CHAPTER SEVEN

ENERGY SECURITY

INTRODUCTION AND BACKGROUND

Energy and national security are closely linked. Energy is essential to a healthy growing economy, and disruptions to the energy supply can have adverse impacts throughout the economy. Historically, security concerns have increased as petroleum and natural gas imports increased. These concerns are typically heightened when there is the possibility of geopolitical events that could adversely impact supply.[1] However, there are reasons to be optimistic about North American energy supplies.

The study approached the multi-faceted issue of energy security by identifying a set of characteristics describing the important characteristics that fuels and vehicle systems should exhibit in order to contribute to energy security. The characteristics are abundant and accessible, reliable, diversified, affordable, energy efficient, and clean. This chapter addresses energy security factors relating to the fuel-vehicle system characteristics of abundant and accessible, reliable and diversified. The factors of affordable, energy efficient, and clean are addressed elsewhere in this study.

RESULTS AND DISCUSSION

Abundant and Accessible Resources

Recent increases in North American natural gas and oil resources enable more abundant and accessible production of fuels for use in transportation and other energy sectors. Increased supplies of biomass also represent a possible source of energy.

The National Petroleum Council's recent *Prudent Development* study[2] finds that domestic sources and production of oil and gas have the potential to grow more than previously expected. This can have energy security benefits and influence affordability of conventional fuels through greater supply.[3] In addition, this study finds that biofuels, natural gas, electricity, and hydrogen can play an increasing role as transportation fuels in the future. Due to the combination of these factors, and potential for improved fuel efficiency through new vehicle technologies, it is expected that imports of petroleum will meet a smaller portion of U.S. transportation fuels demand in the future than previously expected.

The NPC *Prudent Development* study concludes that the United States can become more self-sufficient in its energy supply due to technological advances in natural gas and oil exploration and production techniques. The first two core findings of that study were: "First, the potential supply of North American natural gas is far bigger than was thought even a few years ago." "Second—and perhaps surprising to many—America's oil resources are also proving to be much larger than previously thought." With access and responsible development of our resources, the supply of North American oil has the potential to more than double by

1 Deutch, John, *Oil and Gas Energy Security Issues*, Resources for the Future, June 2010.

2 National Petroleum Council, *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources,* September 2011.

3 Samuelson, Robert J., "Energy 'Independence,' After All?" *Washington Post*, April 1, 2012.

2035.[4] The *Prudent Development* study points out that the North American oil resource base offers substantial supply for decades ahead and could help the United States reduce, but not eliminate, the requirements and costs for oil imported from outside North America. Increasing access to develop abundant U.S. oil and natural gas resources, and sustaining the refining capacity to convert these resources into fuels, would lessen the impact of overseas supply disruptions on the U.S. economy.

There is a potential for an increase in supplies of biomass that could be used as an energy source; however, there are significant technological, economical, commercial, and logistical hurdles to overcome to sustainably produce and deliver biofuels on a mass-scale for transport use. Several studies have been published on the potential supply of biomass out to 2050. For example, the Department of Energy's *U.S. Billion-Ton Update* indicates that by 2050 the United States could be sustainably producing over one billion tons of biomass feedstock from crop and forestry residue and energy crops.[5] This could equate to roughly 85 billion gallons of domestically produced biofuels.[6] However, there are several significant technical issues to overcome to increase availability of advanced biofuels.[7] Also, while the existing liquid transportation fuel infrastructure is consistent with the use of some biofuels (e.g., up to 10 volume percent ethanol in gasoline) substantial investment would be required to make the infrastructure compatible with higher levels of ethanol.

Reliability

Reliability is an important characteristic of energy security. The U.S. liquid petroleum, natural gas, and electricity transmission and distribution systems are reliable.

Gasoline, Diesel, Biofuels, and Natural Gas

American consumers are supplied with the transportation fuels that they need every day through a complex yet extremely efficient system to transport gasoline and diesel fuel from the refineries where they are produced to their local gasoline station. The fuel that consumers use in their vehicles may have traveled a thousand miles or more between its point of production and the local retail gasoline station.

Gasoline and diesel are produced at petroleum refineries and then typically transported to distribution terminals by pipelines. At the same time, biofuels are produced at biorefineries and then generally transported to distribution terminals by rail or barge. At the distribution terminal, the gasoline and diesel are blended with biofuels as the fuel is put into a tanker truck for delivery to retail service stations. This happens 24 hours a day, 7 days a week, 365 days a year to supply consumers with the 9 million barrels/day of gasoline and 3.6 million barrels/day of diesel fuel that they rely on.

Similar to the petroleum distribution, the natural gas distribution system relies on a nationwide network of pipelines to distribute natural gas from well to consumer. According to the *Prudent Development* study: "Natural gas provides a quarter of America's overall energy and is used to generate a quarter of the nation's electricity. It provides the heat for 56 million homes and apartments and delivers 35% of the energy and feedstocks required by America's industries."[8]

Electricity

Electricity is an essential part of modern life. In the United States, power outages are relatively

4 See Figure ES-6 in the NPC *Prudent Development* study. "Figure ES-6 shows the various sources of current supply as well as projected supply in 2035 under "limited potential" and "high potential" scenarios. The limited potential scenario is characterized by limited resource access, constrained technology development, as well as greater regulatory barriers. The high potential scenario is characterized by more access, substantial advances in technology, and regulatory burdens that are not significantly different than today. Even under the high potential scenario, the United States will still need to import oil for the foreseeable future." *Prudent Development,* Executive Summary, page 14.

5 U.S. Department of Energy, *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry*, prepared by Oak Ridge National Laboratory, August 2011.

6 "For example, with continued developments in biorefinery capacity and technology, the feedstock resources identified could produce about 85 billion gallons of biofuels—enough to replace approximately 30% of the nation's current petroleum consumption." Department of energy releases new 'billion-ton' study highlighting opportunities for growth in bioenergy resources, August 10, 2011.

7 It is also important to recognize that there are other competing uses for biomass—e.g., biomass use for electricity production—that may serve to limit the amount of biomass available for conversion to transportation fuels. See Chapter Six, "Greenhouse Gases and Other Environmental Considerations."

8 *Prudent Development,* Executive Summary, page 7.

infrequent and short in duration mainly because we have a reliable and well-maintained electricity generation, transmission, and distribution system.

Diversity of supply sources helps maintain the high level of reliability of the electricity system. In 2010, about 89% of U.S. electricity was generated by three fuels: coal (46%), natural gas (23%), and nuclear (20%), with hydroelectric and other renewables supplying the remainder.[9]

Similar to the petroleum and natural gas distribution systems, the interconnected distribution system for electricity distribution helps to diversify supplies and improve the reliability of the system. Because of the diversity of supply, adequate production capacity, and overlapping distribution systems, the U.S. electricity generation and distribution system is very reliable.

Disruptions

Notwithstanding the impressive reliability of existing systems, there are occasional disruptions. Occasional supply disruptions can arise in a variety of ways. Geopolitical events can cause price shocks or supply disruptions that could affect the world oil markets. There is the possibility of cyber attacks on energy production, transmission, and distribution systems. There are also weather events that can have an impact on fuel supplies. For example, hurricanes such as Katrina and Rita can significantly disrupt both the electricity system and the transportation fuel system to some parts of the United States. Electricity power plants were temporarily closed, and distribution lines were damaged. Refineries were temporarily closed; pipeline, barge, ship, and truck shipments of transportation fuels were disrupted. In each case, it took the system weeks to return to normalcy. Such disruptive events will periodically occur in the future.

Energy supply systems can be made more reliable to minimize the adverse impacts of upsets. For example, strategic reserve stocks of petroleum are held in order to mitigate impacts of short-term disruptions in oil supply. The global marketplace for oil and relatively low freight costs also enable access to the global supply chain in case of local supply disruptions. Energy diversity is also important in this context because it may increase the resiliency of the system.

Energy Diversity

Increased diversity of fuel supplies may enhance energy security, as it increases the resiliency of the supply system by offering more optionality. Optionality can come from having more suppliers, more supply types, different supply chains, or methods to migrate demand. This flexibility, however, typically comes at a higher cost. Given the scale of the infrastructure in the United States, supply chain redundancies for the sole purpose of increased supply security are not cost effective. The current U.S. fuel supply chain is made more robust from participation in the global energy marketplace where multiple supply sources are available.

There are limits to the benefits of diversity. Using petroleum fuels as the primary energy source has an energy security benefit because there is a world market for oil with multiple supply options, in addition to economy of scale benefits that can be captured through the use of petroleum fuels. Conversely, diversifying fuel types can have energy security benefits because it increases optionality and increases resiliency. But, diversification may result in strained infrastructure and losses in economies of scale.

Increasing the diversity of transportation options would not remove the risk of disruption. For example, consumers relying on electric vehicles could not instantaneously switch to a natural gas powered vehicle in the event of a power disruption. However, flexible- or dual-fueled vehicles have built-in fuel supply optionality. Increased penetration of alternative fuel-vehicle systems creates a more diversified supply capability, which should reduce reliance on a single energy source. The option of producing multiple fuels from a single feedstock, or a single fuel from multiple feedstocks, may provide resiliency. For example, natural gas can be used for electricity generation, compressed natural gas, liquefied natural gas, and hydrogen production. Hydrogen can be made from a wide variety of domestic and readily available energy sources such as natural gas, coal resources, and low carbon feedstocks such as wind power and nuclear. Electricity can be generated from renewables, oil, gas, coal, or nuclear. While multiple supply chains could

9 U.S. Department of Energy, Energy Information Administration, "Table 8.2b, Electricity Net Generation: Electric Power Sector, 1949-2010," in *Annual Energy Review*, October 2011.

provide increased resiliency, ultimately the infrastructure costs for a wide variety of options would impact the utilization and cost effectiveness of the supply chains.

Increased diversification of fuel-vehicle systems in the light-duty sector and a reduction in oil use is driven by increasing cost competitiveness of alternative fuels and vehicles, as discussed elsewhere in this report. The quantitative analysis of this study suggests that the addition of natural gas vehicles to a portfolio can contribute significantly to diversification. In terms of absolute oil use, adding alternative fuel-vehicle systems to the fleet portfolio can have a dramatic impact. It should be noted, however, that the lack of supply, demand, and price feedback in the analysis has its biggest limitation when predicted petroleum reductions are the largest, since these conditions differ most from conditions assumed when developing the price forecasts used as input. Using natural gas in heavy-duty vehicles may also achieve significant market share if the fuel is available at a sustained cost advantage.

FINDINGS

In the years ahead, the U.S. transportation sector could have access to a broad array of economically competitive fuel-vehicle system options, the diversity of which can contribute to our nation's energy security.

Energy and national security are closely linked. Energy is essential to prosperity, and disruptions to the energy supply can trigger adverse impacts throughout the economy. Historically, security concerns are usually heightened when geopolitical events threaten reliable energy supply. There are reasons, however, to be optimistic about North American energy sources and technologies, which are abundant, accessible, reliable, affordable, efficient, and clean. Increasing the diversity of economically competitive fuels and vehicles will bolster the nation's economy and its security.