Energy in the United States: An Industry Analysis

by

Dakota Sweet

Honors Thesis

Appalachian State University

Submitted to the Department of Finance and Banking

in partial fulfillment of the requirements for the degree of

Bachelor of Science

May, 2020

Approved by:

Dakota Sweet, **Researcher**

Brandy Hadley, PhD **Thesis Director**

Lorilee Medders, PhD **Second Reader & Dept Honors Director**

Table of Contents

Abstract

Energy in the United States is a widespread topic focused primarily on two areas, fossil fuels and renewable energy. These two sectors can be broken down into energy sources such as hydroelectricity and crude oil. Solar and wind power are the most prominent renewable energy sources, particularly due to high cost-effectiveness. The importance of less volatile energy, which can be found in renewable sources, is emphasized through current market conditions with sentiment gathering around lexicons such as “crisis,” and “collapse.” As cost-effectiveness continues to increase, additional organizations will begin to adopt sustainable energy in future endeavors and industry concentration will shift from conventional energy to renewable energy, especially regarding electricity generation.

Introduction

Beginning millennia ago with the discovery of fire, mankind’s ability to harness natural resources as a means of energy production has grown considerably, allowing technological advancements such as nuclear power. According to the Energy Industry Spotlight maintained by the US Department of Commerce (2019), investment in the domestic energy sector was valued at $350 billion, with an additional $178 billion in foreign direct investment during 2018.[1] Currently, major energy production sources include but are not limited to: natural gas, crude oil, biomass, hydroelectricity, wind, solar, geothermal, and nuclear energy. This analysis will examine several aspects of the energy sector such as: energy sub sectors, trend analysis, production cost, sustainability analysis, governmental policy, and market sentiment. These topics will be broken down further into discussions on: Energy Sources, Meta Trend Analysis, and National Energy Analysis. At present, there are multiple almanacs covering the entirety of the

industry, however, these references are hundreds of pages long, making them an impractical source for the individual investor. This guide will serve as a more sensible and practical resource for those looking to invest in the energy industry, in addition to individuals looking to learn more about the current state of this quickly changing sector.

Energy Sources

Fossil Fuel

Natural Gas

Background. The Energy Information Administration's (EIA) article, *Natural Gas Explained* (2019) illustrates an exceptional understanding of natural gas formation and production.[2] Formed over millions of years, natural gas consists of plant and animal remains. Upon gradual exposure to immense pressure and heat, these remains undergo a chemical reaction transforming them into coal, petroleum, or natural gas. Of natural gas, the largest component is methane, with a chemical formula of CH_4. By cooling natural gas to a temperature of roughly -260 °F, hydrocarbon gas liquids may be formed, such as propane or ethane. Production of natural gas has grown considerably over the past decade and continues to replace coal due to cost efficiency. Industrial and electrical power consumers are driving demand for the product, with the chemical industry being one of the largest consumers according to the *Annual Energy Outlook 2019* (EIA, p 81).[3]

Demand Analysis. There are many different methods utilized in modeling natural gas demand. However, the Gas Trade Model (GTM) is popular among professionals, as stated in *The Energy Journal*, "GTM is a market equilibrium model that allows interdependence between gas

prices and the quantities traded at a single point in time" (Beltramo, et al, p 16).[4] This is one of many demand modeling methods, Deloitte and various other organizations often create proprietary modeling software for consumers. The EIA has recorded 2019 natural gas consumption to be approximately 85.3 billion cubic feet per day (Bcf/d), with 2020 estimations of 86.73 Bcf/d; however, projections remain flat over the long-term. Slight increases in industrial consumption will be off-set by decreased consumption in the residential and commercial sectors. Natural gas inventories began the year at 2.210 trillion cubic feet, these inventories are typically correlated with industry consumption such that decreased consumption would place upward pressure on future inventories (2020).[5]

Market Analysis. According to the American Petroleum Institute, "Natural gas provides 27% of the marketable energy consumed in the United States" (2014, p 4).[6] Natural gas derivatives are often traded on the New York Mercantile Exchange (NYMEX), where a derivative is a contract that reflects the value of an underlying asset, such as a futures contract. Additionally, a spot price is the current price an asset is bought or sold at. The EIA recorded the Louisiana Henry Hub spot price at $2.22 for December 2019 and a futures contract price ranging from $2.17 to $2.28. These prices are referred to in dollars per million british thermal units (Btu); below (Figure 1) presents this pricing in a chart. It is apparent that over time, natural gas has become cheaper, presumably due to technological advancements and an increased development of shale gas supplies. These supplies can be seen below (Figure 2) in a map of the United States' largest natural gas field reserves.

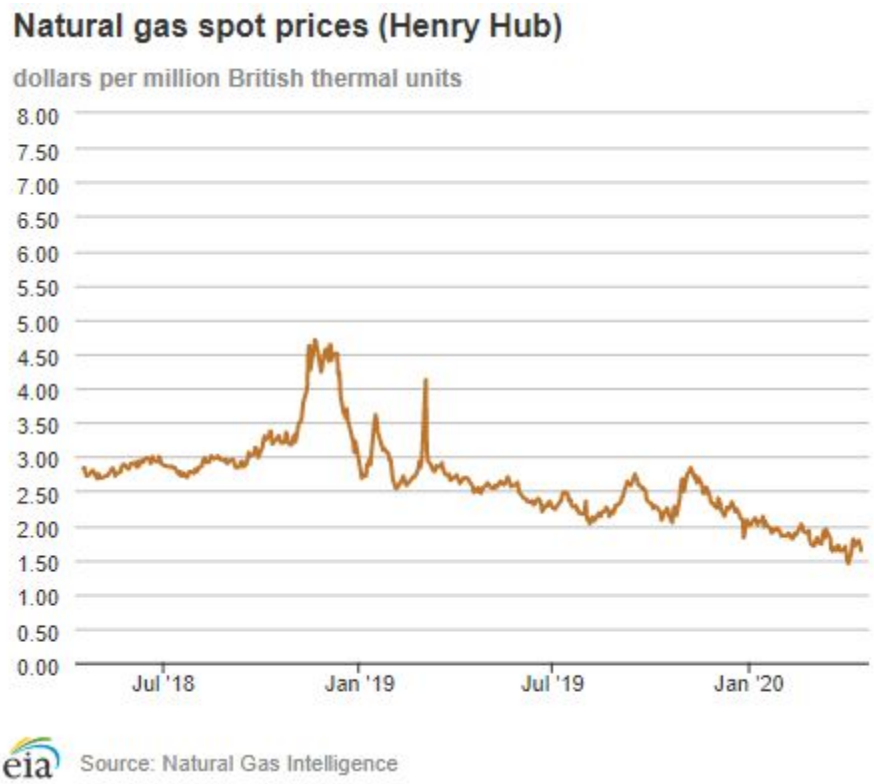

Figure 1. From *Natural Gas Weekly Update*, by the US Energy Information Administration, April 2020, https://www.eia.gov/naturalgas/weekly/#tabs-prices-1.

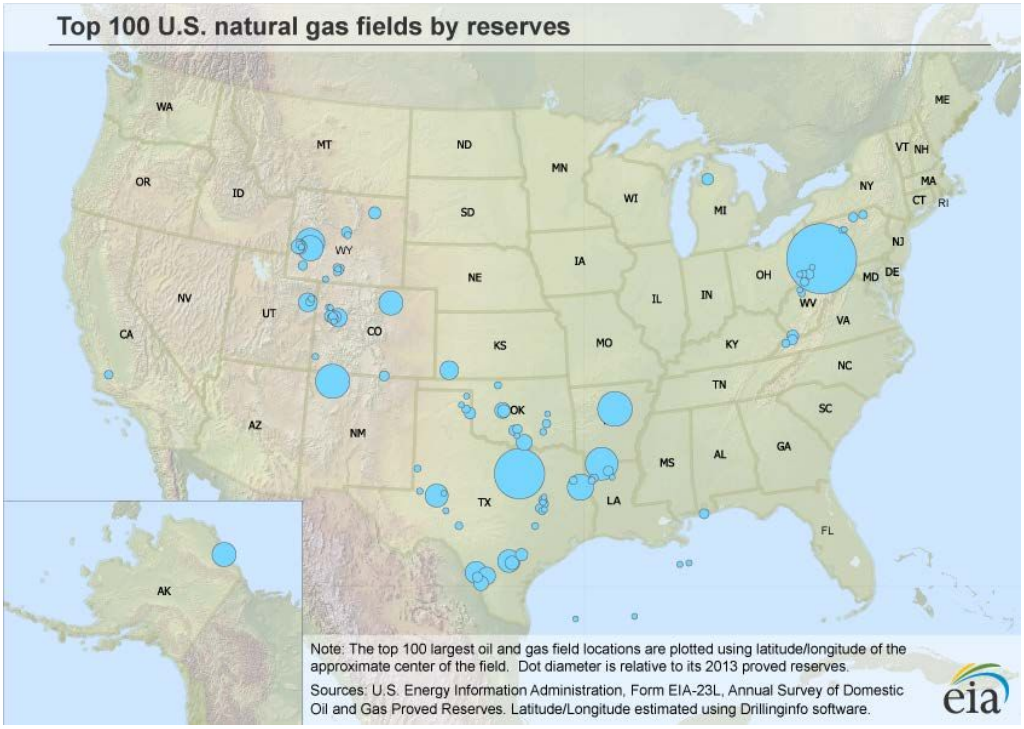

Figure 2. From *Top 100 US Oil and Gas Fields*, by the US Energy Information Administration, 2013, https://www.eia.gov/naturalgas/crudeoilreserves/top100/image/top100gas.jpg.

Regarding future trends, according to McKinsey & Company, long-term natural gas prices will likely remain below $2.80 per million Btu (MMBtu), debottlenecking in Appalachia will produce a local 6% per annum production growth, and coal retirements will increase natural-gas demand, even with renewable offsets (2019).[7] Via the EIA, natural gas prices are expected to be 9% lower in 2020 than in 2019, with a yearly average spot price of $2.33/MMBtu, while the 2019 spot price averaged $2.57/MMBtu. Production is expected to increase, with consumption remaining flat, and data provided by the National Oceanic and Atmospheric Administration (NOAA) has led the EIA to forecast 1.8% fewer heating degree days (HDD). A heating degree day is typically defined as a measure of the energy needed to heat a building. This drop in HDD will slightly decrease demand, however as previously stated, consumption is likely to remain flat overall (EIA, 2020).[8]

Crude Oil

Background. Similar to natural gas, crude oil is formed from plants and animals over time with the application of heat and pressure. This product is typically found underground as a liquid, whereas natural gas is gaseous. Per the EIA, a 42-gallon barrel of crude oil may result in approximately 45 gallons of usable product, which includes but is not limited to: diesel fuel, heating oil, jet fuel, and gasoline (2019).[9] In the United States, Texas produces the greatest quantity of crude oil, with the largest refinery being located in Port Arthur. In 2019, total domestic crude oil production averaged 19.25 million barrels per day (b/d) (EIA).[10] This energy source is usually not considered environmentally friendly largely due to carbon emissions, hydraulic fracturing, and transportation risk.

Demand Analysis. There are many factors that influence crude oil prices and, in turn, demand. Seven factors will be examined through information available from the article *Energy and Financial Markets* (EIA, 2019).[11] Typical of economic markets supply is a major contributor, divided into OPEC and non-OPEC sources, where OPEC is an acronym for the Organization of Petroleum Exporting Countries. It can be seen that reduced production in both OPEC and non-OPEC regions correlates with an increase in prices. Additionally, the expectation of this supply impacts market sentiment. The next factor addresses a dynamic system of inventory in balancing supply and demand. Per the EIA, "If market expectations indicate a change toward relatively stronger future demand or lower future supply, prices for futures contracts tend to increase, encouraging inventory builds to satisfy the otherwise tightening future balance" (2019, paras 3).[11] Various fuel spot prices impact the price of crude oil such as quality price differentials. A quality price differential is the premium or discount assigned to a product based on quality or perceived quality. Geopolitical and economic events can greatly disrupt crude oil prices as demonstrated in the oil crisis of the 1970s or as seen in current markets.

Typical of popularly traded commodities, financial market movements have a price impact on crude oil. Several factors contribute to this influence: an increase in market participants, money managers holding positions net long, higher future price correlations between commodities, and increased daily return correlation with the S&P 500. Lastly, demand/consumption in Organization for Economic Cooperation and Development (OECD) and non-OECD countries affects price. Typically, "Economic growth has a strong impact on oil consumption" (EIA, 2020, Table 1).[12] However, this trend was broken in the time leading up to the Great Recession of 2008. Non-OECD countries saw consumption increase more than 40%

between 2000-2010 while OECD regions contributed to a decline in consumption during the period.[12]

Market Analysis. Crude oil production is divided into seven geographical local regions: Southwest, Gulf Coast, Northern Great Plains, Rocky Mountains, Midcontinent, East, and West Coast. Of the oil deposits in the United States, the largest appear in the Permian, Texas-Louisiana-Mississippi, Western Gulf, Fort Worth, Palo Duro, and Anadarko basins (OilScams, 2020).[13] Petroleum can be found in various industries or products, from agriculture to cleaning products. For example, numerous solar panels use petroleum derived plastic in solar cells (OilScams, 2020).[14] The *Annual Energy Outlook*, released by the EIA in January 2020, predicts growth in domestic oil production through 2025, with a decline in consumption. Much of this purported growth is expected to be in the lower 48, driven by onshore shale oil development (p 23).[15]

As of April 2, 2020 crude oil contracts averaged $29.94 per barrel, down from approximately $65.00 at this time last year (EIA, 2020, Figure 1).[16] Additionally, crude oil reserves are down 2.55% from last year, resulting in a current stockpile of about 442.9 million barrels. Domestic production has steadily grown year-over-year while imports have decreased rather dramatically. Via the International Energy Agency (IEA), this trend is counter to what is being seen globally, since 1990 imports have increased steadily while exports have decreased (2020, Figure 3).[17] In current news, the IEA has adjusted demand forecasts to reflect the adverse impact of the coronavirus (COVID-19). Per the *Oil Market Report* - February 2020,

> Global oil demand has been hit hard by the novel coronavirus (COVID-19) and the widespread shutdown of China's economy. Demand is now expected to fall by 435 kb/d y-o-y in 1Q20, the first quarterly contraction in more than 10 years (2020, paras 2).[18]

Additionally as of January 1, 2020, the International Maritime Organization (IMO) has enacted a sulphur limit in fuel used on-board ships (2020).[19] This signifies that ships will be required to swap to higher quality fuels with sulphur contents of less than or equal to 0.5% m/m (mass by mass).

Market Update (April 28, 2020). Since developing the previous section, the oil market has exhibited an immense increase in volatility and unprecedented activity. Mentioned briefly in the previous paragraph, COVID-19 has decreased demand for liquid fuels, especially due to shelter-in-place and lock-down measures undertaken by various global leaders aimed at preventing the spread of the virus. In addition to the slash in demand, OPEC's expiration of production limiting contracts has created an increase in supply, further decreasing prices. The United States is expected to return to net-importer status during the third quarter of 2020 due to domestic production cuts. Crude oil prices are projected to average $33/b throughout the year with estimates of $23/b for the second quarter and an increase to $46/b during 2021 (EIA, 2020, paras 3).[20] Regarding gasoline, "For the April-September 2020 driving season, the EIA forecasts US regular gasoline retail prices will average $1.58 per gallon (gal), down from an average of $2.72/gal last summer" (p 2).[20] A decline of more than $1/gal and some of the lowest prices seen in roughly two decades (Wagner, 2020).[21]

Figure 3. From *The Next Chapter of the Oil Crisis: The Industry Shuts Down*, by Blas Javier, April 2020, https://www.bloomberg.com/news/articles/2020-04-26/the-next-chapter-of-the-oil-crisis-the-industry-shuts-down.

By examining the chart presented above (Figure 3), it is apparent that West Texas Intermediate (WTI), the main oil benchmark for North America, fell to -$40 a barrel. The lack of demand has created storage issues, "...producers of crude streams such as South Texas Sour and Eastern Kansas Common had to pay more than $50 a barrel to offload their output last week" (Blas, 2020, paras 11).[22] Organizations are attempting to close wells as quickly as possible to decrease the supply of oil in the market. OPEC+ is expected to cut production by more than 20% beginning this week in an attempt to curb the glut. Putting this event in perspective as of April 27, "About three dozen massive oil tankers are anchored from Los Angeles and Long Beach up to San Francisco Bay, turning into floating storage for crude oil that is in short demand because of the coronavirus" (Northam, 2020, paras 1).[23] Northam reports that this equates to roughly 20

million barrels of crude oil compared to the average of 5 million, which is a considerable strain on oil companies, as storage on tankers is expensive.

According to Professor Alex Holcomb of Appalachian State University, OPEC's venture to contractually cut oil production, led by Saudia Arabia, during the month of January resulted in a disagreement within the organization. In retaliation to this dispute, Saudia Arabia greatly increased oil supply, which in turn led dissenting countries to also increase supply, creating a sudden flood of oil into the market (Holcomb, 2020).[24] Presenting as a larger than anticipated surprise to the industry, the coronavirus spread throughout the globe, causing governments to shut down cities, even entire countries, to prevent contagion. This created an unprecedented drop in demand and, when combined with the oversaturated market, drove oil prices into a negative position. Suppliers are quickly running out of areas to store the oil being produced and attempts to sell this surplus has resulted in other organizations having no location to store it, thus these businesses are reluctant to purchase more, further degrading the price.

Coal

Background. A combustible sedimentary rock, coal is composed largely of carbon and hydrocarbons. This resource is typically classified into four types with categorization depending upon the type and amount of carbon available. These categories are classified as:

- Anthracite ↦ 86% - 97% carbon, often delivers the highest heating value, rare.
- Bituminous ↦ 45% - 86% carbon, generally used to generate electricity, abundant.
- Subbituminous ↦ 35% - 45% carbon, mainly mined in Wyoming, abundant.
- Lignite ↦ 25% - 35% carbon, can be converted to synthetic natural gas, uncommon.

Long-term exposure to heat and pressure determines the percent composition of carbon in coal, with anthracite having the highest percent carbon and the longest exposure to heat/pressure (EIA, 2019, paras 3).[25] Coal has remained the leading primary energy source in electricity generation for several decades. According to the University of Calgary, in 2015 coal produced 39.3% of the total world energy balance, whereas the next highest source, had a lowly 22.9% market share (2019).[26]

Demand Analysis. Via the EIA's April 2020 *Monthly Energy Review*, over the past several decades, the electric power sector has driven demand for coal. However, from roughly 2005 to present, demand for this resource has been declining (2020).[27] It is estimated that through coal, North Carolina produced 1.4 million MWh of electricity during January of 2020, making it the third largest electricity producing resource in the state. However, North Carolina has no coal, natural gas, or oil production facilities, leading to the conclusion that the state imports a large quantity of its electricity producing capacity (EIA, 2019, paras 1).[28]

In 2019, the average price of exporting coal in the United States was $109 per short ton, while the average import price was $81/st, with most imports coming from Columbia. It is projected that coal production will total 537 MMst (million short tons) in 2020, a decline of 22% from 2019. Same year consumption is expected to decline 19% in 2020, with electric power demand falling 20% (EIA, p 4).[16] In the following graphic (Figure 4), it can be seen that coal consumption exhibits seasonality.

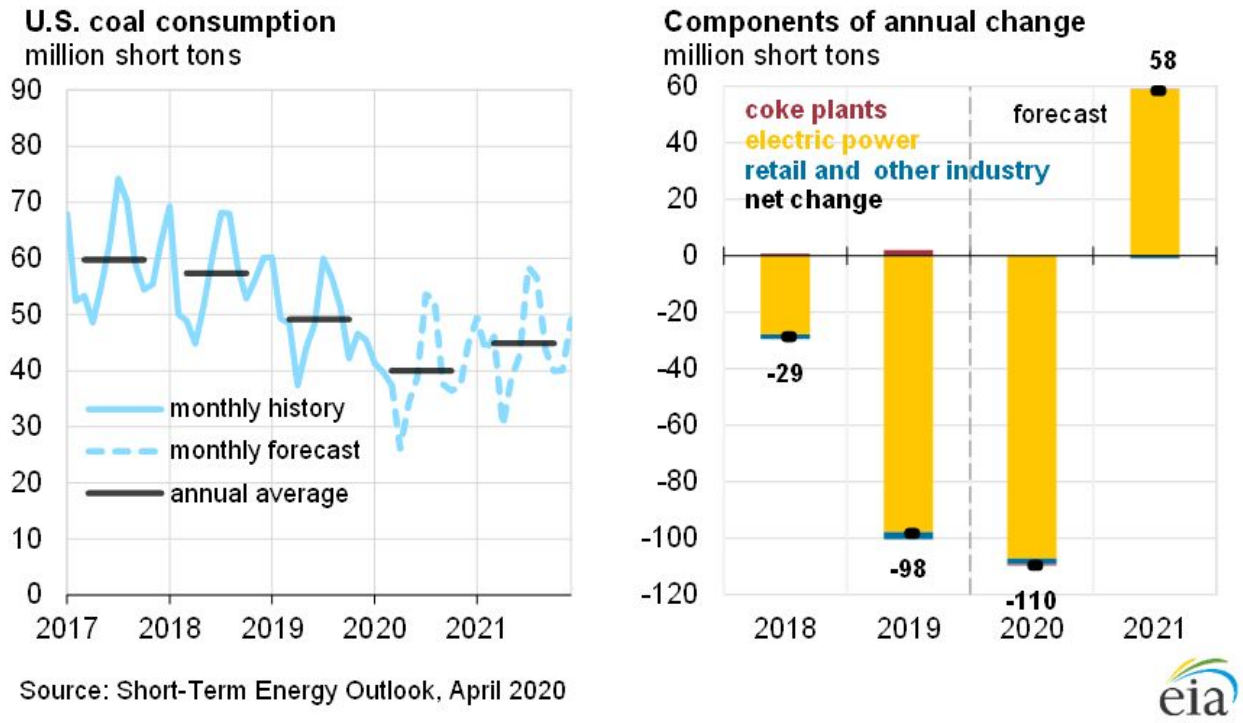

Figure 4. From *Short-Term Energy Outlook, April 2020*, by the US Energy Information Administration, 2020, https://www.eia.gov/outlooks/steo/images/Fig30.png.

Per the EIA, "The economic slowdown and stay-at-home orders are likely to affect US electricity consumption over the next few months" (EIA, p 4).[16] This decline in electricity consumption will impact the sub sector due to the previously mentioned fact that coal is closely related to electricity demand, especially with regards to industrial consumption.

Market Analysis. According to the EIA, there are three generally recognized coal producing regions in the United States, with five states accounting for roughly 71% of coal production in 2018. These states include: Wyoming which produced 40% of the domestic total, West Virginia producing 13%, Pennsylvania 7%, Illinois 7%, and Kentucky 5%. The country's largest coal mines are the North Antelope Rochelle and Black Thunder mines, found in Wyoming. In 2018 these two mines alone accounted for approximately 22% of total U.S. coal production, whereas the Appalachian region produced 56% of the total underground coal mine

quantity (EIA, 2019).[29] Below is a map (Figure 5) illustrating the prominent coal producing regions.

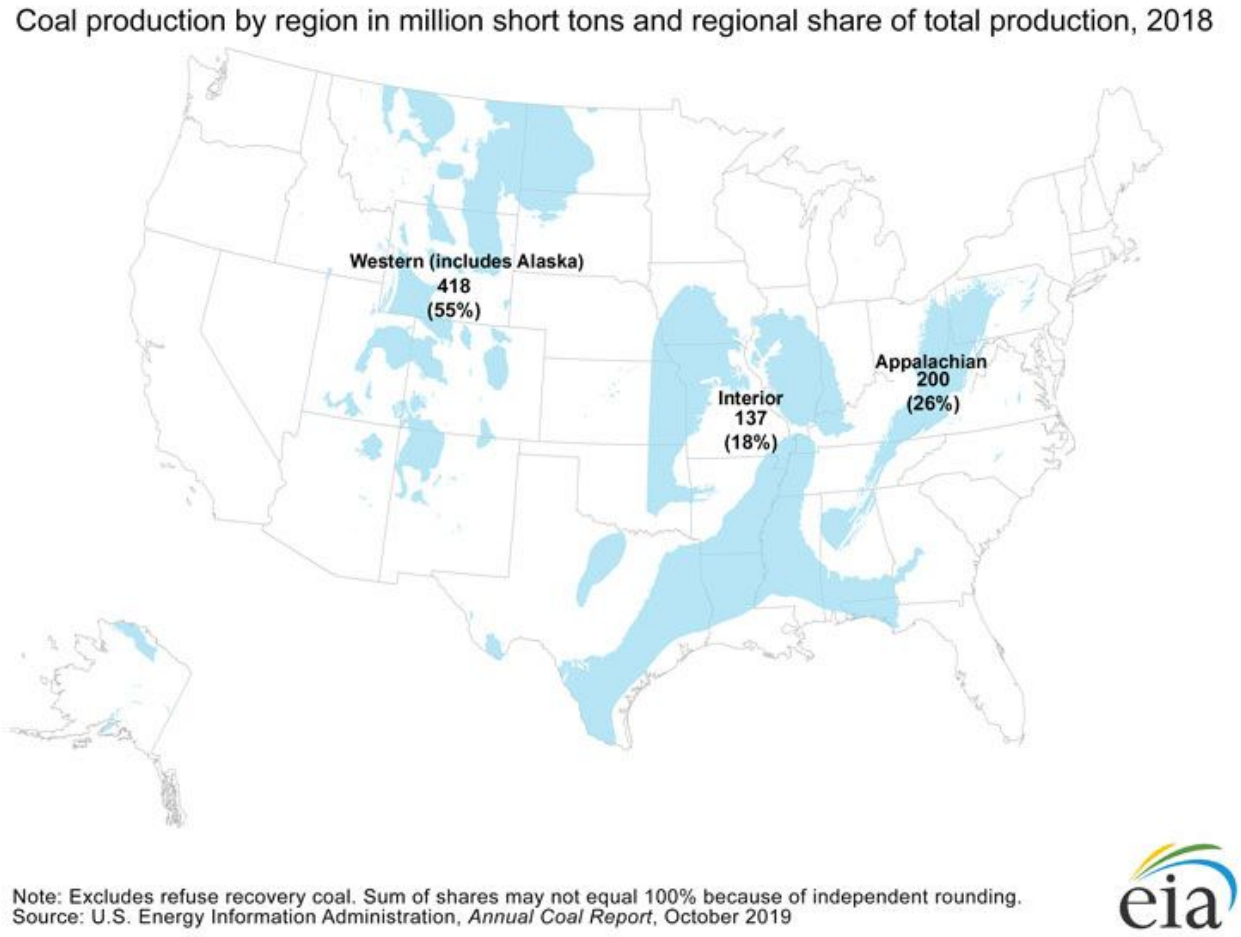

Figure 5. From *Annual Coal Report*, by the US Energy Information Administration, October 2019, https://www.eia.gov/energyexplained/coal/images/coal_production_map.jpg.

Employment in the coal industry typically decreases year-over-year, with West Virginia, Kentucky, and Wyoming employing the most individuals; however, West Virginia employs more than double the individuals of Kentucky (Garside, 2020).[30] Declining employment is coupled with a decline in productivity, "Total U.S. productivity as measured by average production per employee hour decreased by 4.8% to 6.23 short tons per employee hour" (EIA, 2019, p IX).[31]

The coal mining industry is fragmented, highly competitive, highly globalized, and contains high barriers to entry. According to IBISWorld, there are three leading organizations in the coal sub sector: Peabody Energy Corporation, Arch Coal Incorporated, and Contura Energy Incorporated. In 2011, these organizations controlled roughly 50% of the coal mining market; however, today these three account for approximately 24% of the market. It is common knowledge that this industry has experienced decline in recent years due to changing environmental concerns. With that, each of the previously mentioned companies has filed for chapter 11 bankruptcy in the past five years. In 2019, industry revenue totalled $29.6 billion with bituminous coal producing roughly 75% of that revenue. There are four critical success factors in the coal mining industry: availability of resources, ability to find new resource deposits, economies of scale, and obtaining a large supply contract. Unsurprisingly, "Coal producers are diversifying their holdings to reduce the risk of the increased environmental regulation of coal and falling coal prices" (Henry, 2020, NAICS 21211).[32]

Renewable Energy

Biomass

Background. Biomass energy can be defined as, "...energy generated or produced by living or once-living organisms" (National Geographic, 2012).[33] There are several sources of this energy variant, including but not limited to: wood, agricultural crops, and waste materials (EIA, 2018).[34] This energy is produced through the process of thermal conversion, which involves burning, dehydrating, or stabilizing the fuel source. The intermediate step of dehydration, referred to as torrefaction, is particularly important as biomass must be dehydrated before it can be burned (National Geographic).[33] In 2017, biomass energy provided roughly 5% of the total

domestic energy use (EIA).[34] This particular energy source is exceptionally efficacious at producing heat or heat-led combined heat and power (CHP) with an efficiency of 75%-80%; however, the efficiency of electricity generation ranges from 20%-25% (Biomass Energy Resource Center, 2009).[35] Due to the variability of this energy source it is widespread, as seen below (Figure 6).

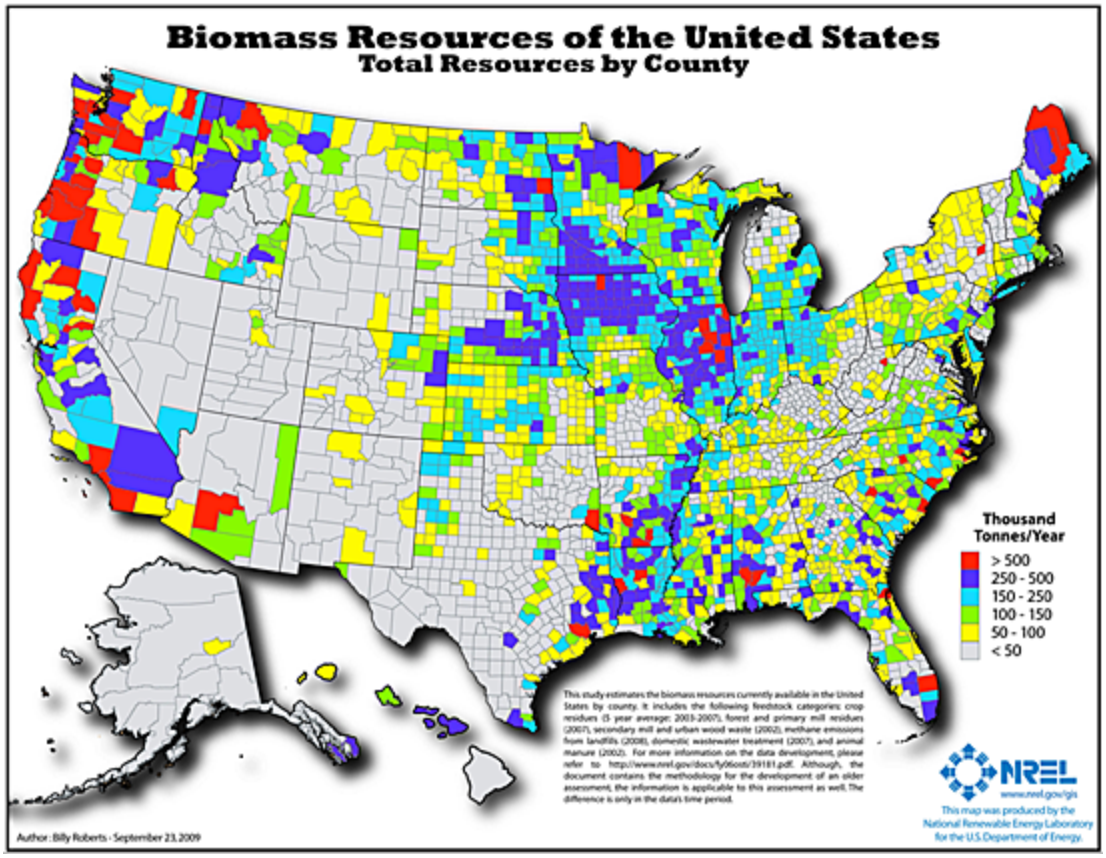

Figure 6. From *Biomass Resource Data, Tools, and Maps*, by the National Renewable Energy Laboratory, January 2014, https://www.wbdg.org/images/biomass_elec_04.png.

Demand Analysis. Biomass has the potential to supply up to 15% of the energy demand in the United States by the year 2030 (Nuclear Information and Resource Service [NIRS], 2005).[36] For reference, as previously mentioned, in 2018, total domestic primary energy consumption was roughly 101.3 quadrillion Btu, while biomass was responsible for

approximately 5.175 quadrillion Btu or 5% of the domestic total (EIA, 2019).[37] Continuing onto electricity generation, biomass was responsible for 2% of total generation in 2016 using the following fuel sources:

- Wood solids accounted for roughly 33% of production,
- Wood-derived fuels, specifically black liquor - 27.5%,
- Municipal solid waste - 20%,
- Landfill gas - 16%, and
- Biogenic fuels - 5% (EIA, 2017).[38]

Typical levelized energy production costs range from $0.08 to $0.15 per kWh, however, this is subject to volatility due to the reliance on commodity type energy sources (Whole Building Design Guide [WBDG], 2016, paras 19).[39]

Market Analysis. Per IBISWorld, revenues for 2019 totaled $907.9 million, with Progress Energy, a subsidiary of Duke Energy, reporting $49.0 million in revenue. Five states contain roughly 40% of the biomass business concentration: Virginia contains 10.8%, Texas 9.9%, California 9.0%, Michigan 7.2%, and North Carolina 7.2%. The biomass power industry serves two main segments, the industrial electricity sector and electric power utility sector. Direct-fired production supplied 64.2% of total biomass produced electricity. This is a relatively difficult market to operate in because of high levels of capital intensity, medium revenue volatility, and heavy regulation, however, legislative assistance is substantial. Due to the primary product in this sub sector being electricity, it is typically regulated as a public utility. Air and water pollution regulations are highly impactful, in addition to the regulating of handling and storage of any hazardous waste that may be used as fuel (Moses, 2020, Report OD4497).[40]

Hydroelectricity

Background. One of the oldest forms of energy generation, hydroelectric energy utilizes the kinetic energy of flowing water to mobilize a turbine, in turn, generating electricity. There are three common variations to hydroelectric energy plants: impoundment facilities, diversion facilities, and pumped storage facilities. This is the most common renewable energy source regarding electricity, with approximately 71% of global renewable electricity being produced through hydroelectric facilities (National Geographic, 2019).[41] In 2019, the states of Washington, Oregon, New York, California, and Alabama accounted for 60% of conventional hydroelectricity generation capacity in the United States, with Washington producing 27% of that capacity. Washington is home to the Grand Coulee Dam, considered to be both the largest hydropower facility and largest power plant by generation capacity. On a yearly basis, the dam produces enough electricity to supply roughly 4.2 million households and contains enough concrete to build a sidewalk that wraps around the equator twice. (Department of the Interior, 2018).[42] Total domestic generation was roughly 274 billion kilowatthours (kWh), equivalent to nearly 6.6% of utility-scale electricity generation (EIA, 2020).[43]

Demand Analysis. Following (Figure 7) is an map that illustrates recent data regarding United States hydroelectricity plants,

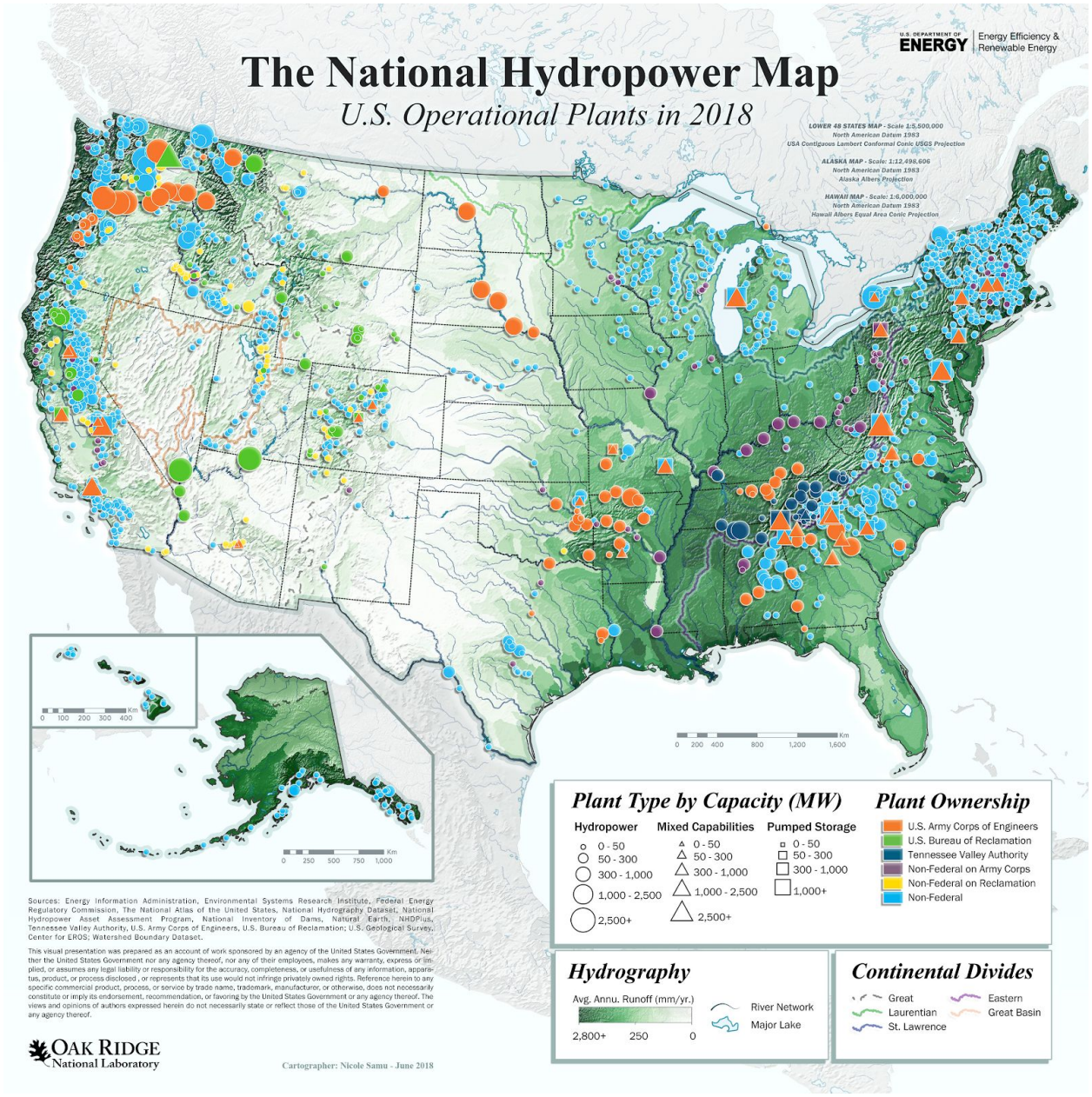

Figure 7. From *ORNL's HydroSource*, by the Oak Ridge National Laboratory, 2018, https://hydrosource.ornl.gov/sites/default/files/images/national_hydro_map_2018.jpg.

According to the United States' Department of Energy, "More than 90% of dams are used for services such as regulating water supply and controlling inland navigation, and lack electricity-generating equipment" (DOE, 2013).[44] Overall in 2018, hydropower generation decreased, especially in the Southwest-region of the United States. This was caused by an

increase in drought conditions, in addition to below-average snowpack levels. At the end of 2018, 243 hydropower projects and 55 pumped storage projects were in development, projecting a new capacity of 2.5 GW and an estimated value of approximately $500 million. However, federal approval for hydropower projects have reached decade low levels, with 21 project approvals in 2018 (DOE, 2018).[45]

Market Analysis. The Hydroelectric power industry is highly fragmented, with the United States Bureau of Reclamation having the greatest market share at 6.4%. Revenues for the industry totaled roughly $11.65 billion in 2019, with hydroelectric plants producing less than one megawatt, accounting for most of this revenue. Major external drivers for the industry include: average annual precipitation, price of natural gas, electric power consumption, value of utilities construction, and the price of electric power. Being a primary producer of electricity, the hydroelectric industry is geared toward selling to the industrial, commercial, and residential sectors, with residential producing the most revenue. Top producing states include: New York at 12.2%, Wisconsin at 9.9%, and California at 7%. IBISWorld identified four critical success factors in this industry: the ability to negotiate successfully with regulators, optimum capacity utilization, ability to pass on cost increases, and further development in turbine technology (Patel, 2019, NAICS 22111c).[46]

Wind Utilization

Background. A form of solar energy, wind energy refers to the use of wind turbines to convert kinetic energy into mechanical power. There are three main elements that determine the efficiency of a wind turbine: air density (ρ), wind speed (V), and swept area (A) (Open Energy Information, 2009).[47] For reference, the equation regarding wind power generation is as follows,

$P = \frac{1}{2}\rho A V^3$. Currently, the installed capacity for the United States is 97 gigawatts (GW), with an estimation that over 10,000 GW of potential energy is available from this resource. There are many facilities the Department of Energy utilizes in an effort to develop this potential and advance wind energy generation technology. These include, but are not limited to the National Renewable Energy Laboratory based in Colorado and the Argonne National Laboratory in Illinois (2020).[48]

Demand Analysis. Wind energy is quickly becoming a poster child for sustainability, with cost production falling roughly 69% since 2009. The American Wind Energy Association CEO Tom Kiernan states, "Wind power is on strong footing with trend lines - rising consumer demand, falling costs, improving technology - all pointing in the right direction" (2019, paras 11).[49] Figure 8 below, published in November 2019, is a graphic representing levelized energy prices,

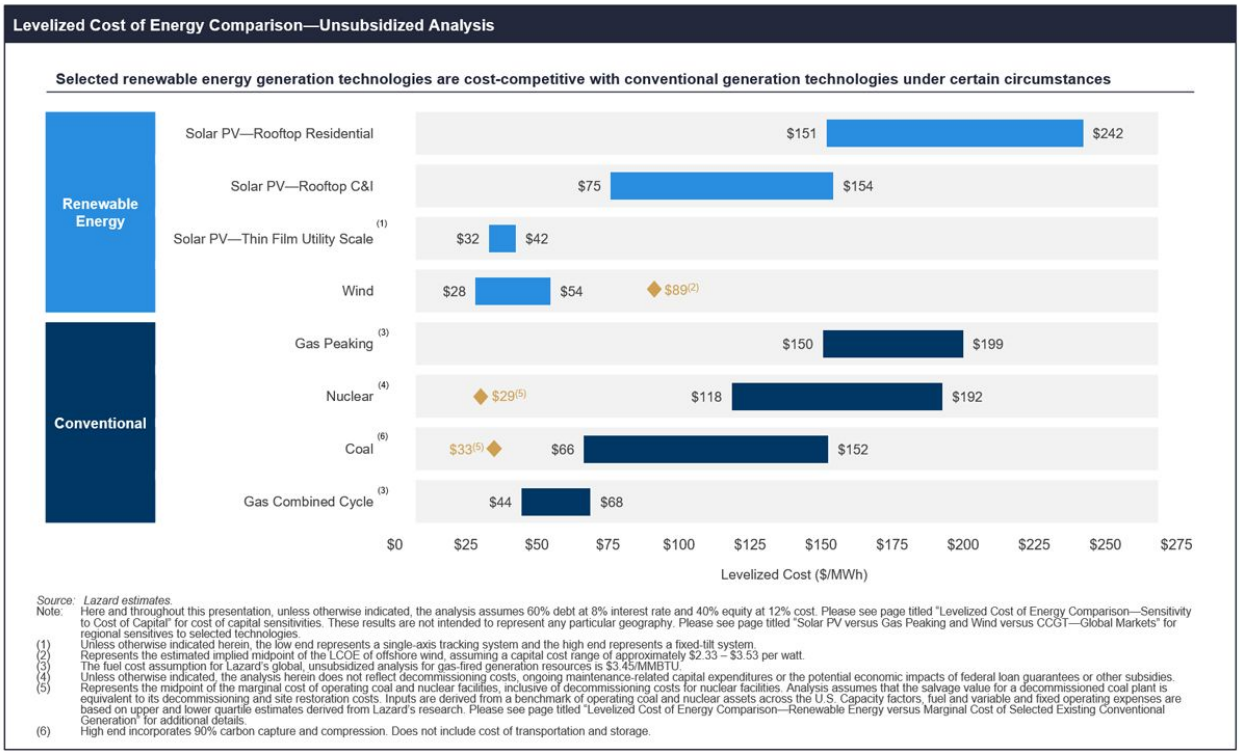

Figure 8. From *Levelized Cost of Energy and Levelized Cost of Storage 2019*, by Lazard, November 2019, https://www.lazard.com/perspective/lcoe2019.

In addition to lower prices, wind energy does not suffer from the price volatility coal and natural gas do. According to the Wind Energy Technologies Office, "By reducing national vulnerability to price spikes and supply distributions with long-term pricing, wind is anticipated to save consumers $280 billion by 2050" (DOE, 2014).[50]

Market Analysis. Currently, there are two major competitors in the wind power industry, Avangrid Renewables, with a 23.2% market share, and NextEra Energy Incorporated, at a 14.4% market share. Revenues for 2019 totaled $14.8 billion, with most revenue creation coming from utility scale generation. There are four critical external drivers for the industry: regulation, price of electric power, electric power consumption, and the world price of steel. In contrast to many of the previously discussed industries, this industry is currently in the growth phase. Additionally, approximately 56% of the electricity produced from wind power is sold to utility companies. Similar to the relatively even split between utility and commercial seen in the hydroelectricity market, Texas - 14.4% and California - 13.3%, are leading the market in wind energy production with most states falling quite short of those concentrations (Patel, 2020, NAICS 22111D).[51]

Solar Energy

Background. Similar to hydroelectricity, solar energy has been used for centuries. In the past, this energy variant aided in drying meat, fruits, and grains for food preservation. Today, this energy source can be used in numerous diverse ways, from heating water in buildings to generating electricity. This increase in applications is largely due to the development of photovoltaic systems, often referred to as solar cells, and technological innovation (EIA, 2019).[52]

In 2018, solar domestic primary energy consumption was roughly 8% of the total renewable energy consumption. When comparing this to the 22% wind power and 23% hydroelectricity consumption, it is apparent that solar is not being utilized as greatly (EIA).[37] Additionally, there are two well known drawbacks to making use of solar cells: the amount of sunlight arriving on Earth's surface is not constant and a large surface area is required to produce a significant amount of energy.

Demand Analysis. An important factor in the solar industry has been the Solar Investment Tax Credit (ITC), passed in 2006 and extended through 2021. According to the Solar Energy Industries Association, the cost of installing solar systems has declined more than 70% over the past decade. Seeing as it is often impractical to install a dam or wind turbine at one's house, solar has also experienced growth in the residential sector. Presently, the Department of Energy is working to create lower and uniform soft costs with solar installation. Soft costs are expenses such as labor, inspection, and overhead. There are two prominent programs the DOE sponsors at the moment, the SolSmart program and Solar Automated Permit Processing (SolarAPP). California has the greatest installed solar capacity, 26,232 MW, equivalent to 4.5x that of the next ranking state, North Carolina. Growth in the industry is expected to continue over time as prices fall and energy storage systems become more efficient (Solar Energy Industry Association [SEIA], 2019).[53]

Market Analysis. Revenue for the industry totaled $9.5 billion in 2019, with two organizations having sizable market shares: NextEra Energy Incorporated at 25.7% and Consolidated Edison Incorporated at 11.8%. Roughly 95% of industry revenue was generated through photovoltaic technology. Similar to wind energy, there are several external drivers in the

solar industry: tax credits, price of steaming coal, electric power consumption, component prices, and natural gas prices. Growth is expected to increase at declining rates over the next decade with the curtailment of the ITC, which began last year. As is commonly known, the industry is in the growth stage, especially due to advancements in solar technology. Serving primarily the residential sector, though slightly less than the wind power industry, solar energy production is concentrated in California, North Carolina, Texas, and Florida. Within-industry competition is rated as medium, with high regulation and barriers to entry (Patel, 2019, NAICS 22111E).[40]

Geothermal Energy

Background. Domestic geothermal energy consumption represents only 2% of the United States' total renewable energy consumption. Geothermal energy is a renewable energy source produced through the heat generated inside the earth. This heat is typically reserved as steam, generated by reservoirs of hot water. Similar to solar, it is often used to heat water, buildings, and produce electricity (EIA, 2019).[55] Differing from wind and solar energy, geothermal energy can consistently produce energy and power plants use significantly less land. Additionally, the Office of Energy Efficiency and Renewable Energy (EERE) states, "Through proper reservoir management, the rate of energy extraction can be balanced with a reservoir's natural heat recharge rate" (paras 2).[56] With these benefits, geothermal energy is considered to be one of the most sustainable energy production sources.

Demand Analysis. The United States leads the world regarding geothermal capacity with the future potential to supply 10% of domestic electricity demand. Differing from solar energy, geothermal power plants consistently produce energy at a stable, predictable level. These plants can heat, cool, and, as previously mentioned, generate electricity (EERE, 2018).[57] Currently,

California is home to the largest geothermal energy plant in the world, Caldwell Ranch. The Caldwell Ranch project area involves restoring previously abandoned steam fields and wells (EERE, 2015).[58] Below (Figure 9), a map of the United State's geothermal resources can be seen.

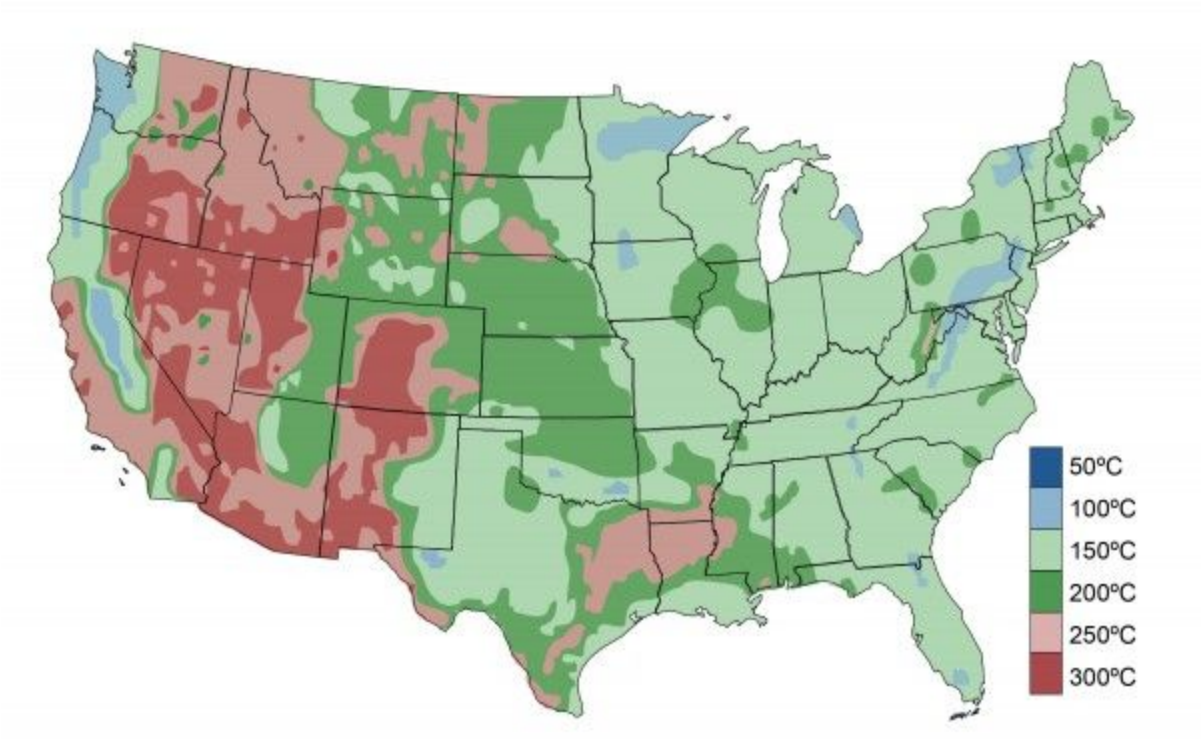

Figure 9. From *Geothermal Energy Factsheet*, by the University of Michigan Center for Sustainable Systems, 2006, http://css.umich.edu/factsheets/geothermal-energy-factsheet.

As of 2018, only seven states contained geothermal power plants, located primarily in the western regions of the country. However, given the illustration above, this distribution of geothermal power plants is sensible.

Market Analysis. In comparison to other sustainable energy sources, growth in the geothermal industry has fallen short. Revenues for 2019 totaled roughly $1.1 billion, whereas solar totaled $9.5 billion, and wind $14.8 billion. This industry, similar to several other renewable energy sources, relies on government assistance to promote initial growth. While recent growth has been suppressed and volatile, future growth is projected to be increasingly

rewarding. There are three critical organizations in this industry: Calpine Corporation with a 28.9% market share, Ormat Technologies Incorporated at 28.8%, and BHE Renewables at 13.6%. This industry is highly concentrated, faces a medium level of competition, has high barriers to entry, but also contains light regulation. Lastly, in-industry success factors include: the ability to find new resource deposits, access to the latest technologies, and operating in states with favorable legislation (Sanders IV, 2020, Report OD4507).[59]

Nuclear Electric Power

Background. Per the Nuclear Energy Institute (NEI), "Nuclear energy comes from splitting atoms in a reactor to heat water into steam, turn a turbine and generate electricity" (2019, paras 1).[60] Nuclear power was responsible for eight percent of the United States primary energy consumption in 2018. Today, there are less reactors online than there were in 2000; however, these reactors produce approximately 20% of the nation's electricity, the second highest amount of energy in the sector (NEI, 2019).[60] This is largely due to technological innovation, increases in efficiency, and increased power plant capacity. Continuing, there are two types of reactors used in domestic nuclear power plants, boiling-water reactors and pressurized-water reactors. As of October 2019, roughly two-thirds of the reactors in the United States were of the pressurized-water variant. Regarding the same time period, there were 58 commercially operating nuclear power plants with 96 reactors (EIA, 2019).[61]

Demand Analysis. Nuclear energy is not considered a renewable resource, as the base commodity uranium is non-renewable and must be mined. Currently, five states have legislation in effect that assists nuclear power plants: New York, Illinois, Connecticut, New Jersey, and Ohio. Illinois legislation supports energy production of up to roughly 11 GW, although the state

presently produces about 2.4 GW. Over the past decade, eight nuclear power plants have been retired. A major contributor to this has been falling electricity prices, as low prices in the wholesale segment prevent organizations from recouping costs. Companies participating in the regulated market segment are better able to combat price fluctuations due to state commissioned price controls (EIA, 2019).[62]

Market Analysis. Industry revenues totaled $37.4 billion in 2019, far greater than typical renewable energy resources, with three organizations dominating the market: Dominion Energy at 31.7% market share, Exelon Corporation at 31.5%, and Entergy Corporation at 6.4%. Significant market consolidation is likely due to the high capital intensity required when constructing nuclear power plants or reactors. It is reported that the Vogtle 3 & 4 project, which started June 2014 and is located in Waynesboro, Georgia, would run an estimated $14 billion (DOE, 2019).[63] Still under construction, Georgia Power Company (GPC), Oglethorpe Power Corporation (OPC), and various subsidiaries of Municipal electric Authority of Georgia (MEGA Power), are all involved in the project. This project will produce the nation's newest nuclear reactors in 30 years while providing 9,000 construction jobs and 800 permanent jobs (DOE).[63] Nuclear power may not be considered renewable, but it plays an important role in price stabilization. "The negligible marginal operating costs of wind and solar mean that, when climatic conditions allow generation from these sources, they undercut all other electricity producers" (World Nuclear Association [WNA], 2020).[64] Producers of nuclear power are attracted to regulated markets due to this uncertainty, leaving deregulated wholesale electricity markets with higher volatility and increased uncertainty.

Meta Trend Analysis

Fossil Fuel

During the Industrial Revolution, coal became the prominent energy source used in large-scale combustion projects. Over time, various energy sources have entered the market, gradually overtaking coal. Per Our World in Data, the following chart (Figure 10) presents energy source consumption since 1800.

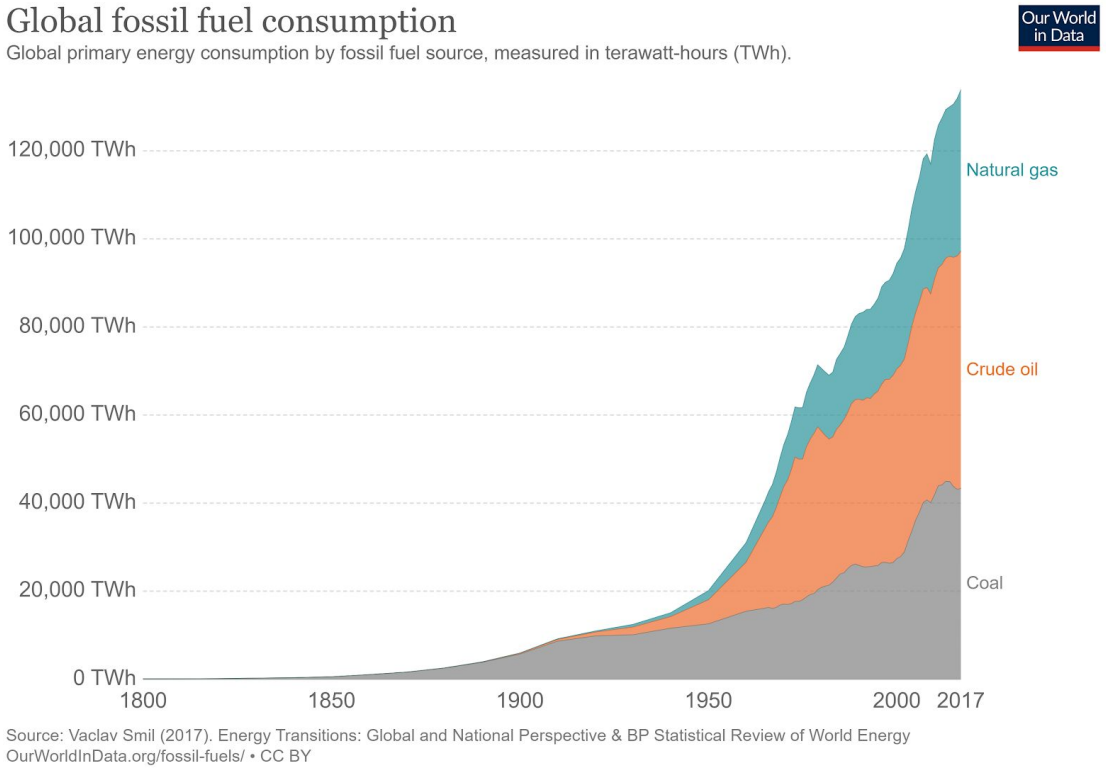

Figure 10. From *Fossil Fuels*, by Hannah Ritchie and Max Roser, 2017, https://ourworldindata.org/fossil-fuels.

It can be seen that during the early-mid 1900s, coal was the leading energy source, however, today there is prominent diversification between coal, natural gas, and oil. Recently, OPEC's inability to reach a contractual agreement regarding oil production cuts has aided in the creation of market volatility not seen in over a decade. Via the EIA, "OPEC's current strategy appears to

be focused on regaining market share by elevating production levels to the point that the resulting depressed prices limit production growth from other market participants, particularly non-OPEC producers" (2020, paras 4).[65] Next, an overview of fossil fuel projections is given, it is important to note that these projections are highly dependent on volatile energy prices. For example, higher than expected crude oil prices will cause cost increases and a decline in crude oil and NGPL production late in the forecast period (EIA, 2020).[66]

Energy consumption is expected to grow slower than production, leading the United States to remain a net energy exporter. The status of net exporter is reinforced through increased production of crude oil and natural gas plant liquids via development of tight oil resources in the coming years (EIA).[66] Domestic crude oil production is forecasted to reach 14 million b/d in 2022 and remain around this level until 2045; for reference, current production averaged 13.025 million b/d on March 6, 2020 (EIA, 2020).[67] Natural gas plant liquid (NGPL) production is expected to reach 6.6 million b/d by 2028 and level off at 6.2 million b/d in 2050; natural gas plant liquid production was roughly 4.97 million b/d in December 2019. Perhaps the most unsurprising projection - domestic coal electricity generation is expected to decline. With a current market share of 24%, it is expected to decline to roughly 13% around the mid-2020s and remain flat throughout the projection period (EIA, p 62).[66]

Renewable Energy

"Overall flat US electricity load growth, rapidly declining renewable energy costs, and maturation of energy storage are increasing competition between traditional and renewable energy sources, as renewables compete to replace retiring coal capacity and aging gas and nuclear plants" (Deloitte, 2020, p 3).[68] It is commonly known that producing renewable energy is

becoming cheaper over time. Take solar energy for example, in 2010 the average system cost was $5.86 per watt, while in 2019 the average system cost was $1.50 per watt, a decline of roughly 74.4% (SEIA, 2019).[53] A common measure used to compare energy values over time is the levelized cost of energy (LCOE). LCOE measures lifetime costs bifurcated by energy production, enabling for the comparison of different energy technologies (DOE, 2013, p 3).[69]

Lazard, a large asset management company, developed a *Levelized Cost of Energy Analysis*, released in 2018, standardizing energy costs in the form of megawatt hours. Via the Clean Energy Authority, a megawatt hour (Mwh) is equivalent to 1,000 kilowatts of electricity used continuously for one hour, or roughly the amount of electricity used in 330 homes during one hour (2010, paras 2).[70] According to Lazard, onshore wind is capable of producing the cheapest energy regarding LCOE in terms of Mwh. When comparing the costs of conventional energy sources such as natural gas, which ranges from $41-$74 per Mwh, to onshore wind energy, which ranges from $29-$56 per Mwh, it can be seen that alternative energy has the potential to be cheaper (Lazard, 2019).[71] It is important to recall that the cost of producing energy through alternative sources continues to decline, whereas fossil fuels remain highly volatile. There are various factors contributing to the decline in alternative energy costs; however, technological advancements provide a prominent contribution. Continued development of more efficient technology will allow for greater energy absorption, transference, and storage.

National Energy Analysis

United States' Energy Overview

The United States' is one of the largest energy producing countries on the planet. For example, in 2019 the U.S. produced 19% of the world's total oil, with Saudia Arabia producing

12% and Russia 11% (EIA, 2020).[72] Total domestic energy production totaled 101.1 quadrillion Btu with the following energy source breakdown:

- 8.37% coming from nuclear energy,
- 11.5% from renewable energy, and
- 80.1% from fossil fuel energy.

This provides an energy comparative ratio of renewable-to-nonrenewable energy equaling approximately 11:80, thus fossil fuel energy is produced at a rate greater than seven times that of renewable energy. Over the past four years net-imports have declined from 11.3 quadrillion Btu in 2016 to -0.775 quadrillion Btu this past year, likely due to energy independence initiatives (EIA, 2020, Figure 1).[73]

Energy intensity, a measure of energy consumption per unit of gross domestic product, represents the energy inefficiency in an economy. A higher energy intensity depicts a high cost of converting energy into GDP. Low energy intensity is desired, "...because it represents an efficient allocation of energy resources to generate wealth and a high quality of life" (Martinez, et al, 2019, p 7).[74] According to the EIA, global energy intensity has been declining steadily for the last 15 years, with countries in the Organization for Economic Cooperation and Development typically having the lowest intensity (EIA, 2013).[75] The *Global Energy Statistical Yearbook 2019* illustrates domestic energy intensity to be lower than Russia, China, and Canada, while falling behind the European Union and Australia (Enerdata, 2019).[76]

Domestic Energy Policy

According to the Congressional Research Service, "Energy policy in the United States has focused on three major goals: assuring a secure supply of energy, keeping energy costs low,

and protecting the environment" (NCSL, 2020).[77] Nuclear electric power would provide a substantial step toward ensuring a "secure supply of energy," however, the public initiative does not appear to be present. The 114th Congress has passed various energy policies including: the Energy policy and Modernization Act, the North American Energy Security and Infrastructure Act, and the Keystone XL Pipeline Approval Act. Individual states energy policy often focuses on topics such as clean energy, workforce development, and fossil fuels. In 2019, decreasing greenhouse gas (GHG) emissions was a prominent trend in Colorado (HB 1261), Nevada (SB 254), and New York (SB 6599) through the passing of legislation that set lower GHG emission targets (NCSL).[77] Additionally, many states such as Montana, Texas, and Virginia are reviewing carbon pricing policies. These policies address methods to decrease carbon emissions through taxes, fees, and cap-and-trade markets.

Fossil fuel legislation typically focuses on two opposite areas, either increasing regulation and restricting development or expanding support for fossil fuel development. Nine states introduced legislation to support the coal industry, protect public health, or assist displaced workers in 2019 (NCSL).[77] Colorado increased regulation of the Colorado Oil and Gas Conservation Commission while states such as California, Florida, and New Hampshire have either banned offshore drilling or the leasing of public land for fossil fuel related activities. Due to the advancement of the energy sector, a demand for workforce development has arisen. The 2020 US Energy and Employment Report states that 6.8 million individuals are employed throughout the sector with a projected two percent growth rate for the year regarding fuel resource employment (National Association of State Energy Officials, 2020).[78] States have also attempted to educate respective workforces through legislation typically focused on clean

energy. For example, Hawaii passed HB 560 to promote training involving the inspection of renewable energy systems and technologies. Additionally, Maryland approved the Clean Energy Jobs Act (SB 516), New Mexico enacted Senate Memorial 24, and Colorado passed HB 1314, which established the Just Transition Office in the Division of Employment and Training.

In the past few decades, lobbying has played a significant role in influencing policy decisions and still does today. Each year industries spend hundreds of millions of dollars lobbying policy makers in an attempt to pass favorable legislation. Ranking fourth in spending in the year 2019, the oil and gas industry spent nearly $125 million (OpenSecrets, 2020).[79] This spending undoubtedly benefits the fossil fuel industry and, according to the Environmental and Energy Study institute (EESI), "Conservative estimates put US direct subsidies to the fossil fuel industry at roughly $20 billion per year; with 20 percent currently allocated to coal and 80 percent to natural gas and crude oil" (2019, paras 3).[80] Following is a short list of direct subsidies: intangible drilling cost deductions per 26 US Code § 263, credit for clean coal investment per Internal Revenue Code § 48A, and percentage depletion per 26 US Code § 613 (EESI).[80] Standard cost depletion expenses are deductible from costs, whereas percentage depletion allows the depletion expenses to be deducted from taxable income, leading to the possibility of greater deductions.

Energy Market Analysis

The above discussion has thus far defined and analyzed a range of energy sub-sectors, ranging from geothermal electricity to conventional crude oil production. Next, the domestic market will be examined as a whole, regarding market capitalizations, efficiency measures, and capital influx. To start, an exchange traded fund or ETF is defined as a collection of securities,

often tracking an underlying index (Investopedia, 2020).[81] In this case, two energy ETFs will be studied to provide information regarding current market conditions. Typical energy ETFs are composed of conventional energy products, as opposed to a mixture of alternative and conventional. For example, the Vanguard Energy ETF (VDE) is 99.80% vested in oil and gas endeavors with the remaining 0.20% lying in coal and consumable fuels (Vanguard, 2020).[82] Compare this to the iShares Global Clean Energy ETF (ICLN) with global and sectoral diversification including but not limited to: solar, wind, hydro-electricity, and geothermal (BlackRock, 2020).[83]

The Vanguard Energy ETF is currently the second largest energy ETF on the market with a net asset total of $2.5 billion as of March 31, 2020. It holds 131 different stocks, however the ten largest holdings comprise approximately 75.5% of the portfolio. This ETF tracks the Morgan Stanley Capital International (MSCI) US Investable Market Index (IMI) Energy 25/50 index, which is an index "designed to capture the large, mid, and small cap segments of the US equity universe" (MSCI, 2020).[84] Much of the reported characteristics are calculated as of March 31, 2020 and, unfortunately for investors, these numbers are likely to be drastically different at the time of writing, April 28, 2020. In March this ETF reached a 52-week low of $31.08 and had a 1-year average annual return of -55%. The recent glut of oil supply creates extreme difficulties for this ETF due to its lack of diversification; this can be seen in the return since inception. As of March 31, 2020, this ETF, which was created in September of 2004, presents an average annual return of 0.38% (Vanguard).[82]

A fund roughly 12 years old, the iShare Global Clean Energy ETF (ICLN) courtesy of Blackrock, contains net assets of approximately $550 million as of April 27, 2020. This fund

holds 30 different organizations and derivatives, with the largest holding being Solaredge Technologies Inc - 5.05% weight, located in the US and operating in the IT sector. As previously stated, the Vanguard Energy ETF is comprised of 99.80% oil and gas investments. Compare this to the diversification of ICLN as of April 27, 2020 (BlackRock):[83]

ICLN Holdings Analysis	
Type	**% of Fund (April 27, 2020)**
Renewable Electricity	39.28%
Electric Utilities	15.72%
Semiconductor Equipment	14.91%
Heavy Electrical Equipment	10.25%
Semiconductors	10.23%
Electrical Components and Equipment	6.63%
Oil and Gas	2.66%
Cash and/or Derivatives	0.32%

Table 1.

This fund is much smaller than VDE, even though it is one of the largest alternative energy ETF currently on the market. Seen above, ICLN provides much more diversification, however, this does not necessarily result in better performance.

Now that two prominent funds have been identified and introduced, a cross comparison can be created. This analysis will focus prominently on ratios and data provided via Morningstar, found in the following table:

VDE and ICLN Performance Comparison		
Industry Measure	**VDE (March 31, 2020)[85]**	**ICLN (April 24, 2020)[86]**
Price/Earnings	25.97x	17.78x
Price/Book	0.68x	1.52x

Dividend Yield	8.36%	1.84%
Beta	1.84x	1.01x
Primary Exposure	Energy (~99%)	Utilities (~55%)

Table 2.

Unfortunately the data provided through Morningstar is not equivalent in time, with VDE being updated March 31 and ICLN on April 24. This is important to keep in mind throughout the following analysis. The price/earnings (p/e) ratio, a measure of price per dollar of earnings, is a common market measure when attempting to quickly gauge the value of an equity. To make accurate conclusions it is best for most financial ratios to be compared to competitors and/or the industry average. In this case, investors are paying more per dollar of earnings when investing in VDE over ICLN.

Differing from the p/e ratio, the price/book ratio (p/b) is a measure of the price per dollar of book value, which is calculated as assets minus liabilities. A value of 0.68x signifies that individuals are paying $0.68 per dollar of equity, potentially indicating the undervaluation of the fund or high stress, whereas investors are paying $1.52 per dollar of equity when investing in ICLN, depicting the fund as more valuable than the assets it holds. Unsurprisingly, the dividend yield of VDE is significantly greater than ICLN. This coincides with the greater market capitalization present in the VDE fund as larger, more mature organizations typically supplement company growth with a dividend payout. Both funds are considered energy based, however, VDE is concentrated in the energy sector whereas ICLN focuses on utilities. This is due to the prominence of electricity generation in the renewable sub-sector, such as hydroelectricity, solar electricity, and wind electricity. Energy sources such as oil and natural gas are utilized for much more than electricity generation, including but not limited to gasoline, propane and plastics.

An excellent measure of current sub sector performance can be seen in the revenues these sub sectors generate. Revenue is an appropriate measure of demand, as high revenues typically illustrate greater demand. Below, Table 3 summarizes the various sub sector revenues and previous-year consumption.[37]

Energy Revenues w/ Previous Year Consumption		
Fossil Fuel	**2019 Revenue($m)**	**2018 Consumption**
Oil Drilling and Gas Extraction	$368,942	67.0%
Coal	$24,546	13.0%
Renewable Energy		
Biomass	$908	4.95%
Hydroelectricity	$15,086	2.53%
Wind Power	$14,803	2.42%
Solar Power	$9,513	0.88%
Geothermal Electricity	$1,095	0.22%
Nuclear Electric Power	$37,362	8.00%

Table 3.

It is important to note that Table 3 compares 2019 revenues to 2018 consumption; this is because consumption data for 2018 is readily available. Nuclear electric power is not considered renewable, but it has been placed with the renewable sub sector for simplicity. Biomass was the highest consumed renewable energy resource in 2018, yet industry revenues were the smallest of all renewable energy sources. This illustrates the idea that biomass has the lowest revenues per percent consumption of the presented renewable sources, whereas solar energy has the highest, with roughly $10,810 million in revenue per 1% consumed. Behind each energy source submarket lies public sentiment and this can either boost the market or collapse it.

Sentiment Analysis

All graphics and calculations in the following section were created in R programming through the use of ggplot2 and various Tidy packages. Accurately defined, "Sentiment analysis is the most common text classification tool that analyzes an incoming message and tells whether the underlying sentiment is positive, negative, or neutral" (Gupat, 2018, paras 4).[87] This sentiment analysis will be done through a Twitter Application Programming Interface (API), allowing access to large quantities of data revolving around the energy industry. For example, regarding tweets focused on "#Oil," time of publication, source device, retweet count, location of publication, and language can all be determined. However, the focus of this analysis will be on the tweets themselves and how the platform currently views the energy industry. This is done through identifying keywords found in the binary bing lexicon such as: abnormal, issue, clean, recovery, and stress. It is important to recall that not all keywords contain significant value for this analysis.

To begin, an analysis was done of "#Energy" and prominent keywords were identified. Found in the supporting documentation, the chart "Analysis of 9,961 Tweets Containing '#Energy'" (Figure 11) presents the 30 most prominent bing lexicons divided into two equal factions of positive and negative.

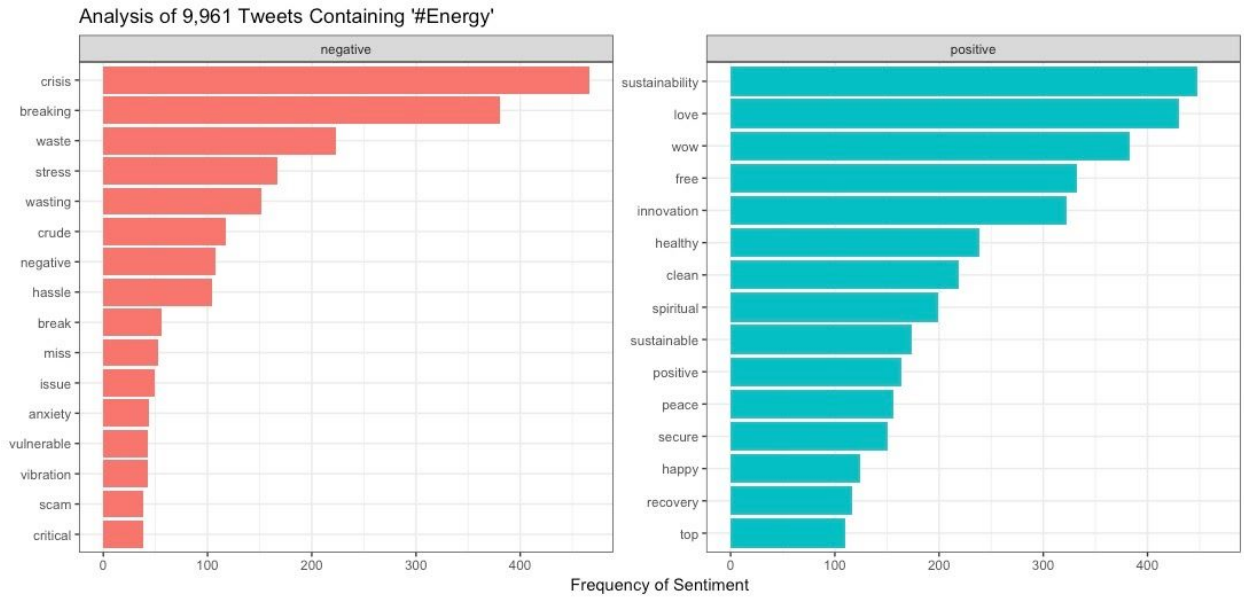

Figure 11.

Significant negative sentiments include: crisis (n = 461), breaking (n = 375), negative (n = 107), crude (n = 119), and anxiety (n = 42), where *n* represents the number of occurrences. These lexicons have independent reasons for being more common than others. Take "crisis," for example, currently the United States' and much of the world is experiencing a global pandemic, COVID-19. However, there is also a lot happening in the oil market right now that might prompt the same reaction.

Seen in the previously mentioned negative sentiment list, the word "crude" has 119 references. When a similar analysis is performed on the key "#Oil" the results are particularly negative, this was expected due to recent turmoil in the oil markets. Impactful results in the chart "Analysis of 9,629 Tweets Containing '#Oil'" (Figure 12) include the following lexicons: negative (n = 435), losses (n = 249), risk (n = 239), crisis (n = 178), damage (n = 176), crash (n = 160), horrible (n = 157), collapse (n = 152), volatility (n = 119), and glut (n = 95).

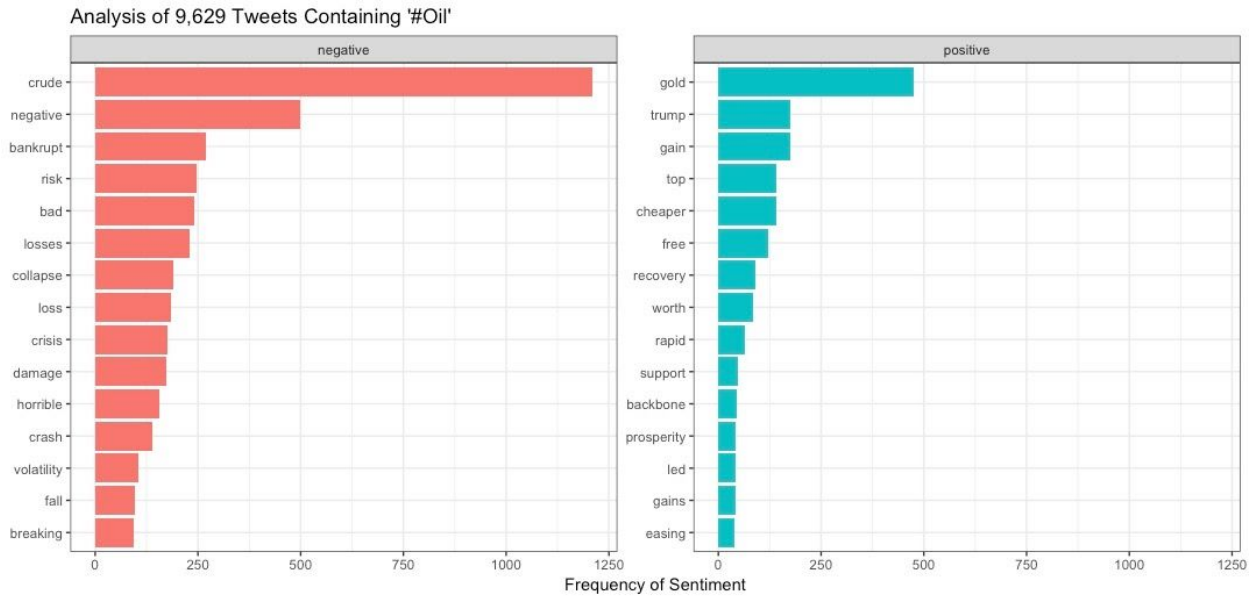

Figure 12.

Thus it can be seen that a portion of the "crisis" keywords found in the "#Energy" analysis are likely related to the oil market. Additionally, the lexicons prominent in this analysis are relevant and illustrate a worrying picture of current market conditions. The oil market is dependent on many variables, one of those being the performance of the market as a whole.

Conclusion

From exploring common energy sources to an industry sentiment analysis, the goal of this paper is to give readers an introduction to the energy industry. Various sources for more information include: the Department of Energy, the International Energy Agency, the Energy Information Administration, the Solar Energy Industry Association, and the American Petroleum Institute. Through this research it is apparent that wind and solar energy have excellent potential for electricity generation, oftentimes being cheaper than conventional energy sources. However, fossil fuel production is likely to increase over the next decade, especially with increasing coal usage in developing countries.

The energy industry, presented as it is today, is highly cyclical. Through the sentiment analysis it can be seen that the oil market is in bad shape, with lexicons such as “bankrupt,” “crash,” and “crisis,” being prominent. Due to the oil glut, organizations have begun to cut supply in an attempt to raise prices once more, enforcing the cyclical cycle. Finding a suitable alternative to fossil fuels will take a significant amount of time, if it is even possible. Products such as oil, found in soap, roofing, and even yarn, are likely to remain a vital component of the industry even as renewables become prominent. Examining current legislature illustrates support for both renewables and conventional energy sources. However, subsidizing fossil fuels to the extent of roughly $20 billion per year does not support a shift to sustainable energy. These subsidies are not surprising given the $125 million spent on lobbying in the previous year. Even with these lobbying budgets, as renewable energy becomes more cost-effective energy organizations will begin shifting to a sustainable business model.

References

[1]U.S. Department of Commerce. (n.d.) *Energy industry spotlight: the energy industry in the United States*. Selectusa. https://www.selectusa.gov/energy-industry-united-states

[2]U.S. Energy Information Administration. (2019, December 6). *Natural gas explained.* https://www.eia.gov/energyexplained/natural-gas/

[3]U.S. Energy Information Administration. (2019, January 24). *Annual energy outlook 2019 with projections to 2050*. https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf

[4]Beltramo, M., Manne, A., & Weyant, J. (1986, July). *A north american gas trade model (GTM)*. *The Energy Journal, 7*(3), 15-32. Retrieved May 2, 2020, from www.jstor.org/stable/41322329

[5]U.S. Energy Information Administration. (2020, April 7). *Short-term energy outlook*. https://www.eia.gov/outlooks/steo/report/natgas.php

[6]American Petroleum Institute. (n.d.) *Understanding natural gas markets*. https://www.api.org/~/media/Files/Oil-and-Natural-Gas/Natural-Gas-primer/Understanding-Natural-Gas-Markets-Primer-High.pdf

[7]McKinsey & Company. (2019, June). *North american gas outlook to 2030*. https://www.mckinsey.com/industries/oil-and-gas/our-insights/north-american-gas-outlook-to-2030

[8]U.S. Energy Information Administration. (2020, January 15). *EIA expects lower natural gas prices in 2020 as production outpaces demand*. https://www.eia.gov/todayinenergy/detail.php?id=42496

[9]U.S. Energy Information Administration. (2019, May 23). *Oil: crude and petroleum products explained*. https://www.eia.gov/energyexplained/oil-and-petroleum-products/

[10]U.S. Energy Information Administration. (2020, April 27). *Oil: crude and petroleum products explained | oil imports and exports*. https://www.eia.gov/energyexplained/oil-and-petroleum-products/imports-and-exports.php

[11]U.S. Energy Information Administration. (n.d.) *Energy and financial markets: what drives crude oil prices?* https://www.eia.gov/finance/markets/crudeoil/financial_markets.php

[12]U.S. Energy Information Administration. (n.d.) *Energy and financial markets: what drives crude oil prices: demand non-OECD*. https://www.eia.gov/finance/markets/crudeoil/demand-nonoecd.php

[13]OilScams. (n.d.) *Oil basins in the U.S.* http://www.oilscams.org/us-oil-basins-investing

[14]OilScams. (n.d.) *Everyday products that use oil*. http://www.oilscams.org/everyday-products-use-oil

[15]U.S. Energy Information Administration. (2020, January 29). *Annual energy outlook 2020 with projections to 2050*. https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Full%20Report.pdf

[16]U.S. Energy Information Administration. (2020, April). *Short-term energy outlook*. https://www.eia.gov/outlooks/steo/pdf/steo_full.pdf

[17]International Energy Association. (2020, March 27). *Oil*. https://www.iea.org/fuels-and-technologies/oil

[18]International Energy Association. (2020, February). *Oil market report - february 2020*. https://www.iea.org/reports/oil-market-report-february-2020

[19]International Maritime Organization. (n.d.) *Sulphur 2020 - cutting sulphur oxide emissions*. http://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx

[20]U.S. Energy Information Administration. (2020, April). *Short-term energy outlook*. https://www.eia.gov/outlooks/steo/pdf/steo_full.pdf

[21]Wagner, I. (2020, January 9). *Relation price of gasoline in the United States 1990-2019*. Statista. https://www.statista.com/statistics/204740/retail-price-of-gasoline-in-the-united-states-since-1990/

[22]Blas, Javier. (2020, April 26). *The next chapter of the oil crisis: the industry shuts down*. Bloomberg. https://www.bloomberg.com/news/articles/2020-04-26/the-next-chapter-of-the-oil-crisis-the-industry-shuts-down

[23]Northam, Jackie. (2020, April 27). *Dozens of oil tankers wait off california's coast as the pandemic dents demand*. NPR. https://www.npr.org/sections/coronavirus-live-updates/2020/04/27/845921122/dozens-of-oil-tankers-wait-off-californias-coast-as-the-pandemic-dents-demand

[24]Holcomb, A. (2020, April 21). *What the hell is going on in the oil market?* Youtube. https://www.youtube.com/watch?time_continue=768&v=T3rz9c-jXCw&feature=emb_title

[25]U.S. Energy Information Administration. (2019, October 11). *Coal explained*. https://www.eia.gov/energyexplained/coal/

[26]Afework, B, et al. (2020, April 28). *Power plant - energy education*. EnergyEducation. https://energyeducation.ca/encyclopedia/Power_plant

[27]U.S. Energy Information Administration. (2020, April). *April 2020 monthly energy review*. https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf

[28]U.S. Energy Information Administration. (2019, October 17). *North carolina - state profile and energy estimates*. https://www.eia.gov/state/analysis.php?sid=NC

[29]U.S. Energy Information Administration. (2019, November 13). *Coal explained: where our coal comes from*. https://www.eia.gov/energyexplained/coal/where-our-coal-comes-from.php

[30]Garside, M. (2020, March 2). *Leading U.S. states in coal-mining jobs 2009-2018*. Statista. https://www.statista.com/statistics/208329/leading-us-states-in-coal-mining-jobs/

[31]U.S. Energy Information Administration. (2019, October). *Annual coal report 2018*. https://www.eia.gov/coal/annual/pdf/acr.pdf

[32]Henry T. (2020, March). *Coal mining in the U.S.* IBISWorld. https://my-ibisworld-com.proxy006.nclive.org/us/en/industry/21211/about

[33]National Geographic. (2012, November 19). *Biomass energy*. https://www.nationalgeographic.org/encyclopedia/biomass-energy/

[34]U.S. Energy Information Administration. (2018, June 21). *Biomass explained*. https://www.eia.gov/energyexplained/biomass/

[35]Biomass Energy Resource Center. (2009, August 14). *Biomass energy: efficiency, scale, and sustainability*. https://www.biomasscenter.org/policy-statements/FSE-Policy.pdf

[36]Nuclear Information and Resource Service. (n.d.) *Factoid #1 - biomass could provide 15% of U.S. energy demand by 2030*. https://www.nirs.org/alternatives-nuclear/factoid1/

[37]U.S. Energy Information Administration. (2019, August 28). *U.S. energy facts explained.* https://www.eia.gov/energyexplained/us-energy-facts/

[38]U.S. Energy Information Administration. (2017, November 27). *Biomass and waste fuels made up 2% of total U.S. electricity generation in 2016*. https://www.eia.gov/todayinenergy/detail.php?id=33872

[39]Whole Building Design Guide. (2016, September 15). *Biomass for electricity generation*. https://www.wbdg.org/resources/biomass-electricity-generation

[40]Moses, J. (2019, August). *Biomass power*. IBISWorld. https://my-ibisworld-com.proxy006.nclive.org/us/en/industry-specialized/od4497/about

[41]National Geographic. (2019, May 31). *Hydroelectric energy*. https://www.nationalgeographic.org/encyclopedia/hydroelectric-energy/

[42]U.S. Department of the Interior. (n.d.) *Grand coulee dam statistics and facts*. Bureau of Reclamation. https://www.usbr.gov/pn/grandcoulee/pubs/factsheet.pdf

[43]U.S. Energy Information Administration. (2020, March 30). *Hydropower explained: where hydropower is generated*. https://www.eia.gov/energyexplained/hydropower/where-hydropower-is-generated.php

[44]U.S. Department of Energy. (n.d.) *Hydropower resource assessment and characterization*. https://www.energy.gov/eere/water/hydropower-resource-assessment-and-characterization

[45]U.S. Department of Energy. (n.d.) *U.S. hydropower market report 2018 update (april)*. https://www.energy.gov/sites/prod/files/2019/05/f62/2018-updates-hydropower-market-report.pdf

[46]Patel, K. (2019, September). *Hydroelectric power in the U.S.* IBISWorld. https://my-ibisworld-com.proxy006.nclive.org/us/en/industry/22111c/about

[47]Open Energy Information. (n.d.) *Wind energy*. https://openei.org/wiki/Wind_energy

[48]U.S. Department of Energy. (n.d.) *WINDExchange*. https://windexchange.energy.gov/

[49]American Wind Energy Association. (2019, January 19). *Consumer demand drives record year*

for wind energy purchases. https://www.awea.org/resources/news/2019/consumer-demand-drives-record-year-for-wind-energy

[50]U.S. Department of Energy. (2015, March 12). *Wind vision*. https://www.energy.gov/eere/wind/wind-vision

[51]Patel, K. (2020, April). *Wind power in the U.S.* IBISWorld. https://my-ibisworld-com.proxy006.nclive.org/us/en/industry/22111d/about

[52]U.S. Energy Information Administration. (2019, December 4). *Solar explained*. https://www.eia.gov/energyexplained/solar/

[53]Solar Energy Industry Association. (n.d.) *Solar industry research data*. https://www.seia.org/solar-industry-research-data

[54]Pradhan, S. (2020, April). *Solar power in the U.S.* IBISWorld. https://my-ibisworld-com.proxy006.nclive.org/us/en/industry/22111e/about

[55]U.S. Energy Information Administration. (2019, December 5). *Geothermal explained*. https://www.eia.gov/energyexplained/geothermal/

[56]U.S. Department of Energy. (n.d.) *Geothermal basics*. https://www.energy.gov/eere/geothermal/geothermal-basics

[57]U.S. Department of Energy. (2018, February 14). *5 things to know about geothermal power*. https://www.energy.gov/eere/articles/5-things-know-about-geothermal-power

[58]U.S. Department of Energy. (2015, April 9). *EERE success story - DOE and calpine corporation tap geothermal energy from abandoned steam wells*. https://www.energy.gov/eere/success-stories/articles/eere-success-story-doe-and-calpine-corporation-tap-geothermal-energy

[59]Sanders IV, S. (2019, February). *Geothermal plant electricity operation*. IBISWorld. https://my-ibisworld-com.proxy006.nclive.org/us/en/industry-specialized/od4507/about

[60]Nuclear Energy Institute. (n.d.) *What is nuclear energy?* https://www.nei.org/fundamentals/what-is-nuclear-energy

[61]U.S. Energy Information Administration. (2019, December 30). *Frequently asked questions: how many nuclear power plants are in the United States, and where are they located?* https://www.eia.gov/tools/faqs/faq.php?id=207&t=21

[62]U.S. Energy Information Administration. (2019, October 7). *Five states have implemented programs to assist nuclear power plants*. https://www.eia.gov/todayinenergy/detail.php?id=41534

[63]U.S. Department of Energy. (2019, March). *Vogtle*. https://www.energy.gov/lpo/vogtle

[64]World Nuclear Association. (2020, March). *Economics of nuclear power*. https://www.world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx

[65]U.S. Energy Information Administration. (2020, March 16). *OPEC shift to maintain market share will cause global inventory increases and lower prices*. https://www.eia.gov/todayinenergy/detail.php?id=43175

[66]U.S. Energy Information Administration. (2020, January 29). *Annual energy outlook 2020 with projections to 2050*. https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Full%20Report.pdf

[67]U.S. Energy Information Administration. (2020, April 29). *This week in petroleum*. https://www.eia.gov/petroleum/weekly/crude.php

[68]Deloitte. (n.d.) *2020 renewable energy industry outlook*. https://www2.deloitte.com/content

/dam/Deloitte/us/Documents/energy-resources/us-2020-renewable
-energy-industry-outlook.pdf

[69]U.S. Department of Energy. (n.d.) *Levelized cost of energy (LCOE)*. https://www.energy.gov/sites/prod/files/2015/08/f25/LCOE.pdf

[70]Clean Energy Authority. (2010, May 4). *What is a megawatt and a megawatt-hour?* https://www.cleanenergyauthority.com/solar-energy-resources
/what-is-a-megawatt-and-a-megawatt-hour

[71]Lazard. (2019, November 7). *Levelized cost of energy and levelized cost of storage 2019*. https://www.lazard.com/perspective/lcoe2019

[72]U.S. Energy Information Administration. (2020, April 1). *Frequently asked question: what countries are the top producers and consumers of oil*. https://www.eia.gov/tools/
faqs/faq.php?id=709&t=6

[73]U.S. Energy Information Administration. (2020, April 27). *U.S. energy facts explained: imports and exports*. https://www.eia.gov/energyexplained/us-energy-facts
/imports-and-exports.php

[74]Elsevier Science. (2019). *Energy efficiency: concepts and calculations.* WorldCat. https://www.worldcat.org/title/energy-efficiency-concepts-and-
calculations/oclc/1101100611/viewport

[75]U.S. Energy Information Administration. (2013, March 1). *U.S. energy intensity projected to continue its steady decline through 2040*. https://www.eia.gov/
todayinenergy/detail.php?id=10191

[76]Enerdata. (n.d.) *Global energy statistical yearbook 2019*. https://yearbook.enerdata.net/

[77]National Conference of State Legislatures. (2020, March 3). *2019 legislative energy trends.* https://www.ncsl.org/research/energy/2019-legislative-energy-trends.aspx

[78]National Association of State Energy Officials. (n.d.) *2020 U.S. energy and employment report*. USEnergyJobs. https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5e78b3c756e8367abbd47ab0/1584968660321/USEER+2020+0323.pdf

[79]OpenSecrets. (2020, April 22). *Industries*. https://www.opensecrets.org/federal-lobbying/industries

[80]Environmental and Energy Study Institute. (2019, July 29). *Fact sheet: fossil fuel subsidies: a closer look at tax breaks and societal costs*. https://www.eesi.org/papers/view/fact-sheet-fossil-fuel-subsidies-a-closer-look-at-tax-breaks-and-societal-costs

[81]Investopedia. (2020, March 16). *Exchange-traded fund - ETF*. https://www.investopedia.com/terms/e/etf.asp

[82]Vanguard. (2020, March 31). *Vanguard energy etf (VDE)*. https://investor.vanguard.com/etf/profile/overview/vde

[83]Blackrock. (2020, April 30). *iShares global clean energy etf*. iShares. https://www.ishares.com/us/products/239738/ishares-global-clean-energy-etf

[84]MSCI. (2020, March 31). *MSCI US IMI Energy 25/50 Index (USD)*. https://www.msci.com/documents/10199/40a8f0d0-44ab-41bf-b76b-4fa21fa9bd14

[85]MorningStar. (2020, March 31). *Vanguard energy etf*. https://www.morningstar.com/etfs/arcx/vde/quote

[86]MorningStar. (n.d.) *iShares global clean energy etf (ICLN)*. https://www.morningstar.com/etfs/xnas/icln/quote

[87]Gupta, S. (2018, January 7). *Sentiment analysis: concept, analysis, and applications*. Towarddatascience. https://towardsdatascience.com/sentiment-analysis-concept-analysis-and-applications-6c94d6f58c17