THE NEED FOR FOSSIL FUEL

Fossil fuels are intricately woven into the fabric of our everyday lives in both obvious and subtle ways. From the hot water and electricity we use to the clothes we wear, the shelter we trust, the vehicles we operate and most of the consumer goods we enjoy, fossil fuels are building blocks of modern society and life as we know it. The widespread use of these resources immensely improved living conditions across the globe, and the productive and meaningful lives that we are accustomed to today would be simply impossible without them.

The productive and meaningful lives that we are accustomed to today would be simply impossible without fossil fuels.

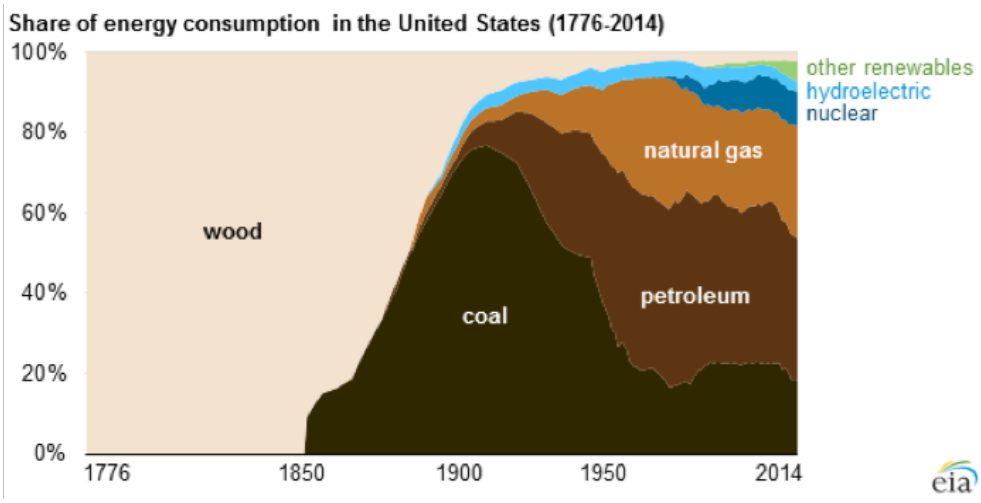
The consumption of fossil fuel has provided incredible benefits to humankind. It has made possible the development of large-scale, reliable and affordable long-distance transportation, which led to better and more affordable nutrition by allowing access to fresh food year-round no matter where one lived, while concentrating food production in the most productive and efficient locations. Prior to kerosene, heavy oil and natural gas, homeowners used poor quality biomass fuels like firewood and peat moss, filling houses with soot and dangerous particulate matter, as well as carbon monoxide and toxic chemicals.

Fossil fuels allowed cars, trucks and tractors to replace work animals (and their associated food consumption), and thus helped eliminate the diseases associated with animal waste. Refined petroleum products reduced harvesting pressures on wild resources such as whales (whale oil, perfume base), trees (lumber and firewood), birds (feathers) and other wildlife (ivory, furs, skin), thus helping preserve biodiversity.[1] There is an enduring economic and social need for fossil fuels, and when well-meaning but misguided criticism of these resources ignores this reality, it also ignores the central role that hydrocarbons play in our lives.

[1] http://www.wsj.com/articles/notable-quotable-energy-and-the-catastrophists-1444600252

FUELED OUR HISTORY

The three primary fossil fuel sources are coal, petroleum (oil) and natural gas, and according to the U.S. Energy Information Administration (EIA), these three sources have accounted for at least 80 percent of total U.S. energy consumption for more than 100 years[2] and will do so for the foreseeable future.[3]



Source: U.S. Energy Information Administration, *Monthly Energy Review*

Pre-Industrial Society

The wide-ranging use of fossil fuels developed during the Industrial Revolution in the 18th and 19th centuries. Prior to this time period, humans relied largely on living nature for virtually all of their energy needs including food, fuel, medicine, clothing and other products. For instance, homes were built from logs, and nearly all fuel originated from trees and other woody plants.[4] Wood, crop residues, animal oils and waxes were the primary fuels for cooking, heating, lighting and other domestic uses – it is difficult to imagine the hardships people faced in pre-industrial society to achieve these basic tasks. And powering today's U.S. economy on wood would

[2] Fossil Fuels have made up at least 80% of U.S. fuel mix since 1900. (2015, July 2). Retrieved September 22, 2015 from http://www.eia.gov/todayinenergy/detail.cfm?id=21912
[3] http://www.eia.gov/forecasts/aeo/section_energyconsump.cfm
[4] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19). Retrieved January 6, 2016 from http://www.cato.org/publications/policy-analysis/humanity-unbound-how-fossil-fuels-saved-humanity-nature-nature-humanity

require constant harvesting of a forest covering two-thirds of the country.[5]

In addition to plant growth and biomass energy, mankind depended heavily on human and animal muscle to fulfil its energy needs before the Industrial Revolution. Human and animal labor provided the majority of the energy used for agriculture and transportation.[6] While mechanical devices existed, most of them depended on human or animal energy to operate. As a result, the products of the pre-industrial world were limited and expensive compared to modern standards. In her book, *Pre Industrial Societies, Anatomy of the Pre-Modern World*, Patricia Crone states that "A machine tended by twenty workers can produce more pots in a single year than can twenty potters in a lifetime, at a fraction of the cost of maintaining twenty potters from youth to death."[7]

Post-Industrial Society

Vast quantities of fossil fuel were finally harnessed during the Industrial Revolution to power the economy, which would change the course of history and improve the quality of life for masses of people. The rapid and sustained economic growth experienced during this time would not have been possible without coal.[8] This plentiful and reliable fuel source enabled broad use of technologies that were being developed or enhanced, including the steam engine which had become compact and efficient.[9] As steamships and steam-powered railroads became frequently used, they relied on coal to fuel their boilers.

Likewise, oil and gas have been used in various ways throughout history as energy sources. The modern petroleum industry is considered to have been born in the 19th century, and one of the

[5] http://www.wsj.com/articles/fossil-fuels-will-save-the-world-really-1426282420
[6] Moan, Jaina, and Zachary Smith. Energy Use Worldwide. Santa Barbara: ABC-CLIO, Inc., 2007. Google Books. Web. 6 Jan. 2016.
[7] Crone, Patricia. Pre-Industrial Societies, Anatomy of the Pre-Modern World. London: Oneworld Publications, 2003. Google Books. Web. 6 Jan. 2016.
[8] White, Kathleen H. Fossil Fuels: The Moral Case. Texas Public Policy Foundation, June 2014.
[9] A Brief History of Coal Use. (2013, February 12). Retrieved on September 22, 2015 from http://www.fossil.energy.gov

driving forces behind the increased demand for crude oil was the invention of the kerosene lamp in the mid-1850s.[10] Kerosene, a petroleum product, was in high demand because it was able to replace whale oil and offered a cleaner-burning and more-reliable fuel for lamps. Decades later, when automobiles with gasoline-burning engines became conventional, the need for petroleum products became evident once again. The growth of the automobile industry and automobile manufacturing would continue to stimulate the petroleum industry, particularly after World War II. Oil consumption grew at a rate of 7 percent annually during the 1950s.[11]

It was also during this time that natural gas began being safely and efficiently transported from producers to end users. One of the earliest common uses for natural gas dates back to the 1800s when it was used to light street lamps; however, there were no pipelines to transport gas to individual homes or businesses at that time.[12] In fact, very few pipelines were built until after World War II. According to the U.S. Department of Energy, "improvements in metals, welding techniques and pipe making during the War made pipeline construction more economically attractive."[13] Pipelines are an important development in the course of natural gas consumption because they allowed the product to be transported to individuals and businesses for everyday use.

Clearly, fossil fuels have revolutionized our energy supply and vastly improved living standards for people across the globe. Indicators like life expectancy, population and gross economic product per capita (income) increased dramatically after fossil fuels became the main source of energy.[14] For example, life expectancy was 20 to 25 years for most of human history; however, from 1750 to 2009, global life

[10] History of the Oil and Gas Industry. (2005-2006). Retrieved from The Library of Congress Business Reference Services on January 6, 2016 from http://www.loc.gov/rr/business/BERA/issue5/history.html
[11] *Id.*
[12] The History of Natural Gas. (2013, February 12). Retrieved on January 6, 2016 from http://www.fossil.energy.gov/education/energylessons/gas/gas_history.html
[13] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).
[14] *Id.*

expectancy more than doubled, from 26 years to 69 years.[15] Additionally, global population increased from 760 million to 6.8 billion during this time frame, and average incomes increased from $640 to $7,300. Rising incomes have shown to improve other indicators of human well-being including hunger, infant mortality, education, economic freedom and child labor.[16]

One obvious counterargument is that advances in medicine are largely responsible for improved human health – but it is also true that the use of fossil fuels substantially helped lead to many of those advances, from the ability to quickly sterilize instruments to the advent of clean and comfortable hospitals, and the use of ambulances and medevac helicopters.

The ways in which we consume fossil fuels will continue to change as new technologies are developed and societies evolve. They have shaped our past, sustain our present and will propel us into the future. In order to fully appreciate these valuable resources, we need to understand the range of critical uses we make of this subset of the hydrocarbon family.

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FUELS OUR DAILY ESSENTIALS

Fossil fuels are a versatile and vital energy source, and our ability to lead happy, healthy and productive lives is largely dependent on these commodities and the efficient transportation and distribution of them to all. Fossil fuels are commonly considered a fuel source for transportation and electricity production (which will be discussed further in this paper); however, they are also used in less-obvious ways to produce products used in homes, businesses and industry. These products include plastics, synthetic fibers, chemicals, steel, road and construction materials, and more.

[15] *Id.*
[16] *Id.*

Textiles and Clothing

Fabrics and textiles are made out of a variety of materials including cotton, wool, silk and synthetic fibers. Until the end of the 19th century, the majority of clothing and other textiles originated from products of living nature like fibers from cotton or wool from animals.[17] This trend has drastically shifted and synthetic fibers, which are derived from fossil fuel, currently account for the majority of global fiber production. In 2014, synthetic fibers like polyester, nylon and vinyl accounted for 67.5 percent of global textile production.[18] The prominent use of synthetic fibers has created more affordable clothing for the masses, while improving their durability.

Even the production of cotton, which accounts for 28 percent of textile fiber consumption, depends heavily on assistance from fossil fuels. The fuel used for farming equipment and the fertilizer used to help produce a bountiful crop are just two examples of how fossil fuel helps grow crops like cotton.

Plastics

Plastic is another fossil fuel product that contributes to comfortable and productive lives. From water bottles to medicine bottles, food containers, grocery sacks, medical tubing, toys, insulation and a myriad of other consumer products, everything "plastic" originates from petroleum or natural gas. According to the EIA, plastics are manufactured from hydrocarbon gas liquids (HGL) and natural gas in the United States.[19] HGL are byproducts of petroleum refining and natural gas processing, and in 2010, about 191 million barrels of HGL were used to make plastic products in the United States. In the

[17] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).
[18] Textile Exchange Preferred Fiber and Materials Market Report. (2014). Retrieved on January 6, 2016 from https://www.textileexchange.org/upload/Preferred_Fibers_and_Materials_Market_Report_2014_FINAL.pdf
[19] How much oil is used to make plastic? (2015 July). Retrieved on January 6, 2016 from http://www.eia.gov/tools/faqs/faq.cfm?id=34&t=6

same year, about 412 billion cubic feet of natural gas were used to make plastic materials.[20]

Plastics became widely used after World War I as they served as substitutes for products like wood, glass and metal during the difficult economic war times.[21] They are produced by treating components of crude oil or natural gas in a "cracking process," in which large hydrocarbon molecules are broken down into smaller and more useful ones. Further processing creates a wider range of molecules that are then combined to create plastics with a broad range of properties and characteristics. Plastics such as polyester, silicones and polycarbonate have been developed over the past few decades, and more recently, high-tech plastics have been created for use in fields such as healthcare and technology. Their wide range of applications fill consumer needs at all levels.

FUELS MODERN AGRICULTURE

Fossil fuels have revolutionized modern agriculture, which is significant because human health and survival rely heavily on access to a sufficient food supply. Societies that have inadequate food supplies are susceptible to high rates of infant and maternal mortality and low life expectancies, in addition to poor health and malnutrition.[22] While the development of agriculture has played a vital role in increasing food supplies and improving human well-being, the practice was drastically enhanced with the pervasive use of fossil fuels. Before the introduction of fossil fuels into agriculture, a plentiful harvest and supply of food was left to the devices of nature and human and livestock health. Fossil fuels have allowed humans to technologically enhance nature's product, vastly improving yield. Between 1961 and 2007, the world's population doubled from 3.1 billion to 6.7 billion and food supplies per person increased by 27

[20] *Id.*
[21] Lifecycle of a Plastic Product, American Chemistry Council. Retrieved on January 6, 2016 from http://plastics.americanchemistry.com/Education-Resources/Plastics-101/Lifecycle-of-a-Plastic-Product.html
[22] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).

percent; however, the total amount of cropland increased by only 11 percent.[23] This productivity increase is a result of improvements to the agriculture industry, most of which rely directly or indirectly on fossil fuels.

The U.S. agriculture industry requires significant amounts of energy to grow and harvest crops. In 2012, the industry used 800 trillion British thermal units (Btu) of energy, or about as much primary energy as the entire state of Utah.[24] This includes direct energy consumption, such as the use of diesel and natural gas for activities on the farm, and indirect consumption, such as the use of fuel and feedstock like natural gas in the manufacturing of agricultural chemicals such as fertilizers and pesticides.

Fertilizers and pesticides are designed to enhance soil fertility, protect against pests and block weeds, thus improving crop productivity. Without them, modern agriculture and human civilization in its current form could not exist. A study in *Nature Geosciences* estimated that fertilizer derived from synthetic nitrogen was responsible for feeding nearly 50 percent of the world's population in 2008.[25] The production of nitrogenous (ammonia-based) fertilizer is a very energy-intensive process that requires extremely high temperatures and pressures and large amounts of natural gas as a feedstock. EIA's 2010 Manufacturing Energy Consumption Survey concluded that "the U.S. nitrogenous fertilizer industry consumed more than 200 trillion Btu of natural gas as feedstock in 2010 and another 152 trillion Btu for heat and power."[26]

In addition to the contribution of agricultural chemicals, the industry relies on direct consumption of fuel, especially distillate fuel, to power

[23] *Id.*
[24] Energy for growing and harvesting crops is a large component of farm operating costs. (2014 October). Retrived on January 6, 2016 from http://www.eia.gov/todayinenergy/detail.cfm?id=18431
[25] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).
[26] *Id.*

both livestock and crop operations.[27] Harvesting, crop tilling, weed control and other operations that require heavy machinery depend directly on this fuel.

Besides increasing productivity on the farm with chemicals and machinery, fossil fuels have increased food availability in alternative ways. The agriculture industry relies on the ability to transport products between farms, cities, states and even countries, and this is made possible by the use of trucks, trains, airplanes and other vehicles that are fueled by fossil fuels. This transportation occurs quickly and affordably, counting on an inexpensive fuel source, refrigerated vehicles and safe food packaging that all originate or are fueled by fossil fuel.

FUELS OUR MOBILITY

Centuries of ingenious effort have gone into perfecting the internal combustion engine (ICE) fueled by gasoline and diesel, with more than 250 million cars and trucks relying on them in the United States alone.[28] The introduction of the fossil-fuel driven ICE forever changed the way people and goods were transported, making work in the home, on the farm and in industry more efficient than ever before. Machines displaced work that was once performed by human beings and livestock, allowing for faster and more efficient transportation and production of goods and services.

Research and development (R&D) conducted over recent decades has reduced nitrogen oxides and particulate matter pollution emissions by more than 99 percent, while at the same time improving

[27] Energy for growing and harvesting crops is a large component of farm operating costs. (2014 October).
[28] http://www.energy.gov/eere/energybasics/articles/internal-combustion-engine-basics

performance and increasing fuel economy.[29] The average fuel economy standards for new light-duty vehicles, which typically use gasoline, are projected to increase from approximately 30 miles per gallon in 2013 to approximately 54 miles per gallon in 2040.[30] This has economic and environmental implications – as more fuel-efficient vehicles replace older vehicles on the road, greenhouse gas and conventional pollutant emissions will continue to decline. Despite federal and state mandates for alternative fuels and massive taxpayer spending on R&D, personal vehicles along with public transportation, like buses, airplanes and trains, overwhelmingly continue to require fossil fuels. Indeed, as of July 2015, more than 90 percent of the energy consumed in the transportation sector came from petroleum sources.[31]

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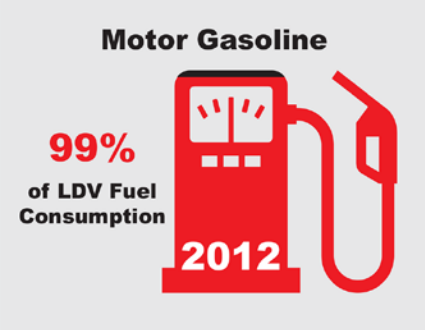
Part of the reason for the continued popularity of gasoline in particular is its energy density. Energy density is the amount of energy stored in a given volume and is one of the key elements in evaluating the dependability, flexibility and affordability of different fuel types. Gasoline and diesel are the most popular fuel sources for transportation due in part to their higher energy densities and ease of onboard storage. In fact, the EIA estimated that motor gasoline accounted for 99 percent of light-duty vehicle fuel consumption in 2012, and over half of the remaining 1 percent was from diesel.[32] While a variety of alternative transportation energy fuels are used across the United States – propane, hydrogen, higher ethanol-gasoline blends (E85) and natural gas – gasoline and diesel remain the leading transportation fuels. Fuels like



[29] Id.
[30] Annual Energy Outlook 2015. (2015 April). Retrieved on October 2, 2015 from http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf
[31] Monthly Energy Review. (2015 September). Retrieved on October 2, 2015 from http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf
[32] Few transportation fuels surpass the energy densities of gasoline and diesel. (2013. February 14). Retrieved on October 2, 2015 from http://www.eia.gov/todayinenergy/detail.cfm?id=9991

compressed propane, ethanol, natural gas (either in liquefied form or compressed) and hydrogen have lower energy densities per unit volume than gasoline and diesel, making them less attractive options for consumers.[33]

Batteries and electric motors offer an increasingly attractive alternative, or more practically a supplement, to vehicles fueled by gasoline and diesel, but they comprise only a fraction of vehicle sales. Most forecasts estimate that electric vehicle (EV) sales are expected to account for approximately 7 percent of new vehicle sales worldwide by 2020.[34] While some EVs are able to outperform the fuel economy of similarly sized gasoline vehicles for short periods of time, batteries and fuel cells are extremely expensive and are not yet well-supported by limited charging or fueling infrastructure.[35]

Consumer concern about the limited driving range of electric vehicles is currently well-founded, particularly in the face of few public charging options. Most experts predict a niche for EVs in urban areas and perhaps in small fleet vehicles that return to a central location on a regular basis. In addition to their cost and range disadvantages, the EV environmental footprint can be surprisingly large. The environmental and health impacts of vehicles using electricity generated from coal may be as much as 80 percent greater than driving a gasoline-powered vehicle.

At the turn of the 21st century, many believed that conventional ethanol and advanced biofuels held the key to environmentally friendly transportation. Further experience and analysis determined that conventional ethanol consumption actually has a greater negative impact on the environment than does gasoline – unfortunately after the federal government mandated specific levels

[33] Few transportation fuels surpass the energy densities of gasoline and diesel. (2013. February 14). Retrieved on October 2, 2015 from http://www.eia.gov/todayinenergy/detail.cfm?id=9991
[34] Navigant Research, Electric Vehicle Market Forecasts. (2013 Second Quarter). Retrieved on October 5, 2015 from http://www.navigantresearch.com/wp-assets/uploads/2013/06/EVMF-13-Executive-Summary.pdf
[35] Annual Energy Outlook 2015. (2015 April). Retrieved on October 2, 2015 from http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf

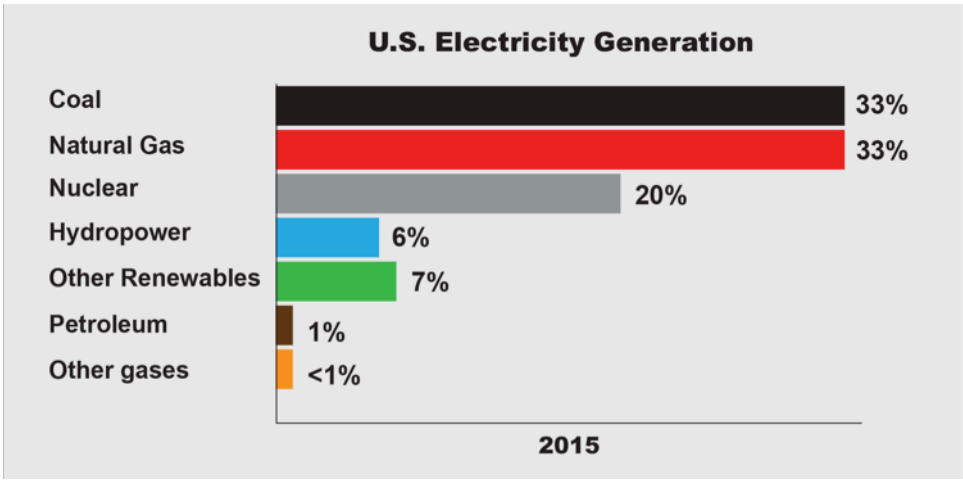
of ethanol usage in America in the Renewable Fuel Standard (RFS) contained in the Energy Policy Act of 2005.[36]

Armed with that knowledge, advocates turned to cellulosic ethanol derived from agricultural and forestry waste. The cost and complexity of producing this biofuel, however, has proved daunting. Even if those challenges are surmounted, incompatibility with existing delivery infrastructure is a problem, leading many previous cellulosic advocates to again shift their focus, this time to advanced "drop-in" biofuels that theoretically can be chemically engineered with properties nearly identical to gasoline and diesel fuel.[37] These fuels continue to be stuck in the developmental stage, however, and widespread deployment is likely decades away.[38] For the average American facing a long daily commute or sharing the common desire for open road travel, conventional, affordable and increasingly efficient fossil-fuel powered vehicles are likely to remain the transportation option of choice – especially in an era of low oil prices.

FUELS OUR ELECTRICITY

With the flip of a switch or the press of a button, electricity turns our world from dark to light and powers our lives in ways that are often unnoticed or undervalued. The dependable supply of electricity experienced in modern societies is primarily generated by fossil fuels. According to the EIA, the United States generated approximately 4 trillion kilowatt-hours of electricity in 2015, approximately 67 percent from fossil fuels. Coal and natural gas each had a 33 percent share of total U.S. electricity generation in 2015, with petroleum accounting for the remaining 1 percent.[39]

[36] Yang, Bae, Kim and Suh, Replacing Gasoline with Corn Ethanol Results in Significant Environmental Problem-Shifting, the Journal of Environmental Science and Technology, March 14, 2012, http://pubs.acs.org/doi/abs/10.1021/es203641p
[37] http://www.afdc.energy.gov/fuels/emerging_hydrocarbon.html
[38] Cellulosic biofuels begin to flow but in lower volumes than foreseen by statutory targets. (2013 February 26). Retrieved on October 5, 2015 from http://www.eia.gov/todayinenergy/detail.cfm?id=10131
[39] What is U.S. electricity generation by energy source? (2016, April1). Retrieved May 6,2016 from http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3



Source: U.S. Energy Information Administration

Diversification of energy sources such as hydropower, solar and wind for electric generation continues to increase slowly, though they still account for only 13 percent of the total (and nearly half of that total percentage is hydropower). Despite decades of R&D spending, tax credits and state mandates, renewables still lag far behind fossil fuels as a source of electricity.[40]

Without substantial breakthroughs in battery technologies, solar and wind power will still only be available when the sun is shining or the wind is blowing. There may be a time in the future when energy storage and renewable power systems are cost-competitive with natural gas, or with renewables plus backup natural gas, but today those systems are either expensive, unreliable or both. The average U.S. residential utility customer uses about 30 kilowatt-hours of electricity each day[41] – but the cutting-edge residential battery only puts out 2 kilowatts of continuous power, about enough to run a vacuum cleaner, but not enough to dry your clothes.[42] Today's battery technology combines inadequacy with great expense. Multiple batteries, each costing more than $7,000, would be needed

[40] http://www.eia.gov/totalenergy/data/monthly/pdf/sec10_2.pdf
[41] http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3
[42] http://energy.gov/energysaver/estimating-appliance-and-home-electronic-energy-use

to maintain sufficient power in the average home. In fact, it would take eight batteries at a cost of $45,000 to produce the same amount of power as a standard generator that costs around $3,700.[43] Installing multiple batteries on top of the cost of solar panels and hoping it is sunny enough to both power your house and charge the batteries is not a strategy most consumers will embrace.

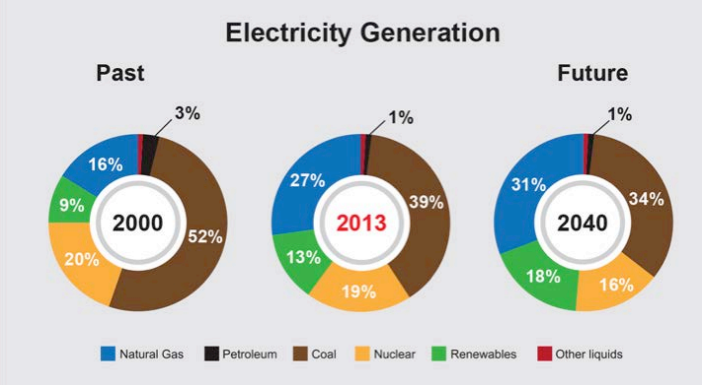
Solar and wind can continue to grow, as mandated in several states, when backed up by flexible, clean and reliable natural gas. Natural gas can compensate for the variability and lack of scale of renewable energy, and natural gas storage is and will remain far more cost effective than battery storage for many years to come. While a major breakthrough in large-scale energy storage could revolutionize the way we produce and consume electricity, its current price tag makes battery storage out of reach for utility companies and others. In fact, it would require a minimum 75 percent price reduction in batteries to become competitive with the power output of natural gas. And that battery storage is only going to last two hours, while gas storage fields are designed to last anywhere from days to months.[44]

As the development of solar and wind energy increases, Kinder Morgan is well-positioned to provide affordable natural gas to support renewables. We are the largest natural gas storage company in the country, with underground storage facilities in 12 states holding approximately 660 billion cubic feet of working capacity. It would take more than a billion Tesla Powerwall batteries, costing more than $5 trillion, to account for the energy content in just one of the company's existing gas storage fields in central Texas.

Clean, abundant, reliable and secure, natural gas is a critical piece of our energy future. EIA projects natural gas consumption in the power sector to increase by more than 14 percent in 2015.[45] By

[43] http://www.bloomberg.com/news/articles/2015-05-06/tesla-s-new-battery-doesn-t-work-that-well-with-solar
[44] Kinder Morgan research
[45] Short-Term Energy Outlook. (2015, September 9). Retrieved September 22, 2015 from http://www.eia.gov/forecasts/steo/report/natgas.cfm

2040, EIA projects that natural gas will account for 31 percent of our electricity generation, with coal at 34 percent and petroleum holding steady at 1 percent.[46] So even with a steady increase in renewable power projected over the coming decades, fossil fuels will still provide almost two-thirds of our electricity needs.



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2015*: Electricity

FUELS OUR ECONOMY

The energy industry and markets constantly evolve, and while the current low commodity price environment is straining some local and national economies, the economic benefits of the fossil fuel sector are robust. From 2007 to 2012, total U.S. private sector employment increased by about 1 percent, while oil and natural gas industry jobs increased by 40 percent.[47] In 2014, the oil and natural gas sector contributed more than $1.2 trillion and more than 9.8 million jobs to the nation's economy. [48] In addition to past and present economic contributions, fossil fuels create future economic opportunities. One of Kinder Morgan's proposed pipeline projects in Ohio is expected to create hundreds of construction-related jobs, and the economic impact will be significant as workers will reside locally and rely upon local businesses, contractors and support services during the construction period. Despite periods of slower growth, the fossil fuel

[46] http://www.eia.gov/forecasts/aeo/section_elecgeneration.cfm
[47] Oil and gas industry employment growing much faster than total private sector employment. (2013, August 8). Retrieved September 23, 2015 from http://www.eia.gov/todayinenergy/detail.cfm?id=12451
[48] Oil and Natural Gas Stimulate American Economic and Job Growth. (2014). Retrieved September 23, 2015 from http://api.org

industry continues to generate opportunities, creating significant benefits for local economies.

While the examples above demonstrate direct economic contributions, the energy industry also significantly contributes indirectly to job creation and economic stimulation. A prime example of this is the automotive industry. This is an industry that depends on diesel, gasoline and other fossil fuels, and it is one of the largest industries in the United States. In its 2015 Auto Industry Jobs Report, the Center for Automotive Research found that over 7 million private sector jobs are supported by auto manufacturers, suppliers and dealers in the United States, paying $500 billion in compensation.[49] This is a major contribution to our nation's economy.

In addition to monetary contributions, access to fossil fuel plays a large role in our economic and national security. The 2015 Index of U.S. Energy Security Risk, a report funded by the U.S. Chamber of Commerce, found that U.S. energy security risk fell for the third year in a row.[50] Energy security risk is mitigated by our access to affordable and abundant natural resources for the energy consumption vital to our national security and position in the global marketplace. The more energy self-sufficient our country is, the less we must rely on foreign countries for energy, jobs and other economic factors. One need only consider the precarious position of many countries from the former Soviet Union, who are wholly dependent for their energy upon the goodwill of Russian leaders.

In contrast, the Chamber's report points to the possibility of North America being "energy self-sufficient," something that was unimaginable less than a decade ago. The cause of this

[49] Contribution of the Automotive Industry to the Economies of all Fifty States and The United States. (2010 April). Retrieved on January 6, 2016 from http://www.cargroup.org/?module=Publications&event=View&pubID=16
[50] Index of U.S. Energy Security Risk. (2015). Retrieved on January 6, 2016 **from** http://www.energyxxi.org/sites/default/themes/bricktheme/pdfs/USEnergyIndex2015.pdf

improvement can be attributed to technological improvements in the industry. The report states that:

> The shale revolution has been unquestionably the single biggest factor in the more favorable view of future risk. It is now expected that by 2017, the United States will become a net exporter of natural gas instead of perennial net importer.[51]

FUELS OUR FUTURE

Renewable energy such as wind, solar and hydro will play a crucial role in powering our future; however, these sources have a long way to go before they can provide enough energy to sustain our needs due to their unreliable nature. As noted above, solar and wind power currently depend on the sun shining and the wind blowing. Due to their flexibility, reliability and affordability, fossil fuels are vital in providing adequate fuel whenever needed and in any weather. Renewable energy sources must currently be supported by fuel such as clean-burning natural gas, and they will continue to rely on this support for the foreseeable future. In fact, a recent International Energy Agency study projects that global energy demand is expected to grow 37 percent by 2040 and that even with growing renewable energy deployment, fossil fuels will still be required to meet approximately 80 percent of the world's energy needs.[52] The study also found that fossil fuels will be needed to meet approximately 60 percent of the world's energy needs by 2040 even under the most aggressive renewable energy development scenario evaluated.

Although fossil fuels are finite resources and some analysts project a peak and subsequent terminal decline in production, the EIA's 2014 International Energy Outlook states that the global supply of crude oil, other liquid hydrocarbons and biofuels is expected to be adequate to meet the world's demand for liquid fuels for at least the

[51] *Id.*
[52] International Energy Agency, World Energy Outlook 2014. (2014, November 12).

next 25 years.[53] There is a significant amount of speculation regarding future liquids supply and demand; however, the EIA projects that over time, global reserves will likely increase as new technologies increase production at existing fields and new projects are established. This has certainly been the experience of the last century.

As advancements in technology continue to evolve, new sources of energy are likely to be introduced and harnessed over time. For instance, gas hydrates, which are cage-like lattices of water molecules containing methane, could be a potential source of natural gas in the future.[54] The EIA projects that gas hydrates, or methane hydrates, may represent one of the world's largest reservoirs of carbon-based fuel. Additionally, they may contain more organic carbon than the world's coal, oil and other forms of natural gas combined, according to the United States Geological Survey.[55] Development and production of these resources is not currently economically viable, and substantial technological improvements and significant research are necessary for this to occur. This, however, offers a glimpse into the future of the energy industry and demonstrates the continuously evolving characteristics of fossil fuel sources.

With the advances in technology and the ongoing efforts to produce abundant, affordable, domestic and environmentally sensitive fuel, the future of fossil fuels' role in the energy industry is promising. In contrast, imagine our civilization without fossil fuels: daily life would be much more burdensome and far less enjoyable, as most of the modern-day necessities and luxuries we take advantage of would not exist – or would be out of reach for the vast majority of our citizens. The bulk of our leisure time would be spent fulfilling basic household

[53] Do we have enough oil worldwide to meet our future needs? (2014 December). Retrieved on January 6, 2016 from http://www.eia.gov/tools/faqs/faq.cfm?id=38&t=6
[54] Potential of gas hydrates is great, but practical development is far off. (2012 November). Retrieved on January 6, 2016 from https://www.eia.gov/todayinenergy/detail.cfm?id=8690
[55] *Id*.

duties like producing sufficient heat, light and food. Thankfully, this is not our reality, nor will it be our future as long as discoveries and improvements in the industry continue. We are fortunate indeed that coal, oil and natural gas fueled our history, continue to fuel our present and will fuel our future for many years to come.