



MODULE 1

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MODULE 1

The Energy Industry

- **Energy Industry Foundations and Improvements**
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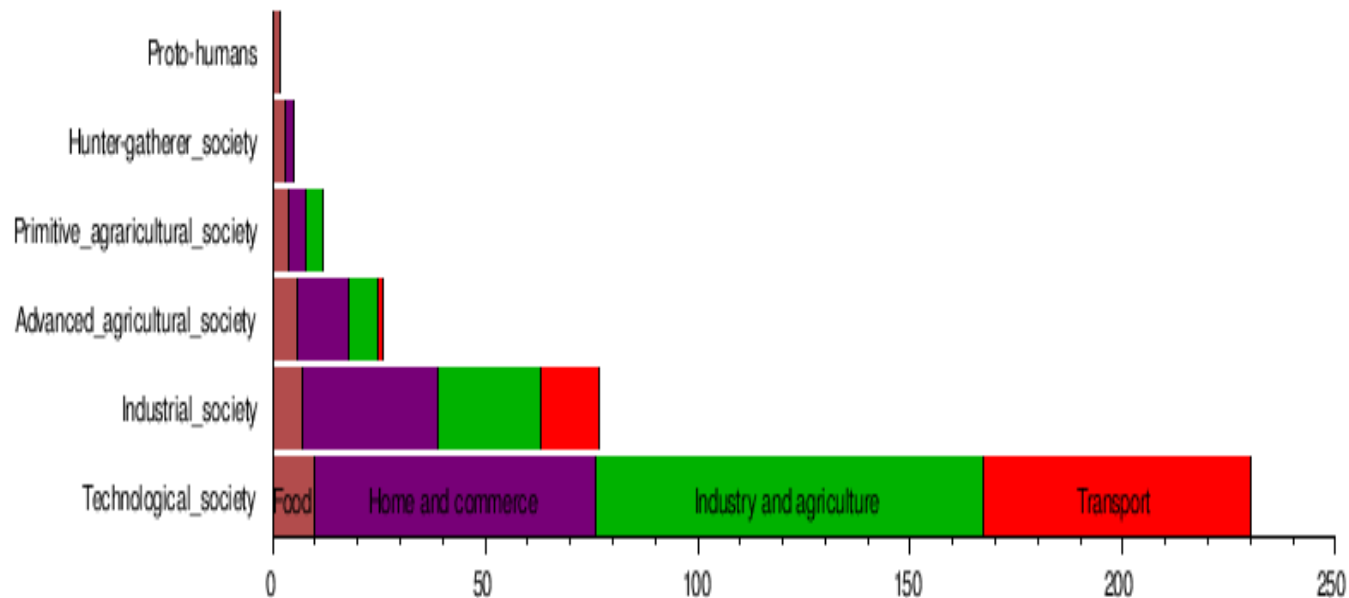
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Foundations of the Energy Industry

History

Energy consumption has played a significant role in the evolution of human civilisation by enabling environmental control and adaptation. In any functioning civilization, energy management is a need. Energy resource development is now crucial for the industrialised world's agriculture, transportation, trash collection, information technology, and communications, which are now necessities for a developed civilization. Since the Industrial Revolution, there have also been a rising number of major issues related to the usage of energy, some of which, like global warming, might pose serious hazards to the entire planet. Because a sizeable percentage of the energy included in these resources may be easily removed to serve a beneficial purpose, the word energy is sometimes used interchangeably with energy resources, which refer to things like fuels, petroleum products, and electricity in general. The overall energy is preserved after a helpful process, but the resource itself is not conserved because a process often converts the energy into useless forms (such unnecessary or excess heat).

Since the human race discovered the many energy sources present in nature, it has been creating machines—devices that use energy sources to improve the quality of life. The use of energy for cooking has expanded significantly with the advent of appliances like gas burners and microwave ovens, even though prehistoric man was aware of the value of fire for this purpose. The tendency is the same in every other area of social endeavour, whether it be the development of public infrastructure, the production of materials for covering, porting, printing, and decorating, such as textiles, air conditioning, information transmission, or the transportation of people and products (automobiles).



The Energy Sector: What Is It?

A group of businesses in the field of energy supply and production make up the energy industry. The firms that explore, produce, refine, sell, store, and transport oil and gas, coal, and other consumable fuels are included in the energy sector, according to the Global Industry Classification Standard (GICS). The energy sector also includes businesses that provide equipment for the oil and gas industry.

The extraction, manufacture, refining, and distribution of fuels are all included in the definition of the energy industry, which encompasses all businesses engaged in the production and sale of energy. Modern society consumes a lot of fuel, and nearly every nation's energy sector plays a critical role in supporting the infrastructure and upkeep of society.

The energy sector includes the following in particular: The coal industries (extraction and processing), the natural gas industries (natural gas extraction, coal gas manufacture, as well as distribution and sales), and the electrical power sector, which includes electricity generation, electric power distribution and sales, as well as the nuclear power sector; the fossil fuel industries, which include petroleum industries (oil companies, petroleum refiners, fuel transport, and end-user sales at gas stations); the traditional energy industry based on the collection and distribution of firewood, which is used, in particular, for cooking and heating in poorer countries. The renewable energy industry is made up of alternative energy and sustainable energy companies, including those involved in hydroelectric power, wind power, solar power generation, and the manufacture, distribution, and sale of alternative fuels.

Because of the 20th century's growing reliance on carbon-emitting energy sources like fossil fuels and carbon-emitting renewables like biomass, the energy sector has frequently played a significant role in the economy's effects on pollution and the environment. Fossil fuels, which up until recently were used to provide the majority of the world's energy, are a significant source of pollution and global warming. A large number of economies are making investments in renewable and sustainable energy as part of the human adaptation to global warming.

Introduction to the Energy Sector

The energy industry is made up of a sizable collection of businesses with strong connections and a broad range of energy products. The following are the two main categories of energy:

One type of energy is non-renewable and includes nuclear power, oil and petroleum products, gasoline, natural gas, and diesel fuel.

The other is renewable energy, which includes wind, solar, and hydropower.

Energy-related enterprises invest a lot of capital and have a lot of fixed assets. These resources include land used for oil reserves, factories and machinery for processing crude oil and unprocessed natural gas, and infrastructure or transportation. Energy corporations invest a lot of money in Research & Development (R&D) to upgrade drilling and processing technologies, increase efficiency, and adjust to shifting environmental regulations.

Energy Sector Components: The Global Industry Classification Standard (GICS®) splits the energy sector further into the oil, gas, and consumable fuels business, as well as the energy equipment & services industry.

Industry for Energy Equipment & Services

Oil and gas drilling contractors, manufacturers of drilling equipment, and companies that offer services associated with the drilling and completion of oil or gas wells make up the energy equipment & services industry. A few of the participants in the US energy equipment & services market include Helmerich & Payne, Inc., Unit Corporation, and Exterran Corp.

Industry for oil, gas, and consumable fuels

Upstream, middle, and downstream companies in the oil and gas sector can all be grouped. They are in various places along the supply chain.

The upstream businesses scout out possible natural gas and crude oil reserves. Through the drilling and operation of wells, they also utilise these energy resources. In the upstream, mergers, acquisitions, and divestitures occur often.

The midstream offers oil, gas, and petroleum product storage, transportation, and wholesale marketing. Companies that provide transportation services include pipeline transporters, barge transporters, train transporters, and other logistics firms.

Activities related to post-production are done downstream. The downstream businesses refine crude oil and unprocessed natural gas to produce consumable fuels like jet fuel, diesel, and gasoline. Additionally, they sell derivative goods including waxes, lubricants, and a variety of other petrochemicals. It's common to think of the midstream as being downstream.

Natural Gas

Natural gas is a colourless, extremely flammable gaseous hydrocarbon that is mostly composed of methane and ethane. It is also known as methane gas or natural methane gas. It is a kind of petroleum that frequently coexists with crude oil. Natural gas is a fossil fuel that is used to produce power, heat homes, fuel some vehicles, and for cooking. In addition to being required for a vast array of other chemical products, such as fertilisers and dyes, it is significant as a chemical feedstock in the production of plastics.

At the high pressures present in a reservoir, natural gas is frequently discovered dissolved in oil. It can also be found as a gas cap atop the oil. The natural gas pressure that is applied to the underground oil reservoir frequently acts as the force that propels oil to the surface. Known as "associate gas," this type of natural gas frequently consists of light liquids like propane and butane and is frequently seen as the gaseous phase of crude oil. Because of this, related gas is occasionally referred to as "wet gas." There are reserves with just gas and none with oil. It is known as non-associated gas. Dry gas, also known as non-associated gas, is produced by reservoirs that are not associated with any known source of liquid petroleum.

More than half of what we produce is natural gas. Gas is in greater demand on a global scale. We anticipate it to rise from its 2014 level by 40% by 2030.

What exactly is natural gas used for?

Natural gas is the least harmful, colourless, odourless, and low-carbon hydrocarbon. It warms food for cooking and heating, and it fuels power plants that supply homes and businesses with energy.

It serves as a fuel for several industrial processes that create anything from glass to textiles, and it is a key component of items like paints and plastics.

Gas-to-liquids facilities transform gas into fuels that burn more cleanly and other goods. Additionally, reduce it to $-162\text{ }^{\circ}\text{C}$ ($-260\text{ }^{\circ}\text{F}$), turning it into a liquid that is simple to transport to energy-starved regions of the world as an emission-reduced fuel for trains, buses, trucks, and ships.

Natural gas advantages

Gasoline is widely available. The International Energy Agency (IEA) calculates there are enough recoverable resources to last around 230 years if consumption stayed at current levels.

It is adaptable. Starting and stopping a gas-fired power plant is substantially faster than one that burns coal. Due to its flexibility, it complements renewable energy sources like solar and wind, which are only used when the sun is out and the wind is blowing. When used to produce power, gas is the cleanest-burning hydrocarbon, releasing about half as much carbon dioxide (CO₂) and just one-tenth as much air pollutants as coal. By switching to gas from coal, there is a significant opportunity to cut CO₂ emissions and air pollution shortly.

Because gas is now so widely accessible through LNG, it can assist nations in coping with short-term supply interruptions. Japan shut down its nuclear reactors in the wake of the Fukushima tragedy and depended heavily on LNG to replace a large portion of its lost electrical supply.

Sometimes, producing gas is less expensive than producing coal. According to the IEA, the most efficient coal-fired plant has investment costs of \$3,700 per kilowatt, while the most efficient gas-fired plant has expenses of \$1,100 per kilowatt. When long-term costs related to climate change and the effects of air pollution on people and the environment are taken into account, gas-fired electricity becomes once again competitive. A rising variety of other applications exist for gas, such as the use of LNG in transportation as a lower-emission substitute for diesel and heavy fuel oil.

Coal as an Energy Source



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A solid carbon-rich substance that is often brown or black and most frequently found in stratified sedimentary layers, coal is one of the most significant major fossil fuels.

When a substance is classified as coal, it must include more than 50% by weight (or 70% by volume) of carbonaceous matter, which is created when altered plant remnants, specifically peat deposits, are compacted and hardened. Different types of plant material (coal type), levels of

coalification (coal rank), and types of impurities result in different sorts of coal (coal grade). Although the majority of coals are found in stratified sedimentary deposits, these deposits are sometimes subjected to high temperatures and pressures as a result of igneous intrusions or deformation during the process of orogenesis, which is the process of creating mountains. This causes anthracite and even graphite to form.

When employing steam generation to produce electrical power, coal is a significant source of energy. Additionally, the gasification and liquefaction of coal result in the production of gaseous and liquid fuels that are appropriate for tank storage and easy transportation (e.g., through the pipeline).

Coal consumption peaked globally in 2012 following the enormous increase in coal use in the early 2000s, which was mostly fuelled by the expansion of China's economy. Since then, the usage of coal has steadily decreased, primarily being compensated by increases in the use of natural gas.

Electricity

Unlike coal, electricity cannot be extracted from the ground. Because it comes from main sources including coal, natural gas, nuclear fission processes, sunshine, wind, and hydropower, it is referred to as a secondary source of energy. The majority of basic energy's direct applications are restricted to producing heat and motion. In contrast, electricity is incredibly adaptable and has a variety of sophisticated uses. Modern American society depends so heavily on electricity that its supply and consumption are frequently studied independently from the fundamental sources that create it.



The secondary energy source is electricity.

The movement of electrical power or charge is known as electricity. A fundamental component of the natural world, electricity is also one of the most extensively utilised energy sources.

Because it is created by transforming main energy sources like coal, natural gas, nuclear energy, solar energy, and wind energy into electrical power, the electricity we consume is a secondary energy source. Electricity is also referred to as an energy carrier, which indicates that it can transform into other energy types like heat or mechanical energy. The primary energy sources are either renewable or non-renewable, but the power we consume is neither.

The usage of electricity has significantly altered daily living. Few people probably bother to consider how life might be without electricity, even though it is so essential to daily living. People often take electricity for granted, just as they do with oxygen and water. But people use energy for a variety of tasks every day, including lighting, heating, and cooling houses as well as running electronics like computers and televisions.

Around 100 years ago, before electricity was widely accessible, the light was given by candles, whale oil lamps, and kerosene lamps; food was kept cold by iceboxes, and the heat was produced by wood or coal stoves.

Since the 1600s, researchers have attempted to understand the fundamentals of electricity. We may thank Thomas Edison, Nikola Tesla, and Benjamin Franklin for making significant advances in our knowledge and application of electricity.

Franklin established the electrical nature of lightning. The first long-lasting incandescent light bulb was created by Thomas Edison.

Before 1879, arc lamps for outdoor illumination were powered by direct current (DC) electricity. Alternating current (AC) energy was invented by Nikola Tesla in the late 1800s, and it has since become more affordable to carry power across vast distances. Tesla's innovations made it possible to power industrial machinery and interior illumination in homes and industries.

Petroleum as an Energy Source

Fossil fuel is petroleum, sometimes referred to as crude oil. Petroleum was created from the remnants of extinct marine animals including plants, algae, and bacteria, just like coal and natural gas. These organic remnants (fossils) changed into carbon-rich substances we rely on as raw materials for fuel and a wide range of goods over millions of years of extreme heat and pressure. Although technically speaking, petroleum also refers to natural gas and the viscous or solid form known as bitumen, which is found in tar sands. The word is frequently limited to the liquid form, popularly known as crude oil. The most significant of the major fossil fuels is petroleum, which exists in its liquid and gaseous forms.

Because of their close ties to one another in nature, liquid and gaseous hydrocarbons are often referred to simply as "petroleum" instead of "petroleum and natural gas".

The German mineralogist Georg Bauer, also known as Georgius Agricola, wrote a paper that was published in 1556 and is frequently credited with being the first to use the term petroleum, which is literally "rock oil" from the Latin words *petra*, "rock" or "stone," and *oleum*, "oil." Evidence suggests that it may have started with the Persian scientist-philosopher Avicenna some five centuries before.

Large amounts of carbon dioxide (CO₂) are released into the atmosphere during the combustion of all fossil fuels, including coal and biomass. Much of the long-wave solar energy that is absorbed by the Earth's surface is prevented from reradiating from the surface and escaping into space by the CO₂ molecules.

The lower atmosphere stays warmer than it would otherwise be because the CO₂ absorbs upward-propagating infrared radiation and re-emits some of it downward. Because of this occurrence, Earth's natural greenhouse effect is amplified, leading to what scientists refer to as anthropogenic (human-caused) global warming. There is strong proof that rising CO₂ and other greenhouse gas concentrations have had a significant role in the rise in Earth's near-surface mean temperature since 1950. f ancient marine creatures like plants, algae, and bacteria. These organic remains (fossils) changed into carbon-rich substances we rely on as raw materials for fuel and a wide range of products over millions of years of extreme heat and pressure.

Modern-day significance of petroleum

The Industrial Revolution had advanced by the turn of the 20th century to the point where using refined oil for illuminants was no longer of fundamental importance. Due in significant part to the development of internal combustion engines, particularly those found in automobiles, the oil and gas industry rose to prominence as a major energy provider. Oil is a significant feedstock for petrochemicals, but its main value is as an energy source for the global economy.

It's difficult to overstate the importance of oil as a source of energy for the entire world. Unprecedented growth in energy output occurred during the 20th century, and rising oil production has been by far the main driver of that growth.

About 100 million barrels of oil per day were being transported from producers to consumers by the 21st century thanks to a massive and complex value chain. International relations are critically dependent on the production and consumption of oil, and foreign policy has frequently been decided by these factors. The place of a nation in this system is determined by its capability for production about its level of consumption. Oil reserves can sometimes make the difference between a wealthy and a poor nation. The availability or scarcity of oil has significant economic repercussions for every nation.

The use of oil as a major source of energy will only be a transient phenomenon lasting a few centuries on a timeline within the scope of potential human history. Even so, it would have been a matter of crucial significance for global industrialization.

Energy Market

Energy markets are regulated markets at the national and international levels that deal only with the supply and trade of energy. A government's creation of an energy policy that promotes the growth of the energy industry competitively is typically what leads to energy development.

Energy markets were characterised by monopoly-based organisational structures until the 1970s when they underwent substantial transformations. The Seven Sisters held a majority of the world's oil reserves. In 1973, things drastically changed as OPEC's dominance rose and the 1973 oil crisis' effects on the world's energy markets were felt.

Review of Energy Regulation and Markets in Nigeria

The petroleum industry, which produces the fuels used in energy production, as well as the business of supplying power, makes up Nigeria's energy sector. Hydropower and other renewable energy sources are additional sources of energy supply. Recent years have seen the development of several solar or natural gas-powered off-grid electric power plants.

Natural gas, which accounts for more than 80% of the electricity provided to the national grid, is heavily reliant on the electricity sector. Given its availability compared to other fuel sources in the nation, natural gas is anticipated to be an important fuel source in Nigeria's energy mix for many years to come.

The estimated 203 trillion cubic feet in known natural gas reserves in Nigeria show that the country is dedicated to using its vast gas reserves to spur industrial growth, as stated in the National Gas Policy.

The installed electric power generating capacity of Nigeria, which is at 12,000MW, is significantly less than what is required. As a result, a sizeable fraction of consumers uses alternative energy sources that are driven by petroleum-based goods like premium motor spirits and diesel. The businesses of natural gas and electricity will be the main topics of this chapter.

18 successor businesses that were unbundled from the state-owned vertically integrated utility as a result of the Electric Power Sector Reform Act of 2005 are market participants in the power sector (EPS).

On-grid and off-grid independent power producers, distributors, and mini-grid operators are among them. These include six generating companies (gencos), 11 distribution companies (discos), all of which have now been privatised, and one transmission company (which is still a state-owned organisation).

The main market players in the gas sector are the gas producers, which are made up of Nigerian independents and foreign oil firms. These firms either operate on a sole-risk basis or through contractual arrangements like petroleum joint ventures and production-sharing contracts (PSCs) with the Nigerian National Petroleum Corporation (NNPC), the country's state-owned oil firm. Local gas distribution businesses, gas marketers, and gas transporters all play significant roles in the industry.

The Nigeria Gas Company (NGC), an NNPC company that owns and runs the nation's primary gas transmission pipelines, and its marketing affiliate, the Nigerian Gas Marketing Company, stand out in this category (NGMC). The majority of gas distribution businesses work with the NGC under a franchising agreement. The numerous downstream gas utilisation firms, which include power generation companies and independent power producers, are among the other market participants (IPPs).

Separate regulators oversee the national markets for gas and electricity.

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