Chapter IV

MODERNIZING U.S. ENERGY SECURITY INFRASTRUCTURES IN A CHANGING GLOBAL MARKETPLACE

This chapter addresses the role of infrastructure in ensuring U.S. energy security in a global marketplace. It first describes the evolution of the concept of U.S. energy security in response to interconnected global energy markets. It then discusses the security benefits of both increased domestic production and increasingly efficient use of energy. The chapter then examines four sets of infrastructures and provides associated recommendations at the end of each discussion. First, it looks at modernizing the Strategic Petroleum Reserve (SPR), analyzing both its physical facilities and the legal authorities governing its use. Second, the chapter examines changes affecting infrastructures for delivering propane and alternative fuels—two important contributors to a diverse U.S. energy supply. Third, it looks at the need to reinvigorate the U.S.-flagged shipbuilding industry, given the importance of marine transport of energy commodities to U.S. security. The chapter concludes with a discussion of the U.S. energy infrastructures that are shared with Canada and Mexico. This discussion is related to the broader issues of North American energy market integration that are covered in Chapter VI (Integrating North American Energy Markets).

FINDINGS IN BRIEF:
Modernizing U.S. Energy Security Infrastructures in a Changing Global Marketplace

Multiple factors affect U.S. energy security. These include U.S. oil demand; the level of oil imports; the adequacy of emergency response systems; fuel inventory levels; fuel substitution capacity; energy system resilience; and the flexibility, transparency, and competitiveness of global energy markets.

The United States has achieved unprecedented oil and gas production growth. Oil production growth has enabled the United States to act as a stabilizing factor in the world market by offsetting large sustained supply outages in the Middle East and North Africa and, later, contributing to a supply surplus that has reduced oil prices to levels not seen since March 2009. The natural gas outlook also has changed tremendously. Just 10 years ago, it was projected that the United States would become highly dependent on liquefied natural gas imports, whereas the current outlook projects that the United States will have enormous capacity and reserves and could become a major liquefied natural gas exporter.

The United States is the world's largest producer of petroleum and natural gas. Combined with new clean energy technologies and improved fuel efficiency, U.S. energy security is stronger than it has been for over half a century. Nonetheless, challenges remain in maximizing the energy security benefits of our resources in ways that enhance our competitiveness and minimize the environmental impacts of their use.

The network of oil distribution ("the midstream") has changed significantly. Product that had historically flowed through pipelines from south to north now moves from north to south, and multiple midstream modes (pipelines, rail, and barges) are moving oil from new producing regions to refineries throughout the United States.

The Strategic Petroleum Reserve's ability to offset future energy supply disruptions has been adversely affected by domestic and global oil market developments coupled with the need for upgrades. Changes in the U.S. midstream (for example, competing commercial demands and pipeline reversals) and lower U.S. dependence on imported oil have created challenges to effectively distributing oil from the reserve. This diminishes the capacity of the Strategic Petroleum Reserve to protect the U.S. economy from severe economic harm in the event of a global supply emergency and associated oil price spike.

Increasing domestic oil production has focused attention on U.S. oil export laws established in the aftermath of the 1973–1974 Arab Oil Embargo. There are now concerns that the U.S. oil slate may be too light for U.S. refineries; although, recent Department of Commerce determinations that liquid hydrocarbons, after they have been processed through a crude oil distillation tower, are petroleum products, and therefore eligible for export, will help avoid adverse production impacts.

An extensive network of pipelines, electric transmission lines, roads, rail, inland waterways, and ports link the United States with Mexico and Canada. These systems not only provide economic value to all three nations, but also enhance continental energy security and improve system reliability.

Biofuel production in the United States has increased rapidly over the last decade, enhancing energy security and reducing greenhouse gases from transportation. This growth has been driven in part by the Renewable Fuel Standard. Ethanol now displaces approximately 10 percent of U.S. gasoline demand by volume; biodiesel, advanced and cellulosic biofuel production volumes have also been growing. Continued growth in ethanol use will depend in part on investment in additional distribution capacity; growth in the use of other biofuels, such as "drop-in" fuels, will depend on continued investment in research, development, demonstration, and deployment.

A Broad and Collective View of Energy Security

Until recently, the concept of energy security has focused on "oil security" as a proxy for "energy security." It is clear, however, that energy security needs to be more broadly defined to cover not only oil, but other sources of supply, and to be based not only on the ability to withstand shocks, but also to be able to recover quickly from any shocks that do occur. In addition, security is not exclusively domestic; it is dependent on interactions in the interconnected global energy market.

Acknowledging the need for a modern and collective definition of energy security, last May in Rome the G-7[a] Energy Ministers adopted a set of seven core principles for energy security,[1] several of which are particularly relevant to energy infrastructures:

- Development of flexible, transparent, and competitive energy markets, including natural gas markets.
- Diversification of energy fuels, sources, and routes and encouragement of indigenous sources of energy supply.
- Reducing our greenhouse gas emissions and accelerating the transition to a low-carbon economy as a key contribution to enduring energy security.
- Enhancing energy efficiency in demand and supply and demand response management.
- Promoting deployment of clean and sustainable energy technologies and continued investment in research and innovation.
- Improving energy systems resilience by promoting infrastructure modernization and supply and demand policies that help withstand systemic shocks.
- Putting in place emergency response systems, including reserves and fuel substitution for importing countries, in case of major energy disruptions.

U.S. energy security and the infrastructures that support it, both physical and geopolitical, should be viewed in the context of this new, broader, more collective definition of energy security. This chapter—and the Quadrennial Energy Review (QER) more widely—addresses each of these elements. Chapter II (Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure) considers various actions that the government and private sector can take to promote a more rapid and effective response to energy shocks, including those from weather, supply disruptions, and physical attacks. This chapter, as well as Chapter VI (Integrating North American Energy Markets), speaks to the increasing diversification of U.S. energy supply, with safe, secure, and economically efficient energy coming from Canada and Mexico through pipelines, over interconnected transmission networks, and via barge and tanker. The discussions in Chapter V (Improving Shared Transport Infrastructures) address issues related to the diversification of fuel supplies and routes, as well as the dynamics of better managing the distribution of the increasing production of domestic energy supplies.

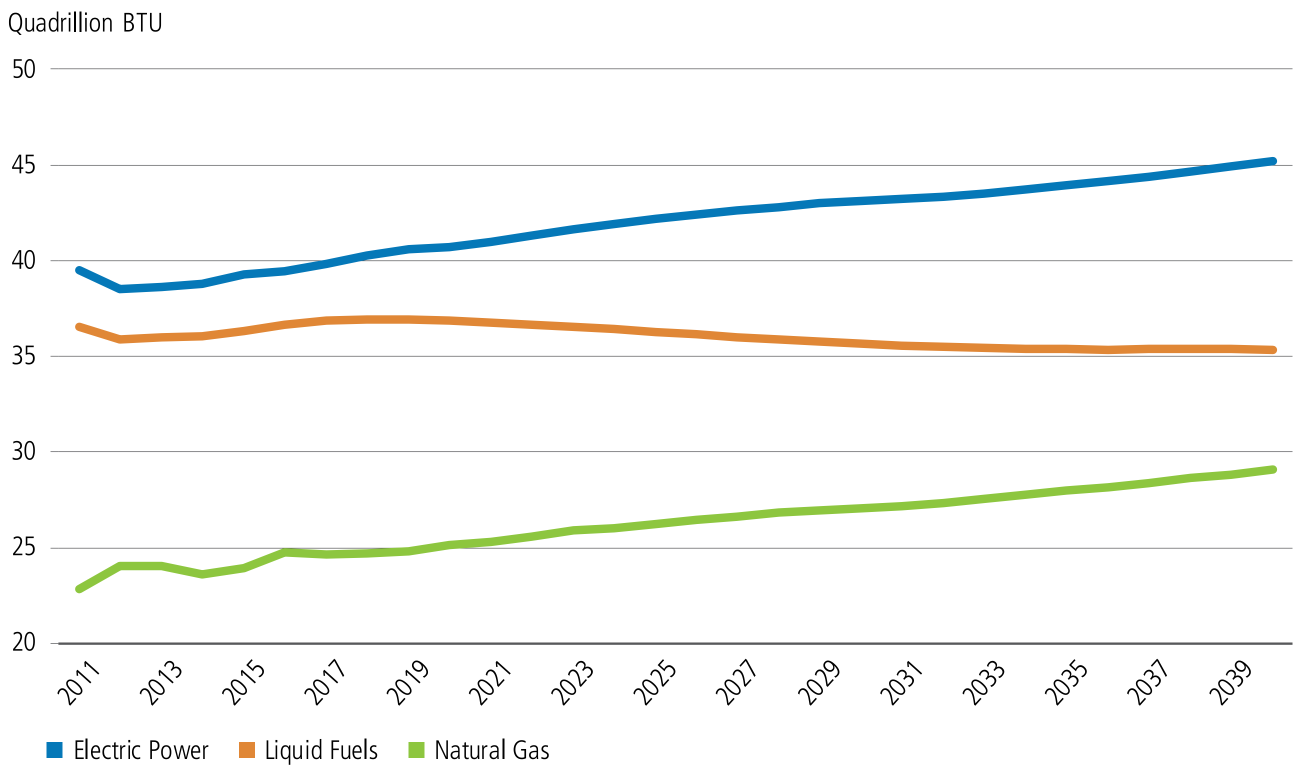
Energy security issues need to be considered in light of future supply growth projections, fuel switching, shifting consumption patterns, and their implications for both U.S. and world energy security. Irrespective of the recent global crude oil price drop, near-term projections from the Energy Information Administration (EIA) and other expert energy market forecasters indicate global supply growth will continue for some time and that potential oil price recovery—when and by how much—remains uncertain for the foreseeable future.

Finally, the discussion of energy security would not be complete without addressing the demand side. While issues of energy conservation, energy efficiency, and demand reduction are largely out of scope for this installment of the QER, they are nonetheless relevant for energy security. Figure 4-1 shows U.S. energy

[a] The G-7 countries include the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom.

demand as projected by EIA through 2040. These projections indicate that U.S. liquid fuel demand is expected to grow through 2018 and then begin a slow decline for the remainder of the period. In contrast, EIA projects a steady growth through the projection period for both electricity and natural gas. However, it should be noted that EIA's projections do not consider regulations that are not yet finalized. Thus, EIA projections do not account for electricity supply and demand changes likely to occur from implementation of the Environmental Protection Agency's "Clean Power Plan," because it has not yet been finalized. Should demand decline in any of these sectors (particularly, if the infrastructure and resources remained in place to manage higher levels of supply), the energy system's ability to withstand supply disruption would increase. Of course, over the longer term, it is to be expected that a new equilibrium would be reached, and supplies and demand would again be in balance, suggesting that supply disruptions could still create insecurities in the energy system even with lower overall levels of energy flows.

Figure 4-1. Trends in U.S. Use of Petroleum, Natural Gas, and Electricity, 2011–2040[2]



EIA projections indicate that through 2040, natural gas and electric power demand will steadily increase, while liquid fuels demand will increase until 2018 and then slightly decline through 2040.

U.S. Energy Security, Changed Production Profile, and Infrastructure Needs

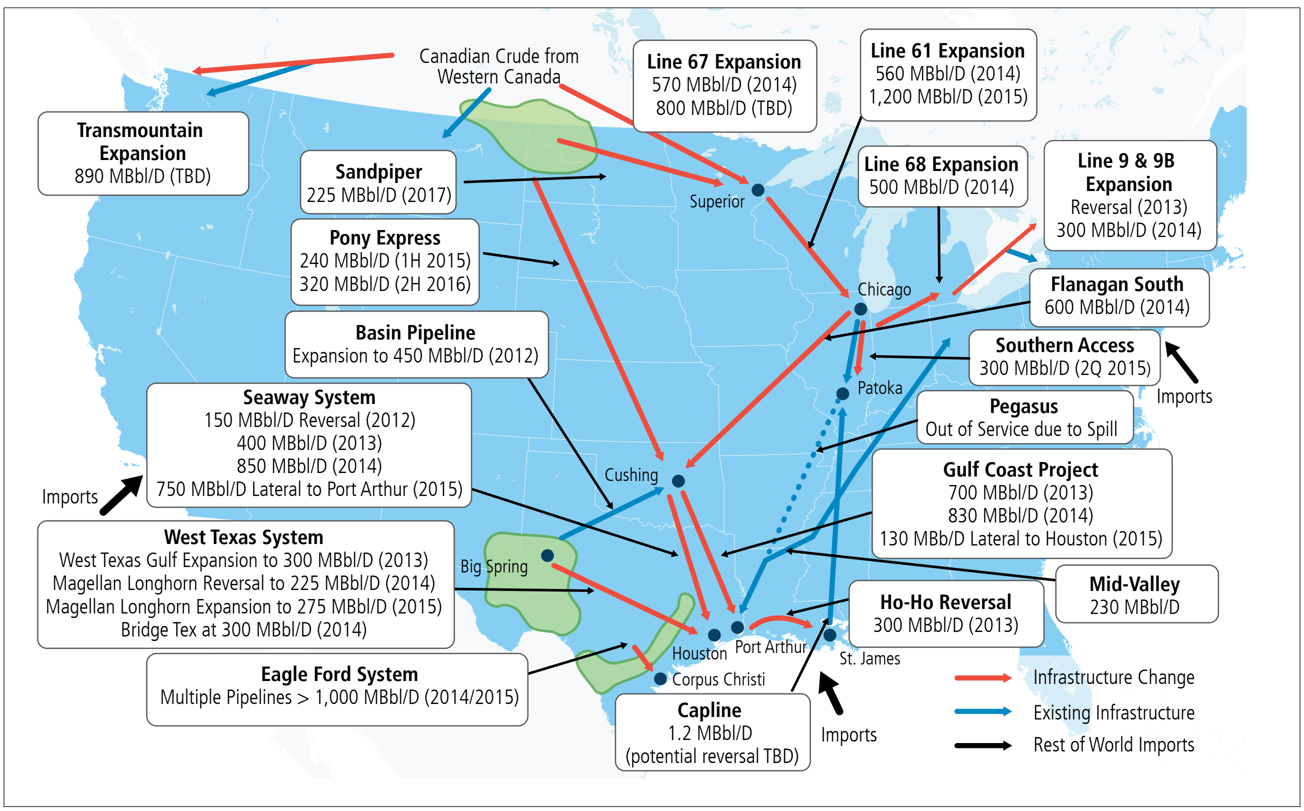
As discussed in Chapter I (Introduction), there have been striking changes in U.S. oil production over the last 5 years, as well as changes in supplies of natural gas, natural gas liquids (NGL), and biofuels. The unprecedented oil and gas production growth in the United States has made it the world's largest producer of combined petroleum and natural gas. Growth in oil production has enabled the United States to act as a stabilizing factor in the world market by offsetting large sustained supply outages in the Middle East and North Africa and, more recently, contributing to a supply surplus that has reduced oil prices to levels not seen since March 2009.[3] The natural gas outlook also has significantly changed. Just 10 years ago, the United

States was forecast to become highly dependent on liquefied natural gas imports; however, the current outlook projects that the United States will have enormous capacity and will likely become a major liquefied natural gas exporter.[4] Combined with new clean energy technologies and improved fuel efficiency, U.S. energy security is stronger than it has been for over half a century.

This production of oil and natural gas is occurring in new locations often removed from areas of historical production. As a consequence, the flow of both raw energy commodities and their refined products is changing, placing demands on the infrastructure that moves them to intermediate users and consumers.

Historically, oil and oil products in the United States have tended to flow from south to north to inland refineries. Now, this generally has been reversed, with oil from the Bakken field in North Dakota and Montana moving from the north toward the Gulf of Mexico, as well as to East and West Coast refineries. Significant new quantities of crude oil from the Eagle Ford and Permian shale basins also are moving to Gulf Coast refineries. To accommodate these changes in the volume and geography of U.S. crude oil production, there have already been substantial pipeline additions and some reversals,[5,6] as shown in Figure 4-2.There have also been significant increases in barge, rail, and truck transport of crude oil, crude oil products, petrochemicals, and ethanol. This build-out of infrastructure has improved U.S. energy security. Without it, the United States could not have reduced its reliance on imports of liquid fuels to the extent that it has.

Figure 4-2. Highlighted Liquid Fuels Pipeline Reversals and Expansions Accommodating Increased Domestic and Canadian Supply (existing or in construction by end 2014)[7]



There have been substantial pipeline additions and some reversals of pipeline product flows to accommodate the changes in domestic production regions and the volumes of product that are being transported.

Natural Gas and Liquid Fuels Scenario Analyses

Quadrennial Energy Review scenario analysis used the Deloitte MarketPoint model (www.deloittemarketpoint.com) and several oil infrastructure models to examine oil and gas transmission pipeline needs between 2014 and 2030. Several cases were run to evaluate different oil and gas production and demand profiles (see Chapter I, Introduction, Table 1-2 for the complete list of cases). Even under conditions where natural gas and liquid fuels demand increases dramatically, pipeline infrastructure requirements do not exceed recent historical industry build rates. The recent build-out to integrate new shale gas supplies has added substantial optionality to the interstate natural gas pipeline system. Options include utilizing excess pipeline capacity in some regions, as well as the potential for additional looping, compression, and pipeline reversals. These options dampen the need for new gas infrastructure; even when new gas capacity is regionally concentrated, as it would be in the Gulf if gas exports were to increase significantly, annual rates of investment are at or below historical levels.

The analysis also incorporated expansion of the transportation and distribution infrastructure currently underway along with expansion of this infrastructure to accommodate forecasted growth in crude production. Crude by rail remained an important mode of transport for moving midcontinent crudes to coastal refineries. In addition, crude oil pipelines from north to south and west to east continued to expand in the midcontinent and west Texas, respectively.

Many U.S. Gulf Coast refineries have been largely configured to use a greater share of heavy crude oils, whereas nearly all of the recent incremental U.S. crude oil production is light oil. To date, U.S. refiners have been able to absorb increasing amounts of light crude oil by displacing imported light and medium crudes. The natural gas boom has not only reduced gas imports and enabled liquefied natural gas exports, but it has also reduced costs for U.S. refiners who use natural gas for process fuel. They are now more competitive in international markets, leading to more highly refined product exports.[8]

As a result of the renaissance of U.S. oil and natural gas production, the U.S. Gulf Coast marine facilities serving the SPR are operating at high capacities. This has implications for the distribution capacity of the SPR, the infrastructures that support it, and the degree to which it can protect the U.S. economy from oil disruptions.

The U.S. Strategic Petroleum Reserve: Oil Security Infrastructure

The SPR is a Federal facility that consists of a network of 62 salt caverns at 4 geographically dispersed storage sites in Louisiana and Texas. It currently holds 691 million barrels of crude oil. The SPR caverns are connected to three distribution networks—Seaway, Texoma, and Capline—that distribute SPR oil through a network of pipelines and marine terminals to Gulf Coast refineries, inland refineries, and refineries on the East and West Coasts. The SPR has a design drawdown capacity of 4.4 million barrels per day from its caverns into its distribution networks.[9] During an SPR release, an auction determines which U.S. refineries will receive SPR oil. The ability to *deliver* oil to the refineries is the SPR's distribution capacity and depends on the SPR's network of pipelines and marine terminals.

The SPR is an important insurance policy for the U.S. economy in the event of serious oil supply disruptions and the associated price increases in domestic petroleum and petroleum products. Sharp increases in fuel prices and declines in gross domestic product growth have consistently followed previous oil supply disruptions. In spite of the changes in the U.S. oil profile, the U.S. economy will remain vulnerable to future international oil supply disruptions without the protection afforded by the SPR.[10]

Changing Global and Domestic Oil Markets Underscore the Need to Modernize the SPR

U.S. and global oil markets have evolved since the 1970s, changing the environment in which the SPR operates. When the SPR was established, U.S. oil production was in decline, oil price and allocation controls separated the U.S. oil market from the rest of the world, and a truly global commodity market for oil, as we know it today, did not exist. The Energy Policy and Conservation Act of 1975's (EPCA's) 1970's-era goal was focused on avoiding "national energy supply shortages"—a loss of supply to U.S. refineries—rather than on the impacts of an overall disruption of global oil markets—a less important concern given the existence of domestic price controls that aimed to separate domestic and foreign prices.

Regardless of the levels of U.S. oil imports, in today's global oil markets, a severe global market disruption would have the same effect on domestic petroleum product prices whether or not U.S. refineries import crude oil from the disrupted countries.[b, 11] EPCA's definition of a "severe energy supply interruption" should expressly include criteria focused specifically on disruptions in the global oil market, regardless of whether they resulted in a loss of oil imports to the United States.

Another change that would increase the effectiveness of the SPR involves the adequacy of the anticipatory authorities in EPCA, which articulate the process and criteria for an SPR release *before* domestic petroleum price increases. In 1990, Section 161(h) was added to authorize an SPR release in anticipation of a severe increase of petroleum product prices; that authority is limited to a release of no more than 30 million barrels of oil and for no more than 60 days. In today's fast-moving and globalized energy markets, the President should not have to wait until higher fuel prices have already damaged the U.S. economy before the SPR can be used without restrictions. The authority to anticipate an economy-damaging price increase as a result of a severe energy supply interruption should be added to the President's broader Section 161(d) release authorities to more closely conform to other EPCA goals of preventing "a severe increase in the price of petroleum products" that "is likely to cause an adverse impact on the national economy."

Further Enhancing the SPR's Value in Today's Oil Markets

In the event of a serious international oil supply disruption, offsetting a significant share of lost supplies with SPR oil, in concert with other countries that hold strategic reserves, would help reduce the sharp increase of international oil prices that would otherwise occur. When SPR oil is sold to domestic refineries, foreign oil shipments that would have been processed by U.S. refineries are freed up for use elsewhere, effectively increasing global oil supplies. The more oil the SPR is able to distribute to U.S. coastal refineries (inland refineries are now well supplied by domestic production and Canadian imports), the more oil will be added to global markets. This will mitigate the increase in international and domestic fuel prices and reduce harm to the U.S. economy. These diversions of foreign oil that would have been used by U.S. refineries are illustrated by the 2011 Libyan Collective Action.[c] At that time, the United States imported about 1 million barrels per day of oil from Nigeria. As a result of the June 2011 SPR release, significant Nigerian supplies were redirected to foreign refineries. The SPR oil sold to domestic refineries caused a corresponding increase of oil into the global market.

In recent years, the changing geography of U.S. oil production has led to major changes in the domestic oil and natural gas pipeline system. New patterns of oil supply and demand among U.S. oil producers and refineries, along with associated changes in the U.S. midstream, have significantly reduced the ability of the SPR to distribute *incremental* volumes of oil during possible future oil supply interruptions. Moving SPR oil to Midwest refineries—a historical pattern—would be of no value during a petroleum supply disruption as non-Canadian imports and Gulf Coast

[b] Domestic petroleum product prices are determined by international oil prices.

[c] In June 2011, the United States, as part of an International Energy Agency "Collective Action," released 30 million barrels of SPR oil in response to the loss of Libyan oil production as a result of the Libyan civil war (February 2011) and subsequent loss of Libyan oil exports.

supplies into this refining complex have essentially disappeared. The U.S. pipeline distribution system, along with other modes of oil transport, is instead moving large volumes of oil to the Gulf Coast, especially from U.S. tight oil plays and Canada.[d] This new geography of U.S. oil production and energy exports has also increased commercial traffic at U.S. Gulf Coast marine loading facilities.

While the SPR can commandeer dock space at certain leased locations, doing so might cause a corresponding reduction in commercial traffic. The changing patterns of U.S. oil imports[e] mean that the location of an international oil supply disruption can affect the disposition of an SPR oil auction and the capacity of the SPR to deliver oil to its customers.[f] If the SPR cannot load oil onto barges and tankers without disrupting commercial shipments, SPR sales could be offset by a corresponding decrease in domestic crude oil shipments or exports of domestically produced petroleum products. For all of these reasons—the evolution of global oil markets, the participation of the United States in those markets, the changed geography and volume of U.S. oil supplies, reduced oil imports, and congestion of commercial facilities in the SPR's distribution region—an effective SPR release will increasingly depend on the ability to load *incremental* SPR oil onto barges and tankers.[12]

SPR facilities are also aging. Investment has not kept pace with need. Some SPR infrastructure is nearing the end of its design life. Life-extension investments will be needed in the near future to ensure the SPR's reliability for the next several decades. The Department of Energy (DOE) is working to address SPR-deferred maintenance issues within the regular budget process. The more costly long-term investments in life extension will need to be addressed separately.

Administration Activities and Plans

In March 2014, the Secretary of Energy ordered the Strategic Petroleum Reserve office to conduct a test sale to demonstrate the drawdown and distribution capacity of the Strategic Petroleum Reserve in the two locations served by its Texoma distribution network. This test sale highlighted changes in the distribution infrastructure in the Gulf Coast region. During the test sale, purchasers had problems getting capacity on one major pipeline for preferred deliveries and had to make adjustments by shipping crude oil to a different terminal and placing the oil into temporary storage until pipeline capacity became available.[g]

The President's Fiscal Year 2016 Budget provides $257 million for the development, operation, and management of the Strategic Petroleum Reserve. This is an increase over fiscal year 2015 enacted levels of more than $54 million. This additional funding includes more than $8.5 million for the operations and cavern integrity program, $17 million to improve distribution flexibility and reliability at the Big Hill site, and more than $26 million to reduce the backlog of deferred maintenance projects and address maintenance issues.

[g] Department of Energy. "Strategic Petroleum Reserve Test Sale 2014: Report to Congress." p. 16. 2014. http://energy.gov/sites/prod/files/2014/11/f19/2014%20SPR%20Test%20Sale%20Final%20Report.pdf. Accessed February 12, 2015.

[d] For example, the SPR's distribution capacity has been affected by reversals of the Seaway and Ho-Ho pipelines. New pipeline capacity has been built to move oil stored at the Cushing, Oklahoma, terminal to the Gulf Coast, or to bypass Cushing by shipping oil from new tight oil plays directly to Gulf Coast refineries.

[e] Besides the virtual disappearance of non-Canadian imports to Midcontinent refineries, Gulf Coast refineries are using more heavy oil from Latin America and less oil from the Middle East, while West Coast and East Coast refiners continue to import Middle Eastern and other light/medium grade crudes.

[f] The maximum distribution rate during an oil supply interruption depends on the location of the oil-exporting nation(s) that has (have) been disrupted, the type of oil that has been disrupted, and whether the United States imports oil from that nation (and, if so, how much and to what refining region). Additionally, due to increased U.S. tight oil production, the three SPR distribution systems will, in the future, rely more on marine distribution of SPR oil than inland pipelines. The pipeline network will remain important, though, especially for disruptions of oil that the Gulf Coast refineries rely on (such as oil from Venezuela, Mexico, or Columbia). Supply disruptions from these sources may result in less congestion for moving SPR oil on its pipeline system.

QER Recommendations

SPR MODERNIZATION

An effective modernization program for the SPR should reflect changed global oil markets and U.S. market conditions. It should be undertaken, as should all recommendations in this chapter, with a more up-to-date appreciation of the nature of energy security in an interconnected world. It should also focus both on physical infrastructure and an updated statutory trigger for the use of the SPR. Addressing both physical and statutory issues will ensure that high volumes of incremental barrels of oil will be able to move rapidly to U.S. refineries in case of a global market disruption, thereby increasing supplies in global markets and maximizing the value of the SPR for meeting the Nation's strategic energy needs. Specific recommendations include the following:

Update SPR release authorities to reflect modern oil markets: Congress should update the SPR release authorities in EPCA so that (1) the definition of a severe energy supply interruption includes an interruption of the supply of oil that is likely to cause a severe increase in the price of domestic petroleum products, and (2) the requirement that a severe increase in the price of petroleum products ***has resulted*** from such emergency situation is changed to a requirement that a severe price increase ***will likely result*** from such emergency situation.

Invest to optimize the SPR's emergency response capability: DOE should make investments to optimize the ability of the SPR to protect the U.S. economy in an energy supply emergency. It is anticipated that $1.5–$2.0 billion is needed to increase the incremental distribution capacity of the SPR by adding dedicated marine loading dock capacity at the Gulf Coast terminus of the SPR distribution systems, as well as undertaking a life extension program for key SPR components, including surface infrastructure and additional brine-drive caverns. This work should be preceded by DOE analyzing appropriate SPR size and configuration and carrying out detailed engineering studies.

Support other U.S. actions related to energy security infrastructures that reflect a broader and collective view of energy security: The United States should continue to consult with allies and key energy trading partners on energy security issues, as well as support actions related to energy infrastructures that are consistent with U.S. interests and G-7 principles on energy security.

Infrastructure Supporting Energy Security through Fuel Diversity

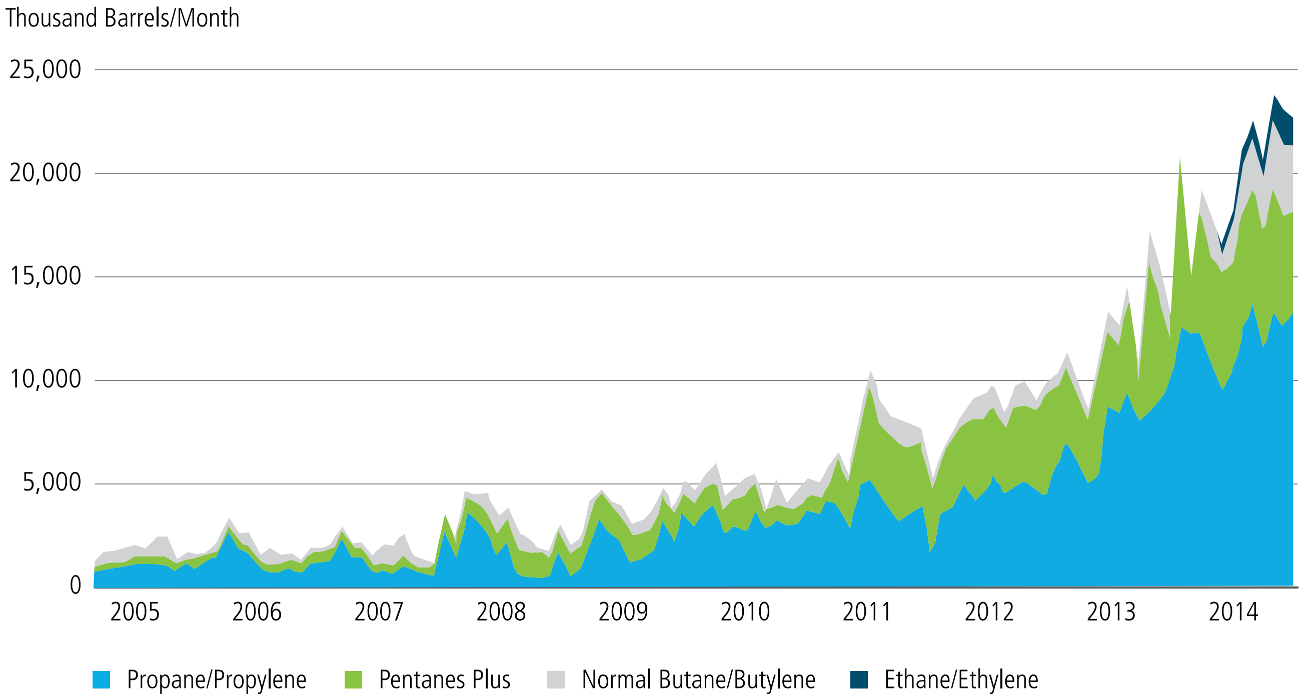
Transmission, storage, and distribution (TS&D) infrastructure has an important role to play in meeting another one of the long-term energy security core principles adopted by the G-7: diversifying energy fuels, sources, and routes and encouraging indigenous sources of energy supply. Two challenges in recent years related to maintaining a diverse supply of energy fuels—in the face of overall TS&D infrastructure changes that have been occurring—relate to the use of propane and biofuels.

Changes in NGL Infrastructure and Exports Could Have Propane Customer Impacts

Propane is a hydrocarbon gas liquid produced in gas plants and refineries. Propane is primarily used in industry, but during the winter, propane is an essential fuel for heat and is especially important in rural areas. The infrastructure connecting the producers of propane with distribution points for customers has changed dramatically in the last few years. As other geographies of energy supply have changed, infrastructure once used to transport propane to these distribution points (particularly those that serve agricultural users predominantly in the Upper Midwest) has been converted to other purposes. One of the major changes in this regard has been the reversal, by Kinder Morgan, of the Cochin pipeline, which originally transported propane from a storage site in Edmonton, Canada, to serve markets throughout the Midwest. In early 2014, the company reversed the pipeline's flow to deliver NGL to Edmonton, cutting off a major supply source of propane for Midwest markets.

Although propane storage has increased along with recent increasing levels of NGL production, a growing portion of propane is being exported. Propane exports are seasonal, however, reflecting tighter markets during the winter when domestic demand is high and greater surplus during the summer. In addition, rapidly increasing exports of propane and other NGL, as shown in Figure 4-3, are competing with the supply needs of users of propane in the agricultural, residential, and petrochemical sectors. This changing interplay of NGL use was highlighted during the fall and winter of 2013–2014 when propane users encountered severe regional shortages and price spikes in some regions across the country.

Figure 4-3. U.S. Hydrocarbon Gas Liquid Exports[13, h]



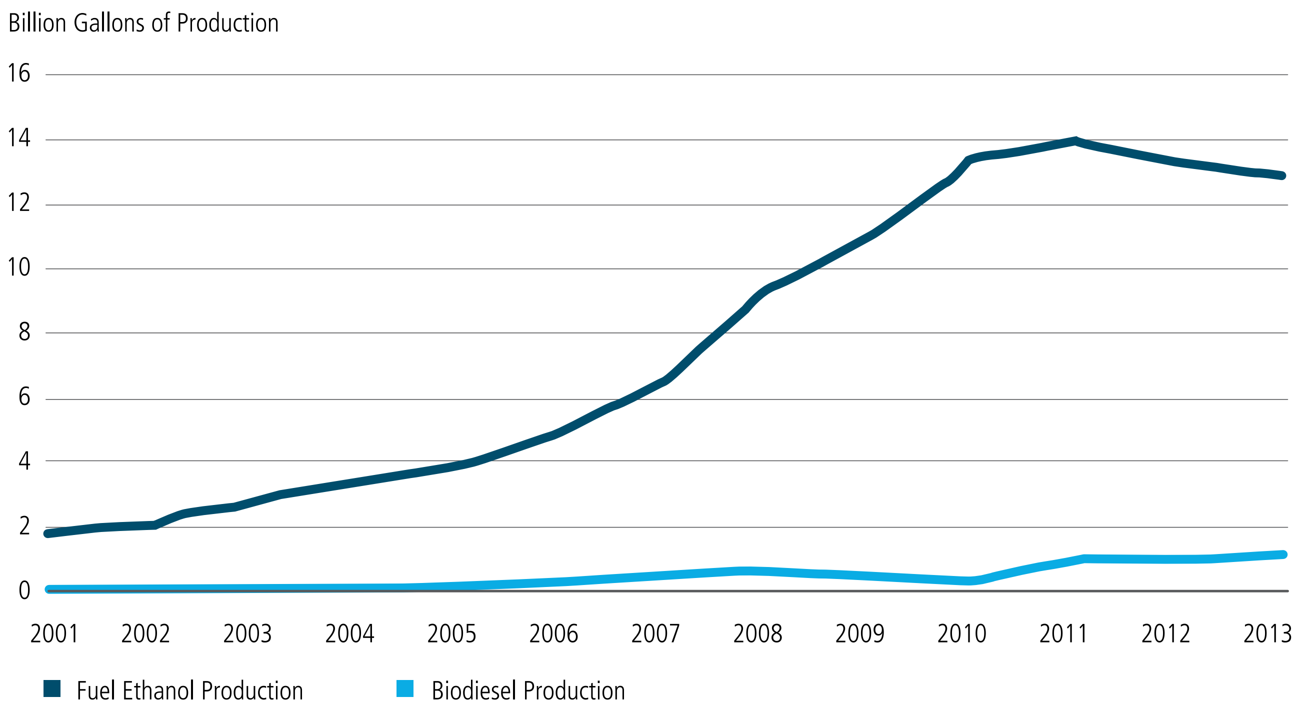
Since 2009, U.S. hydrocarbon gas liquid exports have risen substantially due to increased domestic production and wide international price spreads.

[h] Hydrocarbon gas liquids: A group of hydrocarbons, including ethane, propane, normal butane, isobutane, and natural gasoline, and their associated olefins, including ethylene, propylene, butylene, and isobutylene. As marketed products, hydrocarbon gas liquids represent all NGL and olefins.

Biofuels and TS&D Infrastructure Issues

Ethanol production in the United States has increased steadily over the last few decades, driven by tax credits, the oxygenate standard,[i] the Renewable Fuel Standard,[j] and the lower cost of ethanol relative to other gasoline additives. By 2012, ethanol production reached nearly 10 percent of U.S. gasoline demand by volume. As shown in Figure 4-4, further growth in ethanol production has flattened since then. Increased use of ethanol requires either growing gasoline consumption or higher-level blends (E15, with 15 percent ethanol, or E85, with up to 85 percent ethanol). However, the demand for gasoline is not expected to grow significantly (due to projected improvements of fuel economy and demographic trends). Continued growth in ethanol use will depend in part on private sector investment in additional distribution capacity of higher-level blends.

Figure 4-4. Yearly Ethanol and Biodiesel Production, 2001–2013[14]



Yearly production of ethanol increased between 2001 and 2011 and has declined slightly through 2013.

Ethanol shipments from production plants typically occur by rail, which accounts for approximately 70 percent of ethanol transport.[15] Ethanol is then delivered by truck (or directly by rail) to petroleum product terminals that blend ethanol with unfinished gasoline for delivery by truck to retail outlets. It is difficult to move ethanol shipments by pipeline because ethanol absorbs water and can therefore degrade the specifications of petroleum products, which would follow it in the pipeline.

Other biofuels have chemical properties more similar to gasoline and other hydrocarbons, enabling more ready distribution through existing TS&D infrastructure. Upstream biofuels involve biofuels that could be blended into the petroleum product supply chain at the refinery and then transported with the petroleum product

[i] The oxygenate standard for reformulated gasoline, introduced by the Clean Air Act Amendments of 1990, required a minimum level of oxygen in complying gasoline. The oxygen content of gasoline is typically increased by blending ethanol or methyl tertiary butyl ether into gasoline. The oxygenate standard was repealed in the same legislation that established the Renewable Fuel Standard (Energy Policy Act of 2005).

[j] The Renewable Fuel Standard was enacted as part of the Clean Air Act by the Energy Policy Act of 2005 and amendments in 2007. The Renewable Fuel Standard requires a minimum level of qualifying biofuels, including ethanol, to be blended into U.S. motor fuels.

through its normal infrastructure. These alternatives include oil from the pyrolysis of biomass, hydrocarbons derived from applying the Fischer-Tropsch process to mixtures of carbon monoxide and hydrogen produced in biomass gasifiers, oil derived from algae, and fatty acid methyl esters.[16] Drop-in biofuels, such as biobutanol and renewable diesel, can use existing oil and gasoline infrastructure and be "dropped in" at points along the supply chain without infrastructure modification. Future research on both types of biofuels can support energy security through fuel diversity without posing additional infrastructure challenges.

Administration Activities and Plans

Propane. The Administration has taken a series of actions to respond to the changes in transmission, storage, and distribution infrastructure for propane and other natural gas liquids. The Energy Information Administration has added capability to monitor propane inventories on a more granular, state-by-state basis, greatly enhancing the ability of industry, consumers, and policymakers to monitor possible shortages or distribution issues. Because propane storage in customer tanks can provide an additional margin of supply security, the Federal Government supported public education campaigns to encourage consumers to fill their propane storage early for the 2014–2015 winter season. As of January 2015, propane inventories were above the 5-year average, and the Propane Education and Research Council's market research shows the campaign contributed to these increases.[k,l]

Department of Energy (DOE) alternative fuels programs. DOE has supported research and development on the compatibility of higher-level ethanol blends with distribution infrastructure and vehicles. DOE grants and loans helped initial commercial cellulosic ethanol refineries come online. DOE has active research programs on drop-in fuels, and small amounts are already entering the commercial markets.[m] DOE also has robust research, development, demonstration, and deployment programs using electricity and hydrogen in vehicles, and use of these fuels in transportation is increasing.

Department of Defense alternative fuels programs. The Air Force's 2013 "U.S. Air Force Energy Strategic Plan" includes a goal to use cost-competitive alternative drop-in fuels for half of "non-contingency" operations by 2025. The Navy's 2010 report, "A Navy Energy Vision for the 21st Century," sets a goal of 50 percent of Naval energy use afloat to be derived from alternative fuels by 2020. The Navy designated an aircraft carrier task force built around the USS Nimitz as "the great green fleet," which is intended to operate using biofuels by 2016. In support of these objectives, the Department of Defense has an active program of research and development and testing alternative fuels for use in a range of aircraft and ships, including Fischer-Tropsch synthetic biofuels and small amounts of algal biofuels. The Department of Defense also purchases alternative fuels for research and testing purposes.

[k] Propane Education & Research Council. "Results of the 2014 Consumer Safety Preparedness Campaign." February 2015. http://www.propanecouncil.org/uploadedFiles/Council/Campaigns/ConsumerCampaignPresentationResults.pdf. Accessed March 4, 2015.

[l] Energy Information Administration. "This Week in Petroleum: Propane stocks (million barrels) and days of supply." http://www.eia.gov/petroleum/weekly/propane.cfm. Accessed February 25, 2015.

[m] Department of Energy. "Bioenergy Frequently Asked Questions." http://www.energy.gov/eere/bioenergy/bioenergy-frequently-asked-questions. Accessed February 25, 2015.

QER Recommendations

TS&D INFRASTRUCTURE RELATED TO FUEL DIVERSITY

To address TS&D infrastructure issues related to promoting U.S. energy security through fuel diversity, we recommend the following:

Continue research, development, and deployment of drop-in biofuels and support work related to higher-level ethanol blends: DOE and the Department of Defense should continue to fund research and demonstration activities on drop-in jet fuel and diesel. These applications are important given the challenges of electrifying airplanes and other large vehicles. Most production is in the pilot or demonstration phase, and, beginning in 2011, some commercial flights in Europe and the United States have flown with 50-50 biofuel blends. Despite this, biofuels for aviation and large vehicle applications still face considerable challenges in penetrating these markets. In addition, DOE should provide technical support to states, communities, or private entities wishing to invest in infrastructure to dispense higher-level ethanol blends.

Continue to monitor propane storage, use, and exports: Given the changes occurring in propane TS&D infrastructure, DOE should ensure adequate support for EIA's data collection and analysis relative to domestic propane storage and use, as well as propane exports, going forward.

Infrastructure Supporting Energy Security through Marine Transport

The marked increase in inland, coastal, and offshore maritime traffic stemming from the recent boom in U.S. oil and gas production and the resulting investment in the petrochemical complex highlights the need for new energy transport vessels in the United States.

Trends in U.S. Shipbuilding

American shipyards are experiencing a surge in construction orders for patrol boats, tugs, barges of all sizes, ferries, and other vessels. In 2012 alone, U.S. shipbuilders delivered 1,260 vessels[17] and have since seen a spike in orders for large ocean-going vessels. Today, there are more than 30 large, self-propelled, ocean-going Jones Act-eligible tankers, articulated tug-barge units, and container ships either under construction or on order at U.S. shipyards. The Maritime Administration has noted that U.S. shipyards are experiencing the greatest volume of shipbuilding activity in more than three decades.[18]

An understanding of the history of the decline of U.S. commercial shipbuilding capacity is instructive. Until 1981, the U.S. policy was to actively support its merchant marine fleet and the Nation's domestic shipbuilding industry, recognizing its critical role in supporting national defense.[19] U.S. international shipping companies received an operating subsidy, a condition for which was to buy U.S.-built ships. Subsidized shipping companies received a construction subsidy to make up the difference between the prices of less expensive foreign built ships and the prices charged by U.S. shipyards. In 1981, operating and construction differential subsidies were halted under the theory that the domestic industry would be supported by construction of naval vessels.[20] When construction of naval vessels actually declined, the effect was a significantly diminished capacity for domestic shipbuilding.[21] Prior to the 1980s, U.S. shipbuilders produced nearly 100 commercial ships per year. Orders for commercial ships dropped to zero in the mid-1980s and have averaged just seven ships per year since.[22]

U.S. shipyards traditionally focused on orders from U.S. shipping companies.[23] South Korea, Japan, and China have aggressively sought export business and subsidized their shipping industries.[24] Currently, South Korea and China dominate the shipbuilding industry[25] and benefit from technical learning, capital investment, and improving economies of scale and purchasing advantages. As a result, these nations now operate at much lower costs than competitors, including the United States.[26] Despite accounting for about 20 percent of the global seaborne trade, the United States builds less than 1 percent of the world's merchant vessels.[27] Aside from lost commercial opportunity, some observers believe that reliance on foreign shipyards could have implications for U.S. security and prosperity.

QER Recommendations

MARINE TRANSPORT

The security implications are evident in the inextricable linkage between energy and maritime commerce, as recent changes require moving oil in new ways. Because it is important to have a better understanding of possible energy vulnerabilities associated with the overall decline in U.S. shipbuilding, as well as the competitiveness opportunities associated with enhancing domestic energy shipbuilding, we recommend the following:

Undertake a study of the relationship between domestic shipping and energy security: The relevant agencies should conduct a study of the economic, engineering, logistics, workforce, construction, and regulatory factors affecting the domestic shipping industry's ability to support U.S. energy security. We recommend that the Secretary of Transportation ensure that the National Maritime Strategy includes a consideration of the energy security aspects of maritime policy in its discussion and recommendations.

Energy Security Benefits of North American TS&D Infrastructure

One of the most significant benefits to U.S. energy security is its location; the United States shares the North American continent with two close allies. The United States, Canada, and Mexico are each resource-rich nations; there is an enormous bilateral energy trade; and all three countries have intertwined and increasingly integrated energy markets and infrastructure. Three of the G-7 core principles for energy security have regional implications for the United States and its North American neighbors: the improvement of energy system resilience to disruptions through infrastructure modernization; the development of flexible and competitive energy markets; and the diversification of fuel mixes, sources, and routes.

The TS&D infrastructure across the U.S.-Canadian and U.S.-Mexican borders is diverse and extensive. Currently, there are approximately 85 transboundary pipelines and 35 major electricity transmission lines that transport crude oil, refined products, natural gas, and electricity across the U.S.-Canadian border.[n] To the south, liquid fuels make up the largest share of the energy trade between the United States and Mexico, primarily via shipping in the Gulf of Mexico. Additionally, 17 natural gas interconnections currently span the U.S.-Mexican border, and while minimal, electricity trade does occur between California and Baja California and to a lesser extent between Texas, Tamaulipas, and Chihuahua.[28]

[n] Additional oil and petroleum products are shipped to Canada.

The United States and Canada share water access through the Great Lakes and St. Lawrence Seaway. The Army Corps of Engineers lists more than 60 commercial harbors on the U.S. Great Lakes coast alone.[29] Rail and trucking routes also span the border, enabling the transfer of energy commodities using several transportation modes. Further development of these interconnections could improve continental security and bring economic benefits. For example, the Electric Reliability Council of Texas has peak electricity demand that exceeds generation in south Texas, and it is using new high-voltage transmission lines to provide power from Mexican generating facilities to Texas. Additional generation is being proposed on the Mexican side of the border that can support Texan power requirements and help avoid power outages.

Chapter VI (Integrating North American Energy Markets) contains a more detailed discussion of the North American energy markets and the benefits of increased integration beyond that of enhanced regional energy security.

RECOMMENDATIONS IN BRIEF:
Modernizing U.S. Energy Security Infrastructures in a Changing Global Marketplace

Update Strategic Petroleum Reserve (SPR) release authorities to reflect modern oil markets. Congress should update SPR release authorities to allow the SPR to be used more effectively to prevent serious economic harm to the United States in case of energy supply emergencies.

Invest to optimize the SPR's emergency response capability. The Department of Energy (DOE) should analyze appropriate SPR size and configuration, and, after carrying out detailed engineering studies, should make infrastructure investments in the SPR and its distribution systems to optimize the SPR's ability to protect the U.S. economy in an energy supply emergency.

Support other U.S. actions related to the SPR and energy security infrastructures that reflect a broader and more contemporary view on energy security. The United States should continue to consult with allies and key energy trading partners on energy security issues, building on the G-7 principles on energy security.

Support fuel diversity through research, demonstration, and analysis. DOE and the Department of Defense should continue research and demonstration activities to develop biofuels that are compatible with existing petroleum fuel infrastructure, especially in aviation and for large vehicles. DOE should provide technical support to states, communities, or private entities wishing to invest in infrastructure to dispense higher-level ethanol blends. DOE should ensure adequate support for data collection and analysis on fuels, like propane, that play an important role in the Nation's diverse energy mix and are challenged by changing transmission, storage, and distribution infrastructures.

Undertake a study of the relationship between domestic shipping and energy security. The relevant agencies should conduct a study of the economic, engineering, logistics, workforce, construction, and regulatory factors affecting the domestic shipping industry's ability to support U.S. energy security. The Secretary of Transportation should ensure that the National Maritime Strategy includes a consideration of the energy security aspects of maritime policy in its discussion and recommendations.

Endnotes

1. Foreign Affairs, Trade and Development Canada. "Joint Statement - Rome G7 Energy Ministerial Meeting." http://www.international.gc.ca/g8/ministerials-ministerielles/2014-g7-rome.aspx?lang=eng. Accessed February 1, 2015.

2. Energy Information Administration. "Annual Energy Outlook -- Reference case tables released: May 2014." Energy Consumption by Sector and Source, U.S. Reference Case. Petroleum and Other Liquids Subtotal. http://www.eia.gov/analysis/projection-data.cfm#annualproj.

3. Energy Information Administration. "Short-Term Energy Outlook." February 10, 2015. http://www.eia.gov/forecasts/steo/. Accessed February 25, 2015.

4. Energy Information Administration. "Annual Energy Outlook 2014." April 2014. http://www.eia.gov/forecasts/aeo/pdf/0383%282014%29.pdf. Accessed February 25, 2015.

5. Hays, K. "U.S. crude oil pipeline projects: Kinder Morgan acquiring Hiland Crude." Reuters. January 21, 2015. http://www.reuters.com/article/2015/01/21/us-usa-pipeline-oil-factbox-idUSKBN0KU2SX20150121. Accessed February 3, 2015.

6. Quadrennial Energy Review Analysis: INTEK Inc. "United States Fuel Resiliency: US Fuels Supply Infrastructure (Vol 1–3)." September 2014. http://energy.gov/epsa/qer-document-library.

7. Quadrennial Energy Review Analysis: INTEK Inc. "United States Fuel Resiliency: US Fuels Supply Infrastructure (Vol 1–3)." September 2014. http://energy.gov/epsa/qer-document-library.

8. Department of Energy. "DOE's Program Regulating Liquefied Natural Gas Export Applications." June 18, 2013. http://energy.gov/fe/articles/doe-s-program-regulating-liquefied-natural-gas-export-applications. Accessed February 12, 2015.

9. Quadrennial Energy Review Analysis: INTEK Inc. "United States Fuel Resiliency: US Fuels Supply Infrastructure (Vol 1–3)." September 2014. http://energy.gov/epsa/qer-document-library.

10. Difiglio, C. "Oil, Economic Growth and Strategic Petroleum Stocks." Energy Strategy Reviews. Volume 5. p. 48–58. 2014. http://www.sciencedirect.com/science/article/pii/S2211467X14000443.

11. Energy Information Administration. "What Drives U.S. Gasoline Prices?" October 30, 2014. http://www.eia.gov/analysis/studies/gasoline/. Accessed April 1, 2015.

12. Quadrennial Energy Review Analysis: INTEK Inc. "United States Fuel Resiliency: US Fuels Supply Infrastructure (Vol 1–3)." September 2014. http://energy.gov/epsa/qer-document-library.

13. Energy Information Administration. "Exports." http://www.eia.gov/dnav/pet/pet_move_exp_a_EPLLE_EEX_mbbl_m.htm. Accessed December 2014.

14. Melaina, M.W. et al. "Alternative Fuel Infrastructure Expansion: Costs, Resources, Production Capacity, and Retail Availability for Low-Carbon Scenarios." National Renewable Energy Laboratory. 2013.

15. Association of American Railroads. "Railroads and Ethanol." May 2014. https://www.aar.org/BackgroundPapers/Railroads%20and%20Ethanol.pdf. Accessed February 12, 2015.

16. Bunting, B. et al. "Fungible and Compatible Biofuels: Literature Search, Summary, and Recommendations." Oak Ridge National Laboratory. 2010.

17. Department of Transportation, Maritime Administration. "The Economic Importance of the U.S. Shipbuilding and Repairing Industry." http://www.marad.dot.gov/documents/MARAD_Econ_Study_Final_Report_2013.pdf. Accessed February 1, 2015.

18. Department of Transportation, Maritime Administration. "The Jones Act Moves Industry and America's Economic Prosperity." October 9, 2014. http://www.dot.gov/blog/jones-act-moves-industry-and-americas-economic-prosperity. Accessed February 1, 2015.

19. Lind, M. "Who's Afraid of Industrial Policy?" January 31, 2012. http://www.salon.com/2012/01/31/whos_afraid_of_industrial_policy/. Accessed January 16, 2015.

20. Maritime Activity Reports, Inc. "The Future of American Shipbuilding." http://www.marinelink.com/article/shipbuilding/the-future-american-shipbuilding-805. Accessed March 19, 2015.

21. Globalsecurity.org. "Ship Building 1981-89 - Reagan, Ronald." http://www.globalsecurity.org/military/systems/ship/scn-1981-reagan.htm. Accessed March 17, 2015.

22. The Industrial College of the Armed Forces National Defense University. "Shipbuilding." 2005. www.dtic.mil/get-tr-doc/pdf?AD=ADA449541.

23. Shipbuilding History. "Merchant Ship Construction Since WWII." http://www.shipbuildinghistory.com/history/merchantships.htm#MERCHANT_SHIP_CONSTRUCTION_SINCE_WWII. Accessed March 17, 2015.

24. The Industrial College of the Armed Forces National Defense University. "Shipbuilding." 2005. www.dtic.mil/get-tr-doc/pdf?AD=ADA449541.

25. Stopford, M. "World Shipbuilding." Clarkson Research. Presentation for the SMM Press Conference. September 8, 2014. http://www.smm-hamburg.com/fileadmin/user_upload/4-1_Martin_Stopford_SMM_Press_Conference_8_Sept_2014_Final.pptx. Accessed March 17, 2015.

26. The Industrial College of the Armed Forces National Defense University. "Shipbuilding." 2005. www.dtic.mil/get-tr-doc/pdf?AD=ADA449541.

27. Lind, M. "Who's Afraid of Industrial Policy?" January 31, 2012. http://www.salon.com/2012/01/31/whos_afraid_of_industrial_policy/. Accessed January 16, 2015.

28. Energy Information Administration. "Mexico Country Analysis." April 24, 2014. http://www.eia.gov/countries/cab.cfm?fips=mx. Accessed February 6, 2015.

29. Army Corps of Engineers. "Great Lakes Harbor Fact Sheet." March 2014. http://www.lre.usace.army.mil/Portals/69/docs/Navigation/FY2015/mar19factsheets.pdf. Accessed January 27, 2015.