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May 17, 2017

Congressional Testimony of

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Before the
Committee on Foreign Affairs, Subcommittee on Western Hemisphere
United States House of Representatives
1st Session, 115th Congress

Chairman Duncan, Ranking Member Sires, and Members of the Committee, thank you for inviting me here today to discuss the energy outlook in South America. My name is Jason Bordoff. I am Professor of Professional Practice at Columbia University's School of International and Public Affairs and Founding Director of Columbia University SIPA's Center on Global Energy Policy. In my testimony, I will (1) summarize the importance of South America to the global energy system; (2) discuss the region's importance as an energy trading partner of the US; (3) provide an overview of opportunities for oil and gas and (4) of renewable energy in the region; and (5) offer a few thoughts on key areas of focus and potential partnership with the US if South America is to realize its energy opportunities.

Broadly speaking, the recent oil price collapse and economic strain throughout the region has helped to catalyze reform efforts to liberalize South America's energy sector. Countries in the region are now taking steps to make themselves more competitive and attractive to foreign investment. It is in the national interest of the US to help these countries succeed and develop their energy sectors in order to increase regional political stability and economic growth, promote global energy market stability, and open up new opportunities for investment of foreign capital from the US and elsewhere in the region. Many South American nations are also taking welcome steps to grow the share of low-carbon energy sources in their energy mix. Continued partnership to support cooperation on climate change is important to accelerate efforts to transition to a cleaner energy future.

South America's Importance to the Global Energy Landscape

South America plays an important role in global energy supply, trade and geopolitics. The region, as a whole, is a net exporter of fossil energy with a positive balance in oil, gas and coal alike. Venezuela is home to the world's largest crude oil reserves, larger even than those of Saudi Arabia.[1] Brazil alone could add well over a million barrels per day of oil production in the next five years, and deepwater production in Brazil—alongside US shale—may be key to meeting global oil demand growth and keeping a lid on oil prices in the foreseeable future. Argentina has the second largest technically

[1] As of end-2015, according to the BP Statistical Review of World Energy 2016.

recoverable shale gas and fourth largest tight oil resources in the world,[2] and the country is perhaps the best positioned to replicate something resembling the US shale revolution outside North America.

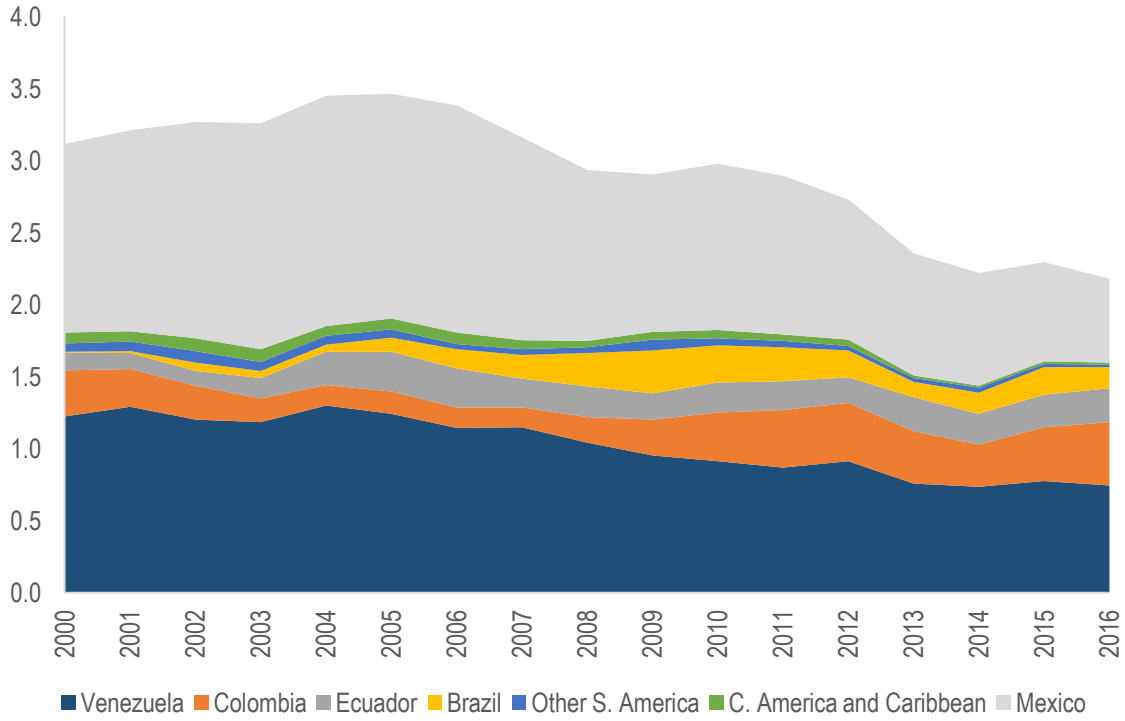
South America is also playing a leading role in clean energy technologies. In 2014, the region produced more than 60 percent of its electricity from renewable sources, compared with a world average of 22 percent, according to the International Energy Agency.[3] Most of this is hydropower, but there are reasons to be optimistic that other renewables can scale up in the coming years, including the region's prodigious solar and wind resource potential.

South America Is a Key Energy Trade Partner for the United States

South America is a key market for energy trade with the United States. As seen in Figure 1, the United States is a major recipient of South America's energy resources, although volumes have declined as US shale oil production has risen. Venezuela and Colombia are two of the five largest sources of America's crude oil imports, and South America, as a whole, accounted for 1.6 million b/d (or about a fifth) of our gross crude oil imports in 2016. (That rises to nearly 30 percent if Mexico is included.) The US Gulf Coast refineries are optimized for processing heavy or high sulfur crudes that make up a high percentage of exports from Venezuela and Mexico (and to a lesser degree Brazil and Colombia). Canada is a big competitor, and if the Keystone XL pipeline is completed, imports of heavy crudes from Latin America are likely to decline. We import relatively little coal as a share of our total consumption (~1.4 percent),[4] but 80 percent of these imports come from South America, most of it from Colombia.[5]

[2] U.S. Energy Information Administration, "World Shale Resource Assessment," *EIA*, September 24, 2015, https://www.eia.gov/analysis/studies/worldshalegas/.
[3] International Energy Agency, "IEA World Energy Outlook 2016," *IEA*, p.552 and p.620.
[4] EIA, "(2016) Table ES-1 U.S. Coal Summary Statistics, 2010-2016," *EIA Quarterly Coal Report, October-December 2016,* https://www.eia.gov/coal/production/quarterly/pdf/tes1p01p1.pdf.
[5] EIA, "(2016) Table 18 U.S. Coal Imports," *EIA Quarterly Coal Report, October-December 2016,* https://www.eia.gov/coal/production/quarterly/pdf/t18p01p1.pdf.

Figure 1. US Crude Oil Imports from Latin America (million barrels per day)



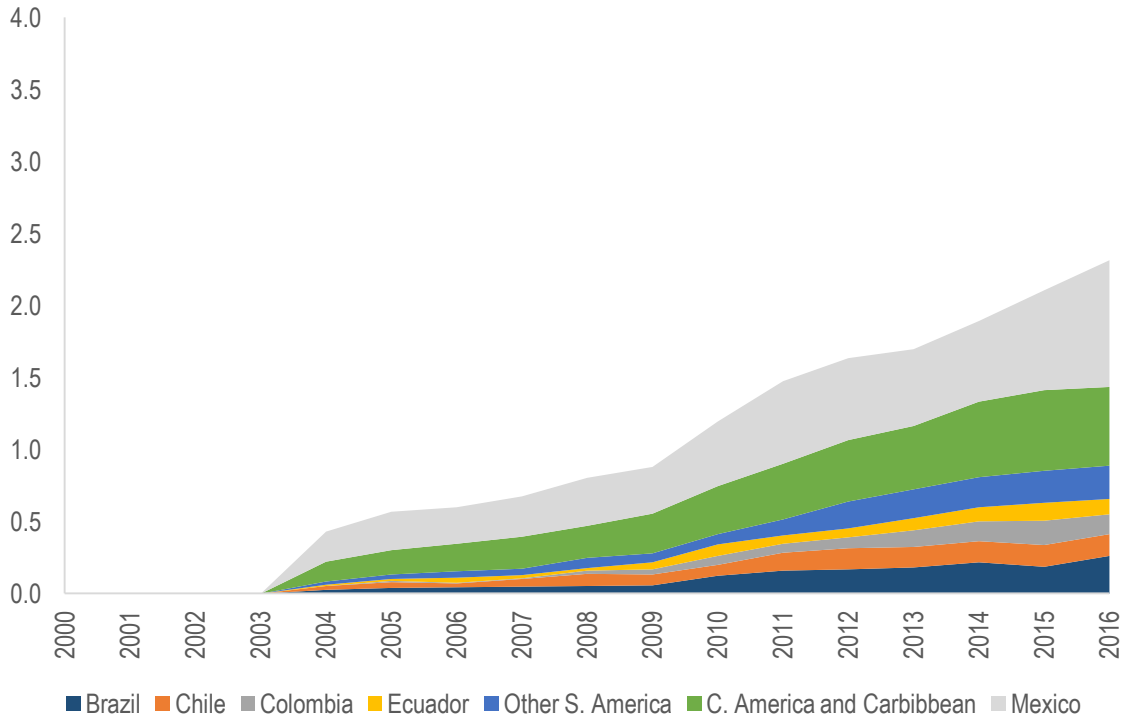
Source: EIA

As seen in Figure 2, Latin America is also an important and growing market for US energy exports, particularly refined products and—increasingly—liquefied natural gas (LNG). Over the last decade, the US has gone from being the largest importer of refined petroleum in the world to the largest exporter of refined petroleum. A little less than a third (or about 1.4 million b/d) of our refined petroleum product exports go to South America and the Caribbean, and just about half (or about 2.3 million b/d out of 4.7 million b/d) if one includes Mexico.[6] Despite their large crude oil reserves, many South American countries have failed to invest in refining due to the lack of capital to build expensive infrastructure, cost overruns, and market uncertainty. The fact that many countries in the region have subsidized domestic fuel prices has made refining investment unattractive, especially for national oil companies with upstream priorities that are short of cash. Moreover, technical problems and poor maintenance mean that many existing refineries operate far below capacity.[7] There is also a growing mismatch between the heavier oil many countries produce and what their refineries can process, forcing them to import light oil and other diluents. Some of Latin America's largest NOCs, on the other hand, have made substantial investments in US refineries. Venezuela's PDVSA owns

[6] EIA, "Exports by Destination," *EIA Petroleum and other Liquids,* Apr 28, 2017, https://www.eia.gov/dnav/pet/pet_move_expc_a_EPP0_EEX_mbblpd_a.htm.
[7] Lisa Viscidi, "Filling the Gap: How the US Energy Boom is Shaping Latin American Refining Markets," Inter-American Dialogue, March 2015, p.5-6, http://www.thedialogue.org/wp-content/uploads/2015/06/Filling-the-Gap-web-Lisa-Viscidi-March-2015.pdf.

Citgo in the US with 749,000 b/d of refining capacity,[8] and Pemex owns half of the Deer Park refinery (in a joint venture (JV) with Shell) with 340,000 b/d of capacity.[9]

Figure 2. US Refined Product Exports to Latin America (million barrels per day)



Source: EIA

In effect, our complex refineries in the Gulf Coast and California take crude oil from Latin America, refine it into valuable petroleum products (such as gasoline and diesel) at a fairly high profit, and sell it back to consumers across South America, where refining capacity falls far short of local demand. US Gulf Coast refineries are much better-positioned to supply the South American market with products than competitors overseas because US refiners benefit from lower fuel costs (thanks to cheap shale gas) and because of their physical proximity to the region. Exports to Latin America, in turn, play a key role in the profitability of US Gulf Coast refiners.[10]

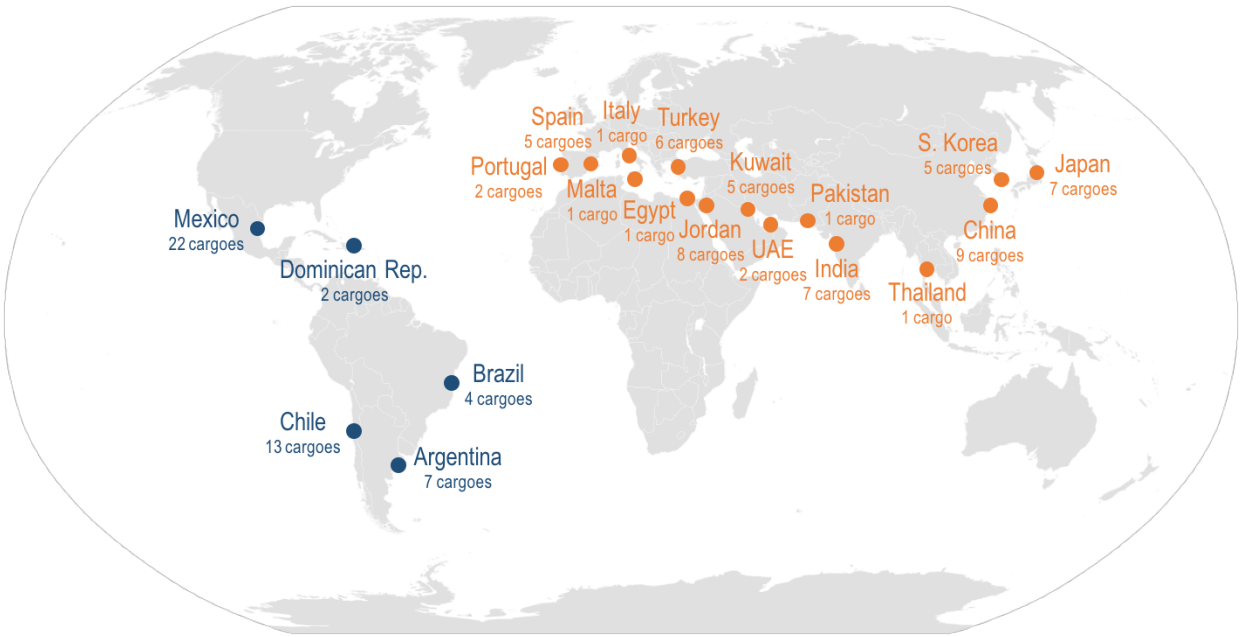
After the US lifted its oil export ban, Latin America became a destination for US light crude exports. In 2016, about 12 percent of total US crude exports went to this region. Given that much of South American production in countries like Venezuela and Colombia is of heavy crude, this light oil from the US may well find its way back to America after being blended with heavy oil to make South

[8] Gordon Meghan, "US Congress calls for CFIUS review of Rosneft's potential stake in Citgo," *S&P Global Platts*, Apr 7, 2017, https://www.platts.com/latest-news/oil/washington/us-congress-calls-for-cfius-review-of-rosnefts-21395865.
[9] "About Deer Park," *About Us Shell in U.S.,* Shell, 3 Oct. 2016, http://www.shell.us/about-us/projects-and-locations/deer-park-manufacturing-site/about-shell-deer-park.html.
[10] Housley Carr, "Livin' La Vida Local - U.S. Distillate Exports From Gulf Coast To Latin America On The Rise," RBN Energy, May 10, 2017, https://rbnenergy.com/livin-la-vida-local-us-distillate-exports-to-latin-america-on-the-rise.

American grades suitable for processing in Gulf Coast refineries.

As Figure 3 shows, Latin America has also emerged as a market of choice for US LNG cargoes since the first LNG export terminal at Sabine Pass started operations in February 2016. Through April 2017, about a quarter of the 100-odd cargoes that were lifted from Sabine Pass went to South America, or nearly half if we include Mexico. This is quite a departure from the expectation a few years ago that most US LNG exports would find their way to the Asian market, given the high price of Asian LNG at the time. The ability for US LNG to shift from one destination to another, based on commercial considerations, is a key feature of US LNG exports that is making the global natural gas market more competitive, secure, and efficient.[11]

Figure 3: Destinations of US LNG Export Cargoes to Date (February 2016 through April 2017)



Source: Bloomberg

The region's potential as a destination for US LNG cargoes is set to increase over time. As production ramps up at US LNG export terminals, America will soon eclipse Qatar as the biggest source of flexible LNG supply that can go anywhere in the world, depending on the price.[12] As I have argued previously, US LNG will make the global gas market more flexible, more liquid and more integrated, thanks to the unique structure of US LNG contracts.[13] Floating storage and

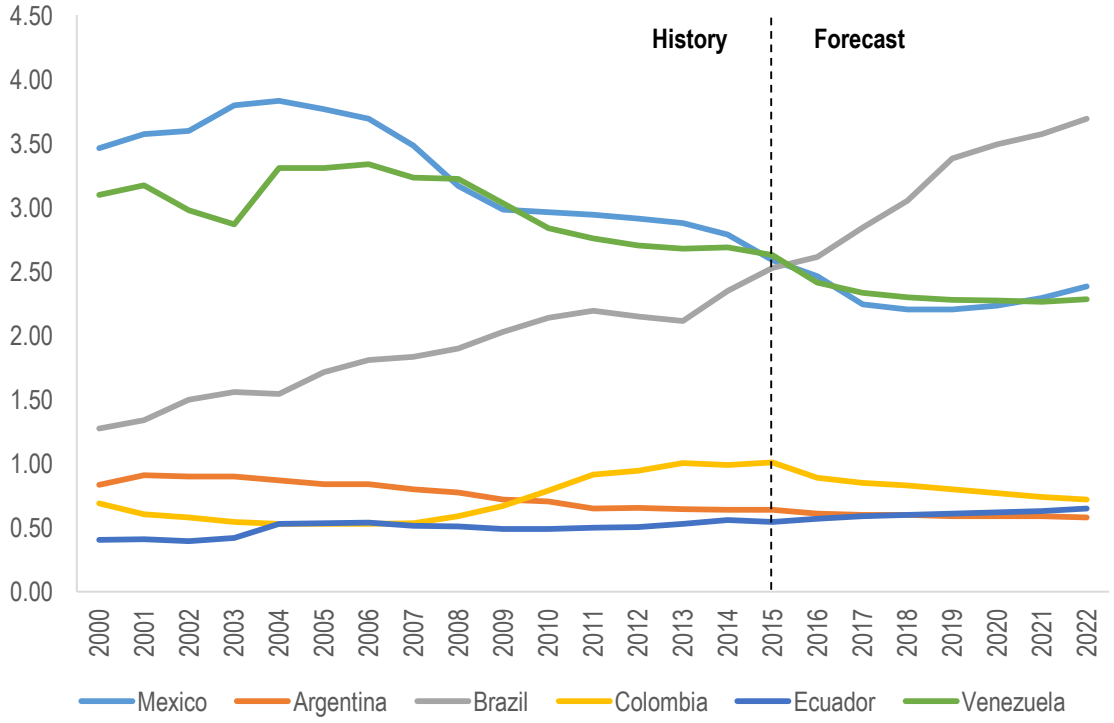
[11] Jason Bordoff and Akos Losz (2016), "The Benign Energy Superpower? The United States Turns On the Gas," *Foreign Affairs*, March 4, 2016, https://www.foreignaffairs.com/ articles/2016-03-04/united-states-turns-gas.
[12] Jason Bordoff and Akos Losz (2016), "If you build it, will they come? The competitiveness of US LNG in overseas markets," Center on Global Energy Policy, Columbia SIPA, November 2016, p.7-8, http://energypolicy.columbia.edu/sites/default/files/energy/Competitiveness%20of%20US%20LNG%20in%20Overseas%20Markets.pdf.
[13] Jason Bordoff and Akos Losz (2016), "The Benign Energy Superpower? The United States Turns On the Gas," *Foreign Affairs*, March 4, 2016, https://www.foreignaffairs.com/ articles/2016-03-04/united-states-turns-gas

regasification (FSRU) technology has recently emerged as the quickest, cheapest and most flexible way to take advantage of this newfound supply, enabling emerging economies to import gas at a fraction of the time and cost than would be the case with traditional onshore LNG import terminals. South America is already the biggest regional market in terms of floating LNG regasification capacity, and this will further expand with the addition of at least two new FSRU terminals (in Brazil and Uruguay) over the next few years.[14] Colombia has recently joined the ranks of LNG importing countries, with the addition of a new floating terminal earlier this year.[15]

Oil and Gas Opportunities in South America

South America has the potential to be an important source of future energy supply, yet oil production has been stagnant or falling in many countries in the region (Figure 4). Falling output, combined with the recent oil price collapse, has severely strained many South American countries, providing a catalyst to undertake much-needed reforms to attract foreign investment. As Figure 5 shows, perceptions of policy risk remain a barrier to investment in much of South America.

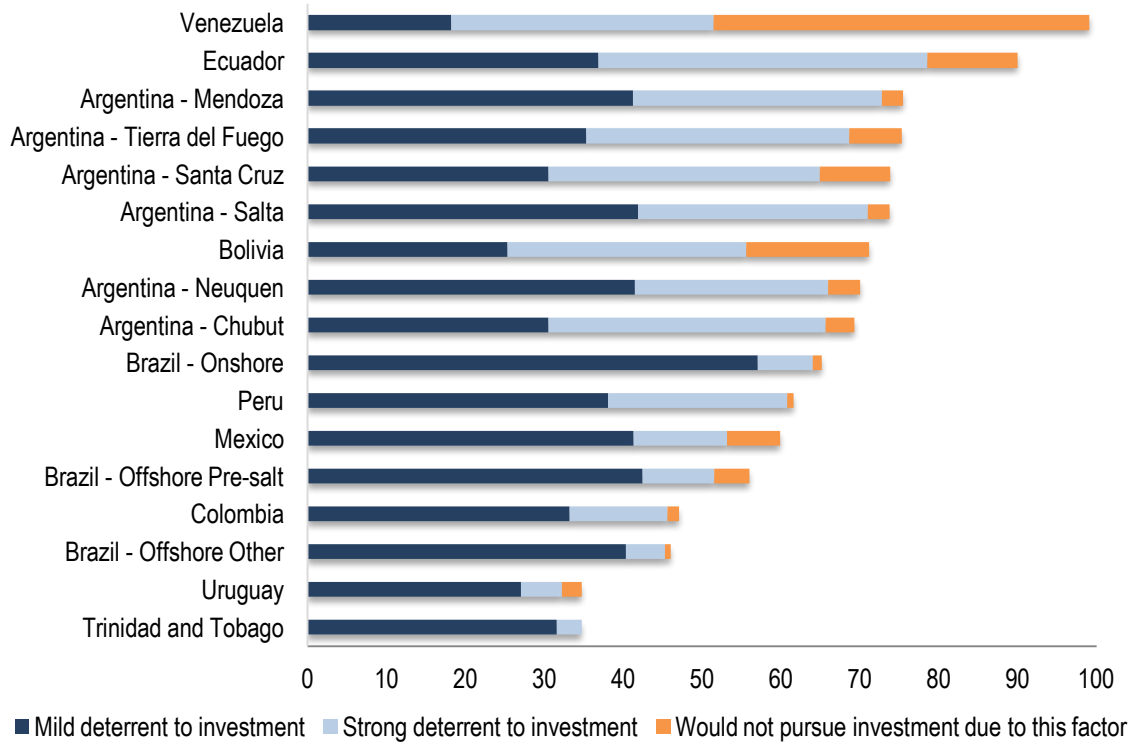
Figure 4. Oil Production in Selected Latin American Countries (million barrels per day)



Source: BP Statistical Review of World Energy, IEA

[14] Wood MacKenzie, "Global LNG - FSRU overview 2017," April 2017, p.5 and p.9
[15] International Gas Union, "2017 World LNG Report", *International Gas Union*, April 5, 2017, p.5, http://www.igu.org/news/igu-releases-2017-world-lng-report

Figure 5: Fraser Institute Global Petroleum Survey 2015 – Policy Perception index



Source: Fraser Institute

Brazil

For oil supply, Brazil's deepwater "pre-salt" oil resources are among the most attractive oil assets in the world, and economical to develop even at today's relatively low oil price levels.[16] The International Energy Agency projects Brazilian production to grow by more than 1 million b/d by 2022. But with recent regulatory changes, others are even more bullish.[17]

While impressive, even this outlook is a far cry from what many had forecasted a few years ago.[18] In a special section of the World Energy Outlook (WEO) in 2013, the IEA projected Brazil's oil output would reach 4.1 million b/d in 2020 and 6 million b/d in 2035.[19] The most recent WEO now projects production of 3.1 and 4.4 million b/d in those years, respectively.[20] Moreover, Brazil's

[16] Sabrina Valle and Peter Millard, "Petrobras Says Deep-Water Opening Luring Big Oil to Brazil," *Bloomberg Markets*, Oct 10, 2016, https://www.bloomberg.com/news/articles/2016-10-10/petrobras-says-deep-water-opening-luring-big-oil-to-brazil.
[17] Citi Research, for example, is projecting a roughly 2 million b/d rise through 2022. See Citi Commodities Research, "Energy 2022: Return of the Unconventionals," February 1, 2017, p.49.
[18] Petrobras's 2011 Business Plan projected Brazilian oil production to reach 4.9 million barrels per day by 2020. See http://www.investidorpetrobras.com.br/download/1575, p.18.
[19] IEA, "IEA World Energy Outlook 2013," *IEA*, p.481.
[20] IEA, "IEA World Energy Outlook 2016," *IEA*, p.136.

legacy fields have some of the steepest decline rates in the world, further hampering efforts to grow the nation's output.

Brazil's energy sector has been hampered for several years by the moves toward resource nationalism undertaken by the Rouseff administration, forcing Petrobras to be the operator and have 30 percent equity in all pre-salt projects, subsidizing the domestic market, imposing stringent local content requirements (often subject to corruption), and swapping reserves for equity in Petrobras. The market capitalization of the firm dropped from a peak of more than $300 billion in 2008 to less than $20 billion in early-2016, before recovering to around $67 billion today.[21]

More recently, Brazil's energy sector has suffered from the controversy preceding the impeachment of former President Dilma Rousseff last year and the epic corruption scandal at Petrobras. Petrobras is financially crippled by the largest debt burden in the global oil industry, and plans to sell off assets and reduce costs to bring that debt burden down. It has made some progress in doing so, as evidenced by the company's latest quarterly earnings report. Petrobras is ahead of schedule to meet its target of reducing net debt to 2.5 times earnings before interest, tax and depreciation (EBITDA), from 3.2 at the end of March 2017 and 5.1 in 2015.[22] Asset sales amounted to $13.6 billion in 2016, somewhat short of the company's $15 billion target,[23] and Petrobras is planning divestments totaling $21 billion in 2017 and 2018.[24]

In the aftermath of the corruption scandal engulfing Petrobras and much of the country's oil and gas sector, Petrobras's new CEO, Pedro Parente, has developed a strategic plan to restructure the company and reform its policies to deliver more accountability and transparency. The Brazilian government has introduced wide-ranging regulatory reforms to attract more foreign investment in the country's energy sector, which it views as key to boosting oil output and supporting an economic recovery. The reforms were aimed at changing the government's previously tight control over deepwater developments. International oil companies can now be the operators of deepwater projects—a role that was previously reserved for Petrobras in the most prolific areas. Local content requirements, which previously held back field development, have been eased, and the government plans as many as 10 bid rounds for new exploration blocks over the next three years.[25] While the reforms have been promising, obstacles remain, including ambiguity about local content rules and different treatment of new versus current licenses.

Reform efforts hold promise to not only help boost Brazil's output, but also open up new opportunities in Brazil's deepwater province for foreign oil companies, investment funds and service companies. For example, Statoil paid $2.5 billion for a 66 percent stake in the Caracara pre-salt field, and Total paid $2.2 billion for a package of assets that included a 22.5 percent stake in the Iara fields

[21] "Petrobras Market Cap," *Y Charts*, May 16, 2017, https://ycharts.com/companies/PBR/market_cap.
[22] Marta Nogueira and Rodrigo Viga Gaier, "Record Petrobras Operating Profit Speeds Debt Reduction," *Reuters*, May 11, 2017, http://www.reuters.com/article/us-petrobras-results-idUSKBN187352.
[23] Luciano da Costa,and Tatiana Bautzer, "Brazil's Petrobras says Missed 2015-2016 Asset Sale Target," *Reuters Africa*, Dec 28, 2016, http://af.reuters.com/article/commoditiesNews/idAFE6N14A03Y.
[24] Investor Relations Press Release, "New Divestment Portfolio," *Investor Relations PetroBras*, May 10, 2017, http://www.investidorpetrobras.com.br/en/press-releases/new-divestment-portfolio.
[25] Stephen Rassenfoss, "OTC: Brazil Energy Reforms Yield Big Lease Sales and Questions," *Journal of Petroleum Technology*, May 2, 2017, https://www.spe.org/en/jpt/jpt-article-detail/?art=2946.

and an operating 35 percent stake in the Lapa projects.[26] The reforms present new opportunities for US firms to invest as well, perhaps through joint ventures with other foreign oil companies active in Brazil.

The oil price collapse has undermined Brazil's outlook as well, although Petrobras estimates its pre-salt breakevens at around $45 per barrel (and others put it even lower). These are among the most attractive deepwater prospects in the world, although the breakeven prices and risks in Brazil remain high compared with the rest of the region, including shale. Mexico's deepwater prospects could also be a formidable competitor. Nonetheless, Brazil stands out in the region (along with Mexico) for the credibility of its new institutional framework and for attracting so much new foreign investment.

Looking forward, the International Energy Agency and others have warned that sharp cutbacks in capital investments in the oil sector during the price collapse of the last two years means that new supply may not be developed to meet rising demand. Notwithstanding the likely rapid rise of shale, oil markets could be tight by the end of the decade. If demand growth remains even moderately strong, US shale oil alone likely will not be sufficient to meet it, and higher prices could trigger even more investment in unconventional resources like Brazil's pre-salt fields.

While Brazil had been self-sufficient in natural gas through the end of the 1990s, it has since imported growing volumes of Bolivian pipeline gas and, more recently, LNG. Development of the pre-salt oil reserves will also yield large volumes of associated gas, and developing the necessary infrastructure to accommodate that gas remains a challenge. A major expansion of deepwater production will require some combination of offshore evacuation infrastructure, onshore gas processing, greater domestic demand, and LNG export facilities. Whether domestic politics may limit export opportunities in the face of rising domestic import needs, as seen in other countries, is another political risk for international firms.

Argentina

The success of Argentina's shale oil and gas developments also crucially depends on foreign capital and technology. The country's Vaca Muerta shale play is one of the most promising shale resources in the world.[27] The area has seen increased activity in recent years, not least thanks to the active participation of international oil majors, such as Chevron, ExxonMobil and Shell, as well as the major US-based oilfield service companies, such as Halliburton, Baker Hughes and Schlumberger. After several years of shale drilling, the performance of the most recently drilled wells rivals that of the Eagle Ford shale formation in the US, according to Morgan Stanley, and horizontal drilling is economically viable at today's prices and drilling costs.[28] Horizontal well costs have fallen by half since 2015—although significant infrastructure, management, and cost issues remain.[29]

[26] Justin Jacobs, "Trying to right the Petrobras ship," *Petroleum Economist*, March 8, 2017.
[27] Philippe A. Charlez, "Geopolitics of Unconventional Resources Outside North America," Society of Petroleum Engineers, 2016, p.3-5, https://www.onepetro.org/conference-paper/SPE-181405-MS.
[28] Morgan Stanley Research, "YPF's Vaca Muerta: Alive and Kicking!," *Morgan Stanley*, March 29, 2017, p.4.
[29] Goldman Sachs Equity Research, "YPF Sociedad Anónima (YPF): Assessing productivity/efficiencies in Vaca Muerta; 1Q2017 preview," *Goldman Sachs*, May 9, 2017.

Four years after the first pilot project, shale production reached 62,000 barrels of oil equivalent per day, representing around 5 percent of Argentina's output.[30] This growth was achieved in the face of a challenging political, regulatory and oil market environment, which is improving. Moreover, just as US shale output was consistently underestimated, it is reasonable to expect that technology and productivity improvements will bring down costs and increase the production potential in Argentina as well. Fewer than 100 horizontal wells have been drilled in the Vaca Muerta, compared with nearly 20,000 in the Eagle Ford.

Nevertheless, ramping up production at Vaca Muerta will require a sharp increase in drilling and foreign investment. Developing Vaca Muerta's shale resources requires capital expenditures of between $10-15 billion annually, according to industry estimates. Foreign investment also brings much-needed technology and expertise. (Shell's CEO Ben van Beurden recently spoke at the CERAWeek industry conference in Houston about the company's first remotely-drilled well in Argentina's Vaca Muerta play, which was controlled by Shell engineers sitting in Calgary. This well was also Shell's cheapest horizontal well in Argentina at the time).[31]

Attracting foreign investment will require continued improvement in the political and regulatory landscape—especially given the competition for capital investments from other regions with attractive oil and gas resources. Political risk has long loomed as a major risk in Argentina, as seen with the prior administration's renationalization of YPF from Repsol in 2012. The country has one of the worst historical records for respecting oil contracts in the industry and is notorious for its political volatility. One advantage of shale is that sunk costs are smaller and capital recovery is faster than in conventional oil production, so the expropriation risks are comparably lower.

Argentina's legislative elections in October 2017 represent a key milestone for the continuity of the Macri administration's reform program. Rigid labor contracts have been seen as a driver of low productivity, but unions recently agreed to make changes in new contracts for unconventional oil and gas activities aimed at boosting productivity and lowering drilling costs. More broadly, Argentina's political and economic challenges over the last several years, including the lack of access to financial markets, have adversely impacted the business and investment climate. The current government is undertaking much-needed macro and fiscal adjustments, but economic challenges at home remain an obstacle. The government has also maintained artificially high crude oil and pump prices with the goal of stimulating production and employment, but history, including in the US, shows that price controls do more harm than good over time, and markets will need to be liberalized.[32]

Unconventional gas in Argentina is still in early stages, but the government is trying to promote foreign investment with a pricing incentive scheme. Boosting Argentina's gas output is key to reduce

[30] Morgan Stanley Research, "YPF's Vaca Muerta: Alive and Kicking!," *Morgan Stanley,* March 29, 2017, p.4.
[31] "Oil Struggles to Enter the Digital Age," *The Economist*, April 6, 2017, http://www.economist.com/news/business/21720338-talk-digital-oil-rig-may-be-bit-premature-oil-struggles-enter-digital-age.
[32] Jason Bordoff (2016), "America's Energy Policy - From Independence to Interdependence," *Horizons: Journal of International Relations and Sustainable Development*, Autumn 2016, Issue No. 9, http://www.cirsd.org/en/horizons/horizons-autumn-2016--issue-no-8/americas-energy-policy-from-independence-to-interdependence.

a growing dependence on imported gas—quite a turnaround from its position as a net gas exporter prior to 2004. As one example, the Argentina-Chile gas pipeline was built 20 years ago to supply Chile's gas needs from Argentinian production, but is now used to transport gas imported by Chile as LNG, to Argentina. Given a decade-long decline in domestic gas production, Argentina relies on costly LNG and imported gas from Bolivia for more than one-fifth of its gas use. This is not only a drag on the economy, but also presents energy security concerns. Boosting shale oil and gas output has the potential to eliminate Argentina's sizeable energy trade deficit, which has gone from a $6 billion surplus to a $6 billion deficit over the last decade.[33] The government incentive program that pays $7.50 per million BTU for gas production has been extended through 2018 at the current rate, and will be gradually reduced to $6 per million BTU by 2021 before market prices take effect from 2022.[34]

Another key to reducing this energy trade deficit is curbing domestic demand in Argentina. The Macri administration is aiming to do that through increases of gas and electricity tariffs towards international levels. Liberalization of gas and power prices has been at the heart of the country's macroeconomic adjustment.[35] Eliminating fossil fuel energy consumption subsidies is a welcome development, as it not only eases strain on government coffers (gas subsidies cost the government $5.7 billion in 2015),[36] but also reduces energy use and greenhouse gas emissions.[37] Although the Macri administration has slowed the pace of price adjustments, it is still aiming for full liberalization by the end of the administration's first term in office.

Venezuela

As this committee knows well, Venezuela is on the brink. The situation in Venezuela is tragic, as the nation descends further into crisis, and it could completely unravel into even more violence and chaos at any moment. The consequences matter enormously for the health and safety of the Venezuelan people, for the stability and economies of neighboring countries, and for global oil markets and US dependence on Venezuelan heavy oil.

Venezuela has the largest oil reserves in the world,[38] but the oil price collapse, falling production, and chronic mismanagement of PDVSA and the wider economy has contributed to severe economic crisis, rapid inflation, and shortages of food, medicine and other basic goods. The

[33] Morgan Stanley Research, "YPF's Vaca Muerta: Alive and Kicking!," *Morgan Stanley*, March 29, 2017, p.21.
[34] Charles Newbery, "Argentina's Tecpetrol Plan 150-well Vaca Muerta Gas Program," *S&P Global Platts*, March 23, 2017, https://www.platts.com/latest-news/natural-gas/buenosaires/argentinas-tecpetrol-plans-150-well-vaca-muerta-21249905.
[35] Benedict Mander, "Argentina Raises Electricity Tariffs by up to 148% to Fight Deficit," *Financial Times*, January 31, 2017, https://www.ft.com/content/fa0718c7-a223-3af5-a1c3-4c3f885697a3.
[36] "Argentina Proposes 203 pct. Hike in Natural Gas Prices at Public Hearing," *Hoy – The San Diego Union Tribute*, September 16, 2016, http://www.sandiegouniontribune.com/hoy-san-diego/sdhoy-argentina-proposes-203-pct-hike-in-natural-gas-2016sep16-story.html.
[37] Toshiyuki Shirai, "Commentary: Putting the Right Price on Energy", *International Energy Agency*, April 27, 2017, https://www.iea.org/newsroom/news/2017/april/commentary-putting-the-right-price-on-energy.html.
[38] Note that many experts believe Venezuela's oil reserves are vastly overstated and mostly consist of extra-heavy oil—although even if adjustments are made, Venezuela still has some of the largest reserves in the world.

accumulated decline in GDP is estimated at 26 percent since 2013.[39] In what was once Latin America's richest country, people are now starving and dying of easily treatable illnesses.[40] Venezuela depends on oil for more than 90 percent of export revenues.

Venezuela already poses a major risk to world oil markets, with production slipping from around 2.4 million b/d last year to around 2 million b/d today. A crippling electricity crisis last year threatened PDVSA operations, and severe cash constraints mean that PDVSA struggles to maintain its oil export terminals, refineries and other infrastructure. Although it has tried hard to attract foreign investment, the outlook is bleak.

The strain of low oil prices on PDVSA's finances threaten an even more crippling impact on the company's production moving forward.[41] PDVSA is already in arrears with suppliers and JV partners, preventing much needed investment to maintain supply. PDVSA may well default later this year. If it does, oil production could be expected to decline even more steeply, as it would struggle to import diluent to mix with Venezuelan heavy crude, or pay for essential oilfield service operations.

At the heart of PDVSA's financial strains are high bond debt service payments which the company has prioritized against payment to other creditors and suppliers. PDVSA fears that a default could lead to disruption of its tankers or receivables from disgruntled bondholders wanting to seize Venezuelan assets abroad. But inability to continue financing itself forced PDVSA into a debt swap last year, and the company had to put up its refinery assets in the US as collateral for the transaction. The Russian oil company Rosneft also received a minority share of Citgo, owned by Venezuela, as collateral for its $1.5 billion loan to PDVSA last year. A potential consequence of default may be that Rosneft takes control of Citgo, a major refiner in the US.[42] As this Committee has emphasized in the past, the potential energy security implications of such a development warrant immediate scrutiny by the Trump Administration.

Two months into street protests, there is much more talk of regime change. The government's severe financial strain makes it more difficult to buy the support of the military. The opposition appears more united than ever, and President Maduro's decisions, like calling a constitutional assembly, have fueled protests even further.

Although oil markets today are buffered by high inventory levels, further disruptions in Venezuela's oil output pose risks of potential oil price spikes in the years ahead, which would thus impact US

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[39] IMF World Economic Outlook Database, *IMF*, April 2017, https://www.imf.org/external/pubs/ft/weo/2017/01/weodata/index.aspx.
[40] Juan Forero, "Venezuela is Starving", *The Wall Street Journal*, May 5, 2017, https://www.wsj.com/articles/venezuela-is-starving-1493995317.
[41] Luisa Palacios (2016), "Venezuela's Growing Risk to the Oil Market," Center on Global Energy Policy, August 2016, p.3, http://energypolicy.columbia.edu/sites/default/files/energy/CGEP_VENEZUELA'S%20GROWING%20RISK%20TO%20THE%20OIL%20MARKET_August%202016.pdf.
[42] Meghan Gordon, "US Congress Calls for CFIUS Review of Rosneft's Potential Stake in Citgo," *S&P Global Platts*, April 7, 2017, https://www.platts.com/latest-news/oil/washington/us-congress-calls-for-cfius-review-of-rosnefts-21395865.

consumers at the pump—yet another reason why the US Strategic Petroleum Reserve remains a vital national security asset despite the recent decline in US oil imports resulting from the shale boom.[43]

Colombia

Colombia has enjoyed a remarkable transformation in its oil and gas sector since regulatory reforms in 2003 turned around declining production. These included Ecopetrol's transition from a state-owned company to an independent and integrated entity, the creation of an independent regulatory agency, and the shift from production sharing contracts to a concession-based regime based on taxes and royalties. In response, oil production nearly doubled from 2005 to 2013.

But today, the oil and gas sector again faces declining output and reserves. Many nations have suffered from the fall in oil prices, but oil field capex in Colombia has fallen at an especially rapid rate. With projections for continued production declines, the government is actively seeking ways to attract more investment with new fiscal incentives offshore. The historic peace agreement with FARC also paves the way to a new era of security and prosperity that can attract further investment into Colombia's energy sector. At the same time, however, the incorporation into the political process of former rebel groups (namely FARC and ELN), which are opposed to foreign investment, may present a barrier to continued inflows of outside capital. As new governance arrangements take hold, it will be important to balance the need for consultation with local communities with the need for industry to have a clear understanding of the regulatory and licensing process moving forward so they can plan and invest.

Colombia also has substantial unconventional oil and gas resource potential with current exploration activities concentrated in the Middle Magdalena Basin. Yet the development of unconventional resources faces intense opposition from environmental, indigenous and other groups.[44] Colombia's Environment Minister recently said the country may not be ready for shale development, although he was reportedly rebuked by President Santos, sending conflicting signals about the government's position.[45] If Colombia is to develop its shale resources, the government will need to maintain a strong regulatory regime aimed at safe and responsible production and engage with local communities to address their important concerns. At the same time, to encourage private sector investment, it should also implement regulations consistently, provide a stable regulatory regime, and enforce existing laws.

In early May, Ecopetrol announced a major offshore gas discovery in Colombia's Caribbean Sea—the largest find in Colombia's oil and gas sector in three decades.[46] President Santos trumpeted the

[43] Jason Bordoff (2015), Congressional Testimony Before the Committee on Energy and Natural Resources, United States Senate, 1st Session, 114th Congress, October 6, 2015, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=6ffc0bd9-49b8-485d-b961-439ac6b38bd2.
[44] Alianza Colombiana Libre de Fracking, "To: President Juan Manuel Santos Calderon," March 27, 2017, https://redjusticiaambientalcolombia.files.wordpress.com/2017/03/2017-03-14-carta-presidente-santos_finalconlogos.pdf.
[45] "Colombia No Esta Preparada para el Fracking, Dice MinAmbiente," *RCN Radio*, March 22, 2017, http://www.rcnradio.com/medioambiente/colombia-no-esta-preparada-para-el-fracking-dice-minambiente/.
[46] Chris Kraul, "Colombian President Announces Largest Gas Find in Decades," *S&P Global Platts*, May 3, 2017, https://www.platts.com/latest-news/natural-gas/bogota/colombian-president-announces-largest-gas-find-21625450.

find in a televised press conference and said it would enable Colombia to be self-sufficient in gas in the coming years.[47] Colombia's gas production has declined in recent years, and it is projected to be a net importer in the near future.[48] New sources of gas supply, from shale or offshore, have the potential to meet Colombia's rising demand with domestic resources.

Other

It is beyond the scope of this testimony to go into detail into the outlook for every South American country. Other countries to note include Guyana[49] and Suriname,[50] with the offshore areas of these countries emerging as one of the region's top deepwater frontiers—although the dispute with Venezuela over claims to the offshore territory will need to be resolved. Chile also holds much promise as a new shale gas province.[51]

Renewable Energy Opportunities

South America is not only important for fossil fuel production and trade, but it is also an important growth region for renewable energy. The region already generates more than 60 percent of its power from renewable sources, the highest in the world, according to the IEA.[52] The vast majority of this comes from large hydropower plants. In 2015, Brazil generated 60 percent of its electricity from hydropower alone. The same share was as high as 74 percent in Uruguay and Costa Rica in 2015. However, further large-scale hydropower developments are increasingly constrained by reliability issues,[53] as was demonstrated during Brazil's multi-year drought between 2014 and 2016.[54]

In South America more than in any other region in the world, the reliability of large amounts of zero-carbon energy is being negatively affected by the unfolding impacts of climate change. Droughts have become increasingly frequent and severe, so water is not always available when needed. Moreover, hydropower is challenged by growing public opposition against hydro projects in

[47] "Latest Find off Colombia Could Delineate New Gas Province," *Newsbase*, Ed. Ryan Stevenson, Week 18, Issue. 662, May 9, 2017, http://newsbase.com/topstories/latest-find-colombia-could-delineate-new-gas-province.
[48] Anouk Honoré (2016), "South American Gas Markets and the role of LNG," Oxford Institute for Energy Studies, October 2016, p.127-129, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/10/South-American-Gas-Markets-and-the-Role-of-LNG-NG-114.pdf.
[49] Clifford Krauss, "With a Major Oil Discovery, Guyana is Poised to Become Top Producer," *The New York Times*, January 13, 2017, https://www.nytimes.com/2017/01/13/business/energy-environment/major-oil-find-guyana-exxon-mobile-hess.html.
[50] Ed Crooks and Andres Schipani, "Guyana oil prospects stir friction between Venezuela and Exxon Mobile," *The Financial Times*, March 20, 2017, https://www.ft.com/content/013bfd26-0a8e-11e7-ac5a-903b21361b43.
[51] "Conoco Phillips eyes Chile and Colombia," *UpStream*, http://www.upstreamonline.com/hardcopy/1192210/conocophillips-eyes-chile-and-colombia.
[52] IEA, "Medium-Term Renewable Energy Market Report 2016", *IEA*, p.80.
[53] Slade Johnson and Kirstin Berndt, "Hydroelectric Plants Account for more than 70% of Brazil's Electric Generation," Today in Energy – *EIA*, August 11, 2016, https://www.eia.gov/todayinenergy/detail.php?id=27472.
[54] Caroline Stauffer, "Drought ends in Brazil's Sao Paulo but future still uncertain," *Reuters*, February 18, 2016, http://www.reuters.com/article/us-brazil-water-idUSKCN0VR1YJ.

environmentally sensitive areas. Brazil and Chile have recently had to cancel major dam projects on environmental grounds.[55]

Non-hydro renewables currently represent a small portion (less than 10 percent) of the region's electricity mix. But solar and wind capacity have seen healthy growth in recent years and are set to expand further at a rapid pace in the medium-term, not least thanks to the region's excellent wind and solar resources.[56] The IEA predicts that wind capacity will increase 2.4-fold between 2015 and 2021 across the region, while solar PV capacity is expected to grow more than 6-fold over the same period.[57] Renewable developers in the region face a host of challenges, including high interest rates, financing difficulties and macroeconomic risks (in the aftermath of recessions in Brazil and Argentina in 2016) as well as a lack of grid interconnectivity in many parts of the region. The lack of gas-fired generation capacity and pipeline infrastructure—which could be an important means to balance the intermittent energy supply from solar or wind—can also hinder the deployment of wind and solar power across the region.[58] If these issues can be resolved then the IEA reckons that the region, as a whole, could see 20 percent more renewable capacity additions through 2021 than in the agency's base case.

Countries such as Chile, Brazil, Mexico and Argentina have recently adopted regulatory reforms to encourage renewable energy without subsidies. Chile, for example, has encouraged renewable investment by auctioning smaller contracts, and has a regulatory framework trusted by investors. It has set a target of producing 20 percent of its electricity from non-hydro renewable sources by 2025. In Argentina, the Macri administration has also placed its bets on renewable energy. Congress last year passed a bill aimed at increasing the share of renewables in Argentina's energy mix to 20 percent by 2025. The results of a bidding process launched last year for new renewable investments was promising, and a new round is scheduled for May 2017.

Renewable energy in South America is beneficial not only for environmental reasons, but also importantly for energy security and economic growth in the region. Despite the region's rich fossil fuel resources, many South American countries are large energy importers. Chile is one of these countries. As a result of its latest auction of energy contracts, prices in 2025 should be a third lower than they are now, according to my Columbia colleague Andrés Velasco, a former finance minister.[59] Large opportunities exist to reduce energy demand growth in South America through energy pricing reforms, energy efficiency standards, and improved mass transit systems, among other measures.

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[55] Felipe Iturrieta and Alexandra Ulmer, "Chile Rejects HidroAysen, Hydropower Project can Appeal," *Reuters*, June 10, 2014, http://www.reuters.com/article/us-chile-hidroaysen-idUSKBN0EL1WR20140610;
John Vidal, "Major Amazon dam opposed by tribes fails to get environmental licence," *The Guardian*, August 5, 2016, https://www.theguardian.com/environment/2016/aug/05/major-amazon-dam-brazil-opposed-by-tribes-fails-get-environmental-license.

[56] "Latin America is set to become a leader in alternative energy," *The Economist*, December 10, 2016, http://www.economist.com/news/americas/21711307-power-andean-sun-latin-america-set-become-leader-alternative-energy.

[57] IEA, "Medium-Term Renewable Energy Market Report 2016", *IEA*, p.84.

[58] Macquarie Research, "Latin America power market: Should I stay or should I go?," October 5, 2016, p.21.

[59] "Latin America is set to become a leader in alternative energy," *The Economist*, December 10, 2016, http://www.economist.com/news/americas/21711307-power-andean-sun-latin-america-set-become-leader-alternative-energy.

Brazil was an early pioneer of biofuel production, and remains the world's largest sugarcane ethanol producer and second largest biofuel producer (after the US) to this day.[60] Brazil's current ethanol mandate stands at 27 percent (and its biofuel mandate for diesel fuel at 7 percent), but thanks to the country's nationwide ethanol infrastructure, biofuel use is even more widespread in the passenger car segment. More than 70 percent of Brazil's passenger car fleet is equipped with ethanol-powered or flex fuel engines,[61] which can run on gasoline, bioethanol, or any combination of the two.[62] In 2013, as many as 94 percent of new passenger vehicle sales were flex fuel vehicles.[63] Biofuels in Brazil accounted for 17 percent of the transport sector's final energy consumption in 2014, compared with 2.8 percent globally.[64]

With the right policies and financing arrangements, South American countries have the potential to lead the clean energy transition and demonstrate that deep decarbonization is not only possible, but also highly compatible with rapid economic development. Costa Rica has an energy policy target to become entirely carbon-neutral by 2021.[65] The country already produces 98 percent of its electricity from renewable sources,[66] and it is currently drawing up plans to electrify much of the country's transportation sector in the next few years.[67] Uruguay plans to achieve carbon neutrality by 2030,[68] and it comes close to Costa Rica in generating more than 90 percent of its electricity from renewable sources today.[69]

Realizing a Clean, Secure and Prosperous Energy Future

As discussed above, South America is rich in energy resources and opportunities—from oil and gas to renewables. While every country faces unique circumstances and challenges, broadly speaking, there are a few common priorities on which South American countries should focus—and on which the US can partner with South American nations to provide support and assistance.

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[60] IEA, "IEA Oil 2017", *IEA*, p.143-144.
[61] USDA Foreign Agricultural Service, "Brazil – Biofuels Annual: Annual Report 2016," GAIN Report No. BR16009, August 12, 2016, p.16, https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Sao%20Paulo%20ATO_Brazil_8-12-2016.pdf.
[62] Francisco Posada and Cristiano Façanha (2015), "Brazil Passenger Vehicle Market Statistics," The International Council on Clean Transportation, October 2015, p.13, http://www.theicct.org/sites/default/files/publications/Brazil%20PV%20Market%20Statistics%20Report.pdf.
[63] Ibid., p.4.
[64] IEA, "World Energy Outlook 2016", *IEA*, p.550, p.562 and p.622.
[65] "Costa Rica pledges carbon neutrality by 2021," *Climate Action UN*, January 20, 2017 http://www.climateactionprogramme.org/news/costa_rica_pledges_carbon_neutrality_by_2021.
[66] Kelvin Ross, "Costa Rica Plans to become carbon neutral by 2021," *Power Engineering International*, January 17, 2017, http://www.powerengineeringint.com/articles/2017/01/costa-rica-plans-to-be-carbon-neutral-by-2021.html.
[67] David Nield, "Costa Rica went 250 days in 2016 without burning any fossil fuels," *Science Alert*, January 3, 2017, http://www.sciencealert.com/costa-rica-went-250-days-in-2016-without-burning-any-fossil-fuels.
[68] Veronica Firme, "Uruguay puts high priority on renewables," *Buenos Aires Herald*, November 21, 2015, http://buenosairesherald.com/article/203404/uruguay-puts-high-priority-on-renewables;
Cole Melino, "Uruguay powers nearly 100% of Electricity from Renewables," *Eco Watch*, December 4, 2015, http://www.ecowatch.com/uruguay-powers-nearly-100-of-electricity-from-renewables-1882128501.html.
[69] IEA, "Medium-Term Renewable Energy Market Report 2016", *IEA*, p.80.

Economic diversification

While countries like Brazil, Colombia, Argentina and others have the potential to ramp up their hydrocarbon production sharply, bringing in much needed investment and revenue, they should not forget the economic strain of the most recent oil price collapse. The oil industry has long known cycles of boom and bust,[70] and there are good reasons to expect that oil prices, moving forward, may be more volatile than in the past.[71] Even as these countries increase production, they must prioritize efforts toward economic diversification to reduce the government's dependence on oil and gas revenue and better insulate themselves from inevitable price fluctuations in the future. Many Gulf Arab countries, for example, are now undertaking economic reform programs to do just that, catalyzed by the fiscal pressures of the recent oil price collapse.

In addition to diversification, countries also must plan for a rainy day by building up fiscal reserves during boom times. Unfortunately, resource nationalism and mishandling of resource wealth has a long history in many countries across Latin America. The plight of Venezuela should remind current and prospective petrostates of the dangers of the resource curse. Guyana, as just one example, has recently discovered vast hydrocarbon reserves that can transform the country's economy—for better or for worse—and should take note to avoid such pitfalls. The potential for another resource windfall should not induce Argentina to ease off on economic reforms,[72] and Colombia could make its economy more resilient to falling oil revenues with tax reforms, spending cuts and further incentives for foreign investments.

Regulatory reform

There is a long history of countries with large resource endowments setting onerous and aggressive rules for foreign investment, in an effort to capture the bulk of the rents for themselves. While these should understandably be treated as national resources that benefit the nation's people, it is also important for countries not to forget that there is an exceptionally competitive global market to attract capital, technology and investment—and an abundance of opportunities. In order to attract much-needed investment, countries should make their regulatory regimes competitive, transparent, stable and predictable. Brazil's recent efforts to allow foreign ownership and reduce local content requirements are a good example.

Ensuring responsible development

Ensuring responsible development of the region's vast hydrocarbon resources through strong, cost-effective environmental and safety regulations has to be a top priority for governments in South America. This is important not only to protect air and water, public health, and the environment, but also to provide industry with a "social license" to operate and build public trust and confidence that oil and gas production will be done safely. And from the perspective of responsible companies, they

[70] Robert McNally (2017), *Crude Volatility: The History and the Future of Boom Bust Oil Prices*, Columbia University Press.
[71] Jason Bordoff (2016), Congressional Testimony Before the Committee on Energy and Natural Resources, United States Senate, 2nd Session, 114th Congress, April 26, 2016, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=30FCC68F-7842-4501-85C0-BEC3FF009DFC.
[72] "A Century of Decline," *The Economist*, February 17, 2014, http://www.economist.com/news/briefing/21596582-one-hundred-years-ago-argentina-was-future-what-went-wrong-century-decline.

protect against a "race to the bottom," in which competitors profit by engaging in risky or irresponsible practices. That is why, if regulations are well-crafted, with benefits that exceed costs, they are in the industry's best interest.

Nonetheless, energy production remains as controversial in South America, as here at home, especially shale resources in countries like Colombia and Argentina. Specifically, governments across the region need to ensure they have put in place smart regulations so that development is done according to the highest standards of safety and environmental protection. They also need to engage in productive consultations with local communities so that important and real concerns can be addressed. At the same time, they need to enforce existing laws and create a transparent and stable permitting and licensing regime to facilitate industry investment in long-term projects.

Climate action

South America is especially vulnerable to global climate change, given the region's susceptibility to extreme weather events and natural disasters. Earlier this year, Bolivia experienced the longest and deepest drought in the country's history, triggering a state of emergency,[73] protests and rationing of drinking water across major cities for months.[74] Recent floods and destructive mudslides across Peru, Ecuador and Colombia have been attributed to climate change by political leaders in these countries.[75] According to a 2015 study by the Pew Research Center, Latin Americans are the most concerned in the world about climate change.[76]

To address these vulnerabilities, countries across the region need to make sure to build a robust, resilient energy infrastructure that can not only accommodate a very high share of intermittent renewable capacity, but is also resilient to the adverse impacts of climate change. The region should also continue to address the problems of deforestation and land use change-related emissions, which, together, account for two-thirds of Latin America's total greenhouse gas emissions, twice as much as energy consumption.[77]

And South America should continue to engage actively in global climate negotiations. Climate cooperation between the US and Latin America cannot only help make the region more resilient and sustainable, but it can also help us succeed in energy and climate diplomacy. The bilateral climate

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[73] Jan Rocha, "Shrinking glaciers cause state-of-emergency drought in Bolivia," *The Guardian*, November 28, 2016, https://www.theguardian.com/environment/2016/nov/28/shrinking-glaciers-state-of-emergency-drought-bolivia.
[74] John Vidal, "As water scarcity deepens across Latin America, political instability grows," *The Guardian*, March 1, 2017, https://www.theguardian.com/global-development-professionals-network/2017/mar/01/water-scarcity-latin-america-political-instability.
[75] Nicholas Casey and Andrea Zarate, "Mud erased a village in Peru, a sign of larger perils in South America," *The New York Times*, April 6, 2017, https://www.nytimes.com/2017/04/06/world/americas/peru-floods-mudslides-south-america.html.
[76] Bruce Stokes, Richard Wike, and Jill Carle, "Global concerns about climate change, Broad support for limiting emissions," *Pew Research Center*, November 5, 2015, http://www.pewglobal.org/2015/11/05/global-concern-about-climate-change-broad-support-for-limiting-emissions/.
[77] Lisa Viscindi and Rebecca O'Connor, "How can Latin America move to low-carbon energy?" *The New York Times*, November 24, 2016, https://www.nytimes.com/2016/11/24/opinion/how-can-latin-america-move-to-low-carbon-energy.html.

agreement between the US and Brazil in 2015, for example, was instrumental to the successful negotiation of the Paris Agreement later that year.[78]

Reforming subsidies and reducing demand

Energy subsidies have been an important driver of fiscal deficits in many Latin American countries in recent years.[79] As noted above, some, like Argentina, have taken steps recently to reform those subsidies. The oil price collapse has provided an especially good opportunity for price reforms, as subsidies can be eased with less of a concomitant increase on consumer fuel spending.[80] Energy subsidies are not only a strain on government finances, but also encourage inefficient consumption, thus reducing resources available for export or increasing imports, as well as increasing greenhouse gas emissions. Further efforts to reform fuel prices can help fiscal balances as well as the environment. While policies are needed to help low-income consumers deal with higher energy prices, a wide body of research and evidence shows that subsidies are regressive and largely benefit wealthier consumers.

Moreover, energy subsidy reform is just one measure to reduce domestic energy demand and greenhouse gas emissions. Policies that boost energy efficiency or encourage mass transit use, for example, could present further economic, energy security and environmental opportunities for South American countries.

Conclusion

South America presents enormous opportunities in energy. But it also faces acute risks that can affect regional stability, global energy markets, and the environment. The US has a strong national interest in helping South America meet its energy development goals safely and responsibly, while together taking more rapid action to address the urgent threats of climate change and the transition to a low-carbon economy.

Continued diplomatic and programmatic engagement between the US government and South American countries is important, through initiatives like the Energy and Climate Partnership of the Americas (EPCA), to help promote open markets, responsible energy development, and action on climate change. Ministers from the ECPA countries—namely all of the countries in the Americas—will gather in Chile on September 7-8, an opportunity for the US to reconfirm its continuing commitment to regional collaboration. This can help ensure that the Americas remains an area of strong and constructive engagement on energy policy, technology, and environmental protection.[81]

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[78] Office of the Press Secretary, Press Release: "U.S. – Brazil Joint Statement on Climate Change," The White House, June 30, 2015, https://obamawhitehouse.archives.gov/the-press-office/2015/06/30/us-brazil-joint-statement-climate-change.

[79] Gabriela di Bella, et al. "Energy Subsidies in Latin America and the Caribbean: Stocktaking and Policy Challenges," *International Monetary Fund*, February 12, 2015, http://www.imf.org/external/pubs/cat/longres.aspx?sk=42708.0.

[80] Keith Benes et al. (2015), "Low Oil Prices: An Opportunity for Fuel Subsidy Reform," *Center on Global Energy Policy*, October 2015, http://energypolicy.columbia.edu/sites/default/files/energy/Fuel%20Subsidy%20Reform_October%202015.pdf.

[81] For more information on the Energy and Climate Partnership of the Americas (ECPA), see: http://www.ecpamericas.org.