POWERING FORWARD

North America's Energy Resurgence

Business Roundtable℠

More Than Leaders. Leadership.

NOVEMBER 2015

JUST THE FACTS

The North American energy landscape has changed dramatically.

In *Powering Forward: North America's Energy Resurgence,* the Business Roundtable explores how technological breakthroughs have unlocked new energy resources and fundamentally transformed North America's energy landscape.

- **North American resources.** North America's proven oil reserves have nearly quadrupled since 2000; natural gas reserves are up more than 60 percent.
- **U.S. shale gas.** U.S. natural gas output surged 42 percent between 2005 and 2014, driven by unconventional shale and tight gas production.
- **Alberta's oil sands.** Canada's crude oil production has increased by nearly 60 percent since 2000 thanks to Alberta's oil sands, which are expected to produce 5.2 million barrels per day by 2030.
- **Unconventional resources in Mexico.** Mexico's technically recoverable shale gas resources are the sixth largest in the world — an estimated 545 trillion cubic feet.

Fully leveraging this energy revolution can generate benefits that ripple through the North American economy.

- The U.S. oil and gas industry supports roughly **$1.2 trillion in economic activity** — the equivalent of nearly 7 percent of U.S. GDP.
- Alberta's oil sands support **514,000 jobs** and are expected to support **more than 800,000 by 2028.**
- Household and business savings associated with lower natural gas prices **boosted real disposable income by $1,200** for the average American household in 2012.
- If successful, energy sector reforms could double Mexico's oil production and boost GDP by **1 percentage point per year** via increased investment and lower energy prices.

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Powering Forward

North America's Energy Resurgence

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Executive Summary

Recent developments in the energy sector are rapidly reshaping the global economy, and North America is at the vanguard of this revolution. Breakthroughs in technology have expanded the frontiers of energy production and unlocked hydrocarbon resources that were considered technically and economically inaccessible just a generation ago. In particular, advances in exploration and production technologies have unlocked vast quantities of oil and natural gas throughout the region, including shale gas, tight oil, oil sands, and deepwater oil and gas in the Gulf of Mexico.

As a result of these advances, the North American energy landscape has changed dramatically in recent years, reversing expectations of declining production and ushering in a new era of energy abundance. Driven by the shale oil and gas boom in the United States and the unlocking of Canada's oil sands, North America's proven reserves and production are up significantly since 2000.

- The U.S. energy revolution began in the mid-2000s with the dawn of the shale boom. After suffering decades of decline, oil output increased by nearly 70 percent between 2005 and 2014, buoyed by robust shale and offshore production. As a result, the United States has recently reclaimed its status as the world's largest oil producer. Shale resources have also boosted proven natural gas reserves, which more than doubled between 2000 and 2014, causing U.S. natural gas production to surge 42 percent between 2005 and 2014.
- In Canada, new mining operations and rising oil prices unlocked Alberta's oil sands and triggered an oil boom at the turn of the 21st century. Canada now holds the world's third largest proven oil reserves, and crude production is up 59 percent since 2000. And while natural gas production has tapered off in recent years, unconventional gas resources represent strong potential for future growth. Specifically, Canada is thought to have an estimated 573 trillion cubic feet of technically recoverable shale gas resources — an amount that is on par with U.S. shale plays.
- Unlike the United States and Canada, Mexico has not experienced a surge in oil or gas production over the past decade. Instead, proven oil reserves have decreased by 65 percent since 2000, and natural gas production has been significantly outstripped by demand growth. However, as a result of recent energy sector reforms, Mexico has a unique opportunity to reverse its prolonged production decline by unlocking its sizeable shale and deepwater oil and gas resources.

The implications of North America's energy revolution are potentially transformative. The oil and gas industry sits at the foundation of many other industries, and the benefits of increased oil and gas production can quickly ripple throughout the economy. In particular, the new energy advantage is powering a manufacturing resurgence in the United States that is generating new investment and providing economic incentives to reshore American manufacturing jobs that were considered lost only a decade ago. Other stakeholders stand to benefit as well, as billions of dollars are invested in new businesses, thousands of dollars are saved in household energy costs, rent and royalty payments are paid to private landowners who lease mineral rights to producers, and tax and royalty revenues are generated for all levels of government. In addition, the North American energy boom promises to improve the region's energy security while reinforcing its role as a global energy leader.

For their part, the region's policymakers have an opportunity to secure and expand on these benefits by enacting policies that reflect the game-changing developments that have taken place over the last several years. It is crucial that policymakers take action to realign energy policies with the realities of today's abundant oil and gas resources, as well as recognize that North America's ability to fully capitalize on its energy advantage is predicated upon improving the integration of energy markets across the region.

Achieving these goals will require policy action on multiple fronts, including creating a more streamlined approach to approving and permitting critical infrastructure projects; improving access to energy resources; updating and rationalizing the legal and regulatory frameworks that govern energy production, processing and transportation; lifting outdated restrictions on exports; and setting effective, predictable and risk-based environmental standards. Accordingly, it is critical that policymakers, regulators, business leaders and other stakeholders work together to find consensus and capitalize on this once-in-a-lifetime opportunity to fundamentally transform the region's economy and usher in a new era of energy security.

I. Introduction

Recent developments in the energy sector are rapidly reshaping the global economy, and North America is at the vanguard of this revolution. Breakthroughs in technology have expanded the frontiers of energy production and unlocked hydrocarbon resources that were considered technically and economically inaccessible just a generation ago. In particular, advances in exploration and production technologies have unlocked vast quantities of oil and natural gas throughout the region, including shale gas, tight oil, oil sands, and deepwater oil and gas in the Gulf of Mexico.

These new resources add to an already-rich portfolio of coal, nuclear power and renewable energy that ensures a diverse and secure regional energy supply. And when combined with projected gains in energy efficiency, these developments suggest that North America has the potential to be a net exporter of energy after 2020.[1] Simply put, the North American energy landscape has fundamentally transformed from an environment of scarcity to one of abundance.

The implications of this revolution are profound. The oil and gas sector sits at the foundation of many other industries, and growth within the sector can quickly ripple throughout the broader North American economy. Moreover, increased North American oil and gas production places downward pressure on regional and global energy prices, which lowers household energy bills and improves business competitiveness. Finally, increased North American oil and gas production has the potential to enhance the region's energy security and strengthen its hand in international affairs, while also providing advantages to our strategic allies and major trading partners.

To preserve North America's energy advantage and make good on its promise, policymakers, regulators, business leaders and other stakeholders across the region must work together to make progress on the key policy challenges facing the energy sector.

And yet, despite this transformation and its potential to generate widespread economic and security benefits, the region's legal, regulatory and policy frameworks are lagging. Policymakers have been slow to pivot from a world of energy scarcity to one of abundance. To preserve North America's energy advantage and make good on its promise, policymakers, regulators, business leaders and other stakeholders across the region must work together to make progress on the key policy challenges facing the energy sector, including infrastructure constraints, environmental concerns, and outdated legal and regulatory frameworks. More must also be done to remove barriers to responsible energy development and to further integrate the region's energy system in the pursuit of a common goal: ushering in a new era of energy abundance and security for North America.

U.S. Energy Policy: A Call to Action

The United States has not passed comprehensive energy legislation in more than a decade. In the meantime, transformative changes across the energy landscape have fundamentally altered our understanding of the United States' resource potential, how energy is produced and consumed, and the prospects for North America to transform itself into a self-sufficient energy superpower. Our ability to fully capitalize on this opportunity and sustain North America's energy advantage over the long term requires action by policymakers to remove barriers to energy development and realign existing rules, regulatory frameworks and permitting processes with the new realities of today's energy systems.

In 2012, Business Roundtable embarked on an effort to re-evaluate U.S. energy policy in light of this changing energy landscape and to articulate a vision and strategy for U.S. energy policy. Based on this research and analysis, the CEOs of Business Roundtable released *Taking Action on Energy* — an assessment of the U.S. energy situation that includes a set of detailed policy recommendations to capitalize on America's strengths and enhance our energy, economic and environmental future.

Three years later, the challenges that remain to expanding energy infrastructure, accessing promising oil and gas reserves, and delivering abundant American energy to global markets only emphasize the relevance and urgency of Business Roundtable's policy priorities, including:

- **Fortify critical infrastructure** by removing impediments to the alignment of market-driven infrastructure investments with future energy production and demand, with a focus on additional pipeline infrastructure and storage capacity.
- **Streamline regulatory, permitting and approval processes** to lower the anticipated and unanticipated costs of investing in, producing, processing and transporting energy resources, while continuing to ensure public health, environmental quality and safety.
- **Open access to promising resources** by increasing access to onshore and offshore federal lands to ensure reliable supplies of coal, oil and natural gas in the coming decades.
- **Engage internationally** by promoting improved regional integration and access to international markets by supporting open and rules-based trade and investment systems, including support for exports of domestic oil and natural gas.

To review *Taking Action on Energy*, visit BRT.org/issues/energy-environment.

To review *Taking Action for America: Smarter Regulation*, visit BRT.org/issues/smart-regulation.

II. North America's Oil and Natural Gas Resource Base

North America has been a key player in global oil and gas markets since their inception. At the turn of the century, however, the region's energy outlook was exceptionally dim. Between 1980 and 2000, North America's proven oil and gas reserves slowly eroded, and conventional wisdom held that the region's standing in global energy markets was entering a period of long-term decline. Indeed, as recently as 2005, the International Energy Agency (IEA) projected that North American oil production would decline 20 percent by 2030 — a trend that would exacerbate the region's reliance on foreign sources of oil. The IEA also projected that North American gas production would fail to keep pace with demand — a trend that would transform the region, which was largely self-sufficient in natural gas at the time, into a significant net importer.[2]

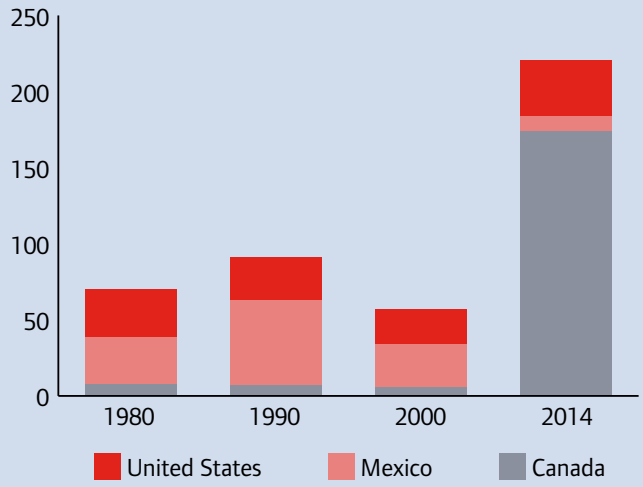
But the North American energy landscape has changed dramatically in recent years. Advances in exploration and production technology — including 3D seismic imaging, horizontal drilling and hydraulic fracturing — have unlocked vast quantities of oil and gas throughout the region. As a result, North America's proven oil reserves have nearly quadrupled since 2000, and its proven natural gas reserves have grown by more than 60 percent.[3] During the same timeframe, production of oil and gas has grown by 39 percent and 21 percent, respectively.[4]

Importantly, forecasts predict that these trends will be sustained. Although a lower energy price environment has curbed investment in oil and gas production, it is also driving down costs and driving up operational efficiencies that will enhance North American producers' long-term competitiveness in global energy markets. Accordingly, experts project that the region will capture an even larger share of the global energy supply mix by the end of the decade.[5]

Figure 1

North American Proven Oil Reserves

Billion Barrels, 1980–2014

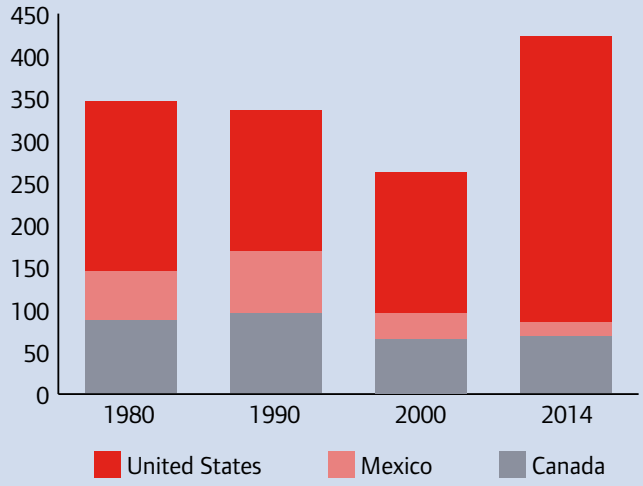


Source: U.S. Energy Information Administration (2015). International Energy Statistics.

Figure 2

North American Proven Natural Gas Reserves

Trillion Cubic Feet, 1980–2014



Source: U.S. Energy Information Administration (2015). International Energy Statistics.

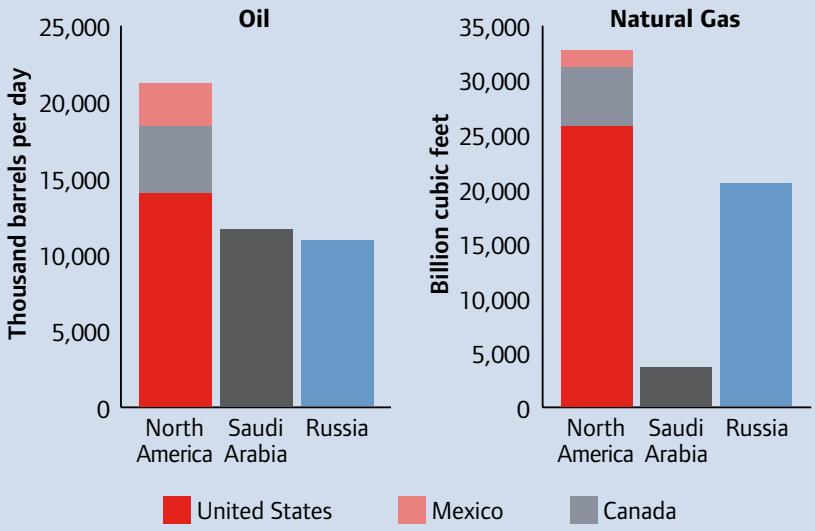
North American Oil Resources

Following steady declines in the 1980s and 1990s, North America's proven oil reserves and crude oil production rates have experienced a stunning turnaround. Since 2000, the region's share of the world's oil reserves has more than doubled, increasing from 6 percent to 13 percent, while oil production is up nearly 40 percent. In contrast, the region's oil consumption declined by 2 percent over that same period.[6] To date, this resurgence has largely been driven by the emergence of Canada's oil sands as a technologically feasible source of oil production and by the American shale and tight oil revolution. By contrast, proven reserves and crude production have declined significantly in Mexico over the past decade due to underinvestment by PEMEX, the state-owned oil company, and falling output at mature fields.

Figure 3

North American Oil and Natural Gas Production

Barrels per Day of Oil and Billion Cubic Feet of Natural Gas, 2014

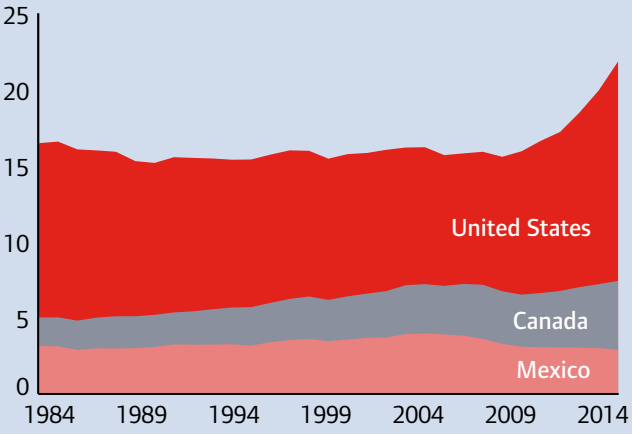


Source: U.S. Energy Information Administration (2015). International Energy Statistics.

Figure 4

North American Oil Production

Million Barrels per Day, 1984–2014



Source: U.S. Energy Information Administration (2015). International Energy Statistics.

Based on these developments, the outlook for crude production across North America is strong. Notwithstanding the recent decline in oil prices and cutbacks in capital expenditures, the U.S. Energy Information Administration (EIA) predicts that regional crude output will increase by 23 percent between 2014 and 2030, when it will peak at 39 percent of non-OPEC production and 22 percent of total world production.[7] Canada and Mexico are projected to experience the most robust growth rates in output, driven by expanding oil sands production and the impact of energy sector reforms, which have opened Mexico's oil and gas industries to outside investment for the first time in more than 75 years. However, the United States is expected to maintain its position as North America's largest oil producer by a wide margin over the next several decades.

U.S. Oil Resources

The U.S. energy revolution began in the mid-2000s with the dawn of the shale boom and has dramatically changed the nation's long-term oil outlook. Proven oil reserves in the United States increased 62 percent between 2005

and 2014,[8] and while estimates vary, most experts believe that the United States has several decades' worth of technically recoverable oil resources.[9, 10]

Recent increases in U.S. oil production have also been dramatic. After suffering decades of decline, output jumped nearly 70 percent between 2005 and 2014 (from 5.2 to 8.7 million barrels per day [mbd]),[11] buoyed by robust shale and offshore production. As a result of these gains, as of 2013, the United States has reclaimed its status as the world's largest oil producer.[12]

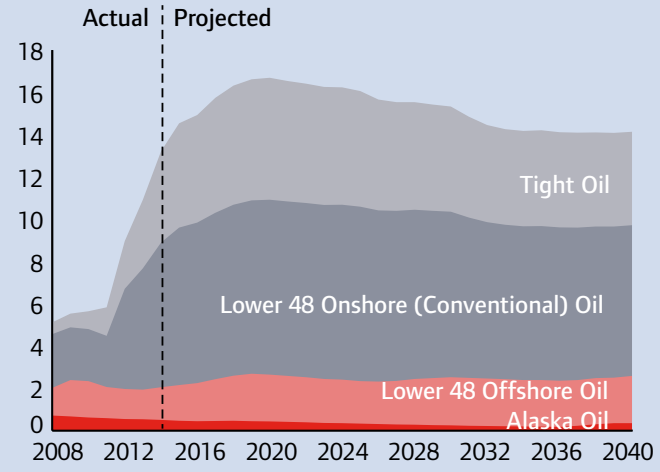
This rebound in both reserves and production is being driven by the extensive development of U.S. shale and other tight oil resources, particularly in the Bakken, Eagle Ford and Permian Basin formations. In fact, between 2011 and 2013, the Bakken and Eagle Ford plays alone accounted for more than two-thirds of the growth in total U.S. oil production.[13] Looking forward, tight oil production is expected to expand substantially in the coming decade, increasing from 2.19 mbd in 2012 to 5.6 mbd in 2020.[14] In fact, U.S. tight oil is set to become the world's leading source of incremental oil supply.[15] Ongoing technological and operational breakthroughs could drive the productivity of U.S. tight oil resources even higher. While production rates at tight oil wells tend to surge early and then decline after their first several years in operation,[16] improvements in the drilling and production processes — such as extending the length of horizontal wells and closer well spacing — are pushing up the estimated ultimate recoveries of older wells and driving down break-even costs across the industry.[17]

Offshore resources have also made a strong contribution to growth in U.S. crude production, with output from federal waters in the Gulf of Mexico more than doubling between 1990 and 2009.[18] More recently, deepwater drilling activity in the Gulf of Mexico has picked up significantly after the moratorium was lifted in October 2010, with several companies working to develop new technologies to enhance safety, safeguard the environment, improve exploration and drilling productivity, and reduce costs.[19] Looking forward, the most promising offshore potential is expected to come from deepwater and ultra-deepwater wells.[20] According to a 2013 Wood Mackenzie report, spending on all deepwater drilling in U.S. waters is projected to increase from $43 billion to $114 billion over a 10-year horizon, with the number of wells increasing 150 percent.[21] And while it is conceivable that the recent decline in oil prices and resulting reductions in capital expenditures will affect the timing of new offshore projects, the long-term nature of deepwater resource development means that deepwater activities tend to be relatively unaffected by oil price fluctuations, and industry observers have so far seen little evidence that activities will slow in 2015 or 2016.[22] For these reasons, the United States appears poised to experience robust growth in crude output from deepwater resources over the next decade.

Figure 5

U.S. Crude Oil Production by Source

Million Barrels per Day



Source: U.S. Energy Information Administration (2013). Annual Energy Outlook. *Figures 96 and 97; U.S. Energy Information Administration (2015).* Annual Energy Outlook. *Table 14.*

Price Effects: U.S. Oil Production and World Oil Prices

After topping out at approximately $105.79 per barrel in June 2014, oil prices have fallen by nearly 60 percent through mid-2015, to just $42.87 per barrel in August of this year.[23] This sudden and unexpected slide shook global oil markets and sparked concerns that lower prices could reverse the strong trends in U.S. oil production.

Indeed, the sharp decline in drilling activity — particularly in the nation's shale plays — is evidence of the impact that lower prices are having on the U.S. oil industry. A Baker Hughes report released in late September 2015 found that the number of oil rigs operating in the United States has fallen to just 640, down approximately 60 percent from this time in 2014 to the lowest level since August 2010. More broadly, investment and capital expenditures in exploration, new projects and expansions have been dialed back or postponed.

And yet, despite these developments, U.S. oil production has remained strong through the first half of 2015. In fact, crude production in the first two quarters of this year was slightly higher than production in the fourth quarter of 2014, despite the fact that the rig count was down sharply over that same period.[24] And while the U.S. Energy Information Administration has predicted that U.S. crude production will slip from an average rate of 9.22 million barrels per day (mbd) in 2015 to 8.82 mbd in 2016, due to the challenges of producing in the current price environment, 2016 production rates remain on track to exceed 2014 output.[25]

Sustained U.S. crude output through the first half of 2015 and the optimistic outlook for production in late 2016 and beyond are being driven by advances in production technologies and operational efficiencies in the tight oil and shale industry, which have only accelerated under the pressure of lower oil prices. Even as rig counts have fallen, the efficiency and productivity of remaining rigs and existing wells have improved substantially.[26] Not only are drilling and completion costs lower than in early 2014, but the time taken to drill and complete new wells has also fallen.[27] Building on these developments, the stage is set for a more efficient, resilient U.S. oil industry to continue to make strong contributions to North American energy production in the coming years.

Canadian Oil Resources

Canada's oil boom began at the turn of the 21st century, as new mining operations and rising oil prices unlocked Alberta's oil sands. As a result of the oil sands' vast resource potential, Canada now holds the world's third largest proven oil reserves.[28]

The oil sands have also had a substantial impact on Canada's production rates. Specifically, crude production has increased by 59 percent since 2000.[29] Looking forward, Alberta's oil sands are expected to continue to drive robust growth in Canadian crude production as new technologies increase the cost-effectiveness and reduce the environmental impacts of extraction. In fact, the Canadian Energy Research Institute (CERI) expects that crude production from oil sands alone will reach 5.2 mbd by 2030.[30]

In addition to oil sands, offshore resources have made positive contributions to crude output in recent years. In fact, offshore production in the Atlantic Ocean accounted for approximately 17 percent of Canada's total oil production in 2013.[31] However, notwithstanding several new offshore projects that are currently under development, offshore resources are unlikely to be a major contributor to future oil production.[32] Most of Canada's eastern offshore fields are relatively mature and face declining production rates. And while the country is thought to possess sizeable offshore resources in the Pacific and Arctic, development in these areas is currently blocked by legal and regulatory barriers.[33]

Finally, in addition to its oil sands and offshore resources, Canada also possesses sizable onshore oil resources. These resources are distributed throughout the Western Canada Sedimentary Basin (WCSB), which includes parts of British Columbia, Alberta, Saskatchewan and Manitoba. Notably, and unlike Canada's oil sands and offshore fields, conventional oil production across the WCSB region has fallen by more than 60 percent since it peaked in the 1970s.[34] However, new techniques and technologies are emerging that have the potential to support WCSB production going forward. For example, enhanced oil recovery techniques are extracting more crude from mature wells, while horizontal drilling is opening up the region's shale deposits. In fact, due to these developments, 2013 was the first time in many years that nonoil sands oil production increased.[35]

Mexican Oil Resources

Unlike the United States and Canada, Mexico has not experienced a surge in oil production over the past decade. Instead, proven oil reserves have decreased by 65 percent since 2000,[36] and declining production rates have pushed Mexico from the world's fifth largest producer a decade ago to its 10th largest today.[37]

The decline in Mexico's crude production has been primarily driven by high depletion rates and low yields in the country's most active fields, which are relatively mature. This is particularly the case for Mexico's offshore fields, which account for approximately 75 percent of total crude output.[38] For instance, between 2004 and 2014, production at Mexico's offshore Cantarell field — once one of the world's largest oil fields — declined by nearly 85 percent.[39] To offset such significant declines from Cantarell, PEMEX has made an effort to ramp up production from another offshore field, Ku-Maloob-Zaap (KMZ). Although PEMEX has been successful in tripling output at KMZ between 2004 and 2013, those gains have been insufficient to offset the overall trend of declining production.[40]

Experts believe that the key to reversing Mexico's prolonged production declines lies in the country's sizeable and relatively untapped unconventional oil resources.[41] In fact, Mexico is estimated to have 13 billion barrels of technically recoverable shale oil resources — the eighth highest in the world.[42] And after several years of exploratory drilling in deepwater areas in the Gulf of Mexico, PEMEX made its first major deepwater discovery in 2012 in the Perdido Ford Belt, an area covered by the U.S.-Mexico Trans-Boundary Hydrocarbons Agreement.[43]

However, with the exception of its Perdido Fold Belt discovery, PEMEX has had little success in exploring and developing Mexico's tight oil and deepwater resources, due to financial constraints, poor infrastructure and limited technological know-how.[44] Looking ahead, the hope is that opening unexplored and undeveloped unconventional fields to outside investment will start to bring Mexico's tight oil and deepwater potential online. However, notwithstanding strong initial interest by private and foreign producers in 2014, a first round of auctions for

offshore blocks in July 2015 yielded disappointing results, with only seven companies submitting bids and only two out of the 14 blocks on offer receiving successful bids.[45] Despite this underperformance relative to expectations, industry watchers remain hopeful that future rounds will be more successful, pointing out that the low oil price environment likely suppressed appetites for new projects, Mexican regulators received high marks for transparency during the bidding process and the initial auction provided a learning experience for the government.[46]

Based on the potential of Mexico's unconventional resources, and assuming that energy-sector reforms are successful in unlocking that potential in the near future, the EIA is optimistic regarding the trajectory of Mexican oil production.[47] Specifically, the EIA projects that Mexico's oil production will climb to 3.7 mbd in 2040, a nearly 75 percent increase over last year's projection and a 32 percent increase relative to current production.[48, 49]

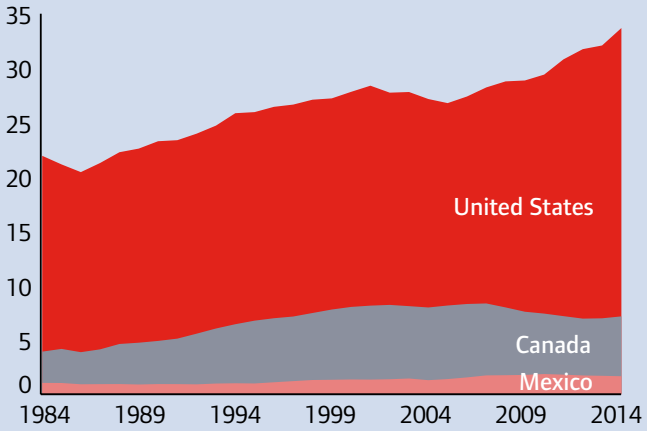
North American Natural Gas Resources

North American natural gas production has surged over the past decade. Primarily driven by the explosion of U.S. shale gas resources, North American proven reserves have increased 60 percent since 2005, and production has grown by 26 percent over the same period. In contrast, the region's natural gas consumption increased by 23 percent over that same period.[50]

Figure 6

North American Dry Natural Gas Production

Trillion Cubic Feet, 1980–2014



Source: U.S. Energy Information Administration (2015). International Energy Statistics.

Evidence suggests that regional natural gas production will continue to expand, due in large part to the continued development of shale and tight gas resources. Canada and Mexico both have substantial shale gas resources, though they are currently much less well developed than the U.S. shale resources. However, continued improvements in production technologies and operational efficiencies will help unlock these resources, while also supporting additional and more efficient production in the United States. In fact, shale gas is expected to account for roughly two-thirds of total North American production by 2035.[51]

Other Drivers: U.S. Coal Resources

Coal has been the cornerstone of America's electricity system for decades. While its share of electricity generation has declined from 50 percent to 39 percent over the last decade, coal remains the primary fuel for U.S. electricity production.[52] Coal's prominent role is largely due to its abundance. The United States contains 27 percent of global coal deposits and coal comprises 85 percent of recoverable demonstrated fossil fuel reserves when measured in British thermal units.[53]

Globally, coal consumption has been the fastest growing energy source in absolute terms over the past decade, up 51 percent between 2002 and 2012.[54] This trend has been largely driven by increased consumption in Asia, particularly in China and India but also in South Korea, Taiwan and Japan.[55] Given America's abundant coal resources, U.S. coal producers have the potential to expand their participation in global markets. To fully capitalize on this opportunity, however, ongoing efforts to establish port capacity on the West Coast must continue.

Domestically, affordable energy is a key driver of economic growth, and low-cost coal is critical to maintaining low electricity prices. According to the International Energy Agency (IEA), U.S. states that depend heavily on coal experience lower-than-average retail electricity rates.[56] Although electricity prices are affected by a variety of factors, coal's prevalence in the U.S. utility sector has helped keep average rates lower than in many European countries (12.5 cents per kilowatt hour [kWh] for residential customers and 7.0 cents per kWh for industrial customers in the United States, compared to an average residential rate of 25.6 cents per kWh and an average industrial rate of 14.8 cents per kWh in the European Union).[57, 58] By making electricity more affordable, coal helps to stimulate the economy by providing more disposable income to consumers and creating a competitive edge for U.S. businesses in supplying global markets.

Through 2014, the coal industry has invested $126 billion in clean coal technologies, which have drastically reduced emissions of particulates, sulfur dioxide and nitrous oxide.[59] An important next step will be to drive similar progress on greenhouse gas emissions through carbon capture, utilization and storage (CCUS) technologies. The IEA has labeled carbon capture "the most important technology option for reducing direct emissions," and while not yet commercially available, near-zero-emission coal technologies are under development and hold great potential for the future.[60] Importantly, plants equipped with CCUS technology will also provide a source of carbon dioxide for use in enhanced oil recovery, which could help boost U.S. oil output.

Looking ahead, energy experts expect coal to maintain its role as the primary fuel source in a diverse U.S. electricity generation mix through 2030.[61] However, a combination of forces stemming from increased natural gas production and tightened environmental regulations are expected to decrease coal's market share.[62] The U.S. Energy Information Administration projects that 37 percent of U.S. coal-fired generating capacity will be retired by 2020, which raises inevitable questions regarding grid reliability and electricity affordability.[63] For example, during the unseasonably cold winter of 2014, 89 percent of American Electric Power's coal plants scheduled for retirement in 2015 were called upon to meet demand and maintain regional reliability.[64] When these plants become unavailable, utilities will be less able to provide replacement capacity during demand surges, thereby risking price volatility and potentially reducing grid reliability.

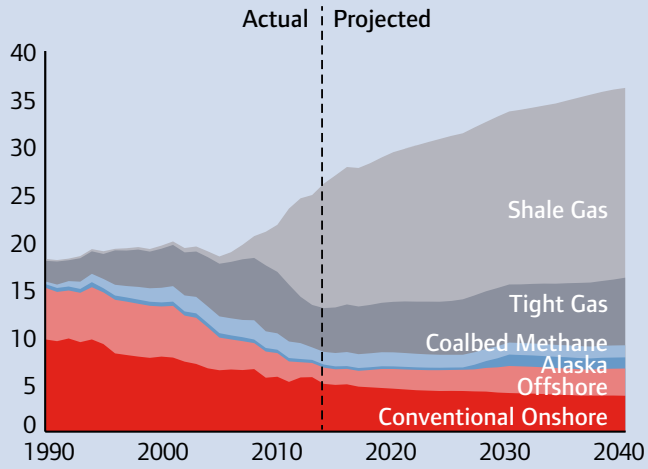
U.S. Natural Gas Resources

The United States' natural gas outlook has changed dramatically in recent years. Due to the application of new extraction and production technologies, U.S. proven natural gas reserves more than doubled between 2000 and 2014.[65] In fact, reserves jumped nearly 10 percent in 2013 alone, equivalent to approximately 13 years of demand at current rates of consumption.[66] Higher reserves have been accompanied by rapidly increasing production rates. Following decades of relative stagnation, U.S. natural gas production surged 42 percent between 2005 and 2014.[67] In its latest energy outlook, the EIA projects that unconventional gas production from shale and tight formations will increase another 31 percent from 2013 to 2020, with most of this growth coming from shale plays in the eastern United States (e.g., Marcellus) and Texas (e.g., Eagle Ford and Barnett).[68]

Figure 7

U.S. Natural Gas Production by Source

Trillion Cubic Feet



Source: U.S. Energy Information Administration (2013). Annual Energy Outlook. *Figure 91; U.S. Energy Information Administration (2014).* Annual Energy Outlook. *Table 14.*

Technological and operational innovations have played a major role in the United States' shale gas story. Producers have learned how to drill more wells at a single site and how to extend the length of horizontal wells, while production services companies are learning how to deliver the same services at less cost.[69] These developments, among others, are having a noticeable impact on the U.S. natural gas industry in terms of cost and output. For example, a well completed by a rig at Marcellus today is expected to yield more than 6 million cubic feet more gas than a well completed by the same rig in 2007.[70]

Meanwhile, the outlook for other natural gas resources — including Alaskan, offshore and coalbed methane deposits — is mixed. Conventional onshore production in the "lower 48" states is set to decline steadily over the coming decades, with the EIA projecting that output will fall by roughly one-third through 2040 (from 5.6 to 3.7 trillion cubic feet [tcf]).[71] On the other hand, offshore production in the lower 48 is projected to increase by 93 percent by 2040 as rising natural gas prices and lower oil prices incentivize offshore drillers to move out of oil and into gas production.[72] Coalbed methane deposits also hold promise, but the EIA projects that production will peak in 2019 and then decrease gradually through 2040.[73] Regarding Alaska's production potential, increasing natural gas output will largely depend on the ability of producers to access overseas markets. Contingent upon the completion of a recently authorized liquid natural gas export facility, the EIA projects that Alaskan gas production could more than triple by 2040 (from 0.3 to 1.2 tcf).[74]

Other Drivers: Energy Productivity in North America

Energy productivity — the level of output achieved from the energy consumed — is a critical component of a balanced North American energy strategy. Capturing opportunities to improve energy productivity can deliver cost savings, reduce emissions and environmental impacts, and enhance energy security by reducing energy demand. In fact, energy productivity in North America has increased substantially in recent years. Since 1990, North American energy intensity — a measure of the energy efficiency of an economy — has improved by 29 percent.[75]

In the United States, energy intensity has improved by 35 percent since 1990,[76] with the EIA projecting that average annual energy consumption through 2040 will grow at less than half the rate of recent population growth.[77] Gains in energy efficiency are evident across the economy, led by improvements in light-duty vehicle fuel economy and appliance and building efficiency. In fact, energy demand in the transportation sector is actually expected to decline slightly by 2040, while residential energy demand is expected to remain flat through 2040.[78] However, given the variation across states regarding building codes and energy efficiency incentives, opportunities remain to realize additional energy efficiency improvements across much of the country.[79] For its part, the utility industry is working to identify and advance policies that will better align rate structures and financing mechanisms to facilitate additional energy efficiency investments.

In Canada, energy intensity improved by 26 percent between 1990 and 2011.[80] As in the United States, Canadian energy efficiency gains cut across multiple sectors, including improvements in building envelopes, home appliances and heating equipment in the residential sector; vehicle fuel efficiency improvements in the transportation sector; and information technology and supply chain management systems in the industrial sector.

In Mexico, energy intensity improved by 4 percent from 1990 to 2011, largely due to energy saving in the residential sector.[81] A 2009 government energy savings plan identified several energy efficiency priorities across sectors to address between now and 2030, including efficiency standards for vehicles, lighting and appliances. The energy savings program is expected to reduce energy consumption by up to 18 percent by 2030 (from 2009 levels).[82]

Canadian Natural Gas Resources

After decreasing through the 1990s, Canada's proven natural gas reserves have leveled off in the last decade. However, reserve levels remain far below those of the United States.[83] Natural gas production has also tapered in recent years, declining 19 percent between 2005 and 2014 (from 6.6 to 5.3 tcf).[84] These declines have been primarily driven by falling output at mature conventional gas fields in the WCSB region — the traditional focus of Canadian gas producers.[85]

However, unconventional resources — including shale gas, tight gas and coalbed methane in British Columbia and Alberta (e.g., the Horn River Basin and the Montney Shale) — represent strong potential for future growth.[86] In fact, although relatively undeveloped, Canada is thought to have an estimated 573 tcf of technically recoverable shale gas resources — an amount that is on par with U.S. shale plays.[87] The Quebec portion of the Utica Shale has already begun attracting the industry's attention, although its development will hinge on removal of the provincial government's drilling moratorium.

Significant offshore natural gas resources are also under development, particularly in several large projects off the coast of Nova Scotia. For example, the multibillion dollar Sable Offshore Energy Project has produced an average of 125 million cubic meters (mcm) per month thus far in 2015,[88] and the Deep Panuke project has produced nearly 119 mcm per month in the first two quarters of 2015, although production has stalled in recent months.[89] Estimates of potential recovery in the area are even higher, and Nova Scotia's government is actively promoting industry exploration.

Mexican Natural Gas Resources

Mexico has experienced a severe decline in its proven natural gas reserves since the 1990s.[90] Moreover, natural gas production has been significantly outstripped by demand growth,[91] largely due to PEMEX's underinvestment in natural gas resources in response to the price differential between gas and crude oil.[92]

However, it is estimated that Mexico has nearly 545 tcf of technically recoverable shale reserves — the sixth largest in the world.[93] The country has begun taking steps to explore and develop these reserves in the wake of the U.S. shale boom. For instance, PEMEX has drilled a limited number of shale test wells and has announced plans for ramping up development of shale resources over the next decade.[94] Nevertheless, Mexico is still far down the learning curve, and effective and responsible shale development will require several major changes, including attracting private investment, expanding pipelines and other infrastructure, addressing security concerns, and developing effective environmental regulations.

Other Drivers: Renewable Energy Resources in North America

Renewable energy sources are important contributors to North American energy diversity, and their share of the region's energy portfolio is growing. Under favorable cost conditions, these resources can serve as important supplements to oil, natural gas and coal. However, given the intermittent nature of solar and wind production and the typically long distances between these energy sources and major load centers, it will be important to modernize and expand the power transmission grid and related infrastructure as renewable energy grows.

In the United States, renewable energy use has increased considerably over the last decade. America has become a global leader in renewable transportation fuels, including ethanol and biodiesel. Production of ethanol has increased more than 3.5 times since 2005, while biodiesel production has increased 14 times over the same period.[95] Renewable energy has had an even larger impact on electricity generation and now supplies approximately 13 percent of generation.[96] While hydropower accounts for roughly half of this production, wind and solar are experiencing the fastest growth rates.[97] Wind power, concentrated in the Midwestern and southern Great Plains states, has quickly grown to be the second largest source of U.S. renewable electricity production.[98] Meanwhile, solar generation capacity is increasing rapidly; several large solar thermal plants are being built in the Southwest, and solar photo-voltaic (PV) plants are entering the utility market on a meaningful scale. Notably, government policies — often in the form of subsidies — have been instrumental to the recent growth of renewable energy. Looking forward, such measures should be used only for fuels and technologies that have a credible path to unsubsidized competitiveness and should be finite in nature and eventually phased out in a predictable fashion. Even if current federal subsidies expire as scheduled, the U.S. Energy Information Administration expects renewables to comprise 18 percent of electricity generation by 2040.[99]

Renewable energy sources are even more prominent in Canada's energy mix, representing more than 50 percent of its electricity generation.[100] Hydroelectric power is the nation's largest source of renewable energy, and Canada is now the world's third largest producer (behind just China and Brazil).[101] However, similar to the United States, wind and solar PV energy are currently Canada's fastest growing sources of renewable electricity, and this growth is expected to continue. Canada's installed wind power in 2013 and 2014 is on track to reach its goal of 20 percent wind generation by 2025, while its solar PV capacity could grow even faster in the future.[102]

Conversely, Mexico's use of renewable energy sources has declined over the last decade, from 21 percent of electricity generation in 2000 to 16 percent in 2012.[103] Hydropower and geothermal energy account for most of Mexico's renewable electricity, but future capacity growth is expected to come primarily from wind. The wind sector has already seen a 600 percent increase in installed capacity since 2006, making it one of the fastest growing wind markets in the world.[104] Mexico also has significant long-term solar potential, with radiation levels exceeding countries like Germany that have heavy solar development.[105] Alongside nuclear and carbon capture and sequestration technologies, renewables should feature prominently in Mexico's efforts to generate 35 percent of electricity from clean technologies by 2024.[106]

III. Implications for North America's Economy and Security

The energy sector has traditionally played a critical role in supporting and expanding economic growth in the U.S., Canadian and Mexican economies. Fully leveraging North America's energy resurgence will serve to augment existing economic benefits and generate new ones for the region, including improving energy affordability for U.S. households, enhancing business competitiveness, and supporting macroeconomic and financial stability. In addition, the North American energy boom promises to improve the region's energy security while reinforcing its role as a global energy leader.

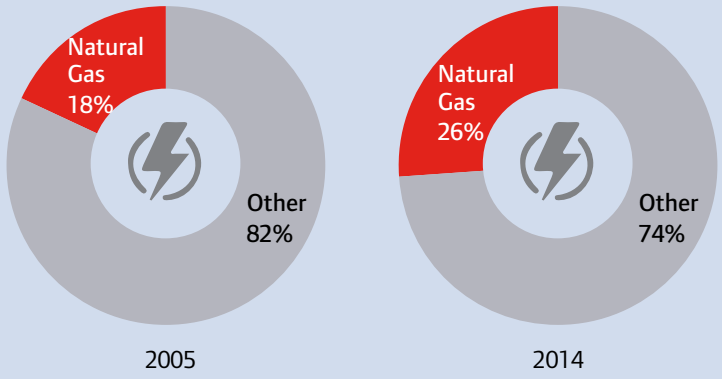
More Affordable Energy for Households

Sustained growth in natural gas production has helped provide affordable energy to North American families. Generally speaking, greater production places downward pressure on natural gas prices and encourages shifts in the fuels used for electric power generation. This shift has been particularly pronounced in the United States, where natural gas's share of net generation has risen from 19 percent in 2005 to 30 percent in 2015 year-to-date.[107]

Figure 8

U.S. Electric Power Sector Generation by Fuel Type

Percentage of Total Net Generation, 2005 and 2014

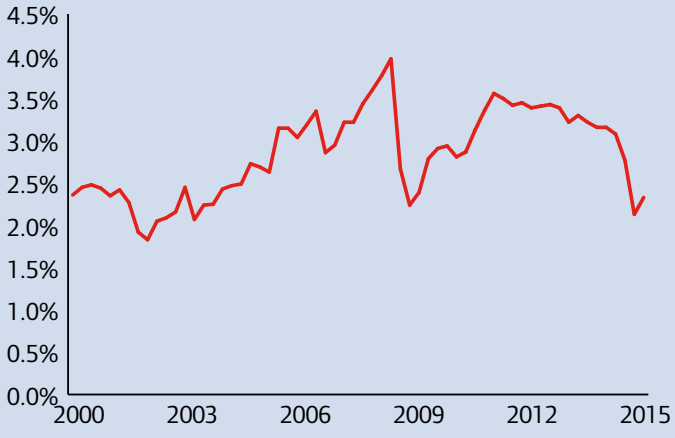


Source: U.S. Energy Information Administration (2015). Monthly Energy Report: August 2015. Table 7.2b.

Figure 9

Spending on Gasoline,* Share of Total Consumption

Nominal Spending at Seasonally Adjusted Annual Rates, 2000–15



*Also includes other types of motor fuel

Source: U.S. Bureau of Economic Analysis (2015). Personal Consumption Expenditures, Table 2.4.5U.

While electricity rates are affected by a variety of factors (e.g., capital costs, regulatory compliance costs), fuel costs are often a significant component of the total cost of electricity generation and transmission. As such, lower natural gas prices help reduce electricity prices, which in turn can lead to considerable cost savings for households. Coupled with the effects of heightened industrial activity (e.g., higher wages and reduced consumer goods prices), these savings boosted real disposable income for the average U.S. household by $1,200 in 2012.[108] This represents a substantial portion of the average U.S. household budget, comparable to the Child Tax Credit (per dependent).[109]

Increasingly robust North American oil production in the past several years, particularly U.S. shale and tight oil output, has also played a role in bringing down energy costs for North American households. Falling crude prices have

placed downward pressure on gasoline prices, with the average price of unleaded regular gasoline in 2015 year-to-date down 32 percent from its peak in 2012.[110] And while both oil and gasoline prices are predicted to drift back up over time, strong production from North American oil sands, shale and tight oil fields contributes to a more abundant global supply, which tends to result in lower oil prices than when supplies are constrained.

The Oil and Gas Industry Value Chain

The oil and natural gas industry generates substantial business activity in the upstream, midstream and downstream sectors. Oil and natural gas development begins in the upstream sector, which includes leasing, exploration, well construction and production. Prior to exploration or production, energy producers must secure mineral rights from landowners. The most common transaction is a mineral lease, which involves an up-front payment and a guarantee that the landowner will receive a share of any future production income via royalty payments. Once a lease is secured, producers will explore the area's resource potential, which typically entails conducting geological evaluations, seismic surveys, pilot drilling and testing.

If substantial resource prospects exist, the producer prepares for extraction, which requires securing permits, constructing roads and well pads, purchasing equipment, and hiring service companies and support personnel. Construction costs for shale gas and tight oil production tend to range from $3 million to $12 million per well, depending on characteristics (e.g., depth, length and pressure) and other factors (e.g., taxes, fees, and availability of services and materials).[111] Following these initial construction activities, staff or contracted field services personnel are paid to maintain the well and equipment and prepare the oil or gas for transportation. All told, postconstruction production costs include maintenance and operational expenses, royalty payments, severance taxes on revenues, and income taxes on profits.

After production, oil and natural gas enter the midstream sector, which involves fuel transportation and storage. Extracted oil and natural gas first enter a network of gathering pipelines. Natural gas is transported via these pipelines to centralized processing plants, while oil is first transported to storage and treatment facilities and then to refineries via pipeline, roadway or rail.

The downstream sector involves processing, refining and distributing finished oil and natural gas products. Natural gas must first be processed into "pipeline quality" dry natural gas before it can enter the distribution network, and crude oil is refined into an array of different petroleum products. Finished oil and gas products are then marketed and delivered to customers.

An important component of the downstream sector involves cross-country trade of finished products. Trade among North American countries increases the diversity of supply, helps balance supply and demand, and promotes an efficient flow of energy resources. For example, Canadian natural gas imports are an important source of energy for the northwestern United States,[112] while Mexico relies on imports of U.S. natural gas to help fill the gap between demand and current production levels.[113] These trade relationships benefit both producers and consumers, improving the quantity and quality of energy supplies. Moreover, as described in Section IV, these positive economic impacts can be further enhanced by resolving current market inefficiencies that stem from suboptimal energy-related trade policies and inadequate cross-border infrastructure.

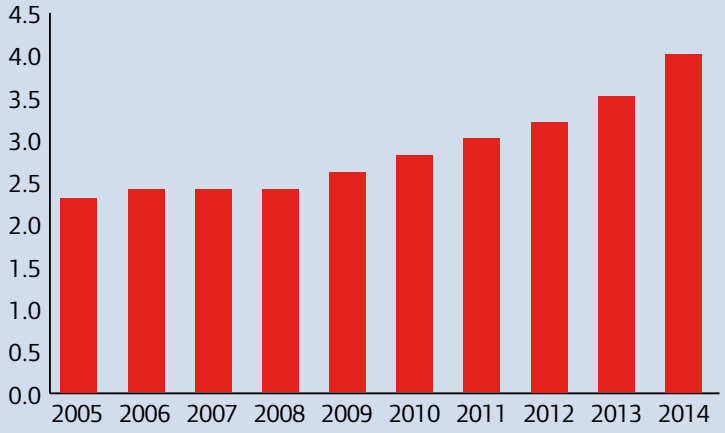
Enhanced Competitiveness for North American Businesses

The competitiveness of North American businesses has also been enhanced by the shale boom. In particular, industries such as chemicals, shipping and steel are benefitting from a large supply of competitively priced natural gas, as well as burgeoning demand for their services or supplies. As a result, companies are increasingly choosing to create new jobs and reshore existing jobs back to North America.

Figure 10

U.S. Natural Gas Liquids Production

Quadrillion Btu



Source: U.S. Energy Information Administration (2015). Monthly Energy Report: August 2015. Table 1.2.

For instance, nearly 150 new investments in chemical industry projects — valued at $100 billion — were announced in February 2014, more than half of which would come from firms based outside the United States attracted by competitive U.S. energy prices.[114] Oilfield service companies are beginning to retrofit pumps and drilling equipment to run on natural gas rather than diesel fuel. Apache Corporation, which operates heavily in the United States and Canada, estimates that this switch will lower fuel costs for its fracturing projects by approximately 40 percent.[115] In the transportation sector, several companies are modifying their truck fleets to run on compressed or liquefied natural gas. Enbridge Gas Distribution, Canada's largest natural gas distributor, estimates that switching to natural gas vehicles can reduce its fuel costs by more than 50 percent.[116] And in Mexico, changing the structure of the electricity industry to incorporate more natural gas and less fuel oil could reduce electricity prices by 13 percent, which could boost manufacturing output by up to 3.9 percent and gross domestic product (GDP) by up to 0.6 percent.[117]

The North American petrochemical industry has undergone a particularly dramatic turnaround, due to the abundance of natural gas in general and the availability of natural gas liquids (NGLs) as a low-cost feedstock in particular. NGLs (e.g., ethane), which are derivatives of natural gas deposits, offer a substantial cost advantage over traditional oil-derived feedstocks such as naphtha.[118] Given this advantage, ethane has become widely used across the U.S. and Canadian petrochemical industries. According to the McKinsey Global Institute, maintaining an abundant supply of natural gas and NGLs could ultimately boost output in the U.S. petrochemical industry by $60 billion to $80 billion by 2020.[119]

Benefits of a Diverse Supply of Electricity

A balanced and flexible electric generation portfolio benefits North American consumers by ensuring reliable and affordable access to energy resources. Because a diverse system is inherently more robust and resilient than one that depends heavily on a limited number of resources, a long-term approach that takes advantage of a variety of energy sources will protect North America from being vulnerable to the unpredictable volatility of any one resource or market. In particular, a diverse mix of energy sources offers fuel-switching opportunities in electricity generation. Fuel switching can provide an important buffer against volatile prices and tightened supply conditions associated with an over-reliance on any single energy source, which can expose households to price spikes when supplies become constrained due to unforeseen weather events and supply bottlenecks.

Macroeconomic Benefits

The oil and gas industry's core function (i.e., extracting raw materials, transforming them into usable forms of energy and delivering them to consumers) places it at the foundation of many other industries, including manufacturing, transportation and electric power. As a result, the industry is in a unique position to generate far-reaching impacts throughout the North American economy, including increased economic growth, job creation and government revenues.

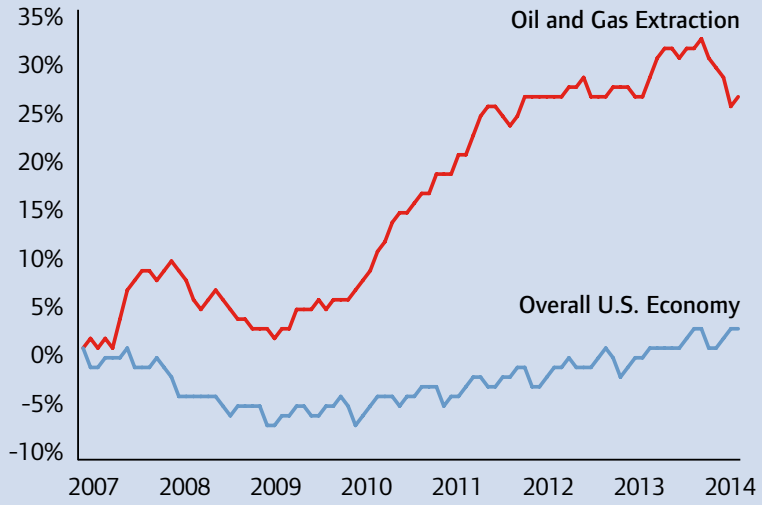
These macroeconomic benefits are delivered at several points along the industry's value chain. First, core business activities, such as exploration, production, transportation and processing, generate a range of "direct" economic impacts, such as the employees who are hired to drill wells and operate rigs. Second, oil and gas production creates new business activities, which result in "indirect" economic impacts. For example, an order for a new drilling rig creates additional business for manufacturing firms that make the component parts and equipment. Finally, employees engaged directly or indirectly in oil and gas operations will generate "induced" economic activity through increased household spending. Because many jobs in the oil and natural gas industry are high-paying positions, the household spending impacts are likely to be particularly pronounced.[120, 121]

In the United States, the oil and gas industry supports approximately $1.2 trillion in economic benefits (including induced effects) — the equivalent of nearly 7 percent of U.S. GDP — and supports more than 9 million jobs each year.[122] In fact, direct employment in the industry rose 40 percent (162,000 jobs) from 2007 to 2012 at a time when the overall economy was experiencing nearly stagnant job growth.[123] In 2015, a low oil price environment has changed the investment equation in the industry, with many companies scaling back capital expenditures and production activities until prices begin to drift back up. However, this price variability is unlikely to change the fundamental nature of the relationship between the oil and gas industry and the U.S. economy in the long term. Implementing key policy changes, such as expanding access to offshore energy production, investing in infrastructure, streamlining the permitting process and applying free trade principles to the energy industry, will amplify these macroeconomic benefits.

Figure 11

U.S. Job Growth: Oil and Gas versus the Overall Economy

Percentage Change from 2007



Source: Bureau of Labor Statistics (2015).

As in the United States, the Canadian oil and gas industry represents a significant component of the nation's economy. It is the largest private sector investor in the country and accounted for approximately 8 percent of Canada's GDP in 2014.[124, 125] The largest source of growth in the coming decades will almost certainly come from Alberta's oil sands. Already, production at the oil sands supports 514,000 jobs and is expected to support more than 800,000 by 2028.[126] The GDP impact of oil sands investment, reinvestment and operating revenues is estimated to reach nearly $3.9 trillion between 2014 and 2038.[127] Finally, Canadian government revenues, across the federal and state levels, from oil sands activities could amount to $1.5 trillion between 2014 and 2028.[128] Canada's resource development will also have significant impacts for the United States, due to the U.S. role in oil sands trade, refining, and storage and transportation operations. Overall, CERI estimates that Canadian oil and gas production could contribute more than $700 billion (USD) to the U.S. economy between 2010 and 2035.[129]

Mexico's economic and financial outlook depends heavily on the productivity of its energy sector. Oil revenues account for more than 30 percent of the government's revenues, and the federal budget has suffered due to years of declining production and, more recently, falling oil prices.[130] In fact, the government recently announced budget cuts amounting to 2.6 percent in direct response to lower global oil prices.[131] However, Mexico's energy sector reforms have the potential to reverse persistent production declines and provide a substantial boost to the country's economy. If implemented effectively, reforms could invite as much as $20 billion to $30 billion of foreign direct investment into Mexico each year and increase oil production levels dramatically.[132] Citigroup estimates that the reforms could potentially double Mexico's crude production.[133] The resulting boost to economic output — via increased investment and reduced natural gas and electricity prices — could add 1 percentage point to Mexico's annual GDP.[134] At the same time, the Mexican government expects that the reform could create 2.5 million jobs by 2025, greatly benefitting households.[135]

Improved Energy Security

Expanding oil and gas production has the potential to enhance North American energy security and alter the balance of power across many international relationships.[136] In the United States, net energy imports as a share of total energy consumption declined from 30 percent in 2005 to just 13 percent in 2013 due to strong domestic production and slow growth in energy demand.[137] In fact, the EIA expects that U.S. energy exports and imports will come into balance around 2029.[138]

Some analysts argue that increased domestic production grants countries a stronger hand in international affairs. For example, they argue that U.S. natural gas resources have played a role in the nation's Trans-Pacific

A Rebirth in U.S. Manufacturing

The manufacturing sector is a critical component of the U.S. economy, accounting for 12 percent of U.S. gross domestic product (GDP),[139] directly employing more than 12 million people[140] and supporting more than 17 million jobs.[141] Although U.S. manufacturing jobs have been steadily declining over the last three decades, the manufacturing industry has reemerged since the end of the recession, and nearly 600,000 manufacturing jobs have been created since June 2009.[142] Much of this turnaround has been triggered by the North American oil and natural gas energy resurgence. The manufacturing sector is also a heavy user of energy — particularly natural gas, which is used as a fuel for plants and a feedstock for producing petrochemical products. As such, energy-intensive manufacturing industries (e.g., chemicals, metals, paper and pulp, and rubber and plastics) have benefitted from the reduced natural gas prices that have accompanied the sharp increases in production. In the future, U.S. manufacturers, utilities and other end users are expected to consume a substantial amount of the gas resources extracted from shale deposits. Ensuring a sufficient and steady supply of domestic natural gas will be a key factor in maintaining and furthering the ongoing manufacturing resurgence.

Spurred by unconventional oil and natural gas production, the resurgence in U.S. manufacturing is expected to generate profound economic benefits. The McKinsey Global Institute estimates that by 2020, up to 270,000 manufacturing jobs could be created as a result of the shale oil and natural gas boom.[143] IHS Inc. projects that unconventional oil and natural gas development will support more than 500,000 jobs by 2025.[144] Including indirect and induced employment effects, as many as 2.5 million to 5 million jobs could be created by 2020 as a result of the manufacturing industry.[145] In addition to creating jobs, manufacturers are expected to expand their plants and infrastructure in response to improved domestic market conditions. These investments will improve U.S. GDP and also help reduce the trade deficit.[146] In addition, many companies in the manufacturing and transportation sectors are benefitting from reduced fuel costs. For example, in the U.S. iron and steel industries, the availability of competitively priced natural gas has translated into increased direct-reduced iron (DRI) production, an energy-efficient process that uses natural gas to produce a key component of steel and raw iron. The McKinsey Global Institute estimates that DRI plants currently under development could generate $2 billion to $3 billion in additional annual output by 2030.[147]

Partnership agreements. As Council on Foreign Relations Senior Fellow Michael Levi explains, "We are offering up access to U.S. natural gas in return for what we want from other countries," such as access to their technology, agriculture and goods markets.[148] Others argue that increased regional supply will strengthen the hand of North American policymakers, allowing them to implement foreign policy based on their nation's values rather than energy needs. By building up global spare capacity, North American production can provide a temporary cushion against global supply disruptions, promote its interests overseas and help moderate global oil prices.[149] For example, regarding Iran's past threats to disrupt world oil supplies in response to the dispute over its nuclear program, Daniel Yergin, founder of IHS Cambridge Energy Research Associates, has commented that "new supply in North America becomes all the more important as a potential offset" to any such moves.[150]

The precise nature and magnitude of the North American energy boom's impact on global energy dynamics and the geopolitical landscape are still being explored, and they should be viewed through a long-term lens. However, increased North American production will, on balance, have a positive impact on regional and national security, including the promotion of a more flexible foreign policy agenda that is less driven by concerns about oil price shocks and more guided by long-term values and nonoil strategic interests.

IV. Policy Challenges to North American Energy Development

The North American energy revolution presents an extraordinary opportunity for the United States, Canada and Mexico to boost their economic growth and international competitiveness while improving their energy security. It also presents a critical opportunity for the region's policymakers to secure and expand on these benefits by enacting policies that reflect the game-changing developments that have taken place across virtually every sector of the energy industry over the last several years, as well as the changing dynamics of energy demand.

Looking ahead, it is crucial not only that policymakers take action to bring the region's energy policies into better alignment with the realities of today's abundant tight oil and gas, as well as other unconventional resource potential, but also that they recognize the extent to which North America's ability to fully capitalize on its energy advantage is predicated upon improving the integration of energy markets across the region. Achieving these goals will require policy action on multiple fronts, including creating a more streamlined approach to approving and permitting critical infrastructure projects; improving access to energy resources; updating and rationalizing the legal and regulatory frameworks that govern energy production, processing and transportation; lifting outdated restrictions on exports; and setting effective, predictable and risk-based environmental standards.

Infrastructure Constraints

Expanding, integrating and maintaining national and cross-border infrastructure systems that support the production, storage, transportation and distribution of regional energy resources will be a key enabler of North America's energy resurgence. Moreover, the shape of energy production across the region is shifting, from the emergence of tight oil and gas production, to declining imports, to the changing composition of electricity generation. These changes have significant implications for the region's energy infrastructure needs going forward and must be addressed by policymakers to prevent costly bottlenecks, supply and demand imbalances, and other market inefficiencies.

In fact, the U.S. Department of Energy's recently released Quadrennial Energy Review emphasizes the importance of cross-border energy flows and infrastructure connectivity for achieving North American energy self-sufficiency, efficiency and resiliency. The value of U.S.-Canada energy flows reached $140 billion in 2013, while the value of U.S.-Mexico flows topped $65 billion in 2012.[151] The scale of this cross-border trade requires strong and integrated infrastructure systems to fully leverage the benefits of the North American energy boom. The United States and Canada are already well connected by a system of natural gas pipelines, which have helped to balance demand and supply on both sides of the border. However, Mexican energy resources are significantly less well integrated with the rest of the region. In addition, better integration of Mexico's electricity grid with the United States' and Canada's (which are already highly interconnected) would advance regional goals of improving efficiency and reliability and reducing greenhouse gas emissions.

In addition to the ongoing need for improved regional integration, the United States, Canada and Mexico face significant policy challenges regarding energy infrastructure at the national level. In the United States, natural gas supply and demand imbalances can lead to price spikes during unanticipated harsh weather, harming end users. In the event that the utility sector continues to shift toward natural gas and, to a lesser extent, renewable fuels, it will be important to ensure that there is a sufficient supply of fuel-neutral electric transmission infrastructure.

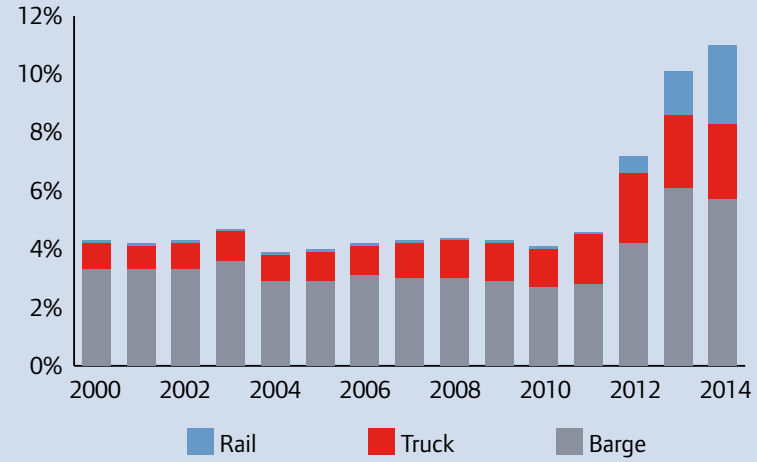
Capacity constraints are also being felt in the U.S. oil industry. Reversing historical trends, crude oil flows are increasingly running from north to south and are relying on a variety of transportation modes (e.g., pipelines, rail and barge) given the failure to develop adequate pipeline options.[152] Although less efficient than pipelines, these alternate modes have provided needed capacity relief and have served as the means of transport for hundreds of

thousands of barrels a day. That said, policymakers must be more proactive when it comes to facilitating the investment in infrastructure that will be necessary to keep up with domestic production and better integrate the U.S. energy industry with regional and global markets. Specifically, prolonged inaction over the Keystone XL pipeline and a generally cumbersome approval and permitting process for privately funded pipeline and storage infrastructure have thwarted efforts to more closely integrate U.S. and Canadian energy markets and to move energy resources more efficiently across the United States.

Figure 12

U.S. Crude Oil Refinery Receipts by Transport Mode

Percentage of Total Crude Oil Refinery Receipts



Source: U.S. Energy Information Administration (2014). Refinery Capacity Report.

In the meantime, continued U.S. reliance on nonpipeline modes of transportation — coupled with reduced U.S. oil imports — is sending mixed messages to our regional partners. In particular, failure to approve the Keystone XL pipeline has prompted Canada to rethink its export strategy and look toward the Pacific Basin as a potential market for its oil exports. However, a shift toward Asia would entail significant new infrastructure demands for Canada, which would be complicated by several factors. For one, it is challenging to build new pipelines through the mountains to West Coast export outlets. Additionally, pipeline construction requires managing contentious issues with local and native ("First Nation") groups who own the land rights.[153]

Meanwhile, Mexico faces more basic infrastructure limitations. Currently, it lacks the supporting infrastructure necessary for large-scale oil and gas development, including pipelines as well as refineries.[154] To meet its future production goals, Mexico will need to invest heavily in its structural capacity, hopefully with the assistance of private capital for the first time in decades.

Legal and Regulatory Systems

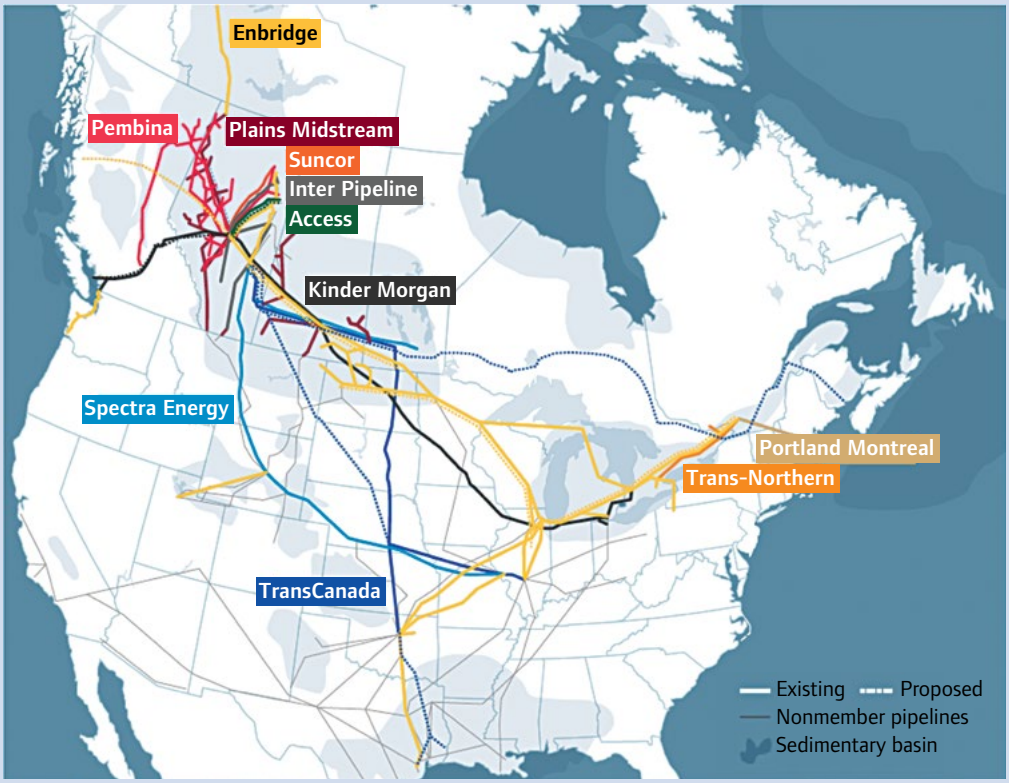
North America's oil and gas industry also faces substantial legal and regulatory hurdles to expansion, most notably in the form of lengthy and unpredictable permitting processes, and barriers to access.

As described in Business Roundtable's report *Taking Action for America: Smarter Regulation,* a complex and often unpredictable permitting system for investments up and down the U.S. energy supply chain increases the cost of investing in energy production and causes significant project delays, which in turn drive up project costs, increase the environmental impact associated with construction and raise energy prices due to bottlenecks.[155] Furthermore, uncertainty surrounding future U.S. environmental regulations complicates business plans and discourages long-term capital investments.[156] Producers in Canada can be similarly affected by policy uncertainty and regulatory fragmentation across multiple jurisdictions.[157] Policymakers across the region should not only take steps toward streamlining and rationalizing their own permitting processes and regulatory systems but also work toward a common regional understanding of how to structure permitting processes and craft regulations in such a way that North America's energy potential can be fully realized.

Figure 13

Canadian Liquids Pipelines

Existing and Proposed



Source: Canadian Energy Pipeline Association (2013).

In addition to regulatory inefficiencies, the U.S., Canadian and Mexican governments have imposed several bans on the oil and gas industry that restrict access to resources and disrupt energy markets. In the United States, federal policy continues to restrict access to promising energy resources on federal lands, including parts of the eastern Gulf of Mexico, the Atlantic and Pacific coasts, and Alaska. In Canada, Quebec's provincial government has imposed a moratorium on shale gas development that has thus far prevented Canada from joining the region's shale boom. CERI impact estimates suggest that if Quebec maintains this ban, Canada could lose out on billions in economic output and hundreds of thousands of person-years of employment.[158]

In the midst of these challenges, Mexico's recently implemented energy sector reforms represent an important and encouraging step toward reducing the legal and regulatory barriers to increased North American energy production. Until last year, Mexico maintained a state monopoly on the country's oil and gas resources. PEMEX, the state-run oil company, was prohibited from partnering with private companies for resource development — blocking investment by some of the world's most technologically advanced companies. However, the reforms have opened up oil and gas exploration and production to private and international companies while maintaining state control over assets, a transformative step for Mexico's energy industry and economy.[159]

Trade Policy

In addition to regulatory hurdles and permitting delays, the oil and gas industry in the United States continues to face a unique legal challenge — barriers to trade. Long-standing federal laws prohibit U.S. producers from exporting

crude oil, other than a small amount to Canada. As domestic production of light, sweet crude has increased, this ban has contributed to supply gluts in portions of the United States, in part because a significant portion of existing U.S. refining capacity is optimized for heavy oil. Current U.S. law also constrains the export of natural gas.[160] U.S. Senator Lisa Murkowski recently observed that the regulatory architecture governing U.S. energy exports is dated and applied unevenly across the sector.[161] Recognizing these impacts, U.S. Energy Secretary Ernest Moniz has suggested that it may be time to review the oil export ban and expand the U.S. energy trade.[162]

Given recent developments in the U.S. energy sector, it is even more important for trade policies to be based on principles of international engagement and open, unbiased and rules-based systems. Free trade of imports and exports for all forms of energy, including oil and natural gas, should support economic growth and energy security and align with the United States' important role as a leading global energy producer and manufacturer.

Environmental Concerns

As North American oil and gas production has increased, so have environmental concerns related to carbon emissions and ecosystem impacts. North American companies are hard at work implementing sustainable practices to minimize the environmental costs of production — while maintaining the economic and energy security benefits of energy production.

In debates over the Keystone XL pipeline, some observers have voiced concerns over the carbon intensity of petroleum extracted from Canadian oil sands, with one noted environmentalist arguing that the development of these resources would be "game over for the climate."[163] However, the U.S. State Department conducted a rigorous life-cycle analysis of greenhouse gas emissions from oil sands — including emissions from extraction, processing, transportation, refining and refined product end use (e.g., combustion of gasoline in cars) — and concluded that the carbon intensity of Canadian oil sands is within the range of other crude oil sources.[164] The oil and gas industry acknowledges the importance of mitigating the greenhouse gas impacts associated with oil and gas production, and companies are investing billions to reduce their carbon emissions by developing carbon capture and storage technologies, substituting cleaner power and fuel sources in drilling operations, and recycling the natural gas that would otherwise be vented during well completion.[165] Due to reduced energy consumption, improved fuel efficiency in the transportation sector and a larger role played by natural gas in the utility sector, U.S. emissions intensity has declined 63 percent since 1990.[166]

The oil and gas industry has also responded to concerns about local ecosystem impacts, including groundwater contamination. While companies must continue to exercise caution and manage risks in drilling and surface activities, a recent report by the U.S. Environmental Protection Agency has concluded that hydraulic fracturing has no widespread or systemic impact on drinking water resources in the United States.[167] Concerns have also been raised regarding the possible link between the underground injection of wastewater and increased seismic activity in some locations. Industry should continue to work cooperatively with state and federal agencies, as well as academia, to conduct further geological research to improve its understanding of such activity and mitigate any risks.

Industry experience demonstrates that unconventional resources can be developed in a manner that protects human health and the environment and that groundwater contamination risks can be effectively managed using a suite of industry practices in conjunction with existing regulatory requirements and oversight. Looking ahead, it will be important for industry and regulatory authorities to continue to work together closely to ensure that drilling operations are conducted safely and responsibly.

V. Conclusion

North America is in the midst of an energy revolution. Driven by advancements in energy exploration, extraction and production technologies, the region is unlocking vast quantities of oil and natural gas and upending long-held assumptions about its energy future. In the United States, continuously improving technologies and production methods are helping the industry discover and produce unconventional oil and gas resources at historic rates. In Canada, new extraction techniques have unlocked the potential of the Alberta oil sands and tight oil and gas reserves. And in Mexico, long-awaited energy sector reforms have the potential to reverse decades of declining oil and gas production by opening the industry to private sector investment and technological progress.

The economic implications of this revolution are potentially transformative. The oil and gas industry sits at the foundation of many other industries, and the benefits of increased oil and gas production can quickly ripple throughout the economy. In particular, the new energy advantage is powering a manufacturing resurgence in the United States that is generating new investment and providing economic incentives to reshore American manufacturing jobs that were considered lost only a decade ago. Other stakeholders stand to benefit as well, as billions of dollars are invested in new businesses, thousands of dollars are saved in household energy costs, rent and royalty payments are paid to private landowners who lease mineral rights to producers, and tax and royalty revenues are generated for all levels of government.

However, the rapid shift in the North American energy landscape has also given rise to new challenges, including infrastructure constraints, heightened environmental and social concerns, and outdated legal and regulatory frameworks. These challenges must be addressed by timely, targeted policies and legislation that take into account the new environment of energy resource abundance in which the region finds itself. In August 2014, the Mexican government finally enacted comprehensive legal reform to restructure and revitalize the country's energy sector. A similar commitment is needed in the United States and Canada to create the policy conditions and legal supports necessary to sustain and grow their own oil and gas industries.

Policymakers have been too slow to pivot from a world of energy scarcity to one of abundance. To take full advantage of the region's energy promise, policymakers must realign legal, regulatory and policy frameworks with current realities and better integrate energy systems across borders — securing North America's status as an energy superpower for generations to come.

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