Coal's Importance to the World

STATEMENT OF ISSUE **February 2021**

Modern life is unimaginable without electricity. It lights houses, buildings, and streets; provides domestic and industrial heat; and powers most equipment and machinery used in homes, offices and factories.

Coal is the most abundant source of electricity worldwide, currently providing more than 36% of global electricity. Coal-fueled power plants account for nearly one-quarter of the electricity in the United States.

In the U.S., coal is a "home grown" energy source. U.S. mines account for virtually all of the coal used to provide electricity domestically. By contrast, other important energy sources, including nuclear and renewable energy, are heavily reliant on imported minerals to fuel nuclear reactors or construct wind turbines and solar panels.[1] Those technologies, however, produce zero emissions. As a result, electricity generation from coal has declined in favor of those and other sources.

Coal-fired power plants provide affordable, reliable and constant power that is available on demand to meet energy consumption needs. As much of the world lacks access to modern, clean energy, coal is still essential to alleviating worldwide energy poverty. The challenge the industry faces lies in developing technologies and pathways to zero emissions, especially carbon dioxide, which scientists identify as a factor in climate change.

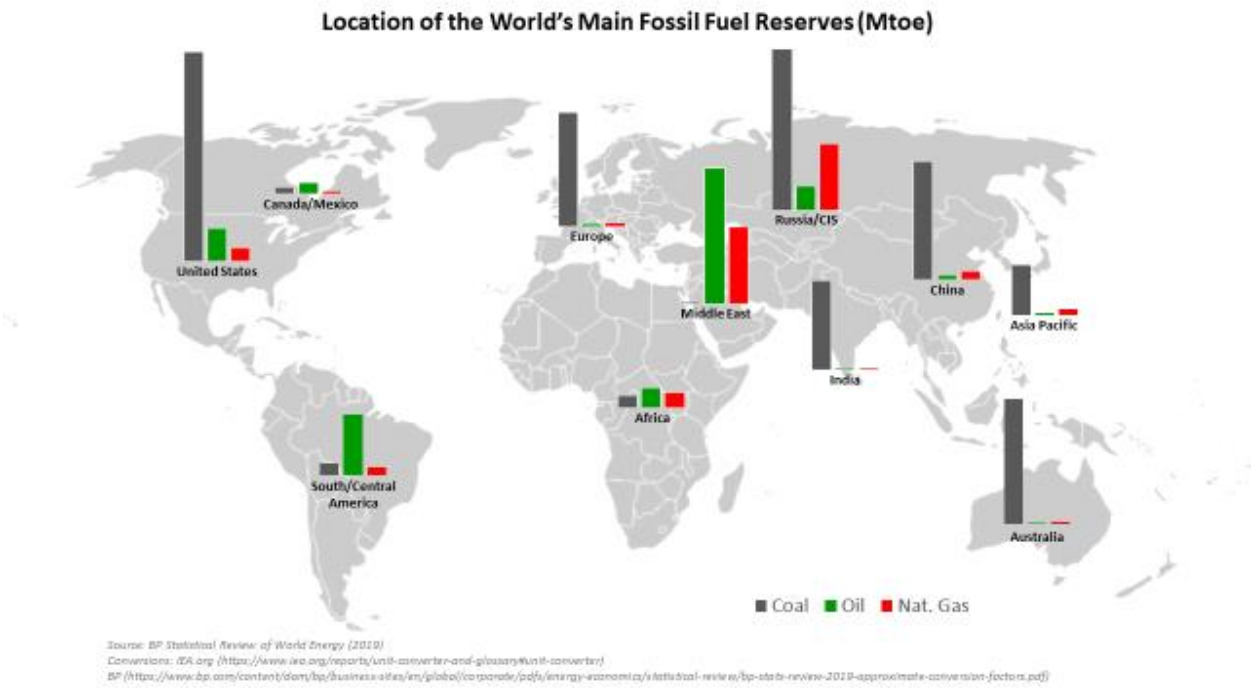
Coal also serves many industrial uses. Among the most significant are steel production, which uses metallurgical/coking coal, and cement manufacture.[2] Coal and coal by-products are also used to manufacture a variety of goods, including activated carbon used in filters for water and air purification systems; carbon fiber in the construction of airplanes and automobiles; silicon metal for lubricants and even chemical processes to extract rare earth elements, just to name a few examples.

BACKGROUND – Coal – What It is, Where It's Found and Why *that's* Important

Coal, What It is - Coal is a combustible organic rock, composed mainly of carbon, hydrogen and oxygen. It is formed from vegetation, which has been consolidated between other rock strata and altered by the combined effects of pressure and heat over millions of years to form coal seams.[3] There are four major types (or "ranks") of coal: Anthracite, Bituminous, Subbituminous and Lignite.[4]

Where It's Found – The simple answer: Almost Everywhere. As the figure below demonstrates, coal exists in significant quantities throughout the world, and is far more plentiful than oil or gas, with coal reserves worldwide in 2018 accounting for 132 years of production.[5]

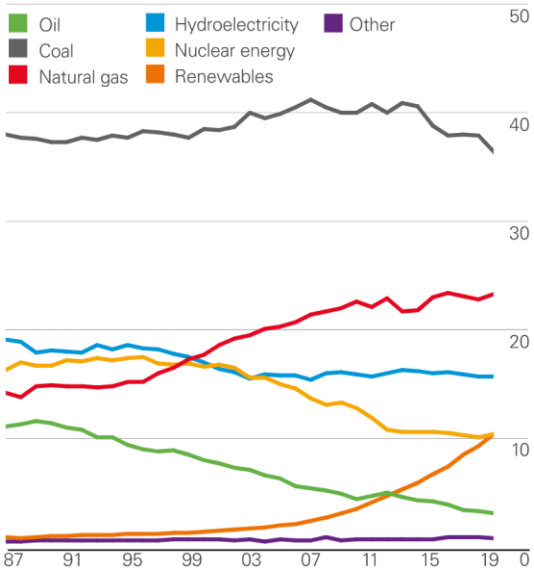
Why that's Important - Due to its abundance and proximity to markets, coal remains the second-largest primary energy source in the world (by consumption), *and the U.S. holds the world's richest coal reserve base, more than 260 billion tons.[6]. See figure below.*



Coal and Electricity Generation Worldwide

In 2019, coal comprised 27% of the world's primary energy consumption and 36.4% of the all electricity generated in the world.[7] *See figure below.*

Share of global electricity generation by fuel (percentage) [8]



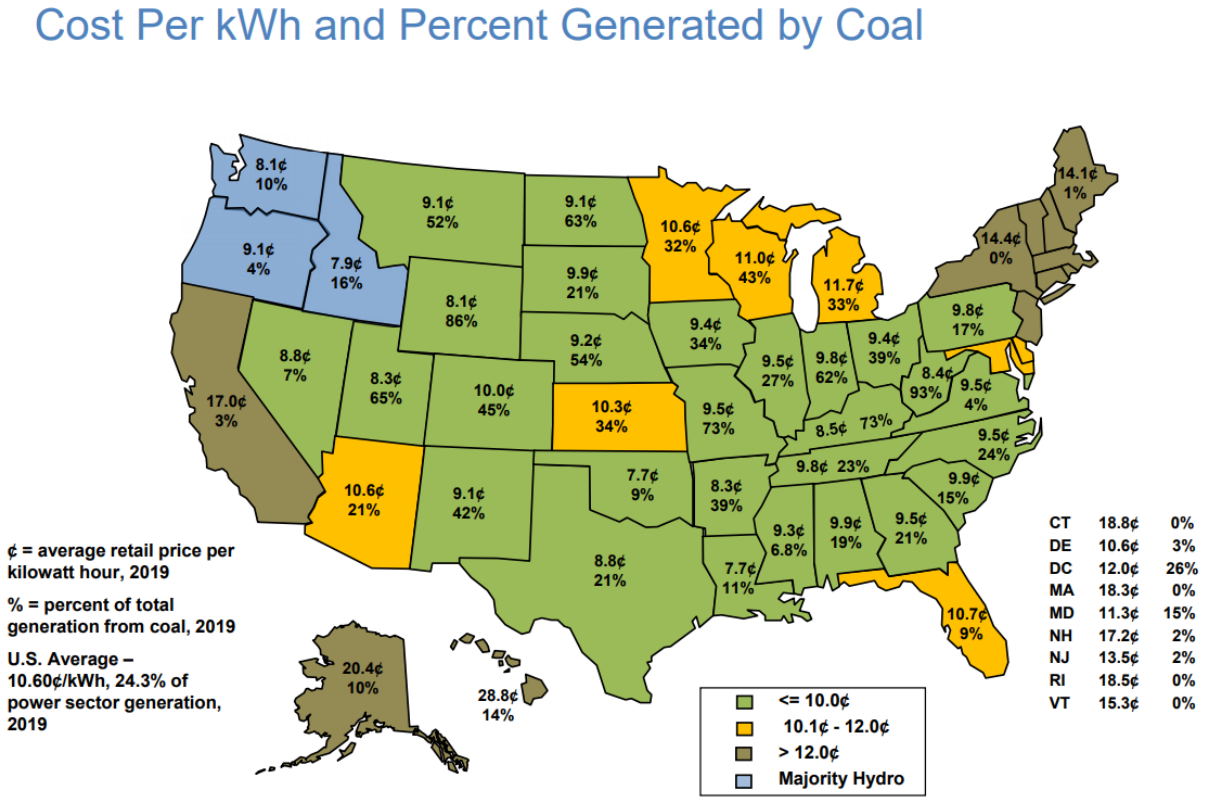
Alleviating Energy Poverty – Coal Is Part of the Solution

Coal is key to alleviating energy poverty. Approximately 860 million people across the globe currently live without access to electricity. Nearly 2.6 billion people do not have clean cooking facilities. The problem is spread across the developing world, but it is particularly severe in sub-Saharan Africa and developing Asia, which together account for 95% of people in energy poverty. Without a commitment to achieve universal energy access, it has been estimated that by 2030 there will be an additional 1.5 million premature deaths per year caused by household pollution from burning wood and dung and through a lack of basic sanitation and healthcare.[9]

Life expectancy, educational attainment and income all correlate with per capita electricity use, and more of the world's electricity is fueled by coal than any other source.[10] Notably, between 1990 and 2010, about 1.7 billion people gained access to electricity, thanks in large part to coal.[11] For these reasons, coal use in some countries, especially in the developing world, is increasing, and other forms of energy are not readily available.

Coal Use in the United States

In the United States, coal is by far the nation's most abundant energy source, constituting nearly 90% of all fossil fuel reserves.[12] Because of its abundance, reliability and affordability, about 23.4% of the nation's electricity is generated from coal, resulting in electricity costs that generally are 30% lower in states that rely upon coal for more than half of their electricity generation versus states that rely on other fuels.[13] *See figure below.*



Sources: Energy Information Administration (EIA), *Electric Power Monthly*, February 2020 (2019 data); WGL Energy Services, District of Columbia (2019); California Energy Commission (2018 latest available); Washington State Department of Commerce (2018); Idaho Power (2019). Note: 2019 EIA data are preliminary.

ECONOMIC CONTRIBUTIONS – U.S. Economy

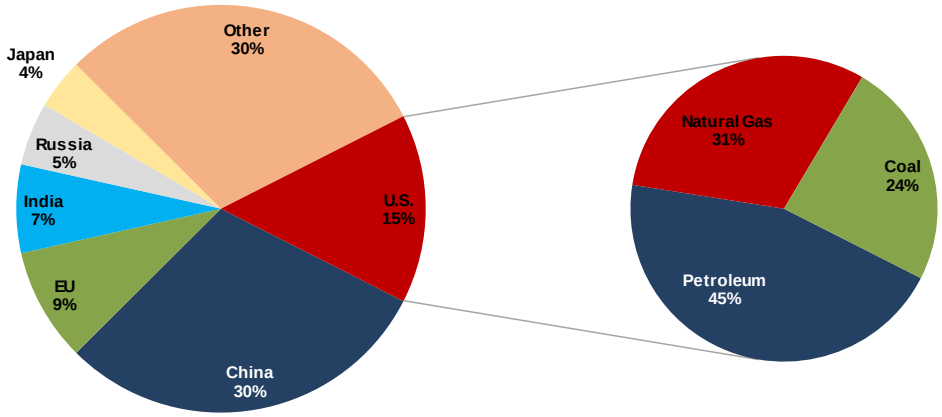
As the National Mining Association reports, the coal industry is a vital source of jobs that create positive ripple effects throughout society and our economy. These include the direct employment of nearly 150,000 people and the creation of 3.3 jobs for every job in coal mining, for a total of more than 500,000 jobs. Coal mines are an especially important source of employment in rural economies throughout America. Coal generated $26 billion in sales and paid $13 billion in direct wages and salaries according to a 2017 analysis by the National Mining Association.[14]

CLIMATE CHANGE AND THE PATHWAY TO ZERO EMISSIONS

Notwithstanding coal's economic contributions, its abundance, reliability and affordability, coal use in the United States has declined due in part to concerns about the impact of carbon dioxide and other emissions on climate. Although emissions of pollutants other than carbon dioxide from coal generation have declined substantially since the 1970s, coal use in the U.S. is expected to continue to decline from current levels to less than 15% of total electricity generation by mid-century, according to the Energy Information Administration.[15] This is due to largely to increased regulation, competition from and mandates for less carbon intensive sources.

The U.S. cannot solve the challenge of climate change on its own, and coal is not the only contributor of CO_2 emissions, as the figure below demonstrates. In fact, coal is no longer the largest source of carbon dioxide emissions in the United States, and the U.S. only accounts for 15% of total worldwide emissions.

Global CO_2 Emissions from Fossil Fuel Combustion: U.S. Energy-related CO2 Emissions by Major Fuel Type



Left to right, Global emissions data based on U. S. Environmental Protection Agency – "Global Greenhouse Gas Emissions Data"; U.S. data by fuel source from EIA – "Energy and the Environment Explained: Where Greenhouse Gases Come From"

As the world will continue to rely upon coal and other fossil fuels to meet critical energy needs, a technologically based approach to reducing CO_2 emissions through an "all of the above" energy strategy and path to zero emissions is arguably the most enlightened solution. As the World Coal Association (WCA) further points out, low emissions technologies exist which make significant reductions in CO_2

emissions from coal use. High efficiency, low emissions (HELE) coal technologies, together with carbon capture and sequestration or storage (CCS), are critical to meeting energy needs and climate goals. According to WCA, "Moving the current average global efficiency rate of coal-fired power plants from 37.5% to 47.5% by deploying more advanced technology could cut 2 gigatons of CO_2 emissions while allowing affordable energy for economic development and poverty reduction. Deploying HELE coal-fired power plants is also a key first step along a pathway to near-zero emissions from coal with CCS."[16] The challenge lies in making these cutting edge technologies commercially viable.

STEEL, CEMENT AND OTHER INDUSTRIAL USES OF COAL

The industry's future will also hinge on diversifying the use of coal beyond electricity generation, given the already substantial industrial uses that currently exist, and new alternative uses in development stage as outlined below.

Coke for Steel - As the WCA reports, manufacturing steel delivers the goods and services that our societies need – healthcare, telecommunications, improved agricultural practices, better transportation networks, clean water and access to reliable and affordable energy. Steel is an alloy based primarily on iron. As iron is bonded with other elements in the earth's crust, the ores must be converted, or 'reduced', using carbon. The primary source of this carbon is coking coal.[17]

Cement – Coal provides around 90% of the energy consumed by cement plants around the world. It takes 200 - 450kg of coal to produce 1 ton of cement. The cement industry consumes around 4% of global coal production, around 330Mt/yr.[18] Cement is an important commodity for building wind turbines.

Other Important Industrial Uses of Coal – The WCA also reports that "other important users of coal include alumina refineries, paper manufacturers, and the chemical and pharmaceutical industries. Several chemical products can be produced from the by-products of coal. Refined coal tar is used in the manufacture of chemicals, such as creosote oil, naphthalene, phenol, and benzene. Ammonia gas recovered from coke ovens is used to manufacture ammonia salts, nitric acid and agricultural fertilizers. Thousands of different products have coal or coal by-products as components: soap, aspirins, solvents, dyes, plastics and fibers, such as rayon and nylon."[19]"[20] Some of these products are needed for clean water purification as well as nonrenewable energy technologies.

These products also come from coal – Coal is an essential ingredient in the following products we use in our daily lives or that are essential to public health:

Activated carbon - used in filters for water and air purification and in kidney dialysis machines.

Carbon fiber - an extremely strong but light-weight reinforcement material used in construction, airplane and automobile manufacture, even mountain bikes and tennis rackets.

Carbon foam - designed to meet growing demand for ultra-high performance engineering materials in the military, industrial, aerospace and commercial product markets.[21]

Silicon metal – used to make lubricants, water repellents, resins, cosmetics, hair shampoos and toothpastes. Silicon is one of the most useful elements to humanity. Silicon alloys are used to make dynamo and transformer plates, engine blocks, cylinder heads and machine tools.[22]

Top left to right, carbon foam products and rocket nozzle design, used in aircraft, automobiles, and military applications. Photos from www.cfoam.com

Coal's Role in Renewable Energy – Research and development stage technologies are also successfully extracting rare earth elements from coal and coal refuse. These rare earth minerals – on which the United States is almost wholly import-dependent - are essential to the military and aerospace industries, as well in renewable energy. https://youtu.be/jR70j-MzWNE

SME STATEMENT OF TECHNICAL POSITION

Given expanding population growth driving increased demand for electricity, coupled with infrastructure projects around the world, especially in developing countries, coal will continue to be a key resource component in the advancement of the global community.[23]

Although coal use has declined in the United States – due to competition and mandates requiring the use of other forms of energy, coal still plays an important role in providing affordable, reliable and increasingly clean electricity.

As coal is the most abundant energy resource in the world, and given its role in providing affordable access to energy and in alleviating energy poverty throughout the world, it is essential that the industry, government and public work together to develop commercially viable technological pathways to zero emissions in a carbon constrained world.

In so doing, these policies must ensure that technologies are in place to take advantage of one of the nation and the world's most valuable resources. This includes support and funding for the development of commercially viable alternative coal products and technologies to extract rare earth minerals from coal.

Coal's future also hinges on the continued development of industrial uses, including growth in the steelmaking, cement and fuel industries. Other uses, including activated carbon, carbon fiber and silicon metals are vital to the industry's growth and to public health and well-being.

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[1] See, SME Technical Briefing Paper, *Rare Earth Elements (2020); Critical & Strategic Minerals Importance to the U.S. Economy (2020):Nuclear Power (2020);* www.smenet.org

[2] Coal | World Coal Association

[3] Coal | World Coal Association;

[4] See, https://www.usgs.gov/faqs/what-are-types-coal?qt-news_science_products=0#qt-news_science_products; The four ranks are:

- Anthracite: The highest rank of coal. It is a hard, brittle, and black lustrous coal, often referred to as hard coal, containing a high percentage of fixed carbon and a low percentage of volatile matter.
- Bituminous: Bituminous coal is a middle rank coal between subbituminous and anthracite. Bituminous usually has a high heating (Btu) value and is the most common type of coal used in electricity generation in the United States. Bituminous coal appears shiny and smooth when you first see it, but look closer and you may see it has layers.
- Subbituminous: Subbituminous coal is black in color and dull (not shiny), and has a higher heating value than lignite.
- Lignite: Lignite coal, aka brown coal, is the lowest grade coal with the least concentration of carbon.

[5] https://www.worldcoal.org/coal

[6] *Science for a Changing World,* https://www.usgs.gov/faqs/which-country-has-most-coal?qt-news_science_products=0#qt-news_science_products;

[7] https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf, at 3, 10.
[8] https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/electricity.html
[9] https://www.worldcoal.org/sustainable-societies/improving-access-energy
[10] United Nation's Human Development Index. Glenn Kellow, Peabody Energy CEO, "The Surprisingly Sustainable Case for Coal" https://www.peabodyenergy.com/Peabody/media/MediaLibrary/Industry%20Insights/CERAWeek-2019-Essay.pdf
[11] Center for Energy Policy and the Environment at the Manhattan Institute: Not Beyond Coal, How the Global Thirst for Low-Cost Electricity Continues Driving Coal Demand, page 9.
[12] https://www.eia.gov/tools/faqs/faq.php?id=427&t=3
[13] *Mining Facts 2020, www.nma.org*
[14] https://nma.org/wp-content/uploads/2016/09/Coal-Americas-Power-2017.pdf
[15] EIA *Annual Energy Outlook 2020 with projections to 2050,* at 10.
[16] https://www.worldcoal.org/reducing-co2-emissions
[17] https://www.worldcoal.org/coal/uses-coal/how-steel-produced Coking coal is converted to coke by driving off impurities to leave almost pure carbon. The physical properties of coking coal cause the coal to soften, liquefy and then re-solidify into hard but porous lumps when heated in the absence of air. Coking coal must also have low sulfur and phosphorous contents. Almost all metallurgical coal is used in coke ovens. The coking process consists of heating coking coal to around 1000-1100ºC in the absence of oxygen to drive off the volatile compounds (pyrolysis). This process results in a hard porous material - coke. Coke is produced in a coke battery, which is composed of many coke ovens stacked in rows into which coal is loaded. The coking process takes place over long periods of time between 12-36 hours in the coke ovens. Once pushed out of the vessel the hot coke is then quenched with either water or air to cool it before storage or is transferred directly to the blast furnace for use in iron making. Iron ore is mined in about 50 countries. The majority of iron ore is mined in Brazil, Australia, China, India, the US and Russia. Australia and Brazil together dominate the world's iron ore exports, each having about one-third of total exports. Around 98% of iron ore is used in steel-making.
[18] https://www.globalcement.com/magazine/articles/974-coal-for-cement-present-and-future-trends
[19] https://www.worldcoal.org/coal/uses-coal
[20] ." https://www.worldcoal.org/coal/uses-coal
[21] https://www.worldcoal.org/coal/uses-coal
[22] https://www.rsc.org/periodic-table/element/14/silicon; https://www.uky.edu/KGS/coal/coal-for-otherspecialty.php
[23] https://www.globalcement.com/magazine/articles/974-coal-for-cement-present-and-future-trends