



U.S. ENERGY POLICY: RECOMMENDED GUIDANCE FOR THE NEXT ADMINISTRATION

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“U.S. Energy Policy: Recommended Guidance for the Next Administration”

The last decade has unveiled significant change in global energy markets, with crude oil, natural gas, coal, and electricity markets all in the midst of a transition. Developments in the US have served as a principal antagonist, with the shale revolution at the epicenter. The global energy landscape has shifted so dramatically that the US Department of State formally established the Bureau of Energy Resources in 2011 to manage three core objectives – energy diplomacy, energy transformation, and energy governance and access. These objectives have been increasingly woven into the fabric of US foreign policy engagement, and it stems directly from the emergence of the US as an “energy superpower.” Importantly, maintaining this position requires balancing energy development with domestic and global environmental objectives, foreign policy objectives, and goals for long-term robust economic growth. Indeed, sustainability requires such calculus be performed and reexamined on an ongoing basis, particularly as technology continues to alter the landscape.

Energy is critical for economic activity. This is highlighted by the fact that the wealthiest and most economically diverse nations—the Organization of Economic Cooperation and Development (OECD)—have collectively shaped global energy demand growth for the last century. According to the International Energy Agency (IEA), the OECD accounted for 60% of global energy demand in 1970 and 58% in 1990, not a significant change over a two-decade period. This becomes even more striking when one considers that the OECD accounted for only about 1.1 billion of the world’s 5.3 billion people in 1990. However, the two decades following 1990 have wrought significant change, with the center of global economic activity shifting since 1990 toward emerging non-OECD nations, particularly in Asia. Population trends are also shifting, as only 1.3 billion of the world’s 7.4 billion people currently live in the OECD. As a result, we are already witnessing a profound impact on patterns of energy demand growth. By 2010, the OECD’s share of global energy use had fallen to 42% and has continued to decline to about 39% currently. When taken with the same indicators from 1970 and 1990, we see a trend that highlights a future that is starkly different than the latter half of the 20th century. Moreover, continued economic development in non-OECD nations will bring new energy demands from more than 6.1 billion people, over 1.1 billion of whom live in such abject poverty that they have no access to modern energy services at all—a condition referred to as “energy poverty.”

Looking forward over the next two decades, it is highly likely that continued growth in developing Asia will be a major driver of global energy markets. This point has been made salient by the emergence of China into the global energy and economic landscape since the early 1990s. Asia, more generally, has been and will be a driver of energy demand. India, the ASEAN region, and China collectively account for 3 billion people, and the region promises to be economically vibrant for the coming two decades. Thus, even at modest rates of economic growth across the region, over 400 million people could move into the middle class by 2030. This translates into significant potential for energy demand growth, all while demand continues to slow in the OECD.

Meeting future energy demands is paramount for continued economic growth around the world. The shifting nature of economic, population, and energy demand growth presents new challenges for global markets, opens up significant new opportunities, and portends new political and geopolitical stresses. The following examples, while neither extensive nor complete, shed light on this point.

- One, global oil markets are being transformed by new sources of supply and emerging demands in resource-poor regions, which foretells a dramatic shift in the direction of oil trade. Regions with significant, accessible unconventional oil resource potential include Canada, the US, Mexico, Venezuela, Brazil, and Argentina, all of which exist in the Western Hemisphere. Meanwhile, demand continues to expand in developing Asia. So, as development of Western Hemispheric resources occurs, it will substantively redraw the global oil trade map and redefine geopolitical relationships along with it.
- Two, global natural gas markets are undergoing a transition that is supported by shifting commercial paradigms, new sources of supply, and environmentally-motivated demands. As environmental pressures mount, the role of natural gas—as the least carbon-intensive fossil fuel—in meeting stated climate objectives is increasingly in focus. This stands to high-grade new natural gas resource opportunities, yet political realities and market structures in various parts of the world can influence the pace at which this happens. This, in turn, sets the stage for circular discussions of climate, natural gas, policy, and economy.
- Three, environmental stresses—both regional and global—will be increasingly highlighted. For instance, the inextricable link between energy and water will force recognition of water stress and the need for new technologies—and the policies to promote their adoption—to minimize those stresses.
- Four, the composition of energy use, or the so-called energy mix, is another area that is receiving considerable attention, and it is heavily motivated by Western-centric viewpoints of facilitating an energy transition to low-carbon energy resources. However, what’s “good for the goose may not be good for the gander.” For example, the last major build-out of coal-fired power-generation infrastructure was in the late 1970s to early 1980s. Given the planned lifetimes of those facilities, electricity generators in the US are on the cusp of a broad set of decisions to either retire or upgrade through retrofit a large fraction of the US coal-generation fleet. Such decisions are brought into clearer focus given the large unconventional natural gas resource in the US. Namely, as low-cost natural gas can be delivered to the electricity sector in highly efficient natural gas combined-cycle generators, coal will find it increasingly difficult to hold market share. In effect, the transition away from coal in the US can be done at relatively low cost. The same does not necessarily hold true in countries such as China and India, where a large fraction of the coal-fired generation infrastructure is only a decade old and natural gas must be imported at a price above that in the US, meaning retirement in the same time frame as the US would force an enormous stranded cost and hence economic burden. So, the timing of policy action is as critical as the policy itself.

- Finally, the prevalence of energy poverty is one of the least understood and perhaps most important factors that will define the future of global energy use. As wealthier regions of the world strive to reduce their environmental impact through new technologies and advanced digitalization, such options may not always be readily available at an acceptable cost in poorer regions. Thus, both domestic and international policies as well as continued technological innovation will play critical roles in establishing the energy pathways poorer nations pursue as they strive to unburden themselves from poverty.

Given the magnitude of the grand energy challenge facing the world today, one naturally wonders what role policy can effectively play in the future of energy, particularly given that global market forces will largely be dictated by factors beyond the control of policymakers. To be sure, market forces will always act to promote the most efficient allocation of resources possible, even when markets are constrained by regulation, government actors, or other exogenous factors. This is perhaps the most underappreciated facet of policymaking and can lead to second- and third-order impacts that are unanticipated—the so-called “law of unintended consequences.” The range of possible market outcomes in response to any policy intervention is wide. On the one hand, policy, if too prescriptive, can result in a complete lack of capital mobility and industry distress. On the other hand, policy can also engender flexibility in the movement of capital, thereby facilitating rapid adjustment by industry to shifting market realities. Depending on the nature of regulatory and political engagement, the reality of the US energy market can be driven anywhere along this spectrum. Regardless, it is important to recognize that any regulatory intervention is a constraint on what market participants might otherwise choose to do. But whether or not a policy intervention or regulatory measure is justified depends on the balance between the cost and benefit, which is why a measured approach with careful study and analysis can provide significant guidance.

What follows are various “notes” building on the above, structured around broadly defined energy issues. This establishes a context for some recommended policy directions. The policy recommendations are generally descriptive. Therefore, the oft-used phrase, “the devil is in the details,” is apt. It will be important to consider the potential implications of any policy direction if sustainable and secure energy and economic futures are desired outcomes.

A Note on Shale Oil and Gas Development and Its Role in the Global Market

Just 10 years ago, most predictions were for a dramatic increase in liquefied natural gas (LNG) imports to North America and continued growth in oil import dependence. This in turn triggered large capital investments in vertically integrated structures to move LNG to the US from the Middle East, Australia, West Africa, and Russia. It also led to broad discussion and adoption of various policies aimed at reducing oil imports—something that, for example, substantially benefitted the domestic corn ethanol industry—and, more generally, invigorated discussions around achieving energy independence. As this occurred,

however, small independent producers in the US began to apply new techniques to extract resources from shale—first natural gas, then crude oil. The resulting “shale revolution” is well documented, as is the massive shift it created in the global energy landscape. However, the new reality that shale has presented could not have occurred without the unique legal and regulatory environment in the US.

Beginning with the Barnett Shale in northeast Texas, the application of innovative new techniques involving the use of horizontal drilling and hydraulic fracturing has resulted in the rapid growth in production of natural gas from shale. Moreover, the techniques that proved so successful in the Barnett Shale matriculated into other gas-producing and then oil-producing shales, including the Marcellus, Haynesville, Fayetteville, Eagle Ford, Bakken, and Permian Shales and elsewhere. The overall impact has seen shale gas production in the United States increase from virtually nothing in 2000 to over 45 bcfd, and oil production from shale increase to over 4.5 million barrels per day since 2008—meaning that shale accounts for about 60% of domestic natural gas production and just under 50% of all domestic oil production. While oil production has declined since its peak in 2015 due to the decline in prices since late 2014, the scale of the shale resources indicates a long-term opportunity that is more flexible and price-sensitive than production from other regions.

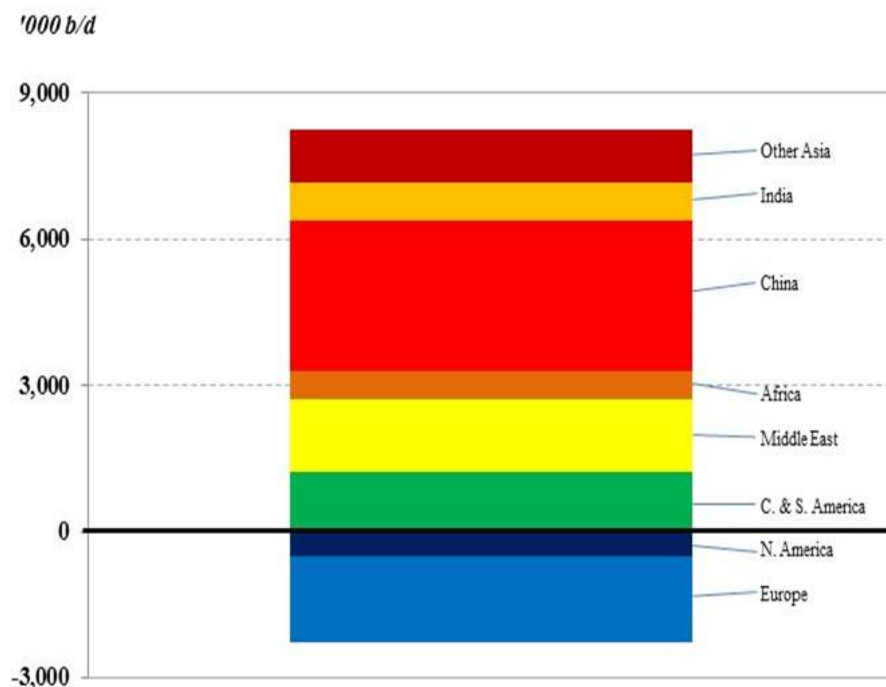
The incredible growth seen in oil and gas production in the US has far-reaching impacts that are transformative for markets and geopolitics.¹ With regard to natural gas markets, shale gas developments in the US have, by displacement, increased the availability of LNG, which has played a key role in the ongoing renegotiation of long-term oil-indexed contracts and enhanced regional market liquidity, thereby stimulating new financial and physical market realities. Indeed, Europe has seen an increase in financial and physical liquidity indicated by more hub-based trading and increased flexibility in the direction of pipeline flows, which has helped mitigate concerns about regional near-term shortages in countries such as Ukraine. For Europe, this is nothing short of a major paradigm shift, but the impacts are not limited to only Europe. They also extend to Asia, where shale gas developments, by displacement, released supplies to be shipped to Japanese buyers in the wake of the disaster at Fukushima. Absent North American shale developments, LNG spot prices would have risen even higher, as global competition for supplies would have been more intense.

For global crude oil markets, the shale story is still being written, but the script to date has also revealed a significant paradigm shift and altered the position of the US in the global oil market. In particular, as seen in Figure 1, global oil demand has risen for the last several years, but not in the OECD. In fact, oil demand declined in the developed economies of the OECD, while it grew in developing economies in South America, the Middle East, and especially Asia. This is a pattern that will most likely persist given that 6.1 billion of the world’s 7.4 billion people live outside the OECD, and those populations are striving to

¹ See, for example, “Shale Gas and US National Security” (2011), “The Market Impacts of New Natural Gas-Directed Policies in the United States” (2015), and “To Lift or Not to Lift? The U.S. Crude Oil Export Ban: Implications for Price and Energy Security” (2015). Each Baker Institute CES study is available at <http://www.bakerinstitute.org/research/north-american-energy/>.

achieve standards of living enjoyed in the OECD. Asian demand growth accounted for over 80% of the increase in global demand from 2008-2015, with China comprising just over three-fifths of that increase. The fact that signs of global demand weakness emerged over the last couple of years as structural shifts in the Chinese economy emerged merely set the stage for short-term price adjustment; it has not altered the reality that future demand growth will come primarily from the developing world.

Figure 1. Changes in Global Oil Consumption, 2008-2015

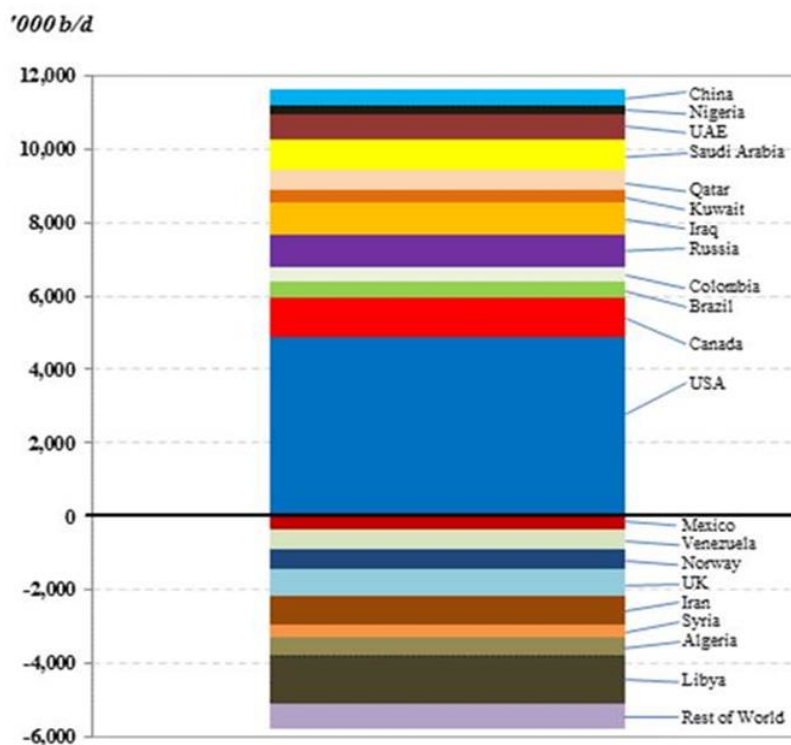


Source: BP Statistical Review, author calculations.

US energy policy must recognize that global energy and economic security is directly tied to the future of energy in the US, and in North America more generally. Over the last decade, the importance of US oil production for global market balance has already been made abundantly clear, as seen in Figure 2. Since 2008, several regions witnessed oil production declines—for totals that approach 6 million barrels per day (b/d)—despite the fact that oil prices were above \$100 per barrel for much of the time. While some of the observed decline was due to geology and economics (e.g., Norway, the UK), a large proportion of the reduction in output—just over two-thirds—was due to aboveground factors such as civil strife (Syria, Libya, Algeria, etc.), sanctions (Iran), and sector mismanagement (Mexico, Venezuela).

Notably, US production largely offset the observed declines due to the aboveground factors listed above. So even as high prices encouraged a positive supply response from other regions, if US production had not increased, oil prices would have been much higher and global dependence on Russia and OPEC would have expanded. Thus, the emergence of shale in the US accomplished the goal of reducing US imports in ways that various previous policy directives—all of which were supposed to reduce US dependence on foreign oil—could not. Moreover, the US emerged as a significant upstream player in the global oil market after decades of consecutive decline. Of course, since late 2014, efforts by OPEC to drive down prices and regain market share have dented US oil production, seeing it decline by about one million barrels per day since mid-2015, but the proverbial “genie is out of the bottle” with shale. Indeed, while the recent lower price environment has stressed US upstream firms, they have responded by emphasizing innovation, and, accordingly, producers have raised productivity and expanded their accessible resource base, thus setting the stage for a healthy sector as global markets rebalance.

Figure 2. Changes in Global Oil Production, 2008-2015



Source: BP Statistical Review, author calculations.

Altogether, this highlights the resilience of US shale and provides evidence that oil supply from shale is rather elastic, meaning it can respond to price movements fairly quickly. The importance of this for US and global energy markets cannot be overstated, as it provides added fungibility and, thus, energy security. It also gives the US an added context in

foreign policy, which should be leveraged to deepen relations in existing energy producing regions as well as in emerging markets, notably Latin America, Africa, the Middle East, and Asia. Deepened US engagement in each region could help to allay the types of unexpected outages seen over the last decade, thereby mitigating sudden price movements. Moreover, deepening relations across these regions could help facilitate access to modern energy services in the most impoverished of regions, thus addressing the phenomenon of energy poverty—an area where the US should take a leadership role.

While much of the focus on global oil markets is on supply, especially from OPEC nations, market balance also hinges on global demand. As demand grows, it will be paramount that supply is capable of responding in a timely manner. If anything impedes supply responsiveness, prices will increase and could do so in a dramatic fashion. Thus, it is important that market participants are able to react to market signals in a timely manner. If policy presents or fails to address impediments to things such as field development, infrastructure growth, commodity shipment, or investment in general, then supply will be sluggish to respond and prices will rise. Taken to an extreme, where such impediments result in a lack of supply responsiveness, prices could respond dramatically. More generally, factors that limit US supply responsiveness will compromise the position of the US as a global energy superpower, thereby pushing a regression to a previous era of energy security concern in US foreign policy engagement.

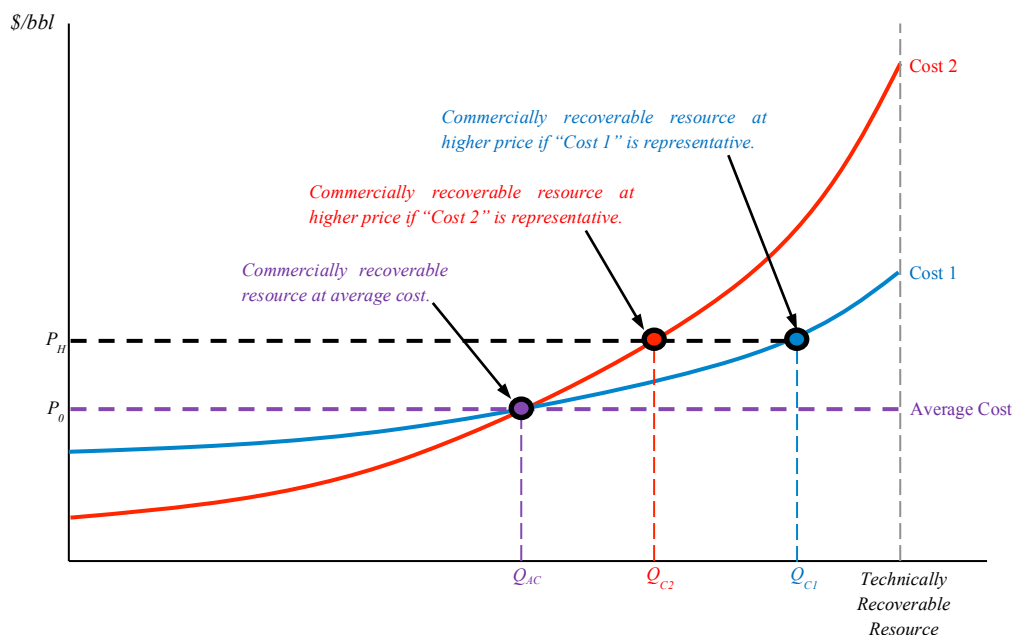
More on the point of supply responsiveness is relevant here. First, it is important to recognize that shale resources also exist outside the US. However, despite higher prices (for natural gas at least) and ample interest in countries outside the US, shale oil and gas development has not occurred with any rigor. This stems largely from the unique legal and regulatory frameworks of the US—starting with the assignment and treatment of property rights through to the existence of a stable regulatory regime and transparent markets with ample infrastructure and significant price discovery—which have engendered a flexible, entrepreneurial energy sector characterized by significant capital mobility and rapid response to price signals.² The flexibility of the US market has resulted in sustained productivity improvements and attracted capital from domestic as well as international investors.

Further on the responsiveness of shale production to price movement, specifically understanding scale and scope, one must first recognize that shale is a very heterogeneous resource. Within a shale formation and across different shale formations, well productivity and the cost to drill and complete wells can vary significantly, which means the cost per barrel of oil equivalent produced will also vary. This variability is relevant on two fronts. One, a reported “average” cost for production for shale is informative, but it has little bearing on how much will be produced at a given market price. And two, using simple averages can be very misleading with regard to understanding how price responsive production from a particular shale might be. Consider, for example, the case where the

² See “The Land of Opportunity? Policy, Constraints and Energy Security in North America” (2014), which is available on the CES Baker Institute website (<http://www.bakerinstitute.org/research/north-american-energy/>).

distribution of costs within a shale resemble those in Figure 3. A reported average cost for the shale play is only valid for the entirety of a shale’s potential if costs are flat (or supply is perfectly elastic). If, however, some acreage is more productive than others, then the cost curve will not be flat. In fact, the steeper costs are, driven by wider variation in well productivity across the shale play, the less price responsive production from a particular shale play becomes. A large body of research indicates there is significant variation in well productivity within individual shale plays as well across different shale plays, so the average-cost approach is invalid.³ Yet, average costs are still often used by analysts as a representative measure of how price responsive shale is. To be sure, shale has increased the elasticity (price responsiveness) of global supply, but an average-cost treatment can be misleading to the policy discourse around shale, which can lead to a misinformed analysis of the impact of various policy actions. Namely, what appears to be nonrestrictive policy may actually have more significance than initially believed, particularly if low-cost, high-productivity portions of the shale resource are disproportionately disadvantaged.

Figure 3. Shale Costs in Two Different Scenarios



³ See, for example, Decker et al., “Unraveling the Oil Conundrum: Productivity Improvements and Cost Declines in the U.S. Shale Oil Industry,” FEDS Notes, (Washington: Board of Governors of the Federal Reserve System, March 22, 2016), <http://dx.doi.org/10.17016/2380-7172.1736>, downloadable at <https://www.federalreserve.gov/econresdata/notes/feds-notes/2016/unraveling-the-oil-conundrum-productivity-improvements-and-cost-declines-in-the-us-shale-oil-industry-20160322.html>. There is also a considerable volume of research in press or in review at the time of writing by scholars from the University of Texas Bureau of Economic Geology, MIT, Rice University, Texas Tech University, and the University of Chicago, to name a few.

Finally, the responsiveness of shale is highly dependent on the factors that have driven productivity improvements observed across the industry in the US over the last two years. In particular, untangling what was driven by cost-reducing process improvement and what was driven by high-grading of acreage is vital to understanding how responsive shale production will be to price.⁴ In sum, it is paramount that a deeper understanding of the resource be brought to bear when formulating energy policies, especially given the importance of shale for the US energy complex.

In addition to stimulating discourse along economic dimensions, the emergence of shale in the US has borne witness to increased interest along diplomatic lines. For instance, there has been considerable exploration of diplomatic channels to facilitate the sharing of shale-related technologies. There is, however, a fine line that exists with regard to government policy and industrial technologies. To begin, the sanctity of intellectual property rights is a fundamental driver of entrepreneurial activity. As such, diplomatic channels should be used to encourage other governments to take steps to protect intellectual property and facilitate unimpeded movement of capital—facets of the US market that have led to success across the energy landscape, not just in oil and gas.

On this note, it is important to emphasize that sustained, robust development of shale resources is not a certainty. As stated above, a stable regulatory environment is critical to maximizing the potential benefits of shale. But stability is not synonymous with lack of regulatory oversight. Indeed, with regard to expanded activity in the oil and gas sector, government must establish a market paradigm that recognizes the environmental costs associated with drilling, processing, transportation, infrastructure siting, and end-user activities so that a balanced path can be achieved. One prime environmental concern, for example, regards the use and potential contamination of water supplies. Even if the potential for calamity is deemed remote, the potential costs associated with an environmental accident should motivate policy to establish rubrics that will incentivize firms to internalize these potential costs in their decisions, perhaps through the adoption of new technologies or the use of alternative water sources. For example, use of brackish ground water would effectively displace the use of other water supplies. Of course, disposal remains an issue, but the adoption of recycling and treatment technologies can and should be emphasized as a solution. In fact, the development of these technologies will carry spillover benefits, as their potential applications extend well beyond just oil and gas field uses. In any case, direct command and control regulatory guidance need not be used to achieve this path; severe penalties for regulatory violations that are strictly enforced should force firms to internalize the expected costs of any accidents. Consider, for example, the steps taken by industry as a whole with regard to offshore drilling in the wake of the infamous Deepwater Horizon incident.

⁴ This point is developed in detail in Medlock and Collins (2017), “Assessing Shale Producers’ Ability to Scale-up Activity,” which is available online at <http://www.bakerinstitute.org/research/north-american-energy/>.

In sum, the appropriate rubric for US energy policy must take a holistic approach, which can be quite different from state and local approaches to energy policy. In particular, local policy will generally tend to weigh local costs and benefits more heavily before an action is taken, and this will typically ignore broader market and geopolitical consequences. But for the Federal government, the policy rubric is much more diverse, so the approach must be sophisticated enough to balance US energy and economic security, broad environmental concerns, and US foreign policy objectives.⁵

A Note on Infrastructure and Market Access

As alluded to above, market structure and transparent regulatory oversight is very important when considering growth opportunities for domestic resource production, and it is likely the most underappreciated factor that positively benefited the growth in domestic oil and gas production seen over the last decade in the United States. Small, independent producers drove the entrepreneurial efforts that led to the large increases in shale oil and gas production—not the large integrated majors. Arguably, the entire conversation about shale would not be occurring had independent producers not taken the first steps into this new frontier, and they could not have done so absent the market structure that exists in the United States. Moreover, this extends to commodity transportation, as moving from field production to the end user is of vital importance. As one example, in the US natural gas market, ownership of transportation capacity rights is unbundled from pipeline ownership on long-haul interstate transmission. Unbundling of capacity rights from facility ownership makes it possible for any producer to access markets through a system of competitive bidding. Were this not the case, many of the small producers that first ventured into shale might not have been willing to do so, specifically because access to markets would have been limited. By contrast, when pipeline capacity is not unbundled from facility ownership, as is the case in many other markets around the world, large incumbents can present barriers to entry through control of the transportation infrastructure.

More generally, the United States has a well-developed competitive regulatory framework governing infrastructure development, transportation services, marketing, and mineral rights. This has supported the rapid development of shale resources, and it may not be fully or quickly replicable where government involvement in resource development and transportation is more prevalent. This could prevent market entry by smaller producers who would be otherwise willing to test and prove field-level concepts on a small scale. It is for this reason that US energy security has benefitted from having an active sector of small, independent energy companies. Without this sector, US shale oil and gas production would likely have taken many more years to grow to its current levels. This, in turn, would have meant greater US import dependence and yielded more market and geopolitical power to a few foreign suppliers.

⁵ This notion is discussed at length in the paradigm introduced in “The Market Impacts of New Natural Gas-Directed Policies in the United States” (2015), which is available on the Baker Institute CES website (<http://www.bakerinstitute.org/research/north-american-energy/>).

The implications of market access and infrastructure have been very apparent for US oil development. Despite what some may immediately think, this is not limited to pipelines, as a lack of pipeline takeaway capacity drove the growth of transportation by rail, which was vital to the successes seen in the Bakken play in North Dakota. While not necessarily the lowest-cost means of getting to market, rail shipment did allow production to grow in the absence of pipelines. This highlights the importance of flexibility in the institutions that govern energy markets. Any policy impediment that restricts such flexibility will ultimately stymie development, because pathways to move energy commodities are what drive market access and allow profitable development across the value chain.

All of the above, of course, brings into frame the challenges—through both legal channels and through public protest—to pipeline construction. The most notable of these challenges in the recent discourse manifested through the Keystone XL pipeline and the Dakota Access pipeline, which have direct implications for oil shipment, but the development of natural gas infrastructure has also been hampered, particularly in the Middle Atlantic and New England states. The end result of an inability to ship a commodity to higher-value markets is something that should be fully understood. Fortunately, we have a recent example that highlights the lesson. Specifically, decades-old policies that banned US oil exports resulted in a lack of timely investment in infrastructure to facilitate trade, thereby creating significant dislocations in oil pricing in the US and Canada. These issues have been resolved, but they stand to highlight what an inability to trade means for investment and pricing. Clear lines of sight to new markets are needed so that pricing signals can properly incentivize the most efficient allocation of capital. This requires transparent regulation on infrastructure development so that the risk of stranding invested capital is minimized.

Importantly, the arguments above extend into electricity markets as well. The ability to connect rapidly expanding wind generation capacity to markets is important for the long-term viability of those resources. Again, this is a simple “trade is facilitated by infrastructure” argument. The development of the CREZ in the Electric Reliability Council of Texas (ERCOT) market in Texas facilitated rapid expansion of wind generation in West Texas.⁶ Since the wind resource is generally far removed from load centers, transmission infrastructure is vital to supporting successful integration. Interestingly, in the case of wind generation capacity, subsidies—both direct and indirect—drove expansion of capacity even without sufficient transmission infrastructure. Then, it was incumbent on policymakers to push forward the financing of transmission so that the subsidies would not go to waste. While this example highlights how policy can create situations that themselves require policy interventions, that is not the point of this example. Rather, it highlights the necessity

⁶ CREZ (Competitive Renewable Energy Zones) were introduced by the Texas State Legislature in 2005 to alleviate transmission congestion and integrate renewable energy resources. After considering means to meet the legislative mandate, the Public Utility Commission of Texas (PUCT) determined that the interconnection of remote wind resources in west Texas with load centers in central and east Texas was the best approach, especially given that growth in wind generation capacity was already robust. Construction of various transmission links was commissioned in 2009. By 2013, around \$7 billion had been spent on an expansive infrastructure upgrade connecting west Texas wind energy resources to the rest of the state.

of infrastructure for moving energy commodities (electricity in this case) through trade, thus avoiding stranded capital assets.

In summary, it is important that regulation support the timely expansion of energy infrastructure so that goals of energy and economic security can be met. This is not meant to imply a free pass on infrastructure siting. Rather, environmental and community impacts must be considered, but the rules on permitting and siting need to be both clear and enforced. Any infrastructure project that meets the specified regulatory guidelines should then be allowed to proceed. This would eliminate any policy-related uncertainty that would negatively affect expanding capital investment in energy infrastructure, thereby leaving market signals and commercial considerations as the primary drivers of infrastructure development.

A Note on Energy Taxation, Research and Development (R&D), and the Environment

We turn now to energy tax policy, research and development, and the environment, which may at first seem like an odd grouping, but many of the issues addressed herein overlap. For example, taxation can be used to stimulate consumer behavior that raises energy efficiency by revealing consumer preference for new energy technologies. Similarly, subsidies can be used to stimulate the development and/or expansion of new energy technologies, which may carry desirable environmental benefits. In any case, the intertwined nature of these areas is fundamental to US energy policy in many ways.

In general, tax policy can be a vehicle for mitigating direct and indirect costs incurred as a result of the taxed activity. To be clear, “tax” also incorporates subsidies (as a negative tax), so we can generally think of energy tax policy as encompassing policies that are aimed at altering the price signals through the energy value chain in order to incentivize desired behaviors or to finance regulatory apparatus. In essence, this boils down to covering direct and indirect costs, but the accounting of costs is not always clear. For example, direct costs—such as the costs of managing various regulatory offices and their roles, as well as vital functionality like municipal water treatment—are fairly straightforward to synthesize. But indirect costs—such as the externalities associated with increased local industrial activity and infrastructure development—can become mired in subjectivity without any clear accounting metrics. This quickly becomes fodder for special interests and often results in significant and intense debate about the overall future of the energy industries. Moreover, the policy discourse often (but not always) carries a local focus because the perceived costs are realized by the local community.

As an example, consider the state of Pennsylvania. The rapid increase in drilling activity at the beginning of this decade exposed the fact that state regulatory agencies did not have the staffing or capability to appropriately manage the permitting and inspection required for the development of the Marcellus shale resource. Not surprisingly, this led to a great deal of public concern. By levying a tax to fund agency growth, the state became better prepared to manage the development of its resource wealth, which is important for the

overall economic and environmental health of the state. Thus, taxation can actually remove certain barriers related to public concern because the appropriate oversight can be funded, thereby ensuring that development commences in a sustainable manner. Of course, what affects one local community may or may not affect another. So heterogeneity across the country with regard to both perceived and real costs associated with industrial activity in general is why state and local regulators may be best situated to address appropriate policy actions. Thus, Federal intervention motivated by distinctly local considerations needs to be carefully considered so that the “law of unintended consequences” does not place an undue burden on regions not affected in the same way.

Another area where tax policy could be reconsidered is in the transportation fuels market, particularly because it could promote significant energy and environmental security benefits as well as provide a means for government financing of infrastructure and R&D. To begin, a modest tax increase on transportation fuels at the point of consumption would promote greater efficiency in end-use. In fact, we have recently seen the impact of higher fuel prices on consumer choice in motor vehicles; during the height of domestic gasoline prices in 2008, consumer demands for higher fuel efficiency led to waiting lists for hybrid vehicles. Of course, with the drop in oil prices since 2014, this trend has dramatically reversed. But to the extent that fuel efficiency rises due to consumer preference in response to higher prices, we would also see greater resilience of future household spending to energy price movements; with a more efficient vehicle stock, a future price increase would have a smaller impact on disposable income. Importantly, the associated tax revenues could be designated for infrastructure improvements and R&D. This would create direct employment opportunities for the refurbishment of the nation’s aging roads and bridges, and it would encourage the expansion of human capital deployment in the development of new energy technologies.

When discussing tax policy, it is important to also address subsidies. Policies of subsidizing energy are under pressure around the world. Subsidies promote inefficient levels of the activity at which they are directed and are ultimately unsustainable. Often, this discourse is directed at subsidies for domestic consumption of petroleum products, natural gas, and electricity, particularly in energy-exporting countries. The simple fact is that in countries with consumption subsidies, we see very high energy use per person and very high energy use per dollar GDP. Ultimately, this challenges the country’s ability to meet goals around export volumes, government revenues, domestic investment, and environmental quality. The bottom line is that subsidies distort consumer behavior and thereby alter the allocation of capital throughout the energy value chain.

While subsidies to end users of petroleum products, natural gas, and electricity are not a primary concern in the US, subsidies in other energy dimensions are. Often, policy has focused on using direct and indirect subsidies for deployment of technologies that are not commercial on their own. Direct subsidies include things such as transfer payments, reduced tax burden, and government financing; indirect subsidies include mandates such as renewable portfolio standards, which provide a subsidy by guaranteeing a market for the technology in question. While there may be real benefits associated with these types of

policy mechanisms, the entirety of the costs is often ignored in order to argue for the appearance of a net gain. This is critically evident in renewable generation technologies such as wind and solar. While each will ultimately have to be relied upon, they have largely been supported through direct and/or indirect subsidy. Moreover, the subsidies come at the expense of the taxpayer and consumer, while market participants must deal with inadequacies of the technology such as intermittency, which ultimately results in inefficient capital redundancy in the power generation grid; i.e., it requires “back-up” generation.

Consider the following example, which uses currently available data from the US Energy Information Administration.⁷ If we install wind capacity at a fixed cost of \$1600/kW, we will need to ensure that back-up capacity is also available in order to ensure grid stability, which is an inherent issue with non-dispatchable power-generation technologies. If conventional gas combustion turbine technology is used to provide this capability, then we must also incur an additional cost of about \$1000/kW to meet the system load, which pushes the total fixed cost of ensuring stable electricity generation to over \$2600/kW. This compares to a cost for natural gas combined-cycle generation technology that is capable of the same amount of power generation at less than \$1100/kW. The point here is that too often the discussion around renewables ignores the back-up capacity requirement. Much of this stems from the fact that the US grid is already well-developed and highly integrated, meaning renewables can be initially integrated without concern of there not being back-up capacity—because it already exists. But as expansion continues, there will be a point at which additional back-up resources are needed, and make no mistake: even battery technology is a “back-up” resource that comes with its own fixed cost. In fact, we can construct similar examples for distributed solar with battery storage, but using EIA data, it is straightforward to verify that the answer is no different with regard to the fixed cost of delivered electricity (note that this differs from commercial-scale utility storage, which we address below). In sum, the capital requirement on the power system increases substantially as renewables are expanded because intermittency must be addressed. Incorporating operating costs and assumptions about capacity utilization does not alter this conclusion,⁸ meaning electricity rates will ultimately have to increase as renewable penetration rises. While this may be an acceptable outcome given the avoided negative environmental externalities, at the very least the cost of any particular policy direction must be a part of the conversation so that a more informed decision can be made.

As previously noted, subsidies led to rapid expansion of wind generation capacity in Texas, which subsequently spurred an additional legislative policy mandate for infrastructure development. While the environmental benefits of clean energy sources are not an issue, the costs associated with integration should be fully accounted. To be clear, this is not unique to renewables. Subsidies and special tax treatments for fossil fuel development

⁷ See “Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2016” available online at http://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf.

⁸ See “Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2016,” available online at http://www.eia.gov/outlooks/aeo/electricity_generation.cfm.

should also be carefully reconsidered. As one example, the intangible drilling cost (IDC) expensing rules afford producers an effective subsidy toward production activity. It is unclear whether or not this actually has a significant impact on the upstream industry, particularly because the incidence of the rule is debatable. For example, straightforward economic analysis suggests that the upstream firm may bear little of the increased tax burden of an elimination of the IDC expensing allowance, while the landowner may bear the brunt through lower negotiated royalty rates.⁹ In the end, a careful evaluation is needed to assess the sustainability of energy tax and subsidy policies across all segments of the industry. And if broader changes to the overall tax code are being discussed, this should certainly be among the issues on the table.

If energy subsidies were reduced, the federal government could use at least a portion of the windfall to finance basic R&D in the energy sector. One such area of research in dire need of expanded funding is in commercial-scale utility electricity storage. Importantly, this contrasts to smaller-scale storage for distributed generation because commercial-scale storage should be able to better benefit from economies of scale. This would not only address the intermittency issue associated with renewables across the grid; it would also benefit the allocation of capital into power generation by reducing the need for redundant capacity designed to meet peak load requirements. The current generation grid has significant redundancy to deal with peaks in demand that occur sparsely during the day and infrequently throughout the year. Specifically, consider the demand for electricity on a late afternoon in mid-August versus demand in the early morning in mid-October—the required available generation capacity is significantly higher in August, but that capacity in the current market paradigm must be in place all the time regardless of whether or not it is used. This results in capital that sits idle most of the time, but it is the cost of ensuring reliability on the electricity grid. Technological innovation in commercial-scale electricity storage stands to mitigate this cost significantly.¹⁰ By eliminating the need for generation capacity that operates so sparingly, capital would be freed up to be allocated toward other endeavors.

Another area that should be open for government-funded R&D is in carbon capture and storage (CCS). As previously noted, the long-term future of energy markets rests in the economic fortunes of the 6.1 billion people that live outside the OECD. As such, it is difficult to paint a future in which fossil fuels are not important for economic activity around the world. This makes it paramount to consider ways to effectively capture carbon dioxide emissions if government policy is to earnestly approach long-term mitigation strategies. The current cost of CCS is prohibitive for large-scale adoption, which has led many to consider creating a marketable value for carbon dioxide use in enhanced oil

⁹ See the discussion in “The Market Impacts of New Natural Gas-Directed Policies in the United States” (2015), available on the Baker Institute CES website (<http://www.bakerinstitute.org/research/north-american-energy/>).

¹⁰ Ongoing research at the Baker Institute’s Center for Energy Studies suggest that commercial-scale electricity storage may benefit generation technologies with significant economies of scale, such as nuclear. This would allow large-scale generation sources to be oversized relative to base load, continue to operate and fill storage when demand drops, then capture higher price margins when demand rises in the afternoon.

recovery, leading to the notion of carbon capture utilization and storage (CCUS). In both cases, the area is in need of significant research and is likely important for long-term sustainability. Indeed, the IPCC in its latest report stated as much, but technology is needed to bridge the divide.

In general, basic R&D is important and should be considered more broadly in national energy policy. A simple analog to highlight is useful here. The shale revolution in the US has its roots in a Carter Administration initiative known as the Eastern Gas Shales Project. Geologists have long known about shale resources, but many considered the resource to be technically and commercially inaccessible. Without the basic lessons of the research that was spawned by the Eastern Gas Shales Project and carried forth by GRI and others, the shale revolution might not have occurred. The key point here is that gains from basic research may not reveal themselves until well into the future, in this case a more than 20-year lead time. But without the initial foray, the economic benefits and environmental attributes of low-cost natural gas would be out of reach.

The topic of the environment is perhaps the most important of the various issues in the energy policy arena, especially given public perception and special-interest engagement. To begin, there are concerns about the emissions of carbon dioxide associated with the combustion of fossil fuels. In the US, the shale revolution has unseated coal as king in power generation and led to a significant reduction in carbon dioxide emissions. When one considers the age of coal-fired generation infrastructure in the US, a continued expansion of natural gas in favor of coal is likely to continue, especially given the abundance of shale gas and its relatively low cost. The last major expansion of coal-fired generation capacity in the US occurred in the early 1980s. While there has been additional capacity added since, we are approaching the 40th birthday of a large fraction of the nation's coal generation capacity. This contrasts substantially with natural gas generation capacity, which saw a significant expansion of highly efficient combined-cycle capacity just over a decade ago. Hence, when considering the future of the fuel mix in electricity, one cannot ignore the realities on the ground. In fact, this reality should be a starting point for energy policy.

On the point of addressing climate change, the conversation is often focused on CO₂, but there are other, more potent greenhouse gases. Therefore, it is important that policy take a broader approach by addressing other greenhouse gases such as nitrous oxide (N₂O). Reducing one unit of N₂O is equivalent to reducing 265 to 298 units of CO₂.¹¹ N₂O emissions derive from activities such as agriculture, fossil fuel combustion, industrial activity, and wastewater management. In agriculture in particular, there are alternative fertilizers, such as biochar, that can mitigate the release of nitrogen, thus reducing N₂O emissions.¹² So depending on the cost of N₂O emission abatement, this could be a relatively

¹¹ See figures from the US EPA at <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>.

¹² This is drawn from ongoing interdisciplinary research by scholars at Rice University in the Baker Institute's Center for Energy Studies, the Department of Civil and Environmental Engineering, and the Earth Science Department.

low-cost means of achieving significant climate impacts, and at the very least deserves further discussion.

As noted above, the role of natural gas in addressing climate concerns has propelled it to the status of preferred transition fuel, specifically because it is the least carbon-intensive fossil fuel. However, when it comes to natural gas in the US, there is significant concern regarding methane leakage on pipelines and in the field. With regard to methane escape, much of it occurs in older, not as well maintained parts of the distribution network. "Of course, methane leakage is of immediate safety concern due to risk of explosion, but recent policy interest in the matter is related to methane being a potent greenhouse gas. Addressing methane emissions through federal oversight need not result in any binding regulatory intervention at the state and local level, but if done well it could expose local issues and elevate transparency. This would, in turn, serve the public interest and promote safety, and it could provide incentive to state and local regulators to act more aggressively in ensuring the nation's gas infrastructure is up to proper specification. An emergent technology that could play a significant role here involves the use of drones, which can facilitate more transparency in the monitoring of methane emissions across the energy value chain. But coordination with government efforts, rather than in spite of them, would serve to make compliance with any "industry best practice" a much more fruitful effort. After all, the oil and gas industry has a vested interest in mitigating methane escape because it is the primary constituent in marketed natural gas, so this could be an easy step to take.

Pulling It All Together: Recommended Policy Directions

Given the above discussion, we have the following recommendations. While this list is by no means exhaustive given the context presented above, it provides a platform for addressing more broadly the future of energy in the United States.

- Adopt a broader North American focus on energy policy by working to establish a paradigm where North America, with US leadership, can take steps to fully realize the potential provided by domestic crude oil and natural gas production in achieving energy security and sustained economic growth.
 - Recognize that Canadian and Mexican oil, gas, and electricity supplies and the pipelines and transmission lines needed for robust North American trade are important for ensuring energy security. This requires expansion of cross-border infrastructure, which facilitates trade and a deepening of the overall North American market.
 - Support the market-oriented allocation of capital throughout the energy value chain so that market forces are the prime determinant of the future of the energy sector. The environmental benefits of market-determined capital allocation are already evident through, for example, the displacement of coal in the power sector by natural gas. Importantly, the development of critical infrastructure throughout the energy value chain—such as pipelines,

- processing and handling facilities, transmission lines, etc.—must be able to progress in a responsible manner.
- Move to broadly reform fiscal policy measures in the energy sector.
 - Adopt a modest tax on transportation fuels at the point of consumption to promote greater efficiency in end use. This carries environmental benefits, but it also carries the important benefit of promoting greater resilience to future energy price movements. Earmark the associated tax revenues for infrastructure improvements and energy R&D. This will create employment opportunities and encourage the expansion of human capital deployment in the energy technology arena.
 - End subsidization—both direct and indirect—of energy resource development and energy technology deployment across the energy landscape. Use the associated budget windfall to fund basic R&D in energy technologies so that breakthroughs can ultimately facilitate commercially successful energy technology deployment.
 - Proactively integrate the new reality of energy in the US into foreign policy engagement and international trade negotiations while recognizing that global energy markets are becoming ever more integrated. This requires an expanded and permanent energy focus at the US Department of State, which must be coordinated with the US Department of Energy.
 - Recognize US tight oil production as a moderator of global oil price swings that provides macroeconomic benefits to the US economy and is paradigm shifting for the US position in global energy markets. As such, the role of energy in foreign policy will be more pronounced, so the Departments of State and Energy must be coordinated with each other. In addition, the US should aim to be more coordinated with our two largest energy trading partners—Canada and Mexico.
 - Work to deepen foreign policy ties in the Middle East, as stability in that region remains very important for global energy security and global security more generally, as has been witnessed over the last decade.
 - Use the recent expansion of domestic production in the United States to promote policies and regulations that facilitate the entry of private capital into the energy sectors of countries in Latin America and Africa. This will enable a deeper US engagement through private sector involvement in the commercial sectors of those countries, and it will also contribute to greater global energy security.
 - Use the emergent reality of the US as an energy superpower to proactively address energy poverty around the world in meaningful ways. This is an area in which the US can play a leadership role by aiming to promote policies that will lead to capital inflows in impoverished countries and ultimately alleviate energy poverty.

- Emphasize transparency and sustainability in energy development.
 - Work with states to establish a baseline regulatory guidance for handling produced water from oil and gas wells, with an emphasis on deploying technologies and regulatory frameworks that facilitate redefining produced water as a resource rather than a waste product. This has the potential to alter the way produced water is handled and ultimately discharged and could carry significant ancillary benefits.
 - Don't use infrastructure permitting as a de facto mechanism for addressing environmental issues. Such an approach raises the specter of near-term unexpected shortages of supply in downstream markets by limiting available capacity, especially in times of extreme stress. This, in turn, can result in price spikes, macroeconomic dislocation, and broad negative welfare consequences.
 - In addressing climate change, incorporate the carbon dioxide (CO₂) reduction potential of natural gas into foreign policy calculus. A broader North American focus on natural gas can encourage the broad penetration of natural gas into power sectors around the world. It is also important to broaden the approach used to address climate change by considering greenhouse gases other than CO₂, particularly those with significantly greater impact such as methane (CH₄) and nitrous oxide (N₂O).
 - Promote the use of currently available technologies, such as drones, to monitor methane emissions in real time more cost-effectively so that so-called “super-emitters” can be more readily identified and remediated. This will mitigate the environmental impact of domestic crude oil and natural gas development.
 - Energy and environmental policy actions should not be based on OECD-centric objectives. A broader approach is important to ensuring long-term engagement from the developing world and, ultimately, successful long-term outcomes in the energy and environmental policy arena.

The bottom line is to take steps that allow market mechanisms determine the allocation of capital and penetration of new technologies. Longer-term goals of global energy and environmental leadership can be sustainably achieved if basic R&D is given greater priority. Indeed, the role of technological innovation in driving affordable and sustainable energy futures is paramount to long-term US energy and economic security. In the short-to-medium term, domestic resource development will remain central to US energy and economic security. So, the development of domestic resources must be done safely and effectively with proper regulation. This follows because a sustainable energy future also requires government regulation of the industry to be clear, transparent, and stable. This is vital to ensuring capital investment is adequate to keep pace with aging infrastructure and the sheer scale of the energy complex.