



I. Overview

The energy industry is quickly changing, driven by increases in demand from emerging markets, rapidly developing technologies, and the depletion of traditional fossil fuel resources. Over the 19th and 20th centuries, coal and oil played critical roles in pushing Western countries into their modern developed forms. As of 2018, almost all growth in energy demand is expected to come from developing countries, while North American and European countries are expected to shift their energy demand towards renewable sources, notably solar, hydro, wind, nuclear, and tidal power. These non-fossil fuels are expected to account for approximately half of energy growth over the next 20 years.

The following document has been written to provide our analysts, case team leaders, and managing directors with a basic overview of the energy industry in the United States. It is by no means complete and should be used only to frame existing, case-specific research.

II. Energy Basics

The United States power infrastructure consists of three main grids or “interconnections”—the Eastern, the Western, and the Texas interconnections. Nationally, in 2016, energy consumption by sector was as follows: Electric power, 39%; Transportation, 29%; Industrial, 22%; Residential, 6%; Commercial, 4%. Energy sources can generally be broken down into two different types—non-renewable and renewable sources. The rest of this section will highlight some of the basics of the main non-renewable and renewable energy sources.

A. Oil

Oil, a non-renewable “fossil fuel,” currently accounts for approximately 37% of the US’s annual energy consumption and 33% of global energy consumption. Oil/gasoline is the primary fuel source for vehicles but is on the decline in the United States, due to a wariness of foreign dependence and because of the rise of electric vehicle technologies. Oil can be transported relatively easily, using pipelines, boats, trucks, and trains, and can produce electricity on demand, using power plants which burn it to create steam power.

B. Gas

Gas, a non-renewable “fossil fuel,” currently accounts for approximately 29% of the US’s annual energy consumption and 24% of global energy consumption. Natural Gas is used for cooking, energy production, and heating. It is relatively difficult to transport, due to its natural gas form, and therefore has to be transformed into liquid form (LNG). It is often thought to be “cleaner” than crude oil and coal. The USA has large deposits of shale, from which Natural Gas can be extracted, with fracking, which, while effective, can be environmentally-damaging.

C. Coal

Coal, a non-renewable “fossil fuel,” currently accounts for approximately 15% of the US’s annual energy consumption and 29% of global energy consumption. Coal is the “dirtiest” of the fossil fuels because its burning emits high levels of CO₂ and other chemicals like sulfur, and its usage has been greatly reduced in North America in recent decades due to cheap natural gas and solar, and government regulations. China currently is by far the world’s largest consumer of coal.



D. Solar

Solar power is a renewable energy source that currently accounts for approximately 0.6% of the US's annual energy consumption and 0.45% of global energy consumption. Solar power is generated through either chemical photovoltaic cells, which can vary greatly in size and are used in both residential and commercial settings, and concentrated solar power, which is only used at a commercial level due to space requirements. The US has several large solar manufacturers, but without more large-scale energy storage solutions, the industry is held back.

E. Hydro

Hydro power is a renewable energy source that currently accounts for approximately 2.4% of the US's annual energy consumption and 6.8% of global energy consumption. Hydro power is currently the largest source of renewable energy in the US, harnessing the power of gravity and falling water to spin giant turbines to produce electricity. America currently has many effective dams, but a large number of them are of the New Deal era and need to be replaced, a process projected to be very expensive and time consuming.

F. Wind

Wind power is a renewable energy source that currently accounts for approximately 2.1% of the US's annual energy consumption and 1.4% of global energy consumption. Like solar power, wind power cleanly harnesses a naturally occurring phenomenon to generate electricity, but is constrained by natural climatic conditions. Wind farms take up a lot of space and have been criticized for their noise and obstructive appearance. The American coasts and the Midwest region are currently the areas of greatest opportunity for wind power.

G. Nuclear

Nuclear power currently accounts for approximately 9% of the US's annual energy consumption and 4.4% of global energy consumption. Nuclear energy is "clean" in that its production does not generate significant carbon dioxide emissions. However, it does however generate significant hazardous waste, with no known permanent method of waste-storage, and several high-profile deadly nuclear disasters, such as Chernobyl and Fukushima, have led some governments to shut down nuclear production. The United States is currently the largest producer of nuclear power, accounting for 30% of global production, with 99 nuclear reactors nationally. However, new reactors are greatly expensive and are often deemed cost-ineffective. Research into thorium-based reactors may bring new hope to the industry, but the technology is still several years away.

H. Tidal

Tidal power is the most recently developed renewable energy technology and currently makes up a negligible percentage of global energy production. Only 0.5 GW of power generation capacity is currently in operation internationally, though it is slowly on the rise. The technology is still in a fledgling state and thus has high costs, but some scientists predict that the total theoretical wave energy potential is a staggering 32 PWh/y.

One of the current issues with renewable energy sources is that they tend to generate power inconsistently or only at certain times of day. Unlike fossil fuels, which can pump power into the energy grid on demand, these sources often require batteries to store the energy for when it can



be most efficiently used. Battery technologies are rapidly developing and are being integrated into electric vehicles (EVs) and, slowly, power grids. This should help with the adoption of renewables over time. Technological innovations by groups like Tesla could provide a much-needed impetus, as evidenced by their projects in Arizona, Hawaii, and Australia.

III. Key Players

Major non-renewable energy producers (mostly oil and gas companies) fill numerous spots on the Fortune 500 list, including Exxon Mobil, Chevron, Valero Energy, and Conoco Phillips. The four largest companies by revenue are from Saudi Arabia and China—Saudi Aramco, Sinopec, China National Petroleum Corporation, and PetroChina. China's giant push into the industry has bolstered the country's clout worldwide and has further put the United States in an awkward competitive position. Even as the United States transitions to an increasingly energy-independent economy, 40% of the nation's oil still comes from competitive markets abroad. Canada currently supplements the country's overseas oil with gasoline and natural gas from its Alberta Oil Fields.

Renewable energy producers tend to be even more specialized than fossil fuel companies, focusing on specific technologies and sources. Major companies include Canadian Solar Inc, First Solar Inc, Risen Energy Co, Vestas Wind, Verengo Solar, SolarCity, Sungevity, Sunpower, Sunrun, RGS Energy, Petersen Dean, General Electric, Siemens, and NextEra Energy. While the United States lags behind other countries in its clean energy production, it has no shortage of companies with stakes in the industry. In coming years, these companies will be threatened by rapidly expanding companies based in Asia and Europe.

IV. Market Trends

As all people and companies consume energy, the energy industry is in the unique position of affecting all aspects of industry and life. In this way, the energy market is robust, but as demand for different sources of power change with consumer and company sentiments and new technologies, the market is always slowly shifting.

On the non-renewable side of the global energy equation, Natural Gas is expected to grow faster than Oil and Coal, driven by vast shale deposits in the United States. As for renewables, they are generally seen to be on the rise as costs decrease. In the coming months and years, professional market analysts suggest that three key trends will drive the market. First, as already highlighted, renewables will continue to increase their marketshare, aided by the Supreme Court's (SCOTUS) acceptance of the Clean Power Plan, SCOTUS's ruling on FERC Order 745, and New York's massive \$5 billion Clean Energy Fund in 2016. Second, digital demands and innovations will disrupt the market, as smart metering increases in ubiquity and consumers have more control over where their electricity is coming from. Finally, uncertain political developments in the country cast doubt on the whole industry, as legislation that promotes renewable energy and regulates fossil fuel production has been weakened.

V. CBE's Role



At Harvard Undergraduate CBE, we are committed to helping the energy economy shift further towards clean, renewable energy. In the past, we have worked with numerous players in the industry, including 24M, a battery technology company based in Cambridge, MA, and CleanChoice Energy, a clean energy provider based in Washington, DC. As an organization, while we favor cases involving renewable energy/technology companies, we also consider working with other energy companies, so long as they are making an attempt to decrease their environmental impact and improve their clean energy divisions. We recognize that the shift to clean energy will not be as simple as stopping drawing upon fossil fuels and therefore are open to working with any related companies to improve their technologies and business models in an effort to make our economy, country, and world more sustainable.

VI. References

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