

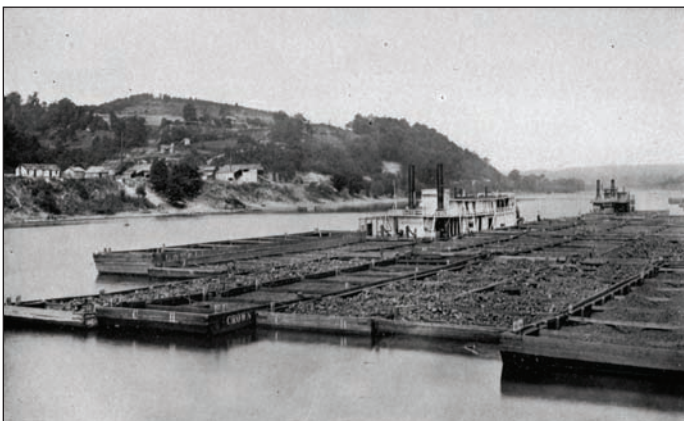
ECONOMIC HISTORY

Liquid Gold

BY CHARLES GERENA

More than a century ago, West Virginians tapped into their vast reserves of coal and turned it into a valuable form of oil

Before the federal government built locks and dams on the Kanawha River to make it more navigable for coal barges like this one, coal oil production provided a way for mining companies along the river to make money.



More than three decades ago, President Gerald Ford met with coal producers at the White House to discuss his proposals to support their industry's growth. At a dinner held on March 21, 1975, he extolled the virtues of coal as an alternative to oil, whose supply had been cut off for five months by OPEC the year before.

"Coal represents one immediate and dependable answer to the question of how we solve our energy needs in this nation," said Ford. "It represents an American answer, not one based on uncertain resources in far-away lands with different ideas and diverse interests. It represents our hope for the future. Coal is America's ace in the hole."

Since then, the federal government has supported research and development of what is called "coal liquefaction" technology. Yet no American liquefaction plants are in commercial operation today.

You have to look as far back as the mid-19th century to find a time when coal was liquefied into a usable form on a broad scale. One product called "coal oil" was widely sold as a lubricant to keep machines moving and as a lamp fuel to keep communities out of darkness. Among those who benefited from the boom were coal mining companies along West Virginia's Kanawha River and one of its tributaries, the Elk River.

The boom would last only a decade, however. The emergence of petroleum as

a competing product and the disruptions caused by the Civil War during the 1860s would eventually undermine the market for coal oil. Still, the devel-

opment of this commodity was an important step in the development of the nation's energy supply. Its story offers some lessons for those who view coal liquefaction as a path away from dependence on petroleum.

There's Black Gold in Them Hills

If the United States is the "Saudi Arabia of coal" as some have called it, West Virginia would be one of the reasons for that designation. As early as 1742, coal was found in what was then considered western Virginia. After the turn of the 19th century, it heated people's homes, stoked the furnaces of salt manufacturers, and powered the steamboats that traversed the Ohio River.

Still, through the mid-1800s commercial mining was limited in the southern counties of the future West Virginia. "Here [in the Kanawha River Valley], in their attempts to match capital, labor supply, and transportation facilities to abundant resources, mine operators experienced advantages and obstacles commonly encountered by other Southern industrialists," wrote West Virginia historian Otis Rice in the November 1965 issue of the *Journal of Southern History*.

The problem was it would be decades before the Kanawha River Valley had the canals and railroads to ship coal in large quantities. "For Kanawha coal the only outlet was the Kanawha River, which was navigable for only about six months each year," noted Rice. "Because of the hazardous state of the [river] and the lack of other transportation facilities, Kanawha Valley coal producers made very few attempts prior to 1850 to ship coal out of the valley."

Rice added, "As a result, the richness of the Kanawha resources, revealed by the findings of William Barton Rogers in the Old South's most

thorough geological survey, stood out in sharp contrast with the valley's share of the nation's expanding coal market." While most of the region's coal was consumed locally, Pennsylvania became the nation's leading coal producer.

So, West Virginians knew they were sitting on an abundant natural resource. But how would they extract the value of that "black gold" in a broader marketplace? Coal oil would provide the answer.

By the mid-19th century, the Industrial Revolution had transformed England and was spreading across the Atlantic to the United States. All of the machinery that kept factories humming needed lubrication, so people turned to oils derived from animal fat and vegetables.

Coal oil turned out to be a good replacement for these lubricants. It kept the parts of a machine moving, while lacking the acidity of organic lubricants that ate at metal and accelerated wear and tear.

Another significant market for coal oil also emerged: illumination. People used a variety of substances in lamps and street lights, from oils extracted from animal fat and plants to concoctions like grain alcohol and camphene — a mixture of alcohol and turpentine, plus camphor oil to improve its odor. The downside of many chemical fuels was their volatility, while oils derived from lard congealed if they weren't kept warm. One of the leading animal fat-derived fuels, whale oil, became scarcer and more expensive as fisheries along the East Coast were depleted of sperm whales.

Coal already played a role in the illumination market, but not in liquid form. So-called "manufactured gas" was extracted from coal and used in lighting throughout the 19th century. However, its use was limited to businesses, municipal streetlights, and wealthy households since it was expensive. Also, burning manufactured gas produced soot and a strong odor, which is one of the reasons why natural gas and electricity would supplant it in the next century.

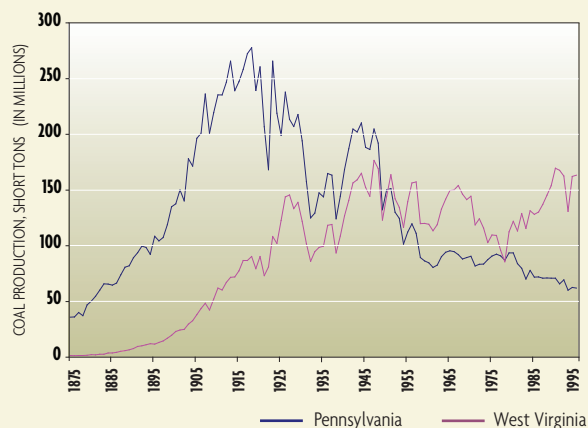
By the 1850s, coal oil stepped into the spotlight. "The building blocks and more importantly, the economic incentives, were in place," wrote lighting expert Daniel Mattausch in a recent magazine article on the history of lamp fuels. "With increasing frequency, inventors investigated three materials, raw petroleum, cannel coal, and the tar left over from the production of illuminating gas."

Inventor-entrepreneurs on both sides of the Atlantic found they could modify the production process for manufactured gas to yield a liquid byproduct that had several advantages over existing lamp fuels. Derived from cannel coal that had a high hydrogen content, coal oil burned brightly and produced less residue than either whale or lard oil. In addition, it resisted cold weather like whale oil and was much cheaper — 50 cents a gallon versus \$2.00 to \$2.50 per gallon for the most desirable whale oils. Camphene sold for about the same price as coal oil, but the latter wasn't as volatile.

Most importantly, coal oil was a value-added product that enabled Cannelton and other communities near the

Playing Catch-Up

Transportation improvements helped open up coalfields in southern West Virginia starting in the 1880s, boosting the state's coal production. West Virginia would eventually catch up to Pennsylvania, the Appalachian Basin's leading coal producer, partially due to the latter's decline in anthracite mining.



SOURCE: *The COALPROD Database: Historical Production Data for the Major Coal-Producing Regions of the Conterminous United States*, U.S. Geological Survey, March 2003

Kanawha and Elk rivers to take advantage of the cannel coal deposits surrounding Charleston, W.Va. "There was still a lot of bulk there" to transport, notes Mattausch in an interview. But "it was a lot better than shipping tons of coal."

Boom and Bust

As lamps that optimally burned coal oil were invented and put on the market, coal oil cut into sales of whale oil. By 1860, dozens of coal oil plants were in operation in big cities like Boston, New York, Cincinnati, and Pittsburgh.

In West Virginia, more than 40 companies secured charters for mining cannel coal (also known as "candle" coal) along the Kanawha and its tributaries. "All but two or three of these groups were formed after the discovery of cannel coal at Cannelton, and the acts by which they were incorporated show clearly that the vast majority of them expected to engage in the mining of cannel coal and in the manufacture of coal oil and other cannel-coal derivatives," wrote historian Otis Rice.

Not all of the mines yielded what their investors hoped, while others found more profitable types of coal to mine and sell. Still, at least six refineries produced coal oil in West Virginia, including four in Kanawha County.

Despite using wasteful methods of liquefying coal, noted Rice, the Cannelton factory managed to extract two gallons of oil from each bushel of cannel coal. (According to several accounts, that was about the best yield any producer could obtain.) Some of the oil was shipped to a refinery in Maysville, Ky., about 180 miles northwest of the factory, and some was likely shipped to Boston for sale under contract.

Perhaps some version of coal oil would have continued to

fuel the Industrial Revolution and eventually fill the tank of every automobile on the road today. Instead, petroleum assumed that pivotal role in the nation's economy.

Petroleum was skimmed off of ponds and scooped from holes in the ground for centuries. (West Virginia salt miners considered the oily substance a nuisance when they found it.) The flammable liquid was used in weapons; as an additive to mortar, paints, and adhesives; and as a remedy for itchy skin and a variety of other ailments.

During the 19th century, lamps burned petroleum, but only on a limited basis since it produced a lot of smoke and a strong odor. Also, supplies were generally limited to locations where petroleum seeped out from underground reservoirs.

Then a former railroad conductor named Edwin Drake was hired to dig a well in Titusville, Penn. He was searching for "rock oil" as an alternative to whale oil and struck pay dirt in August 1859. The subsequent rush led to the creation of a petroleum-derived competitor to coal oil: kerosene.

The coal oil industry may have paved the way for the petroleum industry. The backers of the Titusville oil well sought the profits that coal miners were making from producing lamp fuel. Later, much of the refining and distribution infrastructure for coal oil would eventually be used for petroleum.

The Civil War shut down mining operations in the Kanawha River Valley during the early 1860s, but mining expanded significantly with postwar transportation improvements.

"The Chesapeake & Ohio Railroad in 1873 and the Norfolk & Western in 1881 opened up the southern West Virginia smokeless coal reserves," says C. Stuart McGehee, chair of the history department at West Virginia State University. "The Kanawha River was not channeled with locks until the 1930s to allow serious barge traffic, now mostly to electric power plants on the Ohio River." Indeed by that time, other profitable uses for coal had emerged besides oil for illumination.

What about the commercialization of the incandescent light bulb around 1880? "Edison's light was a poor competitor with the gas and kerosene lights," describes historian Dan Mattausch. "It was much more expensive; it was something wealthy people showed off. Gas lights put out several times the output of an electric light bulb and cost a fraction of the price." Eventually, though, electricity obviated the need for coal oil, kerosene, or any fuel for lights.

Dethroning Petrol

The rise and fall of coal oil in West Virginia illustrates how market demand can drive the development of new commodities. As the supply of one product approaches exhaustion and becomes relatively expensive, companies are motivated to find alternatives.

Today, hydrogen is often mentioned as the country's next-generation energy source. But it's hard for any new commodity to compete with petroleum, which has been a relatively cheap transportation fuel for so long and has an extensive production and distribution infrastructure developed around it.

There are a couple of historic examples of periods when other countries used coal to make oil. In both cases, the countries did so mainly because they were shut out of the more routine channels of supply for oil. Nazi Germany used coal liquefaction technology to keep their warplanes in the air during World War II. South Africa used gasoline and diesel fuel extracted from coal when the world turned its back on the country during its age of apartheid.

If coal was turned into liquid fuel on a mass scale, the end product could utilize the same infrastructure as petroleum and be useable in the same vehicles by adding hydrogen to it or removing carbon. However, using indirect liquefaction — the same method South Africa has used — would produce more than twice the amount of carbon dioxide as the production of diesel fuel.

Other countries are discovering there might be important investment opportunities for this sort of technology. The Shenhua Group in China, the world's largest coal producer, is building a plant in Inner Mongolia — 375 miles west of Beijing — based on the Germans' direct liquefaction process. West Virginia University is working with the company to study the environmental and economic impact of the plant.

With crude oil prices breaking new records, there could be more talk in the United States of liquefying coal on a large scale. Of course, the price of coal and the cost of building liquefaction plants compared to the financial and ecological costs of sticking with petroleum will ultimately be the deciding factor.

In the meantime, Dan Mattausch has some advice for those who are pursuing coal liquefaction. "It won't lead where you think it's going to go. The people working with coal oil had no concept that they were preparing the way for something they had never heard of." **RF**

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