Burning Coal for Residential Heating

A White Paper

by

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We continue to witness the rapid development of new, highly efficient heating sources, in response to a search for efficiency and environmental responsibility. Increasing attention is directed toward the carbon footprint of heating systems. Coal, at first glance appears to be out of place. It has been formed mostly from ancient organic matter under conditions of intense heat and pressure, and is a result of the conditioning of dead plant and animal material over thousands of years. As such, coal contains a high percentage of fixed carbon, the highest percentage of any fossil fuel. While carbon is an indispensable component of Earth's biosphere, when burned in large quantities, carbon can disrupt environmental processes through its chief byproduct, carbon dioxide. Coal has been a steadfast source of energy in the United States for over 200 years. Burning coal and other fossil fuels has led to an increase in CO2 levels in the atmosphere from 265 ppm to over 400 ppm. Increased use of clean variants such as anthracite coal of the Northeast, and improved technology for burning lower grades of coal, has resulted in dramatic pollution reduction. Carbon dioxide capture has received a great deal of attention as a means of reducing the impact of using coal. Economic dependence on coal is still high. In 2008, electricity generation accounted for nearly 93 percent of coal consumption (Miller, 2011, 1-51).

Since 2005, the United States has spent over $1 trillion annually on energy, including residential, commercial, industrial, and transportation. Much of the expansion in coal consumption during the twentieth century came from increased use for electricity generation. Coal's decline later in the century was primarily a result of lower petroleum and natural gas prices (Miller, 2011, 1-51). With this in mind, it is important that homeowners make the best decision they can for their heating system, with regard to both efficiency and financial return. Coal can be a cheap, clean

source of energy, especially in the Northeast, where much residential coal is mined. With efficient heating and low prices, interest in residential coal burning cyclically revives when fuel oil and other fuel costs spike.

Types of Coal: Bituminous and Anthracite

When most people think of coal, they think of soot—the black, dirty ash result of burning soft bituminous coal that dirties your fingers when you hold it. Bituminous coal is a low cost, commonly available form of coal produced across the United States. For residential use, however, bituminous coal is less efficient than alternatives—generating less heat and being far dirtier than its more fit for residential use counterpart, anthracite coal. Bituminous coal use has a long history in the U.S., seeing use from railroads to industrial plants to electricity generation. Bituminous has also been used to make coke, a still important raw material used in the production of steel ("The Differences between Bituminous Coal and Anthracite Coal").

Anthracite coal, or hard coal, is abundant in the Northeastern United States. It naturally contains little sulfur, produces virtually no smoke or particulate emissions, and is clean to touch. Most of this coal in the US has been mined in the Northeast, with nearly all anthracite coming from Pennsylvania. Roughly 4 to 6 billion tons of reserves of anthracite are left in Pennsylvania—enough to last another 300 to 500 years (PA Anthracite).

Burning quality anthracite produces nearly 25 million gross BTUs per ton. It can conveniently be used in areas where wood stoves are banned or restricted due to factors such as air pollution or forest fire risk from chimney embers. Anthracite has both a higher relative energy density than bituminous, as well as a lower percentage of volatile matter. It has a higher

percentage of fixed carbon, stemming from the fact that anthracite has a longer development history than bituminous. Its chemical composition also results in even heat output. When this is accompanied by good stove design, high heating efficiency will follow.

Pennsylvania anthracite is of extremely high quality. It accounts for up to one percent of the gross state product. Most coal production in the U.S. is done by way of surface mining, rather than underground. Surface mining, as the name suggests, is done by removing the soil and rock covering the mineral deposits. This is done as opposed to underground mining, in which minerals are removed through shafts or tunnels. Types of surface mining include strip mining, open-pit mining, mountaintop removal, and highwall mining (Great Mining).

The resurgence of anthracite has been accompanied by reentrance into inactive, past mines, which were inefficiently mined by hand. At the time, it was common to only recover 45-50% of the coal in accessible areas, with the idea that pillars had to be left in place in the mine. Safety hazards created impasses that left billions of tons in the ground, which are being collected today with newer and safer equipment, extending the life of some mines 25-30 years (Buchsbaum). In the interest of environmental stewardship, restoring mined land has become a standard practice for types of surface mines through acts like the Surface Mining Control and Reclamation Act (SMCRA). By re-layering rock, dirt, and soil onto mined land, areas can become economically viable again for plants and animals to thrive.

History of Anthracite

Coal exists in almost all countries worldwide and is the most used solid fuel in the world. Use in China dates to around 1000 B.C. Known by the Greeks and Romans, coal received its first

usage boost in Medieval Europe, several hundred years after the Roman Empire fell. During the Industrial Revolution, a coal boom arose from the use of coal to produce coke for iron smelting and fuel for locomotives and steam engines. Electric lighting of the late 1800s led to large scale coal combustion for electric utilities and independent power producers. After World War II, coal was still relied on for nearly 75 percent of total energy use in the United States (Miller, 1-51).

Anthracite use in the United States began in Pennsylvania in 1790 in the northeastern town of Pottsville. Legend has it that a man named Necho Allen fell asleep one night at the base of Broad Mountain and woke "to the sight of a large fire because his campfire had ignited an outcropping of anthracite coal" ("Pennsylvania Anthracite Fields"). Since then, anthracite has been used for several purposes—including, but not limited to, residential heat.

The Appalachian Region contains some of the most important deposits of bituminous and anthracite coal in the the eastern United States. Nine states contain what historically amounted to 75 percent of total annual coal production as recently as 1970. Increased production in the western U.S. has brought eastern production numbers to a lower fraction, but three of the largest coal-producing states (Kentucky, West Virginia, and Pennsylvania) are located in the east (Miller, 1-51).

Clean Coal: Is it Dirty?

Clean coal technology has demonstrated promise in breaking the status-quo of bituminous coal burning and its dirty past. Nonetheless, competition from abundant and cheap natural gas has put a damper on increased coal use, displacing coal in areas further from mines and resulting in more mines becoming uneconomic. Should these circumstances be reversed, a

number of labs today continue to develop clean coal technologies that approach near-zero emissions when generating electricity. In a market demanding both low-cost electricity and environmental efficiency, resources must be used wisely and cleanly. Current technology has given us ways to filter 99 percent of tiny particles that could escape in burning coal, as well as 95 percent of acid rain pollutants. Burning coal more efficiently can also create a smaller release of carbon dioxide byproduct. Coal is not a perfect fuel, but research and development has led it to be considerably more efficient and economical than in times past (Coal-Introduction; Miller, 513-612). Burning anthracite coal for residential heating, by comparison to bituminous usage for power generation, is inherently efficient, and produces low emissions without large investments in the technology involved in burning it.

Ashes, Ashes

Coal ash is a byproduct of burning coal, which can come out powdery, coarse, molten, or wet. All grades of coal produce considerable amounts of ash when burned. The amount of ash contained in coal can vary from just under 10% to as much as 20% or more. Ash disposal remains a challenge for large scale users. Power plants dispose of coal ash in several ways, from landfills to safe water discharging. Other uses include recycling the ash into concrete or wallboard pieces. The reuse of coal ash offers potential benefits to communities by reusing what would otherwise end up in a landfill. Coal ashes can be used as a base for concrete, as well as scattered on driveways during winter to provide traction.

Different types of coal ash produced in industrial uses include fly ash, bottom ash, boiler slag, and flue gas desulfurization material, arranged from finest to coarsest and/or wettest. When

one ton of fly ash is recycled in cement, roughly one ton of carbon dioxide is prevented from entering the earth's atmosphere. It is estimated that nearly 13 million tons of CO_2 is prevented from entering earth's atmosphere due to use of fly ash in concrete (CCP). Currently, about 45 percent of coal ash waste is recycled. The reuse of coal ash is an important process in both industrial and residential practices, and prevents coal from ending up in landfills or ash ponds, with resulting detriment to the environment. Residential users can use coal ash in cement mixes, as landscaping fill or anti-skid material.

The Future of Coal

China is the world's largest producer and consumer of coal by a wide margin, producing nearly 3.7 billion tons. This compares to just under 1 billion for the United States (United States Energy 2016). Worldwide, heavy reliance on coal continues for electricity generation, which stands at roughly 50 percent currently. Electricity usage in the U.S. is expected to increase through 2030 to meet the country's demand. Though the U.S. has a diverse inventory of energy from sources such as coal, oil, natural gas, nuclear, hydroelectric, and others, more energy will still be consumed than is produced, leading to industry expansion and continued imports of energy (Miller, 1-51).

Using anthracite coal for residential heating continues to be a cost effective alternative to using electricity, wood pellets or other fossil fuels. By comparison to overall fossil fuel usage, it is a tiny contributor to CO_2 levels in the atmosphere. When anthracite coal is used within a few hundred miles of where it is mined, its contribution to greenhouse gas accumulation is less than the fuel oil it would replace. The actual burning of fuel oil is not the only contributing factor to

greenhouse gas formation. The entire production cycle must be taken into account, including crude oil extraction, and the refining and transporting of finished fuels. When these are properly accounted for, local anthracite compares favorably.

Anthracite coal burns cleanly, with less particulate matter emissions than wood burning and no visible smoke. It offers even and efficient heat output. It is easy to store and unlike wood will not deteriorate in storage. When utilized local to its point of origin, it has very low costs per BTU, and lower greenhouse gas contributions than fuel oil. Large reserves remain ready to be mined, reducing fuel imports. All these advantages add merit to its consideration for heating applications throughout the northeastern United States.

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