 billion in the United States on developing shale gas in 2012 alone; in contrast, foreign direct investment in every sector in Latin America last year totaled \$180 billion.³

Driving much of the US sector is the participation of smaller and medium sized companies, which are more nimble and willing to take risks that other companies might not consider. Such companies face a more difficult value proposition in Latin America given the challenge of accessing capital and working within complicated political environments. Improvements in capital market efficiency and easier access to funding would assist small and medium sized companies, both foreign and domestic, to play a similar role in developing Latin America's own revolution if given the opportunity to do so.

Policymakers possess several tools to aid in the process of shale gas development. In addition to support for increasing access to finance, governments can prioritize gas demand over more expensive, dirtier fuels to incentivize further investment in the natural gas sector. They can develop standards and best practices which will allow for the transparent, efficient development of the sector in a manner that limits environmental consequences. They should consider common regulations that will create larger internal markets and economies of scale. Additionally, given the need to develop human resources within the energy sector in order to reach peak effectiveness, governments should consider supporting workforce development as appropriate.

SHALE GAS DEVELOPMENT IS A PATH TO PARTNERSHIP WITH THE UNITED STATES

The United States possess a comparative advantage in the sector and therefore it is appropriate for the United States to engage in the sector regionally at the public and private sector levels. The presence of natural gas in shale deposits has long been known, but technology was not advanced enough to make

¹ "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States." U.S. Energy Information Administration. June 2013.

² Arthur, Alexis. "Shale Oil and Gas the Latest Energy Frontier for South America," Oilprice.com. June 5, 2014.

³ "Shale Gas Development in Latin America." Americas Society/Council of the Americas. October 22, 2013.

exploitation commercially viable. The development of techniques such as hydraulic fracturing and horizontal drilling, among others, provided the catalyst for rapid development in the United States and elsewhere. Once technology became available, the shale revolution in United States then began to thrive due to inexpensive access to basins, subsoil rights given to property owners rather than to the state, and sound and enforceable contract law. In addition, environmental regulations are adequate and generally give confidence for appropriate sectoral development.

As a result, potential for partnership with Latin America and the Caribbean in the development of the shale gas sector is significant. The United States enjoys technology, capital, and managerial expertise which is critically important, especially on environmental issues. The United States has experience developing guidelines and regulations for the sector that promote the full development of shale gas resources. Furthermore, the United States government and industry can assist in the development of regional shale gas resources through technology transfer and training, infrastructure, and workforce development. These are common issues facing all nations in the region that seek to participate in the shale gas revolution, and can form the basis of regional partnership based on mutual self-interest and concrete results, even when other avenues for US cooperation with the region may be temporarily inconvenient.

THE WESTERN HEMISPHERE SHALE GAS COUNCIL

One idea to develop this strategy would be the formation of a Western Hemisphere Shale Gas Council, for the purpose of coordinating best practices and exchanging sectoral views at the government level. Initially, membership in the Council, headed by the Secretary of Energy or his designee, would be drawn from those nations in North America, Latin America, and the Caribbean Basin with the largest regional shale gas resources. Over time, non-hemispheric nations which enjoy significant proven shale gas reserves, including Australia, China, Russia, and South Africa, could be included as observers, as could nations including India and Japan which have a vested interest, as consumers, in the success of Western Hemisphere shale gas development. In the meantime, significant attention must be paid to the efficient and effective development of shale gas in Latin America specifically if the region is to participate fully in the global shale revolution.

Top 10 Countries with Technically Recoverable Shale Gas Resources

RANK	COUNTRY	SHALE GAS (TRILLION CUBIC FEET)
1	CHINA	1,115
2	ARGENTINA	802
3	ALGERIA	707
4	U.S.	665 ¹ (1,161)
5	CANADA	573
6	MEXICO	545
7	AUSTRALIA	437
8	SOUTH AFRICA	390
9	RUSSIA	285
10	BRAZIL	245
WORLD TOTAL		7,299 (7,795)

¹ EIA ESTIMATES USED FOR RANKING ORDER. ARI ESTIMATES IN PARANTHESES

Source: EIA

ARGENTINA

According to some estimates, Argentina is second only to China in technically recoverable shale gas reserves, at 802 trillion cubic feet (Tcf).⁴ Argentina has the most advanced shale industry in Latin America, with hundreds of wells drilled and numerous projects in production. This activity is primarily located within the Neuquen Basin. The Neuquen Basin contains the Los Molles and Vaca Muerta shale formations, with Vaca Muerta considered one of the premier shale gas development areas in South America if not the world. It is estimated that the Vaca Muerta formation has technically recoverable shale gas and shale oil resources of 308 Tcf of gas, approximately 38% of Argentina's total technically recoverable shale gas reserves.⁵ The country also has three other untested sedimentary basins which could prove to contain shale gas. These include the Parana, San Jorge, and Austral Magallanes basins.

Argentina has great potential to attract investment. In 2013, state energy company YPF reported holding 3 million acres in the Neuquen Basin, making it the top acreage holder in the country. Together with older Repsol-operated wells, YPF had drilled 37 Vaca Muerta wells through 2012. This constitutes over 70 percent of the wells drilled in Vaca Muerta, indicating the significant involvement of YPF and the Argentine government in shale discovery and exploitation. YPF has made a number of deals with foreign corporations which signal openness to oil and gas partnerships. According to YPF, Chevron aims to invest \$1.6 billion in shale development in Vaca Muerta, and plans to drill 170 wells in a 96,000 acre area.⁶ YPF has also consummated deals with Bridas, Shell, and Chinese corporation CNOOC; President Xi Jinping's recent visit showcased China's interest in the sector.

MEXICO

Historic energy sector reform signed by President Enrique Pena Nieto in August 2014 will provide a needed boost for Mexico's shale gas production. By opening the country to foreign investment, among other steps, reforms will usher in capital and technology in shale gas and oil. Mexico's technically recoverable natural gas is estimated at 545 Tcf, potentially larger than the country's proven conventional reserves.⁷ Mexico holds the 6th largest shale gas resources in the world. The best documented play is the Eagle Ford shale in the Burgos Basin, which extends from south Texas. This play has an estimated 343 Tcf of risked, technically recoverable shale gas potential. Based on similarities with Eagle Ford shale in Texas, this is considered to be Mexico's top-ranked prospect for shale exploitation. Other basins in Mexico in which drilling has not yet occurred, and where potential is far less certain than the Burgos Basin, include the Sabinas, Tampico, Tuxpan, and Veracruz basins.

As of 2013, Pemex had drilled less than 10 shale gas and oil exploration wells in the Eagle Ford, and Pemex's initial shale exploration wells have been unusually costly (\$20–25 million per well) while only providing modest results. There are also security concerns, including coastal zones where drug-trafficking organizations have engaged in large-scale violence to gain control of routes and branch out into other illegal activities such as kidnapping and oil theft. Additionally, shale gas development requires significant water resources, and much of Mexico's shale potential lies in arid areas, requiring

⁴ EIA.

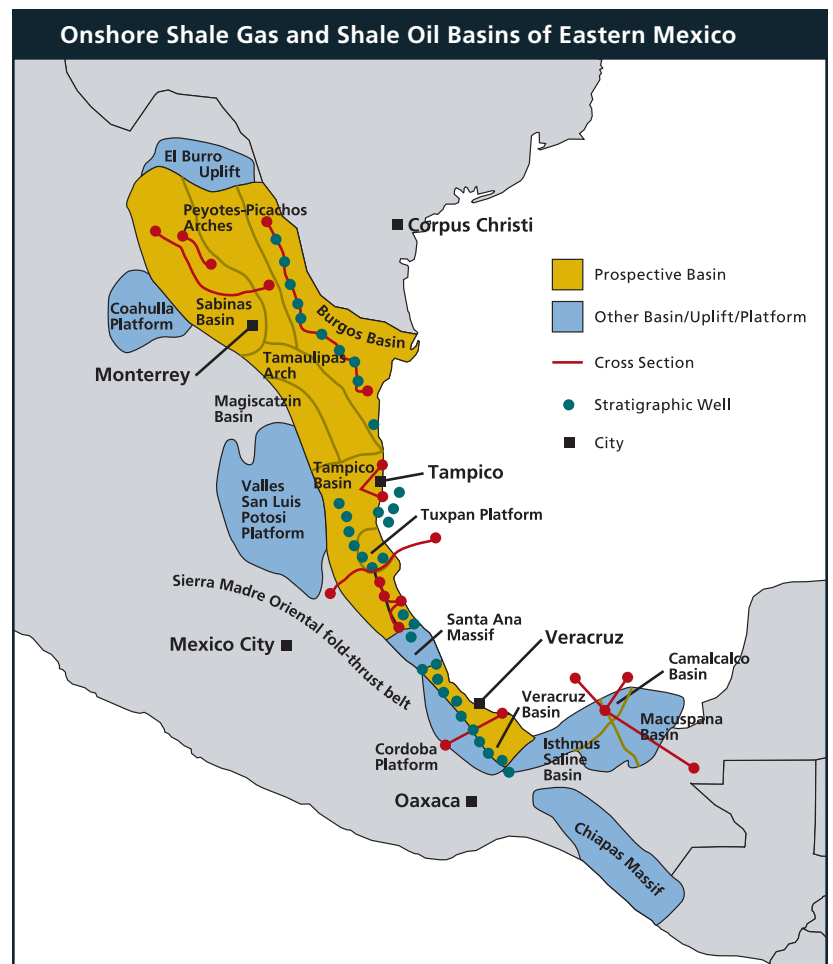
⁵ Ibid.

⁶ Gonzalez, Pablo. "Argentina Prepares China Shale Deal to Boost Gas Reserves." Bloomberg. August 21, 2013.

⁷ EIA.

thought about ways to satisfy water resource requirements. Nonetheless, Pemex plans to increase shale activity in the next few years, budgeting 6.8 billion pesos (\$575 million) in 2014, highlighting some 200 shale gas opportunities in five geologic provinces in eastern Mexico.⁸

Over the past several months, Emilio Lozoya, Pemex's CEO, has invited the world's largest energy companies to join the exploration opportunity. On March 4, he said that Pemex aims to attract as much as \$1 trillion in energy investment to exploit Mexico's shale oil and gas reserves. He also said that, "Capital from all over the world is welcome in Mexico...We hope to have hundreds of companies operating in any type of rock formation, be it shale, or shallow water, or mature fields, or deep water projects."⁹



Source: Advanced Resources International

BRAZIL

Access to capital is the most significant challenge facing shale production in Brazil. Most investors are focused on offshore pre-salt oil fields. While much of Brazil's oil and gas potential lies offshore, it has 18 mostly undeveloped basins onshore. Three of these, the Paraná in the south and the Solimões and Amazonas in the north, already produce conventional oil and gas and have significant potential for shale. There are also six other basins which may have shale potential, but they are unproven. In total, Brazil's technically accessible shale gas resources are around 245 Tcf.

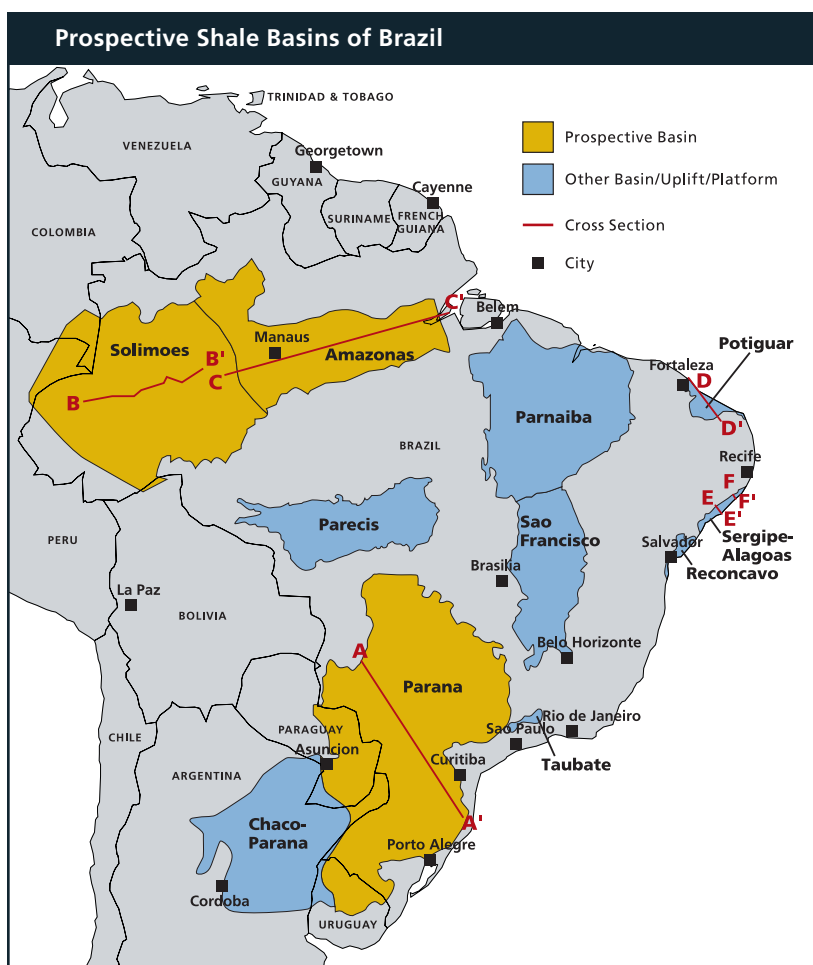
The Paraná extends to Argentina, Uruguay and Paraguay. The Brazil-Bolivia, and Uruguiana-Porto Pipelines already exist in this region. No shale gas activity has occurred in the Brazil portion of the Basin, although Amerisur Energy has discussed the Paraguay portion. Risked, technically recoverable shale gas is estimated at 81 Tcf in the Parana Basin. The Solimões is the country's most productive onshore basin for conventional oil and gas. However, it has not been explored for shale. There are estimates that this basin contains 65 Tcf of risked, technically accessible shale gas. The Amazonas is extremely remote and conventional petroleum was only commercialized in 2009, and this basin is estimated to contain 100 Tcf of risked, technically accessible shale gas.¹⁰

⁸ Ibid.

⁹ Williams, Adam. "Pemex CEO Invites World to Tap Mexico's Energy Shale Reserves." Bloomberg. March 4, 2014.

¹⁰ Ibid.

Given the large potential of shale gas development in Brazil and the country's growing clean energy needs, particularly as a long-term drought continues to impact Brazil's hydroelectric capacity, the government has decided to stimulate shale gas exploration and put onshore shale gas blocks for auction in 2013. In early 2013, Petrobras drilled its first shale oil well in Argentina, and during the November 2013 auction of exploration concessions, Petrobras dominated the bidding. When exploration concessions were first auctioned off, many top companies sat out the sale since many blocks were not considered prime territory.¹¹ Only Shell and Total were registered to participate. Environmental issues may also complicate investor interest, which could have implications for other Latin American countries.



Source: Advanced Resources International

COLOMBIA

Despite not having abundant shale gas resources compared to the other three countries discussed, Colombia has the most competitive energy framework and most energy-friendly regime of any country in the region. Colombia has only 55 Tcf of shale gas.¹² These are still sizeable reserves, and the relatively stable regulatory environment combined with the country's openness to investment is encouraging. Three main basins exist in Colombia that could be lucrative for shale production, although security remains a risk in some locations. Initial shale drilling by Ecopetrol as well as the entrance of private companies such as ConocoPhillips, Exxon, Shell and others has been positive.

The Middle Magdalena Valley Basin has been the focus so far, both for shale leasing and drilling and also conventional onshore drilling. There are estimates of 18 Tcf and 4.6 billion barrels, out of risked shale gas and shale oil in-place of 135 Tcf and 79 billion barrels. In comparison, Ecopetrol has estimated the basin to have 29 Tcf of shale gas potential. The Llanos Basin is another large basin in eastern Colombia. The Maracaibo/Catatumbo Basin is shared with Venezuela and is one of South America's richest petroleum basins. The Putamayo may contain shale but has not yet been assessed.¹³

¹¹ Fick, Jeff. "Brazil Auctions Shale Oil, Natural Gas Blocks." *The Wall Street Journal*. November 28, 2013.

¹² EIA.

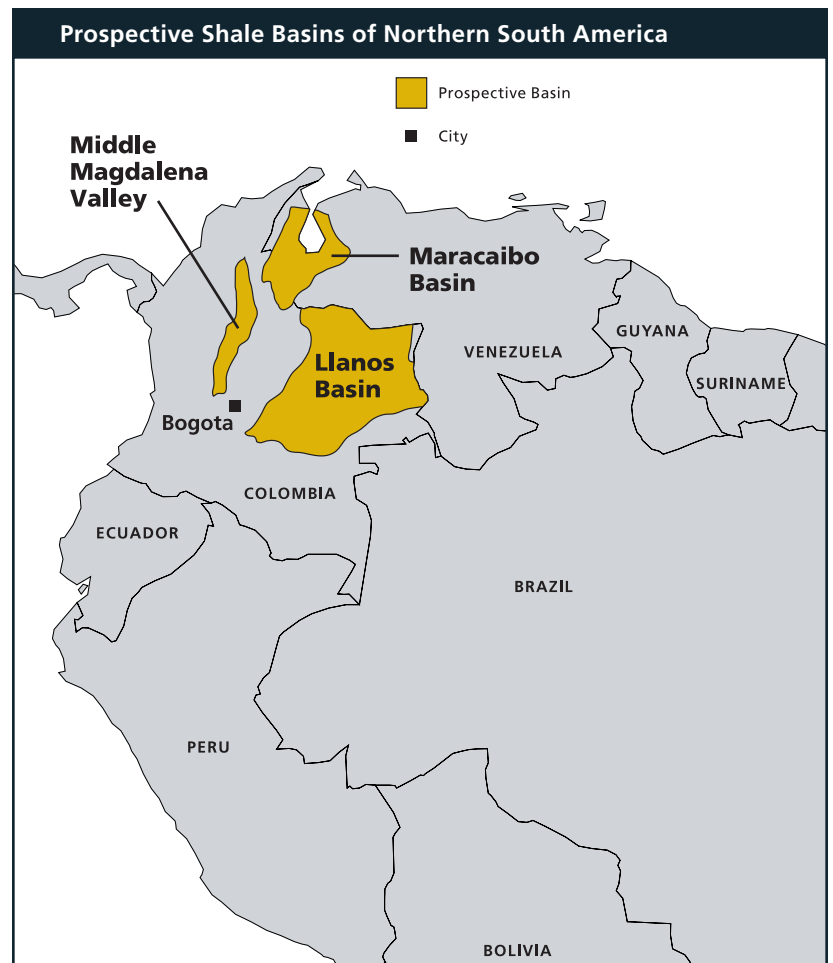
¹³ Ibid.

Colombia's Agencia Nacional de Hidrocarburos (ANH) regulates oil and gas exploration and development. The model for contracts established by the ANH includes eight year exploration and 24 year production terms, with preferential terms for shale gas including a 40 percent reduction in royalties and higher oil prices. ANH conducted Colombia's first shale block auction in 2012. ANH had high hopes for the second unconventional auction through Ronda Colombia 2014. However, only 26 of the 95 available concessions secured offers. The auction raised about \$1.4 billion, according to ANH, significantly less than the \$2.6 billion originally forecast.

Despite this, Ecopetrol continues to control the majority of the market, managing about one third of the oil and gas licenses in Colombia. Shale exploration has become a critical facet of Ecopetrol's business plan, and the company plans to drill for unconventional hydrocarbons this year in the Middle Magdalena and Catatumbo areas, including nine stratigraphic wells, three exploratory wells and three productivity and study pilots.¹⁴

CONCLUSION

Shale resources in the Western Hemisphere are abundant, clean, and lower cost than alternatives, and can fuel economic growth by attracting investment, boosting power generation and employment, and making national economies more cost competitive, among other things. But success is not guaranteed, even with an abundance of resources. Gas pricing regimes, regulations including the rule of law, access to technology and capital, and infrastructure are fundamental variables that investors consider before committing to move ahead with project development. When it comes to energy resources including shale gas in the Western Hemisphere, conditions above ground are just as important as conditions below ground. Establishment of a cooperative regional mechanism could be one way to encourage development of these vital resources in a cost effective, efficient, and environmentally-effective manner.



Source: Advanced Resources International

¹⁴ Willis, Andrew and Dan Murtaugh. "World Oil Stock Seeks Shale Lift as Colombian Boom Fades." Bloomberg. March 12, 2014.

ACKNOWLEDGEMENTS

We would like to thank Sophia Sciabica for her valuable research and writing assistance.

The Americas Society and Council of the Americas is grateful to Chevron and the Inter-American Development Bank for supporting the Energy Action Group.

The opinions expressed herein do not necessarily reflect the views of sponsoring companies and organizations.

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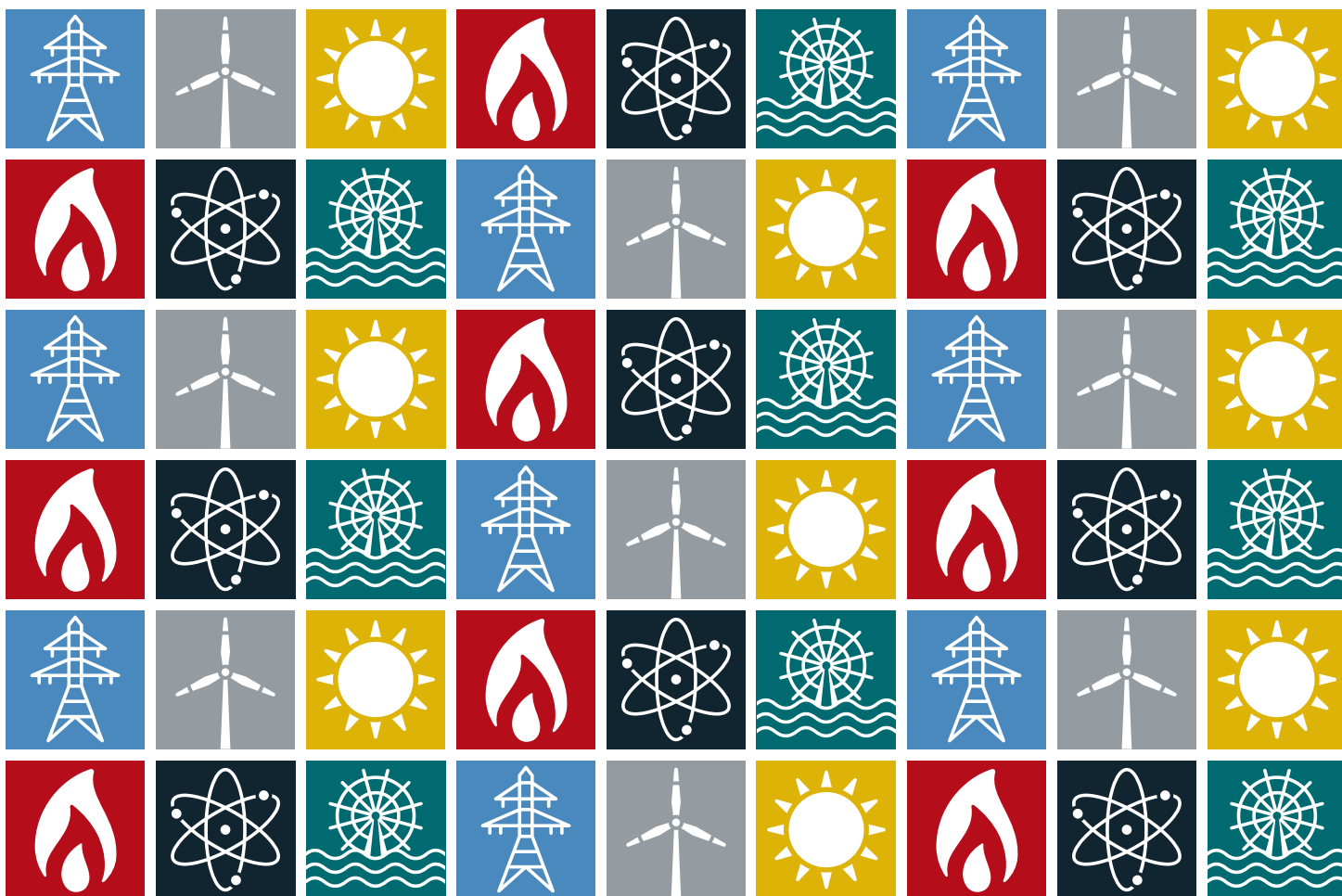
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