THE NEED FOR FOSSIL FUEL

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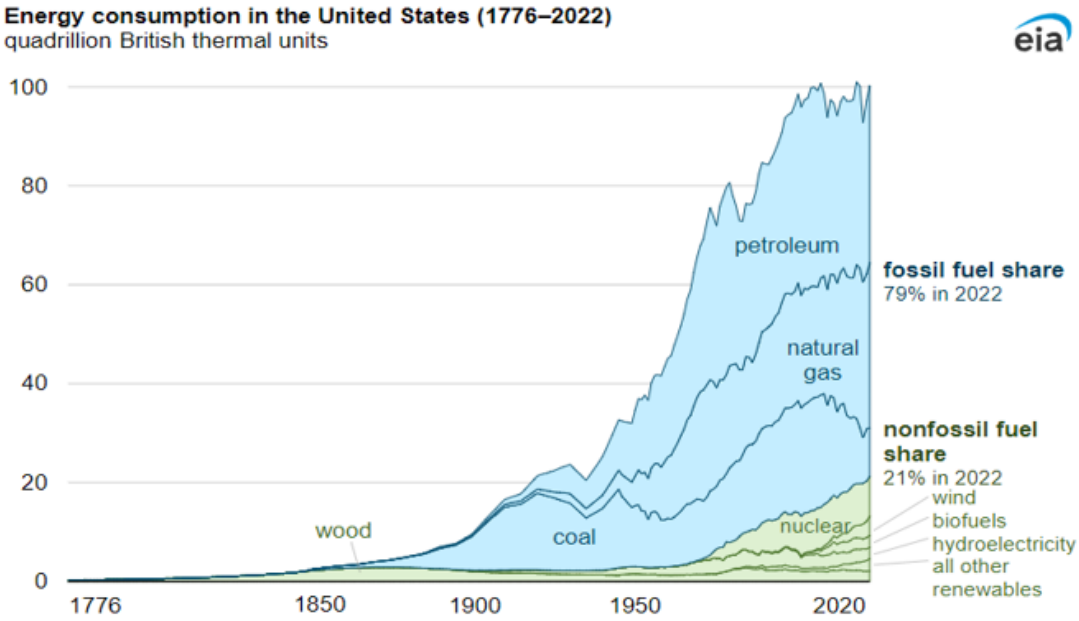
Fossil fuels are intricately woven into the fabric of our everyday lives, and modern life would simply be impossible without them. From the hot water and electricity we use to the clothes we wear, the shelter we trust, the vehicles we operate and most of the consumer goods we enjoy, fossil fuels are the building blocks of life as we know it.

The widespread use of fossil fuels has immensely improved living conditions around the world and played a significant role in the large-scale development of reliable and affordable long-distance transportation, resulting in widespread improvement of the quality of and access to nutrition. Prior to the use of kerosene, heavy oil and natural gas, homeowners used poor quality biomass fuels like firewood and peat moss, filling houses with soot and hazardous particulate matter, as well as carbon monoxide and toxic chemicals.

Beyond cooking, the switch to fossil fuels allowed cars, trucks, and tractors to replace work animals (and their associated food consumption), eliminating the diseases associated with animal waste. Refined petroleum products also 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] In many ways, there is an enduring economic and social need for fossil fuels that will continue to play a central role in our lives.

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 approximately 80-95% of total U.S. energy consumption since 1900.[2]



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

[1] http://www.wsj.com/articles/notable-quotable-energy-and-the-catastrophists-1444600252
[2] https://www.eia.gov/todayinenergy/detail.php?id=56980

PRE-INDUSTRIAL SOCIETY

The wide-ranging use of fossil fuels was developed during the Industrial Revolution in the 18th and 19th centuries. Prior to this, humans relied on 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.[3] 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.

In addition to plant growth and biomass energy, mankind depended heavily on human and animal muscle to fulfill its energy needs before the Industrial Revolution. Human and animal labor provided much of the energy used for agriculture and transportation.[4] 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-Modem 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."[5]

POST-INDUSTRIAL SOCIETY

Vast quantities of fossil fuels were finally harnessed during the Industrial Revolution to power the economy, which would change the course of history and improve our quality of life. The rapid and sustained economic growth experienced during this time would not have been possible without coal.[6] This reliable fuel source enabled broad use of technologies that were being developed or enhanced, including the steam engine which had become compact and efficient.[7] 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 numerous ways throughout modern history as energy sources. The modern petroleum industry is considered to have been born in the 19th century, and one of the driving forces behind the increased demand for crude oil was the invention of the kerosene lamp in the mid-1850s.[8] Kerosene, a petroleum product, was in high demand because it replaced 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 grew.

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[3] https://www.cato.org/policy-analysis/humanity-unbound-how-fossil-fuels-saved-humanity-nature-nature-humanity
[4] Moan, Jaina, and Zachary Smith. Energy Use Worldwide. Santa Barbara: ABC-CLIO, Inc., 2007. Google Books. Web
[5] Crone, Patricia. Pre-Industrial Societies, Anatomy of the Pre-Modern World. London: Oneworld Publications, 2003. Google Books. Web.
[6] White, Kathleen H. Fossil Fuels: The Moral Case. Texas Public Policy Foundation, June 2014.
[7] A Brief History of Coal Use. (2013, February 12). https://www.energy.gov/fecm/office-fossil-energy-and-carbon-management
[8] History of the Oil and Gas Industry. (2005-2006). https://guides.loc.gov/oil-and-gas-industry

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% annually during the 1950s.[9]

It was also during this time that the safe and efficient transportation of natural gas from producers to end users began. 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.[10] 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."[11] Pipelines were 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.[12] For example, life expectancy was 20 to 25 years for most of human history; however, from 1860 to 2023, global life expectancy nearly doubled, from 39 years to 73 years.[13] Additionally, global population increased from 1.2 billion to 8.04 billion during this time frame, and the average annual income increased from $640 to $9,733.[14] Rising incomes have shown to improve other indicators of human well-being including hunger, infant mortality, education, economic freedom and the end of child labor.[15]

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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.

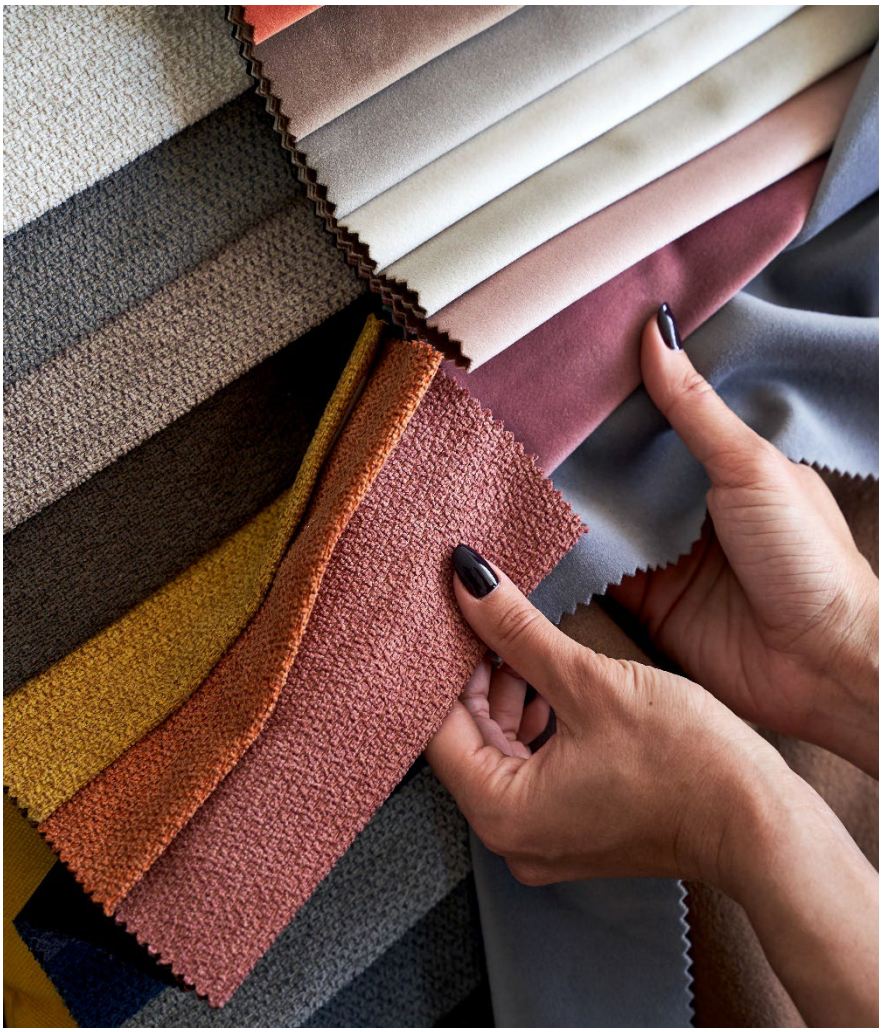
The ways in which we consume fossil fuels will continue to change as new technologies are developed and societies evolve. They have shaped our past, sustain our present and will propel us into the future. In order to fully appreciate these valuable resources, we need to understand the range of critical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

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. 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 the industry. These products include plastics, synthetic fibers, chemicals, steel, asphalt, cement, construction materials and more.

9 *Id.*
10 http://www.fossil.energy.gov/education/energylessons/gas/gas history.html
11 Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).
12 *Id.*
13 https://www.worldometers.info/demographics/life-expectancy/
14 https://www.zippia.com/advice/average-income-worldwide/#:~:text=The%20average%20global%20personal%20income,you%20in%20the%20top%201%25
15 Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).

Textiles and Clothing



Fabrics and textiles are made from a variety of materials including cotton, wool, silk and synthetic fibers. Until the end of the 19th century, most clothing and other textiles originated from products of living nature like fibers from cotton or wool from animals.[16] This trend has drastically shifted and synthetic fibers, which are derived from fossil fuels, account for the majority of global fiber production. In 2022, synthetic fibers like polyester, nylon and vinyl accounted for approximately 65% of global fiber production.[17] The prominent use of synthetic fibers has created more affordable clothing for the masses, while improving their durability.

Even the production of cotton depends heavily on assistance from fossil fuels in the form of fertilizer and fuel for farming equipment.

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, computers, cell phones and a myriad of other consumer products, everything "plastic" originates from petroleum or natural gas. Plastics are manufactured from natural gas and feedstocks derived from natural gas processing or crude oil refining that are known as natural gas liquids.[18]

Plastics became widely used after World War I as they served as substitutes for products like wood and glass that became scarce during the war.[19] They are produced by treating components of crude oil or natural gas in a "cracking process," which involves breaking down large hydrocarbon molecules 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 used in healthcare and technology fields. Their wide range of applications meets consumer needs at all levels.

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[16] *Id.*
[17] https://textileexchange.org/app/uploads/2023/11/Materials-Market-Report-2023.pdf
[18] https://www.eia.gov/tools/faqs/faq.php?id=34&t=6
[19] http://plastics.americanchemistry.com/Education-Resources/Plastics-101/Lifecycle-of-a-Plastic-Product.html

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 with inadequate food supplies are susceptible to high rates of infant and maternal mortality and low life expectancies, in addition to poor health and malnutrition.[20] 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 were left to the devices of nature, human and livestock health. Fossil fuels have allowed humans to technologically enhance nature's capabilities by 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%; however, the total amount of cropland increased by only 11%.[21] 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. From 2012 to 2015, agriculture became more energy intensive, as energy consumption grew over 10% compared with about 6% growth in agricultural output. In 2016, the industry used 1,872 trillion British thermal units (Btu) of energy.[22] 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.[23] 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.

[20] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).
[21] *Id.*
[22] Energy consumption in agriculture increased in 2016, driven mainly by diesel and fertilizer use
[23] Goklany, Indur M., Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity. (2012, Dec. 19).

In 2021, U.S. production of nitrogenous fertilizers and other agrochemicals required the consumption of approximately 95 billion cubic feet of natural gas throughout the supply chain.[24]

In addition to the contribution of agricultural chemicals, the industry relies on direct consumption of fuel, especially distillate fuel, to power both livestock and crop operations.[25] 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 using trucks, trains, airplanes and other vehicles that are fueled by fossil fuels. To transport food to markets economically, the agriculture industry depends on an inexpensive fuel source, refrigerated vehicles and safe food packaging that all originate or are fueled by fossil fuels.

FUELS OUR TRANSPORTATION

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 U.S. alone.[26] 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%, while at the same time improving performance and increasing fuel economy.[27] 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. In 2022, more than 90% of the energy consumed in the transportation sector was from petroleum sources.[28]

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

[24] https://www.aga.org/wp-content/uploads/2023/03/Advancing-Americas-Agriculture-The-Value-of-Natural-Gas-to-U.S.-Agriculture-and-Agrochemicals.pdf
[25] Energy for growing and harvesting crops is a large component of farm operating costs. (2014 October).
[26] https://www.energy.gov/eere/vehicles/articles/internal-combustion-engine-basics
[27] https://www.eia.gov/outlooks/aeo/
[28] https://www.eia.gov/energyexplained/us-energy-facts/

evaluating the dependability, flexibility and affordability of different fuel types. Gasoline and diesel are the most popular fuel sources for transportation due to their higher energy densities and ease of onboard storage. While a variety of alternative transportation energy fuels are used across the U.S. - propane, hydrogen, higher ethanol gasoline blends (E85) and natural gas - gasoline and diesel remain the leading transportation fuels. Fuels like 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.[29]

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.[30] While some electric vehicles (EV) can outperform the fuel economy of similarly sized gasoline vehicles for short periods of time, batteries and fuel cells are expensive and are not yet well-supported by limited charging or fueling infrastructure. Consumer concern about the limited driving range of electric vehicles is currently well-founded, particularly in the face of limited public charging options.

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 of choice for years to come.

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 U.S. generated approximately 4.23 trillion kilowatt-hours of electricity in 2022, about 60% from fossil fuels–coal, natural gas, petroleum and other gases.[31] Diversification of energy sources such as hydropower, solar and wind for electric generation continues to increase, though they still account for only 20% of the total. Despite decades of R&D spending, tax credits and state mandates, renewables still lag behind fossil fuels as a source of electricity.[32]

29 https://www.eia.gov/todayinenergy/detail.php?id=9991
30 https://www.cnn.com/2023/12/06/business/americans-bought-1-million-electric-this-year/index.html
31 https://www.eia.gov/tools/faqs/faq.php?id=427&t=3
32 https://www.eia.gov/totalenergy/data/monthly/pdf/sec10_2.pdf

Solar and wind are continuing to grow, as mandated in several states. However, to achieve energy reliability, it is important for renewable sources to be backed up by affordable and reliable natural gas that is easily dispatchable. 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. As the development of solar and wind energy increases, Kinder Morgan is well-positioned to provide affordable natural gas to support renewables.

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FUELS OUR ECONOMY

While the energy industry and markets constantly evolve, the direct economic benefits of the fossil fuel sector are robust. The affordability and accessibility of oil and natural gas have infused hundreds of billions of dollars into new manufacturing, supporting the development of new jobs, infrastructure and economic opportunity in the U.S. In 2021, the oil and natural gas industry directly provided 2.3 million jobs for American workers and generated $773.6 billion in gross domestic product (GDP) for the U.S.[33] In addition to past and present economic contributions, fossil fuels create future economic opportunities. Despite periods of slower growth, the fossil fuel industry continues to generate opportunities, creating significant benefits for local economies.

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 U.S. In fact, according to the Alliance for Automotive Innovation, 9.6 million jobs that are supported by the automotive ecosystem represent more than $650 billion in payroll compensation annually in the U.S.[34] This is a major contribution to our nation's economy.

In addition to monetary contributions, access to fossil fuels plays an influential role in our economic and national security. Energy security risk is mitigated by our access to affordable natural resources for the energy consumption vital to our national security and position in the global marketplace. A good measure of energy security is to look at whether a nation exports more energy products than it imports. In 2022, annual U.S. natural gas exports reached a record high of 6.90 trillion cubic feet, and the U.S was a net exporter of natural gas for the sixth year in a row.[35] The more energy self-sufficient our country is, the less we must rely on foreign countries for energy, jobs and other economic factors. This is especially important during times of geopolitical crisis, like the Russia-Ukraine war, which introduced significant impacts to energy markets worldwide in 2022.

[33] https://www.api.org/-/media/Files/Policy/American-Energy/PwC/2023/API-PWC-Economic-Impact-Report-2023.pdf
[34] https://www.autosinnovate.org/resources/papers-reports/Driving%20Force%20Annual%20Report.pdf
[35] https://www.eia.gov/energyexplained/natural-gas/imports-and-exports.php

FUELS OUR FUTURE

Renewable energy such as wind, solar and hydrogen 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 to provide adequate fuel whenever needed and in any weather. Renewable energy sources must be supported by fuel such as cleaner-burning natural gas to ensure our energy supply remains reliable.

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 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 oil and natural gas fueled our history, continue to fuel our present and will be an important part of the fuel mix for our future for many years to come.

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