

# AN ENERGY TRANSITION BEFORE THE AGE OF OIL

THE DECLINE OF ANTHRACITE, 1900–1930

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**ABSTRACT:** Anthracite was the first casualty of the great twentieth-century energy transitions from coal to liquid fuels. However, its demise occurred in two stages, for oil and natural gas did not begin to undermine the market for hard coal until the 1920s. By 1900 anthracite had lost its industrial markets and even as a domestic fuel it was besieged. Strikes that led to uncertain supplies and rising prices encouraged consumers to search for substitutes while innovations in production and marketing made coke, manufactured gas, and coal briquettes increasingly attractive alternatives. Anthracite sales peaked in 1917 and declined sharply well before the onset of oil and natural gas. Although its demise might have taken longer, anthracite would have expired even if there had been no age of oil.

**KEYWORDS:** Anthracite, bituminous, coal, energy transition, resource shortage, smoke ordinances

New England's captains of public policy organized their preparations yesterday for a "war to end war" with the anthracite industry.

—*Boston Globe*, August 22, 1925

We deliver coke in white canvas bags loaded into a white wagon with the driver in white canvas overalls. In muddy weather the wagon is washed . . . every trip. All the coal wagons are painted black [like] a funeral procession.

—*American Gas Institute of 1906*

The National Commercial Gas Association (NCGA) created Nancy Gay as an advertising image who became their public face in 1914. In magazines and a pamphlet entitled "The Story of Nancy Gay," the association explained that she had nearly broken up with her sweetheart, George, because he was

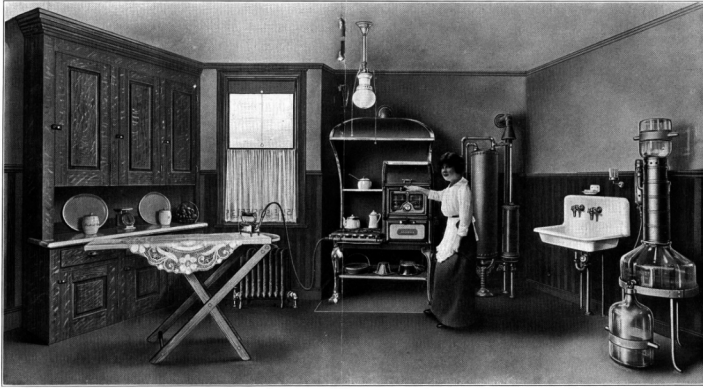
so old-fashioned as to want a coal stove. True love finally won out, for Nancy persuaded George of the wonders of the all-gas kitchen, and the reader learns “what gas provides in the way of domestic service and therefore contentment and happiness.” Nancy so won over George that he wrote his parents—who lived in “Old Fashionedville”—urging them to convert to (manufactured) gas as well.<sup>1</sup>

It seems unlikely that anthracite (“hard”) coal producers paid any attention to Nancy Gay, for in 1914 their future must have seemed bright. Although expensive compared to bituminous (“soft”) coal, anthracite was the domestic fuel of choice in the Northeast, especially among affluent householders. Since 1850 output had grown at an average rate of nearly 8 percent a year and the boom of World War I carried production to slightly less than 100 million tons in 1917. In retrospect, this proved to be its highest level ever, and while many worried the nation might soon run of this wonderful resource, no one foresaw it would be lack of demand, not lack of supply, that would lead to the eclipse of the hard-coal business. Nancy Gay, in short, was symptomatic of the changes reshaping energy markets during these years.

While World War I fuel shortages and the great strikes of 1922 and 1925–26 helped propel buyers away from hard coal, these were less important than



**FIGURE 1** “Nancy Gay” promoted the all-gas kitchen in a pamphlet titled *The Story of Nancy Gay* distributed by the National Commercial Gas Association beginning in 1914.



### THE ALL-GAS KITCHEN FOR THE MODERN HOME CONTAINS

- A Gas Range, insuring successful results in cooking, with facility and economy.
- A Gas Water Heater, insuring plenty of hot water for all household purposes. The turn of a faucet operates the Automatic Heater, while the lighting of a gas burner starts the Circulating Heater.
- A Gas Iron, insuring comfort and convenience on ironing day. It heats quickly, stays hot and stays clean.
- A Waffle Iron, insuring four deliciously baked waffles at one time. It turns without lifting.
- A Pancake Griddle, insuring unsurpassed browned pancakes. The heat is evenly distributed over the cooking surface.
- A Toaster, insuring four slices of bread being toasted at one time to a beautiful golden brown.
- An Incandescent Light, insuring a maximum amount of light at a minimum cost for gas.

FIGURE 2 Gas began to drive anthracite from the kitchen by World War I. From *The Story of Nancy Gay*.

innovations resulting in better fuels. Anthracite was among the first—and most serious—casualties of the great twentieth-century energy transitions from coal to liquid fuels. The end of anthracite occurred in two stages, for oil did not begin to undermine the market for hard coal until the middle 1920s and natural gas came even later. Well before that, competition from traditional fuels (bituminous coal and its derivatives) was eroding the market for anthracite.<sup>2</sup>

Writing on energy transitions has largely focused on the broad shifts among primary fuels—from coal to liquids and gasses—and indeed, the rise of fuel oil was a dramatic, disruptive Schumpeterian innovation at once creative and destructive.<sup>3</sup> Yet such a focus can easily blind one to the less dramatic economic changes that were eroding anthracite markets well before the age of oil. The initial move away from anthracite involved many small decisions made by households and businesses. It reflected consumer responses to the rising price of hard coal as well as entrepreneurial actions by producers of coke, manufactured gas (the creators of Nancy Gay), and fuel briquettes, all of which derived from bituminous coal and promised a better combination of cost, convenience, and cleanliness than anthracite could offer. This article begins with a review of the hard-coal industry at the time of World War I. The next section traces the rise of substitutes for anthracite before the dawn

of the heating oil age and looks at their market penetration. The article then traces the belated and ineffective sales and product-improvement efforts of the anthracite producers to win back their eroding markets. The final section offers some conjectures and conclusions.<sup>4</sup>

#### PEAK ANTHRACITE

Anthracite coal and America grew up together. The industry was almost entirely located in northeastern Pennsylvania and records show it was used locally before the writing of the Constitution. High transportation costs initially precluded wider use, and the earliest data show production of only about 1.3 million tons in 1821. With the opening of canals to tidewater in the mid-1820s, however, production took off. Anthracite not only displaced wood for domestic heat in East Coast cities, but as Alfred Chandler has shown, it also powered the early Industrial Revolution. On the eve of the Civil War, consumption had reached nearly 10 million tons, half again as much as bituminous coal use at that time. Yet if declining costs of transport spread early anthracite use, they ultimately began to constrict its markets as well. The railroads breached the Appalachians in the 1850s and brought a flood of cheap bituminous coal to market. By the 1870s, soft-coal production had outstripped that of anthracite, gradually forcing the latter almost entirely out of industrial uses, while it remained the fuel of choice for domestic heating in eastern homes.<sup>5</sup>

Anthracite came from beds that were pitching, faulted, and deep, and the coal itself was hard, requiring much black powder to loosen it and much labor to clean it, all of which contributed to the expense of underground mining. By World War I, strip mining had made an appearance, accounting for 1–2 percent of output, while companies were also reworking old culm banks of previously discarded coal and dredging coal waste from local rivers. An informal cartel dominated production: there were eight major producers—the railroad coal companies—that typically accounted for about three-quarters of output, and a competitive fringe of around 100 independents. Essentially anthracite was not branded until the 1930s and all companies sold coal by size. Domestic sizes (e.g., “lump,” “chestnut,” “stove”) were for home burning. A second size group, termed “steam coal” (e.g., “Buckwheat #1”), were smaller still. These sold to apartment buildings, utilities, and other large users that had equipment designed to burn the

smaller sizes. Various sizes were produced jointly; all cost the same to mine but market prices roughly reflected size; thus in 1918 the average mine realization for chestnut and stove coal ranged from \$5.87 to \$6.64 per net ton. Steam sizes, essentially a byproduct of production for the domestic market, sold for less because competition with bituminous coal governed their price and so they yielded from \$3.48 to \$3.55 per ton. While such prices for steam coal did not cover average cost, they contributed to revenue to help cover fixed costs.<sup>6</sup>

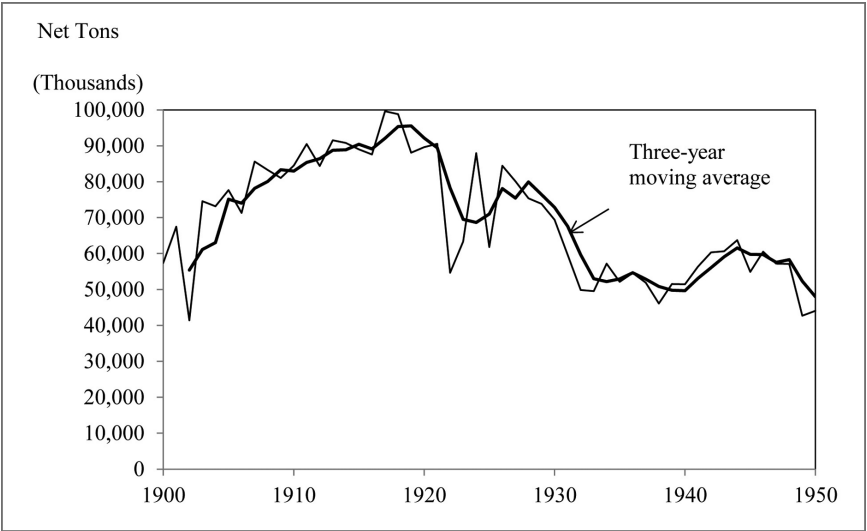
Companies marketed hard coal using a variety of wholesale and retail arrangements. The railroad companies announced their “circular” prices about April 1 of each year. Discounted in the spring to encourage households to spread purchases through the months, prices otherwise usually remained fixed during the year. Those charged by independents reflected market forces, however, selling at a premium or discount from circular prices depending on market conditions. Transportation by water or rail or both might account for 18–20 percent of the retail price in cities close to producing areas, but in Chicago or St Louis transport costs amounted to 35–40 percent of the final price. Wholesaler and retailer costs of coal included transport fees, while their markups similarly reflected market conditions. Taken together, transport costs and dealer margins ensured that the retail price of coal was usually around twice its price at the mine.<sup>7</sup>

Because hard coal was located in eastern Pennsylvania, while nearly thirty states mined the bituminous product, and because all coal was expensive to transport, anthracite sold in a narrow geographic area. Its major markets were eastern Pennsylvania, New York, New Jersey, and New England, while cheap water transportation allowed modest sales in the central and lake states as well. Consumers valued anthracite because it was comparatively clean to handle, while burning resulted in a fine ash with fewer clinkers than characterized combustion of its bituminous cousin. Finally, hard coal was expensive, but for heating, hot water, and cooking, it was the fuel of choice for those who could afford it. About World War I, the Bureau of Labor Statistics tabulated use of anthracite and bituminous coal by income level and the data confirm that hard coal was the fuel of the well-to-do who were more willing to pay for its cleanliness than were lower-income households.<sup>8</sup>

In the years before World War I, with Progressives worrying about natural resource waste and scarcity, anthracite was one of the resources they had in mind. In 1907 Chief of the US Forest Service Gifford Pinchot warned

a popular audience that reserves of anthracite would last only fifty years. Members of the US Geological Survey (USGS) also worried that the United States squandered its natural resources. They too thought that anthracite had a gloomy future, reasoning its geographic concentration and the increasing difficulties of mining the deeper seams foreshadowed long-term cost increases, further narrowing the market. Anthracite was becoming “more and more a luxury,” a writer for the US Bureau of Mines claimed in 1911 for he thought, “prices must advance with the increasing cost of production.” The maximum output, the writer concluded, would likely be about 100 million long-tons followed by decline. A decade later the US Coal Commission saw the anthracite problem in nearly identical terms. It also stressed the “increasing natural difficulties” that reduced labor productivity, although the problem reflected as well, the commission believed, a shortage of unskilled labor.<sup>9</sup>

The forecast of 100 million tons proved almost quite accurate (fig. 3), but the Malthusian explanation of scarcity was at best partly correct. Output per worker-hour in hard coal did indeed stagnate in the early decades of the twentieth century, and with rising wages this led to sharply increasing costs. As a



**FIGURE 3** Anthracite: Peak and decline, 1900–1950. *Source:* US Geological Survey and Bureau of Mines, *Mineral Resources of the United States* and *Minerals Yearbook*, various years.

result, between 1910 and 1925 anthracite prices rose about 50 percent relative to the price of bituminous coal. Yet this productivity stagnation seems to have reflected company lethargy more than natural scarcity, for beginning in the mid-1920s, as companies invested in better technology, labor productivity began to rise and the fuel's relative price declined. Moreover, even without rising prices, competition from new fuels would have reduced the demand for anthracite.<sup>10</sup>

In retrospect, it is easy to see that worries over anthracite shortages were overblown, for while the rise in urban populations raised coal demand, other demographic changes were reducing its growth. Urbanization was shifting people from single-family dwellings to apartments, which were more fuel-efficient and burned the smaller, more available sizes of anthracite. A New York City fuel survey of 1936 pointed out that single-family dwellings had fallen from nearly 32 percent of the total in 1921 to 20 percent in 1936 with the remainder being, of course, multiple-family dwellings. Moreover, the largest apartment buildings used about 24 percent less coal than the smallest buildings to heat a given volume of space. Similar trends were occurring nationwide. These events, the survey concluded, were "most unfavorable to anthracite."<sup>11</sup>

While they reduced the growth of anthracite sales, such demographic changes could not have resulted in the disintegration depicted in figure 3, for all fuels faced the same problems and some of them experienced sales growth. Rather, the collapse in sales resulted because anthracite had, after 1900, become highly vulnerable to competition. While well aware of the rise of substitute fuels, writers at the USGS and the Coal Commission failed to grasp the magnitude of the threat. Indeed, so powerful was the Malthusian vision that the commission saw substitute fuels as merely a stopgap. "To eke out the inadequate supply of anthracite each year the waning supply must be supplemented by increased use of other fuel," it warned. Yet as a high-priced fuel, hard coal could not defend against lower-cost alternatives, especially if they might duplicate some of its advantages. Because one of its selling points was convenience (less dirt; fewer clinkers), anthracite was susceptible to attack from more convenient fuels. Substitutes would do more than supplement the anthracite market, however. In 1930, well before natural gas or oil had any significant market impact, anthracite sales were off about 30 percent from their wartime peak. The combination of rising prices for hard coal along with largely independent innovations in other fuel markets had put anthracite on the road to oblivion.<sup>12</sup>

## THE RISE OF SUBSTITUTE FUELS

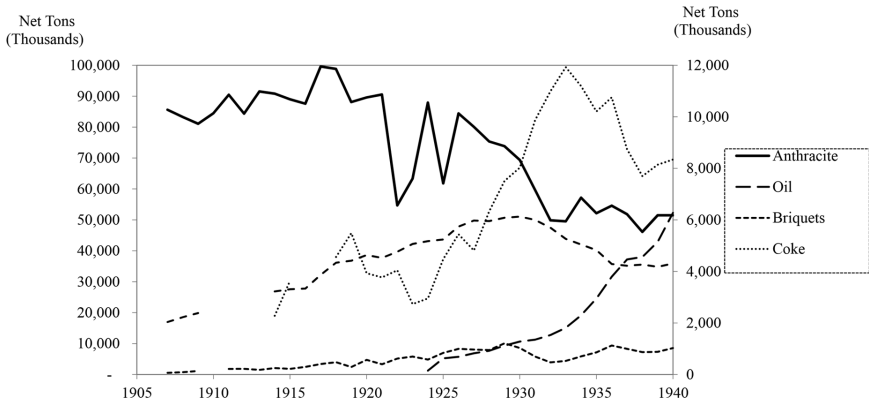
The World War I boom in anthracite was an aberration. In fact, anthracite production grew only about 1.5 percent a year in the decade ending in 1917. Substitutes, like mice, had been nibbling away at hard coal markets for years, retarding its growth.<sup>13</sup> As noted, anthracite had once been an industrial fuel, but by 1900 its bituminous cousin had long since supplanted it for most uses. For buyers of domestic fuel, there were a number of choices, and households of varying incomes and tastes no doubt balanced price against fuel characteristics. With the exception of East Coast cities, most burned cheaper bituminous coal for heat and hot water. Thus, while Boston households used no soft coal around World War I, in Chicago homeowners burned 20 percent more of it than they did hard coal; and in Cleveland 36 percent more, while Cincinnati, Columbus, and St. Louis households burned no anthracite at all. By World War I, kerosene stoves had been competing with anthracite for decades. Although some areas such as West Virginia and southern Ohio used natural gas, in general it provided little competition for anthracite during these years.<sup>14</sup>

In addition to direct competition with bituminous coal, by 1900 anthracite faced increasing competition from three other fuels—manufactured gas, coke, and fuel briquettes—all of which derived from its bituminous cousin.<sup>15</sup> Figure 4 presents data on consumption of anthracite and other domestic fuels except for soft coal for which there are no data. For comparison, the figures extend to 1940. “For domestic purposes, coke and gas, the products of bituminous coal, are competing more and more with anthracite in the markets of the larger cities and towns,” the USGS reported in 1907. Manufactured gas was the most important of these competitors. By 1900 every large city and many small towns had a coal gas plant that derived its product from the distillation of bituminous coal. Gas producers also sold the byproduct (gashouse coke) for domestic fuel. Gas from these sources was expensive but as electricity increasingly drove it out of illumination after 1900—and as economies of scale and technological change reduced its cost—manufactured gas became increasingly employed for cooking and in stoves and radiators for heat. By 1905 these sources produced about 108 billion cubic feet of gas, the equivalent of around 2.3 million tons of hard coal.<sup>16</sup>

A second source of gas came from the byproduct coke ovens that increasingly supplied coke for steel making. By 1915 producers were selling about



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**FIGURE 4** Anthracite and some of its competitors, 1907–1940. *Source:* These data derive mostly from USBM *Mineral Resources*, part 2, various years. Manufactured gas figures are from Jacob Gould, *Output and Productivity in the Electric and Gas Utilities, 1899–1942*, National Bureau of Economic Research 47 (New York: NBER, 1946). Data on coke and gas prior to 1923 are approximated. Gas and oil are expressed as coal-equivalents. Coal and oil left axis; all others right axis.

27 billion cubic feet of byproduct gas for domestic purposes and the expansion of coking during the wartime boom would soon increase this total. In 1930 manufactured gas from all sources used for domestic consumption totaled 281 billion cubic feet; not all of this displaced anthracite but much of it did, and was equivalent to 6.3 million tons of hard coal.

Coke, as noted above, resulted from the destructive distillation of soft coal. Nearly pure carbon, it was cleaner to handle and burn than bituminous coal, easier to light than anthracite and had roughly the same heating value. Its disadvantages were that it required more tending than did anthracite and, because it was lighter, took more bin space. Gashouse coke had long been available for domestic fuel, typically selling at one to two dollars a ton below anthracite in local markets near the gas plant. Because producers needed to operate byproduct coke ovens full-time, it too began to penetrate the domestic fuel market. Byproduct coke also required educational efforts for it was harder and more difficult to light than the gashouse product. In 1923 domestic coke from all sources amounted to about 2.7 million tons (fig. 4); thereafter sales took off, peaking at nearly 12 million tons in 1933. Most coke

production was in the Northeast; a 1930 Bureau of Mines survey found consumers used 90 percent of domestic coke in the north central or middle Atlantic States, where it competed directly with anthracite.<sup>17</sup>

Byproduct coking meshed nicely with Progressive Era ideals about reducing waste of natural resources. It was a far more efficient way to produce coke than was the older beehive process that wasted all the byproducts. The same logic made coke a better domestic fuel than raw coal. The Bureau of Mines explained that its use for domestic heating would “save many valuable by-products that are wasted when [bituminous] coal is used directly in the raw state.” Finally, like anthracite, coke was smokeless. In the years before World War I urban Progressives began campaigns to pass city smoke ordinances and the bureau urged that this too made coke an attractive fuel, and far more widely available than anthracite.<sup>18</sup>

Like coke, coal briquettes warmed Progressive hearts as well as their hearths for they too embodied what the Bureau of Mines termed “practical conservation.” Briquettes, which in shape and form resembled modern charcoal briquettes, were made by combining a binder with very fine (slack) coal that would otherwise be wasted, and of which vast mountains existed. Initially, because they used coal tar as a binder, briquettes smoked, making them inferior to anthracite, and they might be expensive. But by 1940 one company marketed “Solorite” that it alleged to be a smokeless briquette. Briquette sales grew rapidly, from almost nothing in 1907 to a half-million tons in 1920 and over a million tons in the last year of that decade (fig. 4). Their natural market was near a cheap supply of fuel, yet protected from coal competition by high transport costs. The lake states of Wisconsin and Michigan fit this profile as their docks contained vast stores of slack.<sup>19</sup>

Domestic fuel choices were difficult to change for they embodied both the physical investment in heating plant and the hard-won expertise in the use of a particular fuel. As contemporaries understood, for families to shift to a substitute fuel they first had to learn how to use it. The incentive to learn was the possibility of better or cheaper energy and that motive was ongoing, assisted by articles in women’s magazines and by self-interested suppliers. In 1902 a writer in *Good Housekeeping* stressed one aspect of gas cooking that must have appealed to many housewives: “The woman with a gas stove can economize a good many steps and many minutes by arranging a number of pantry things and cooking aids close by her stove. When one uses coal this cannot be done: dirt and ashes would keep things constantly dirty.”<sup>20</sup>

Before World War I, only the gas industry engaged in significant sales promotion. Gas producers had strong motives to advertise because the market for illumination faced disruptive competition from electricity, resulting in underused capacity. Gas producers undertook aggressive local promotions and coordinated in national campaigns through trade associations. In 1906 the American Gas Institute polled its members on their various methods of getting new business, and the focus by that time was on expanding gas use for cooking and water heating. The replies provide a glimpse into sales practices of that day. Nearly all employed newspaper advertising, sometimes in foreign-language papers as well. These ranged from the bland to snappy one-liners that played on themes such as modernity and comfort. "Might as well make your own shoes or weave your cloth as use a coal range. Cook with gas." "Who is afraid of the hot weather with a gas range in the kitchen?"<sup>21</sup>

A theme that runs through company responses was the need for good, efficient, honest service, for a bad reputation was disaster. Indeed, several companies taught meter-reading classes for customers, and because gas was expensive they provided tips on economical use with slogans such as "matches are cheaper than gas." Bulk mailings were widely employed as well. Most companies offered appliances in addition to gas and the Battle Creek (Michigan) Gas Company sent out a mailing informing its recipients "The price of one cigar a day would buy your wife a [gas] range." Most companies hired "solicitors," women who made house calls providing advice, home cooking demonstrations, and free items such as waffle irons or horse blankets emblazoned with "Cook with Gas." L. C. Graham of the Winona (Minnesota) Gas Light and Coke Company explained why companies favored women for these jobs. "We find lady canvassers are better than men for selling gas ranges. It is possible for them to get in closer touch with the ladies and analyze the situation better and follow up what a man would think a poor prospect and turn it into a sale."<sup>22</sup>

Many gas companies marketing stoves and heaters did so on time and at cost or sometimes at a loss; they might also throw in free installation. The Bedford (Indiana) Heat and Power Company even provided 5,000 cubic feet of free gas for stoves bought in March. There were endless contests: the person writing the best ad might get a free range, or there might be cash for the "lady baking the best loaf of bread, or cake on a gas range." The Bridgeport (Connecticut) Gas Light Company had women demonstrators in the office baking pastries. Some companies that included gas, electricity, and transit advertised on their trolleys. The Butte (Montana) Gas Light and

Fuel Company's offering, read, "Everybody works but mamma, 'cause she uses a gas range." Mamma's view of this assessment has not been recorded.<sup>23</sup>

As the market for gas expanded, utilities producing coal gas inevitably generated an increasing amount of coke. Protected by the high cost of shipping anthracite, coke usually sold in local markets at slightly less than the price of hard coal, but to make the sale companies had to employ many of the techniques they used to market gas. Here again the sales material included a strong dose of information, for—as noted—coke needed to be handled and burned differently than either anthracite or bituminous coal. Rome (New York) Gas and Electric made a virtue of coke's light weight, advertising it as the perfect fuel for "dainty women." That company also emphasized the cleanliness of coke, distributing it in white wagons with drivers wearing white costumes. It claimed that coal wagons, by contrast, were black and dirty and looked like a funeral procession. Albion (Michigan) Gas Light successfully increased coke sales by arranging with local hardware stores to donate a quarter ton of coke with each gas stove sold. In some towns, grocery stores sold coke on commission and offered free samples from the gas company. Fort Dodge (Iowa) treated its coke and gas as complements, not substitutes, offering gas stoves with a side-arm heater to burn coke. In 1913 booming gas demand faced Detroit City Gas Company with the need to double its coke sales, which they accomplished by a stepped-up campaign featuring the usual mix of billboards, trolley ads, and discount coupons.<sup>24</sup>

There were also industry-wide campaigns to sell gas. As noted above, the National Commercial Gas Association (NCGA) created the character Nancy Gay, who began appearing in advertisements in 1914. About the same time the association also sponsored "Gas Range Week" that featured advertising in major magazines such as *Literary Digest* and *Saturday Evening Post*.<sup>25</sup>

These various marketing campaigns got an enormous boost from the declining price of gas, which fell steadily in real terms: adjusted for inflation gas prices were 27 percent lower in 1915 than they had been in 1899, while by comparison anthracite prices had been rising. These price declines, along with cleanliness and ease of use, made gas increasingly attractive for cooking and water heating. Gas also steadily encroached on anthracite as a secondary source of heat in room heaters or gas radiators and in the spring and fall when adjusting the heat from coal fires was difficult.<sup>26</sup>

Still, until World War I, households rarely chose manufactured gas for central heating; the reason was cost. Data on prices and efficiency for 1915 indicate that gas might be five times as expensive as anthracite.<sup>27</sup> Yet change

was already underway. In 1917, perhaps because of its access to low-cost coke-oven gas, Consolidated Gas and Electric Company of Baltimore pioneered the introduction of manufactured gas for domestic central heating. After considerable testing and experimentation with rates and heating systems, the company offered gas at \$.35 per thousand cubic feet for purchases in excess of 4,000 cubic feet. With anthracite by then selling at about \$18 dollars a ton, gas heat had finally become economic.<sup>28</sup>

While the jump in gas prices associated with World War I set back its use for central heating, gas continued to spread slowly during the 1920s. The use of special rates for heating became more common and to avoid the shock that might arrive with January bills companies devised ways of averaging monthly payments. Initially utilities had been unwilling to install gas-conversion burners in existing coal furnaces as they often proved inefficient and therefore expensive to run. Such a policy, of course, raised installation costs and restricted markets. Gradually, however, conversion burners improved and by 1929 their sales outstripped those of gas furnaces and boilers. Because of the expense of gas, utilities also encouraged the use of better house insulation and some offered gas conversion packages that included insulation and weather-stripping. Consumption of manufactured gas for all domestic purposes peaked in 1931, equivalent to about 6 million tons of coal. Its slow decline thereafter reflected the shift from manufactured to natural gas as well as the increasing competition from oil (see fig. 4 above).<sup>29</sup>

#### LABOR AND WARTIME DISRUPTIONS

The demographic changes discussed above and the rise of substitute fuels help account for the gradual cessation of growth and then sharp decline in anthracite sales before 1930. Recurrent strikes and the output disruptions resulting from World War I assisted these longer-term forces. The labor disruptions resulted not only in major price spikes, but also in shortages—coal was sometimes unobtainable at any price—and in quality deterioration. These shocks encouraged producers to enter new geographic markets and encouraged consumers to experiment with alternative fuels, thereby speeding up learning.<sup>30</sup>

Anthracite began the twentieth century with a labor disruption in 1900 but the great strike of 1902, lasting 163 days, was far more important. The *Boston Globe* reported that consumers, in shifting to bituminous coal, were

“learning that they could do without anthracite,” and that some markets were “permanently lost.” In Philadelphia and New York the strike increased the use of bituminous coal and the resulting air pollution resulted in “soft coal eye.” About the same time the *Chicago Tribune* reported large sales of gas and kerosene heaters while anthracite burners were “a drug on the market.” The strike also moved public institutions in that city to shift from anthracite to bituminous coal, allowing the producers of low-volatile “smokeless” bituminous coal from West Virginia to gain a beachhead in Chicago. The USGS also noted that the strike caused use of coke and gas in New York City, while households in Baltimore shifted from hard to soft coal. Users of the smaller sizes (apartment and commercial buildings), the Survey later observed, had been “driven to bituminous coal” by the strike and continued to use it afterwards.<sup>31</sup>

Wartime disruptions after 1916 boomed the demand for gas in Baltimore and per capita use doubled between 1916 and 1922. “Many new homes are built without a coal range in the kitchen so that gas alone is used,” Johns Hopkins University professor of economics Jacob Hollander told the Coal Commission. “Gas water heaters are also coming into common use,” he observed.<sup>32</sup> Wartime shortages seem to have yielded quality deterioration in hard coal as well. Individual anthracite producers had developed standards for size and impurities in coal and would condemn shipments exceeding the limits, but the Federal Trade Commission discovered that condemned shipments dropped sharply during the period of shortage in 1916. It seems unlikely that this reflected an outbreak of quality control, for households complained that their coal contained so much stone and slate that some termed it “fireproof.”<sup>33</sup>

In 1917 shortages of bituminous coal in the East led the US Fuel Administration to allocate a disproportionate share of 1918 anthracite production to eastern states. This surely accelerated consumer education about alternative fuels in those other states receiving sharply diminished supplies. The federal government also did its part to speed learning about alternatives, for the Bureau of Mines and US Fuel Administration published brochures on that topic. The war immensely expanded byproduct-coking capacity as well, leading that industry to push more strongly into domestic markets for manufactured gas and coke in the postwar years. Koppers, for example, began to market coke in New York City as early as 1919.<sup>34</sup>

Table 1 presents sales by state of domestic anthracite for 1916 and 1921, two “normal” years. As noted above, use of domestic anthracite was concentrated

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TABLE 1. Geographic Distribution of Domestic Anthracite Sales, 1916 and 1921

	Net Tons		
	1916	1921	Change
New England	9,938,863 (17.08%) <sup>a</sup>	9,234,675 (19.32%) <sup>a</sup>	-7.09%
Maine	620,808 (1.07%)	614,306 (1.28%)	-1.05%
New Hampshire	352,326 (0.61 %)	398,042 (0.83%)	12.98%
Vermont	349,374 (0.60%)	334,100 (0.70%)	-4.37%
Massachusetts	5,636,662 (9.69%)	5,399,677 (11.29%)	-4.20%
Rhode Island	739,652 (1.27%)	681,185 (1.42%)	-7.90%
Connecticut	2,240,041 (3.85%)	1,807,366 (3.78%)	-19.32%
Atlantic States	31,452,931 (54.05%)	31,176,797 (65.21%)	-0.88%
New York	15,870,681 (27.27%)	15,756,030 (32.96%)	-0.72%
New Jersey	5,320,870 (9.14%)	5,176,250 (10.83%)	-2.72%
Pennsylvania	8,109,089 (13.94%)	8,250,721 (17.26%)	1.75%
Delaware	250,779 (0.43%)	232,805 (0.49%)	-7.17%
Maryland	1,045,557 (1.80%)	954,078 (2.00%)	-8.75%
District of Columbia	590,087 (1.01%)	583,737 (1.22%)	-1.08%
Virginia	265,868 (0.46%)	223,937 (0.47%)	-15.77%
Central States	5,583,395 (9.59%)	4,458,340 (9.33%)	-20.15%
Ohio	649,914 (1.12%)	463,802 (0.97%)	-28.64%
Indiana	512,234 (0.88%)	329,310 (0.69%)	-35.71%
Illinois	2,639,102 (4.54%)	2,252,036 (4.71%)	-14.67%
Michigan	1,782,145 (3.06%)	1,413,225 (2.96%)	-20.70%
Northwest	3,207,805 (5.51%)	2,577,323 (5.39%)	-19.65%
Wisconsin	1,343,953 (2.31%)	1,469,803 (3.07%)	9.36%
Minnesota	1,177,898 (2.02%)	835,933 (1.75%)	-29.03%
Nebraska	177,610 (0.31%)	59,071 (0.12%)	-66.74%
North Dakota	271,509 (0.47%)	105,959 (0.22%)	-60.97%
South Dakota	236,835 (0.41%)	106,557 (0.22%)	-55.01%
Trans Mississippi	864,848 (1.49%)	359,752 (0.75%)	-58.40%
Iowa	469,610 (0.81%)	192,489 (0.40%)	-59.01%
Missouri	197,882 (0.34%)	100,176 (0.21%)	-49.38%
Nebraska	177,610 (0.31%)	59,072 (0.12%)	-66.74%
Kansas	19,746 (0.03%)	8,015 (0.02%)	-59.41%
Total	51,047,842 (87.72%)	47,806,887 (100.00%)	-6.35%

Source: *Mineral Resources*, 1917, 1245; US Coal Commission, part 2, 685.

Note: Includes exports and railroad fuel; excludes steam sizes and coal used at mine. Data are in net (2,000 lb) tons.

<sup>a</sup>Percent of total.

in New England and the Mid-Atlantic states. These data also suggest that the wartime changes were important. Anthracite sales had been growing slowly for some time, but they declined about 15 percent from 1916 to 1921. Moreover, the greatest decline was in those central and northwestern states where distance had made anthracite expensive and marginal before the war and that had experienced the greatest wartime shortages. It seems clear, therefore, that anthracite was in trouble long before the two great strikes of 1922 and 1925–26.

Industry problems extended to the smaller “steam” sizes as well. These had been a steadily increasing share of output, rising from about 23 percent of all shipments in 1890 to 33 percent in 1922. Sold at a loss in competition with soft coal as boiler fuel, they contributed to companies’ financial health as long as their sales covered out-of-pocket costs. However, as *Coal Age* reported in 1925, the price spread between domestic and smaller sizes widened even as their market shrunk; the journal also claimed that they rarely sold beyond a 100-mile radius from the mines.<sup>35</sup>

Two immense strikes—one in 1922 lasted 163 days and another in 1925–26 dragged on for 170 days—also hastened the shift away from anthracite. In the 1922 episode the industry followed wartime precedent and instituted its own geographic allocations and, as in wartime, these disproportionately favored eastern consumers. Moreover, with domestic hard coal scarce and expensive, entrepreneurs saw their chance. Imports of hard coal, much of it from Wales, jumped from virtually nothing to 234,000 tons in 1922. Thereafter, they would range from that figure to as high as 800,000 tons (most of which went to New England) despite a two-dollar-per-ton tariff applied in 1932. The rise of imports was one manifestation of a revolt against domestic anthracite in New England, as the region collectively seemed determined to escape the cycle of strikes and shortages that resulted from dependence on American producers. Massachusetts appointed a fuel administrator with “wartime powers,” who promptly urged consumers to shift to soft coal. In 1923 Boston’s municipal buildings switched from coal to coke for fuel.<sup>36</sup>

That strike also appears to have reduced product quality. In the summer of 1923 the Bureau of Mines took samples from anthracite stocks at Massachusetts retailers. In one of the steam sizes (“Buckwheat #1”) it found impurities (“ash”) averaging 19 percent while some samples of domestic sizes contained as much as 46 percent ash.<sup>37</sup>

Even before the 1925 strike the *Boston Globe* was reporting, “a very large number of New Englanders have switched from hard to soft coal.” Late that



year *Coal Age* noted a “Bitter Anti-Anthracite Campaign in New England.” The moving force behind the efforts to reduce anthracite use was the New England Governors’ Council and especially Massachusetts governor Alvin Fuller and John Hays Hammond, formerly of the US Coal Commission. Remarkably enough, Hammond at least urged the federal government to stay out of the way, apparently believing that it might interfere with New England’s efforts to punish producers by weaning the region from anthracite. Aside from a publicity campaign featuring a “war to end war” with anthracite, the council’s most important work was to provide information on the availability and use of alternative fuels. It publicized the efforts of the West Virginia Smokeless Coal Operators to gain a foothold in New England markets. When those operators opened an advertising booth to display their wares on Boston Common, Governor Fuller inaugurated the festivities by shoveling the first scoops of coal.<sup>38</sup>

The Bureau of Mines and the council also tried to educate consumers on the advantages and techniques of burning soft coal as well as coke. In a 1923 report that sounded like an advertisement for the smokeless coals, the bureau concluded:

The “smokeless” Pocahontas [coals] . . . are higher in heat value and usually contain less ash than anthracite; and as a general rule they can be bought considerably cheaper . . . the purchaser actually gets almost twice the amount of available heat for his money.<sup>39</sup>

By December 1927, with anthracite at \$16.50 a ton on its way to \$18, the Massachusetts Special Commission on the Necessaries of Life underlined the bureau’s claim that adjusted for heating value, the cost of smokeless coal was about half that of anthracite. An assist in these efforts to shift New England away from anthracite came from the Interstate Commerce Commission, which established new, lower joint freight rates on coal from West Virginia to New England. Rising prices again attracted imports, including anthracite from Wales and coke from Scotland. Massachusetts coke sales from all sources jumped from about 270,000 tons 1924–25 to 500,000 in 1925–26.<sup>40</sup>

With local variation, similar events played out in New York, Philadelphia, Chicago, and other cities. Noting the increasing availability of coke, the *Chicago Tribune* editorialized “it is the consumer’s chance . . . [for] independence.” Indeed, while consumers in that city used about twice as much soft as hard coal around World War I, by the mid-1930s they used about five times

as much. In New York the state and city began an educational campaign in 1925 to explain to households the proper way to burn soft coal. The *New York Times* reported that Pennsylvania byproduct coking plants were stepping up production for New York markets. Since the 1922 strike, the state's gas plants had added 60 million cubic feet a day of capacity. New York State's coke capacity had risen from 150,000 tons to a million tons a year in the past three years, and Schenectady, Troy, Watertown, Buffalo, Syracuse, Rochester and a number of other cities and towns were now using coke.<sup>41</sup> As figure 4 (above) demonstrates, oil's importance was modest as late as 1930; use of manufactured gas grew steadily down to about 1931 while coke sales grew slowly to 1923, after which time they boomed until the middle 1930s. The strikes and World War I disruptions were important, but they only hastened the diffusion of substitutes for anthracite that had been underway for decades.

The Bureau of Mines summarized the hard-coal situation in 1927 observing, "Over a period of years there has been a gradual downward trend in the tonnage taken by certain important anthracite markets." About that time an editorial in the *New York Herald Tribune* captured the changes. "Just a generation ago coal hods were big sellers in every American city. . . . They were the symbol of anthracite. . . . Today you strain your eyes looking for [one]."<sup>42</sup>

#### ANTHRACITE STRIKES BACK

Monopolists are not noted for addressing consumer complaints with alacrity, and the anthracite producers failed to respond to inroads in their sales from other solid fuels and gas until the mid-1920s. In 1922 *Coal Age* reported a large producer that still seemed indifferent to the concerns of its customers. Companies did little advertising. In 1925 the *Age* decried the lack of merchandizing and reported that "from producer to retailer [the industry] has been nothing but an assemblage of order takers." In 1928 it recalled the "dead level of complacent self-sufficiency" that characterized most producers right after the war. Dealer relations were often poor. The industry's trade association—the Anthracite Operators Association—largely focused on labor relations and did no research. There was little coordination with furnace makers.<sup>43</sup>

Anthracite producers belatedly woke up to the threat, for the first real changes did not begin until 1925 when producers finally adopted industry-wide quality standards.<sup>44</sup> The companies had rejected standards when the US Coal Commission recommended them in 1923, but apparently reconsidered, as poor quality-control (noted above) resulted in a chorus of complaints

from dealers. "The present lack of uniformity . . . [in] sizing and preparing coal . . . gives rise to much of the criticism, complaint and ill-will on the part of consumers," the National Retail Coal Merchants Association reported. Moreover, the industry was then trying to interest consumers in smaller sizes of coal and if these contained too much ash they simply would not burn in domestic furnaces. The first standards governed size and percent of impurities. A new inspection service was to ensure compliance. Because they reduced the quantity of marketable output per ton of coal mined, the standards had the effect of reducing productivity and raising costs. They were tightened in 1927, but they did improve quality: a 1935 survey found that impurities in Buckwheat #1 dropped from 18 to about 11 percent.<sup>45</sup>

In 1927 a subgroup of the Operators Conference began the Anthracite Coal Service, to improve dealer relations with an eye to better customer service. Dealers and producers had long been wary allies. In 1925 New England dealers complained that producers sometimes sold to large customers at the same price they gave to dealers, while many dealers returned the favor by carrying coke, bituminous coal, and fuel oil. The Coal Service established regional offices as far west as Minneapolis that offered dealer training in combustion so that they could provide furnace services to customers. By 1929 it had supplied instruction to employees of nearly 1,800 retailers in 111 cities. The Coal Service began *Anthracite Salesman*, distributing about 14,000 copies a year to dealers. Many consumer complaints, dealers discovered, reflected either improper firing techniques by consumers or faulty equipment. Soot buildup on the boiler, for example, was a wonderful form of insulation and might result in skyrocketing coal consumption to maintain comfortable temperatures.<sup>46</sup>

In 1927 the Bureau of Mines described the Mount Carmel Conference as a "united effort on the part of operators, miners, distributors, consumers and all others interested in the economic welfare of the anthracite region." Resulting in an Anthracite Cooperative Association (later the Anthracite Institute), it focused on public relations, taxes, and freight rates. In 1929 producers also established a credit bureau to aid company sales.<sup>47</sup>

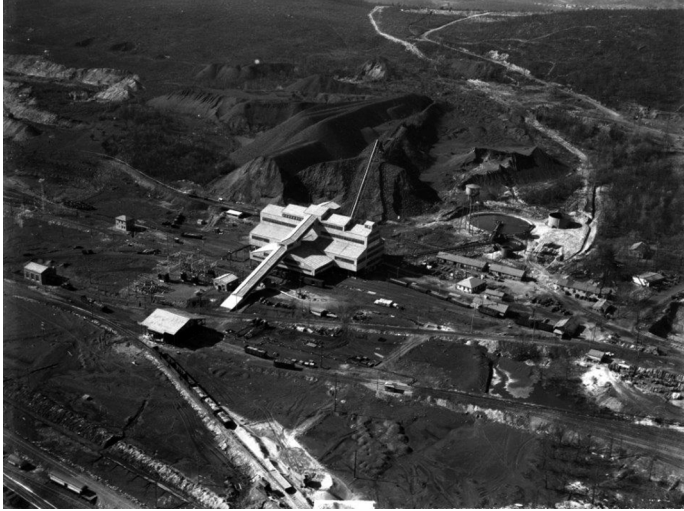
Motivation for these early efforts was competition from other solid fuels and manufactured gas, not oil. In 1925 New England dealers concluded that bituminous coal and its derivatives (coke, electricity and manufactured gas) were "more menacing" than oil. A year later Edward Parker of the Anthracite Information Bureau informed the American Mining Congress that oil competition would "grow less menacing." Such hopes reflected the pronouncements of a chorus of experts that the United States would soon run out of

oil. As late as 1932, two years after the discovery of the enormous East Texas oil field, the Federal Oil Conservation Board was still warning of a “paradox of a present oversupply in the face of ultimate shortage.”<sup>48</sup>

By 1928 anthracite had belatedly woken up to the threat posed by competition. That year the Bureau of Mines reported that industry was “assisting in the development” of mechanical stokers that would feed smaller, cheaper sizes of anthracite. In 1929 producers formalized an Anthracite Equipment Corporation to encourage technical improvements in furnaces. Mechanical stokers fed coal from a hopper and therefore required much less tending. They might be thermostat-controlled and some came with automatic ash removal as well. Stokers seemed to be the key to meeting gas and oil competition and by 1936 several coal companies manufactured their own, and all encouraged dealers to carry them as well. Stokers reemphasized the need for clean coal, for stone might clog the mechanism potentially breaking a shear pin or causing motor overload. Yet “automatic anthracite,” as companies termed these developments, was a mixed blessing. Bituminous producers also awakened to the need for better marketing and they too began to develop stokers, ensuring that hard coal was unlikely to make sales gains from that direction. In addition, because stokers used smaller, less profitable sizes, unless they expanded the *overall* anthracite market their use might prove suicidal. *Coal Age* pointed out as early as 1925: to induce consumers to purchase, say, Buckwheat #1 if its sales came at the expense of domestic sizes would *reduce*, not increase, profitability.<sup>49</sup>

By the mid-1920s anthracite also had a price problem. In 1924 a representative of the gas industry happily predicted that the higher prices resulting from the 1922–23 strike settlement “will automatically sell . . . over 7½ billion cu. ft. of manufactured gas in New York State alone.” Anthracite prices had been creeping up relative to bituminous coal as well. The average mine price of hard coal had stood about 80 percent above the mine price of bituminous coal before World War I but had risen to 2.5 times soft-coal prices by the middle 1920s. In Chicago anthracite retailed for \$17.19 a ton in October 1925 while soft coal sold at \$8.99.<sup>50</sup>

In response, companies improved testing for size and purity; they employed new flotation methods and began major investments in breakers and washeries to producer cleaner coal (fig. 5). Large producers also speeded up underground mechanization in order to control costs. *Coal Age* began featuring many stories such as “Machines Help Anthracite Regain Lost Markets.” In 1927, the first year the Bureau of Mines gathered such data, about 5 percent of anthracite came from strip mining or was loaded



**FIGURE 5** A March 22, 1930, aerial view of the Locust Summit Coal Breaker, Northumberland County, of the Philadelphia and Reading Railroad symbolized coal companies' efforts to mechanize. It was at one time the largest breaker in America. Courtesy: Pennsylvania State Archives, Aero Service Company Photographs (MG-416, #12135).

mechanically underground; by 1940 these increased to about 31 percent of the total. Accordingly, labor productivity (output per worker-hour), which had stagnated between 1903 and 1926, rose about 61 percent between that year and 1940 even as product quality improved.<sup>51</sup>

In 1928 the industry held a research conference and soon contracted with Frost Research Laboratory, which undertook investigations aimed at improving stokers, finding new markets for anthracite, and possible uses for coal ash. In the early 1930s a research division of the Anthracite Institute replaced this arrangement and it cooperated closely with scientists at Penn State.<sup>52</sup>

Anthracite began a marketing campaign about 1927. The Philadelphia and Reading Company inaugurated newspaper and some magazine advertisements. Rather belatedly it proclaimed the smoke-control benefits of anthracite with ads urging, "let a little sunshine in." A number of other producers and dealers combined to advertise "cert-i-fied" anthracite, stressing quality. These early advertising campaigns aimed at anthracite's core market, appearing in East Coast newspapers. They rarely employed humor and visual images were often uninteresting. The campaign soon petered out. There were

trademarking efforts as well; Reading advertised that it had “Fyrewell” coal, a small amount of which would allegedly work wonders when added to the coal pile. Another company included cardboard advertisements in its coal and in 1929 Glen Alden and the Delaware Lackawanna and Western mines began to dye their product and advertise “Blue Coal” (fig. 6). Such a focus,

# STOP GAMBLING ON COAL!



**AT LAST** a way to tell the best coal every time you order

*America's biggest producers of home fuel now color the finest hard coal BLUE . . .*

**HOW** often you've talked this way, before ordering your winter's fuel, "Coal is coal—I can't tell how good it is by looking at it."

You can now. For the finest anthracite in the world now comes to you actually tinted an unmistakable blue. Its name is 'blue coal.'

'Blue coal' is the famous D. L. & W. Scranton and Wilkes-Barre anthracite which for over 50 years has been the largest-selling home fuel in America—coal that has achieved tremendous popularity because people found from experience that it was the most satisfactory fuel that money could buy.

Then why color it blue, you naturally ask? Here's why—so that you can tell at a glance this high quality hard coal—so that you can be downright sure that you get it every time you order it.

This blue color is your positive guarantee that you are getting full tons of the finest anthracite from the Northern Pennsylvania hard coal region! Anthracite that has been washed and reworked by millions of gallons of rushing water to free it of wasteful impurities. Anthracite that has reached a new state of perfection, due to the employment of the most modern and ingenious engineering methods in its preparation.

Not only that, 'blue coal' burns long and evenly and doesn't need an excessive draft which forces most of your heat up your chimney. 'Blue coal' furnishes the maximum of useful heat because it burns evenly and completely.

If we weren't proud of 'blue coal' we wouldn't dare trademark it so unmistakably. It's blue because it's best.

The comfort of fewer trips to the cellar—the thrill of getting almost instantaneous response to your draft control regardless of weather conditions, the joy of not having to watch the fire continually—will begin for you the moment you fill up your bins with 'blue coal.' Get in touch with your nearest 'blue coal' dealer today.

*Copyright, Scranton, Lackawanna & Western Coal Co.*

## 'blue coal'

*Better heat for less money*

FIGURE 6 Branding coal failed to stem loss of markets to coke, briquettes, manufactured gas, and bituminous coal. Courtesy of *The Brooklyn Daily Eagle* (Brooklyn, NY) February 14, 1933, page 11.



emphasizing one supplier of hard coal over another, seems entirely misplaced in the face of interfuel competition.<sup>53</sup>

Spokesmen for hard coal in the early 1930s were invariably upbeat, claiming that these measures would soon reverse the decline in anthracite sales. With hindsight, it is clear they did not, for in the 1930s and later, oil and natural gas turned what had been a genteel decline into a rout. In 1917 production had been just short of 100 million tons; in 2015 it was just over 2 million tons.

## CONCLUSIONS AND CONJECTURES

In the twentieth century anthracite underwent two energy transitions. The first, before about 1930, was a gradual shift from coal to coal: from anthracite to soft coal, burned either directly in homeowners' furnaces, or as manufactured gas, or briquettes, or coke. The second transition, this one largely to oil and far more rapid, began about 1925, and, in the pre–World War II years, oil stole markets from both kinds of coal. Market forces dominated these energy transitions. Coke, manufactured gas, smokeless coal, and briquette producers all saw opportunity in anthracite's high prices, deteriorating quality, and supply disruptions. Public policies influenced these events at several places. While antismoke regulations had little impact in creating a demand for anthracite, wartime allocations narrowed the markets for hard coal. Requirements for through freight rates widened the area in which smokeless coal could compete, while New England's politicians made a concerted and successful effort to speed that region's transition away from hard coal.

As this article has demonstrated, to focus exclusively on the energy transition to oil and natural gas is to miss much of the story. Ultimately most households did shift from anthracite to oil or natural gas, but these fuels were like the wolves that ate the rabbit *and* the coyote that was about to eat the rabbit. Thus, it is worth speculating on how events might have differed had oil and natural gas not entered the picture as early as they did.

Anthracite's problem was that by about World War I, it no longer had much to sell. Its cost advantage over gas was eroding and even with a stoker it could not match that fuel's cleanliness, convenience, and comfort. Had oil not arrived when it did to pick off higher income households, they would likely have shifted to heating with manufactured gas instead, although perhaps more slowly. Nor was anthracite less smoky than coke or the low volatile bituminous coals, and it was usually more—sometimes much more—expensive. Had oil

not arrived, the rapid growth in coke sales would probably have continued while smokeless briquettes may also have found favor and contributed to the decline in hard coal. Even in the absence of oil and natural gas competition, there would have been no U-turn on hard coal's road to near extinction.

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#### NOTES

The author would like to thank John K. Brown as well as the editor and two anonymous reviewers for helpful comments upon an earlier draft of this article.

1. *The Story of Nancy Gay* (New York: National Commercial Gas Association, 1914); “The Smile of Nancy Gay,” *Lighting Journal* 2 (August 1, 1914): 184.
2. Much of the literature on anthracite focuses on the nineteenth century (n. 5) while work covering the twentieth century emphasizes labor issues or the social consequences of the industry's decline rather than the decline itself. H. Benjamin Powell, “The Pennsylvania Anthracite Industry, 1769–1976,” *Pennsylvania History* 47 (January 1980): 3–28, provides a broad overview but says very little about the industry's collapse. The best analyses of the decline of anthracite are Richard Mead, “An Analysis of the Decline of the Anthracite Industry since 1921” (Ph.D. diss., University of Pennsylvania, 1935) and Benjamin Michalik, “The Decline of Anthracite, 1913–1955” (Ph.D. diss., Fordham University, 1957).
3. On Schumpeterian innovations see Thomas McCraw, *Prophet of Innovation* (Cambridge: Harvard University Press, 2007), and W. Michael Cox and Richard Alm, “Creative Destruction,” *Concise Encyclopedia of Economics*, Library of Economics and Liberty, <http://www.econlib.org/library/Enc/CreativeDestruction.html>.
4. Most of the energy transition literature is highly policy focused. For a sampling see Vlacov Smil, *Energy Transitions: History, Requirements, Prospects* (Santa Barbara, CA: Praeger, 2010). Arnuf Grubler, “Energy Transitions Research: Insights and Cautionary Tales,” *Energy Policy* 50 (2012): 8–18.



- Benjamin Sovacool, "How Long Will It Take? Conceptualizing the Temporal Dynamics of Energy Transitions," *Energy Research and Social Science* 13 (2016): 202–15. Peter O'Connor, *Energy Transitions*, Pardee Papers 12 (Boston: Boston University Pardee Center, 2010). Two of the few historically detailed analyses are Martin Melosi, "Energy Transitions in Historical Perspective," in *Energy and Culture: Perspectives on the Power to Work*, ed. Brendan Dooley (Burlington, VT: Ashgate, 2006), 3–18, and Robert C. Allen, "Backward into the Future: The Shift to Coal and Implications for the Next Energy Transition," *Energy Policy* 50 (2012): 17–23.
5. A discussion of the vicissitudes of the anthracite industry in the nineteenth century is beyond the scope of this article and others have covered the topic well. See, for example, Sean Adams, "Promotion, Competition, Captivity: The Political Economy of Coal," *Journal of Policy History* 18 (January 2006): 74–95, and his *Home Fires: How American Kept Warm in the Nineteenth Century* (Baltimore: Johns Hopkins University Press, 2014); Frederick Binder, "Anthracite Enters the American Home," *Pennsylvania Magazine of History and Biography* 82 (January 1956): 82–99; Alfred Chandler, "Anthracite Coal and the Beginnings of the Industrial Revolution in the United States," *Business History Review* 46 (Summer 1972): 141–81. Thomas Winpenny provides a skeptical view of Chandler's argument in "Hard Data on Hard Coal: Reflections on Chandler's Anthracite Thesis," *Business History Review* 53 (Summer 1979): 247–55. Christopher Jones, "A Landscape of Energy Abundance: Anthracite Coal Canals and the Roots of American Fossil Fuel Dependence, 1820–1860," *Environmental History* 15 (July 2010): 449–84; Christopher Jones, "The Carbon Consuming Home: Residential Markets and Energy Transitions," *Enterprise and Society* 12 (December 2011): 790–823; Eliot Jones, *The Anthracite Coal Combination in the United States* (Cambridge: Harvard University Press, 1914); Scott Nearing, *Anthracite: An Instance of Natural Resource Monopoly* (Philadelphia: John Winston, 1915). A modern discussion of industry economics is Richard Healey, *The Pennsylvania Anthracite Industry, 1860–1902* (Scranton, PA: University of Scranton Press, 2007).
  6. Contemporary descriptions of industry economics are US Coal Commission, *Report Transmitted Pursuant to the Act Approved September 22, 1922*, parts 1 and 2 (Washington, DC, 1925), hereafter US Coal Commission, *Report*. See also US Federal Trade Commission, *Report on Premium Prices for Anthracite, July 6, 1925* (Washington, DC, 1925). Prices are from US Bureau of Mines (hereafter USBM), *Mineral Resources of the United States 1918*, part 2 (Washington, DC, 1919), 105; prior to 1910 this series was published by the US Geological Survey.
  7. For the breakdown of retail prices see US Coal Commission, *Report*, part 2, table 51.
  8. A reviewer has pointed out that anthracite will clinker, but an early study described its "relative freedom from clinker" as compared with soft coal. See Charles Stuart, "A Report of the Engineer in Chief of the Navy on the

Comparative Value of Anthracite and Bituminous Coals,” *Journal of the Franklin Institute* 24 (October 1, 1852): 228. Fuel choices by income level are from US Bureau of Labor Statistics (USBLS), “Cost of Living in the United States,” *Bulletin* 357 (Washington, DC, 1924), table E. While both soft coal and coke might substitute for anthracite, the substitutions often required learning on the part of households. See below.

9. USBM, *Mineral Resources 1911*, part 2, 19. US Coal Commission, *Report*, part 1, 53 and 55. Jacob Hollander, an economist at Johns Hopkins University, who authored one of the commission’s studies, dissented from the prevailing views on resource scarcity, ascribing the problem to monopoly instead. See his “Memorandum on Combination and Profits in the Anthracite Industry,” in US Coal Commission, *Report*, part 2, 989–1010.
10. The forecast was for 100 million long tons while the chart is in net tons so the forecast was about 10 percent too high. The prices discussed in the text are average realizations per ton at the mine. Productivity calculations are the author’s, based on USBM data. They are consistent with USBLS findings in its *Productivity and Unit Labor Cost in the Anthracite Mining Industry, 1935–1947* (Washington, DC, 1948). The best source on coal-mining productivity in these years is Keith Dix, *Work Relations in the Coal Industry: The Hand Loading Era, 1880–1930* (Morgantown: West Virginia University Press, 1977).
11. “Statistics on Fuel Used for Heating Apartment Buildings in New York City,” *Heating and Ventilating* 37 (July 1939): 60–61. New York City Office of the Coordinator for the Retail Solid Fuel Industry, *A Survey of the Fuel Situation in New York City for the Period 1926–1937 with Particular Reference to Anthracite and Bituminous Fuels* (New York, 1937), 2. For similar analysis see Albert Bemis, *The Evolving House*, vol. 2 (Cambridge, MA: MIT Press, 1936), chap. 2. The USBM also noted the impact of apartment living on fuel demand; see its *Mineral Resources 1928*, part 2, 755. These developments harmed bituminous coal as well, but only about 20 percent of its market was domestic.
12. US Coal Commission *Report*, part 1, 56. About 29 million barrels of fuel oil were burned for domestic heat in 1930. This was equivalent to a little more than 7 million tons of coal but not all of it displaced anthracite. Natural gas did not reach Chicago, Indianapolis, Minneapolis, or Washington, DC until 1930–31, while New York and New England waited until after World War II. See Arlon Tussing and Connie Barlow, *The Natural Gas Industry: Evolution, Structure and Economics* (Cambridge, MA: Ballinger, 1984), chap. 3.
13. For energy calculations, I have assumed that anthracite coal has 25.4 million btus per short ton following Sam Schurr and Bruce Netschert, *Energy in the American Economy, 1850–1975* (Baltimore: Johns Hopkins University Press, 1960), 499. The USBM estimated manufactured gas to have about 550 btus per cubic foot (*Mineral Resources 1925*, part 2, 601). Hence 46.18 thousand cuft = one ton of coal. The bureau also assumed that four 42-gallon barrels of fuel oil had the heating equivalent of one ton of hard coal.

14. Figures in the text are from USBLS, "Cost of Living," table E. Wood only accounted for about 4 percent of energy use for urban families about the time of World War I, although in rural areas its use remained surprisingly common. Natural gas competition is from USBM, *Mineral Resources 1930*, part 2, 730.
15. Neither electric heat nor electric stoves provided much direct competition to hard coal during these years, yet electricity use grew explosively. With household expenditures on electricity to run toasters, curling irons, vacuum cleaners, and similar items rising more rapidly than incomes, something had to give. While it is unlikely that families bought less coal so they could afford to run the toaster, they may have switched to a cheaper fuel. Electricity competed in other ways as well. Central power stations located near urban areas might market waste steam for heat to stores or apartment buildings, thereby reducing their demand for coal. Finally, as electricity cut into the market for manufactured gas, generating excess capacity, it spurred gas producers to enter the home cooking and heating market.
16. USBM, *Mineral Resources 1907*, part 2, 168–69. With 550 btus/cubic foot, 108 billion cubic feet \* 550 = 59,400 billion btus or roughly 2.3 million tons of coal. For a discussion of the technologies of manufacturing gas and the growth of the industry see the chapters on artificial gas in USBM, *Mineral Resources*, part 2, for 1908, 1912, 1915 and 1919. The 1919 volume has a discussion of economies of scale in gas making. See too Joel Tarr, "Toxic Legacy: The Environmental Impact of the Manufactured Gas Industry in the United States," *Technology and Culture* 55 (January 2014): 107–47.
17. If coke was clean to burn, it was not clean to make. See Tarr, "Toxic Legacy." For a discussion of coke as a domestic fuel see "Coke in a Residence Heater Designed for Coal," *Heating and Ventilating* 14 (May 1917): 19–20. A. C. Fielder, "Why and How Coke Should Be Used for Domestic Heating," USBM *Technical Paper* 242 (Washington, DC, 1920), and Rudolf Kudlich, "Fuels Available for Domestic Use as Substitutes for Anthracite Coal," USBM *Report of Investigation* 2520 (Washington, DC, 1923). For early domestic sales see USBM, *Mineral Resources, 1912*, part 2 (Washington, DC, 1913), 1166. Its geographic distribution is from USBM, *Mineral Resources, 1930*, part 2, 536.
18. Fielder, "Why and How Coke Should Be Used," 5. For the advantages of coke as smokeless fuel see C. G. Atwater, "Smokeless Fuel for Cities: Its Relation to the Modern Byproduct Coke Oven," *Cassier's Magazine* 30 (August 1906): 313–21 and George Perrot and H. W. Clark, "Smokeless Fuel for Salt Lake City," USBM *Report of Investigation* 2341 (Washington, DC, 1923). There is little evidence that municipal smoke ordinances had an important impact on consumers' fuel choices. Anthracite use was widespread before such ordinances became common and, in any event, many regulations exempted households. Nor does modern secondary literature suggest that municipalities seriously considered anthracite as a means to reduce smoke. See Joel Tarr and Carl Zimring, "The Struggle for Smoke Control in St. Louis," in *Common Fields: An Environmental History of St. Louis*, ed. Andrew Hurley (St. Louis: Missouri Historical Society,

- 1997), 199–220; Dale Grinder, “The Battle for Clean Air: The Smoke Problem in Post–Civil War America,” in *Pollution and Reform in American Cities, 1870–1930*, ed. Martin Melosi (Austin: University of Texas, 1980), 83–103; Walter Pittman, “The Smoke Abatement Campaign in Salt Lake City, 1890–1925,” *Locus* 2 (Fall 1989): 69–78; and David Stradling, “To Breathe Pure Air: Cincinnati’s Smoke Abatement Crusade, 1904–1916,” *Queen City Heritage* 55 (Spring 1997): 2–18. See too Noga Morag-Levine, *Chasing the Wind* (Princeton, NJ: Princeton University Press, 2003). While New York’s smoke ordinance says nothing about anthracite, the *Wall Street Journal* thought that it prevented apartment buildings in that city from switching away from anthracite during the strike of 1922. See “Simple as Selling Soap in Pittsburgh,” *Wall Street Journal* (August 15, 1922). In fact, as others pointed out however, there were good substitutes so in no sense did municipal smoke ordinances mandate use of anthracite. See “Plenty of Other Coal Available Should Anthracite Be Cut Off,” *New York Times*, September 9, 1923.
19. “Practical conservation” is from USBM, *Mineral Resources 1915*, part 2, 1. “Smokeless Fuel Made from Illinois # 6 Coal in the New Milstadt Carbonizing Plant,” *Coal Age* 45 (May 1940): 33–35.
  20. E[llen] M[urdock], “From Long Experience with Gas,” *Good Housekeeping* 34 (May 1902): 398.
  21. *Report of New Business Methods of the American Gas Institute of 1906* (The Institute, 1906), 121. For a discussion of gas company advertising methods during the 1920s, see Mark Rose, *Cities of Heat and Light: Domesticating Gas and Electricity in Urban America* (University Park: Pennsylvania State University Press, 1995).
  22. *Report of New Business Methods*, 144, 79, and 145.
  23. *Ibid.*, 106 and 84.
  24. *Ibid.*; “A Coke Campaign that Increased Sales Seventy-Five Percent,” *American Gas Light Journal* 101 (September 14, 1914): 166–67.
  25. “Gas Range Week,” *American Gas Light Journal* 102 (April 26, 1915): 257.
  26. Price data are census prices adjusted by the consumer price index. Werner Troesken’s price data for Chicago gas sales for this period are more complete and yield similar results. See table 2.1 in his “The Institutional Antecedents of State Utility Regulation: The Chicago Gas Industry 1860 to 1913,” in *The Regulated Economy*, ed. Claudia Goldin and Gary Liebcap (Chicago: NBER, 2008), 55–80. Consolidated Gas Electric Light and Power Company, *Annual Report, 1910–1916*. “Between-Season Gas Heating,” *Heating and Ventilating* 16 (September 1919): 41–46.
  27. Assuming anthracite had 25.4 million btus/ton and manufactured gas had 550,000 per thousand cubic feet (cuft), about 46,000 cuft of gas was equivalent to a ton of anthracite. With gas retailing at \$.93 per thousand feet, in 1915 it took about \$43 worth of gas to equal the heating value of a ton of anthracite when the latter sold at \$8.00 a ton. Adjustments for furnace efficiency only modestly reduce this disparity.

28. Thomson King, *Consolidated of Baltimore* (Baltimore: Consolidated Gas, Electric Light and Power Company, 1950), chap. 14; "Manufactured Gas for Home Heating," *Gas Age* 39 (January 15, 1917): 57–60; "Block Rates Promote Heating," *Gas Age* 45 (February 10, 1920): 103–19. USBM, *Mineral Resources 1928*, part 2, 575–76. Natural gas domestic sales about 1930 were the equivalent of 5.7 million tons of hard coal, but most of it was consumed in areas that had never used much hard coal. While a natural gas pipeline that entered Chicago in 1934 precipitated a fuel war, the duel was largely with soft coal for by then Pennsylvania anthracite had largely abandoned that city.
29. "Number of Gas Companies Promoting House Heating Shows Significant Growth," *Heating and Ventilating* 26 (February 1929): 95–98; "Economics of House Heating with Gas," *Heating and Ventilating* 26 (April 1929): 92–96; "Gas Heat in New England," *Heating and Ventilating* 27 (August 1929): 67–70; "Gas Conversions Gain Favor with Utilities," *Heating and Ventilating* 27 (September 1929): 90–1.
30. Harold Kanarek, "Disaster for Hard Coal: The Anthracite Strike of 1925–1926," *Labor History* 14 (January 1974): 44–62, emphasizes the importance of that strike for the decline of anthracite but largely ignores the longer-term forces causing the industry's eclipse.
31. "Learning that . . ." and "permanently lost" are from "Causes Alarm: Hard Coal Magnates Lose Markets," *Boston Globe*, July 25, 1902; "Many turned . . ." from "Not So Bad for Coal Now," *Boston Globe*, December 10, 1902. "City Now Under Cloud of Smoke," *Philadelphia Inquirer*, June 18, 1902. "Soft Coal Eye," *Boston Globe*, September 21, 1902. Entry of smokeless coal into the Chicago market is from "Soft Coal Men May Do Own Retailing Here," *Boston Globe*, November 6, 1925. "Drug on the Market," from "Few Soft Coal Stoves," *Chicago Tribune*, October 8, 1902; "To Use Smokeless Coal," *Chicago Tribune*, June 28, 1902; USGS, *Mineral Resources 1902*, 290 and 1905, 517.
32. Hollander, "Memorandum on Combination and Profits in the Anthracite Industry," 996.
33. US Federal Trade Commission *Report*, 120–23. US Coal Commission, *Report*, part 1, 51.
34. US Fuel Administration, *The Distribution of Coal and Coke*, part 1 (Washington, DC, 1919), 14–15, 115–17. US Fuel Administration, *Fuel Facts* (Washington, DC, 1918). "Koppers Seaboard Coke," *Brooklyn Daily Eagle*, December 1, 1919.
35. The 100-mile radius is from "Buckwheat Coal Demands Real Recognition in Anthracite Merchandising Problems," *Coal Age* 27 (April 30, 1925): 638–41.
36. The industry allocations are from General Policies Committee, Anthracite Operators, *The Anthracite Emergency of 1922–1923 and How It Was Handled* (Philadelphia, 1923). "100,000 Ton Welch Anthracite Order," *Boston Globe*, October 25, 1923. "States to Fight Coal Monopoly," *Boston Globe*, August 22, 1925, contains the municipalities' switch to coke.

37. "How Much Ash Is Found in Commercial Anthracite?" *Coal Age* 25 (February 21, 1924): 272.
38. "Very large number . . ." is from "No Need to Worry Over the Supply of Coal," *Boston Globe*, August 20, 1925. "Survey Shows Bitter Anti-Anthracite Campaign in New England," *Coal Age* 28 (October 29, 1925): 605. "Thinks Anthracite Strike Will Make Soft Coal Universal Domestic Fuel; President Urged Not to Interfere," *Coal Age* 28 (November 12, 1925): 671. "War to End War" from "States to Fight Coal Monopoly," *Boston Globe*, August 22, 1925. "How to Use Soft Coal and Coke in the Homes," *Boston Globe*, October 2, 1925. "West Virginia Smokeless Producers Plan Campaign to Capture New England," *Coal Age* 28 (November 12, 1925): 669.
39. Rudolf Kudlich, "Fuels Available for Domestic Use as Substitutes for Anthracite Coal," USBM *Report of Investigation* 2520 (Washington, DC, 1923), 3.
40. "New Rates Assure Soft Coal Supply," *Boston Globe*, December 2, 1925. Massachusetts Special Commission on the Necessaries of Life, *Report 1927* (Boston, 1927), 104. While freight rates clearly set limits to coal markets, only a *change* in such rates might *change* anthracite demand. In fact, overall real freight rates on bituminous coal rose more than those on anthracite between 1915 and 1924. See Charles Reitell, "Railway Rates on Bituminous and Anthracite Coal," *Annals of the American Academy of Political and Social Science* 111 (January 1924): 155–64.
41. "Substitutes for Coal," *Chicago Tribune*, October 24, 1925. "Good Coke Supply If Miners Strike," *New York Times*, August 24, 1925, contains the quotation and figures. In the mid-1930s, *expenditures* on soft coal were about five times those on hard coal and with soft coal cheaper the quantity disparity would have been even greater. See USBLS, "Family Expenditures in Selected Cities, 1935–36," *Bulletin* 648, vol. 1 (Washington, DC, 1942), table 7.
42. USBM, *Mineral Resources*, 1928, part 2, 478; "Anthracite," *New York Herald Tribune*, December 21, 1925.
43. "Solving Hard Coal's Commercial Problem," *Coal Age* 22 (October 26, 1932), 659. "Order takers" is from "Competitive Pressure Grows in Hard Coal Markets," *Coal Age* (April 2, 1925): 496. "Dead level . . ." is from "Anthracite Operators Realize Necessity for New Sales Program," *Coal Age* 33 (August 1928): 548. In comments on an earlier draft of this article Jack Brown suggested that the idea of marketing to counter decline may well be a modern invention.
44. While it seems remarkable that anthracite was so late to the standards party—the Chicago Board of Trade had established grain standards in the late 1860s—the difference probably reflects the nature of the two markets. Wheat and flour were comingled from many suppliers and often sold to large buyers, while hard coal came from an individual company and wholesalers and retailers had little countervailing power. See Charles Taylor, *History of the Board of Trade of the City of Chicago* (Chicago: Robert O. Law Company, 1917).



45. How Much Ash Is Found." "Anthracite Trade near Accord on Uniform Standards," *Coal Age* 27 (March 19, 1925), 436, contains the quotation; "Let Fine Sizes Be Fine in Quality," *Coal Age* 27 (January 1, 1925). Better quality is from "First Annual Anthracite Conference Staged at Lehigh University," *Coal Age* 43 (June 1938): 72–74.
46. "Anthracite Industry Rests Success for Future on Engineering and Merchandising," *Coal Age* 37 (January 27, 1927): 107–8. "New England Dealers See Menace to Anthracite in Wider Use of Soft Coal," *Coal Age* 27 (April 2, 1925): 512. "Dealer Customer Service Plan Is Inaugurated," *Coal Age* 31 (March 3, 1927): 326–27. "How Anthracite Attacks Sales Problems," *Coal Age* 33 (August 1928): 467–69. "Anthracite Battling to Regain Lost Markets Takes the Dealer into Partnership," *Coal Age* 38 (March 1933): 82–84. USBM, *Mineral Resources 1926*, part 2, 553; 1927, part 2, 481; and 1929, part 2, 829–31.
47. For the Mt. Carmel Conference see USBM, *Mineral Resources 1927*, 481. For the Anthracite Institute see the chapters on anthracite in the 1927 and 1929 issues of USBM, *Mineral Resources*.
48. "New England Dealers See Menace to Anthracite." Parker is from "Economic Problems of the Coal Industry," *Coal Age* 30 (December 17, 1926): 816. *Report of the Federal Oil Conservation Board 1932* (Washington, DC, 1933), 7.
49. "Assisting . . ." is from USBM, *Mineral Resources 1928*, part 2, 576. "Buckwheat Coal Demands Real Recognition in Anthracite Merchandising Problems," *Coal Age* 27, April 30, 1925: 638–41.
50. "Gas Proves to Be an Active Rival of Anthracite," *Coal Age* 25 (May 22, 1924): 766. Mine prices are from USBM, *Minerals Yearbook 1947*, 275 and 355, while retail prices are from USBLS, "Retail Prices, 1890–1926," *Bulletin* 445 (Washington, DC, 1927), table 16.
51. "Machines Help Anthracite Regain Lost Markets," *Coal Age* 36 (February 1931): 64–65. Productivity data are author's calculations bases on USBM data.
52. "Institute Hard Coal Research," *Coal Age* 33 (October 1928): 652. "Anthracite Experiments with Research," *Coal Age* 35 (January 1930): 12–13. "Anthracite Research Seeks New Markets for Both Fuel and Non-Fuel Uses," *Coal Age* 39 (February 1934): 58–59. In 1938 anthracite researchers also held the first of what would prove to be a long-running series of conferences on anthracite technology at Lehigh University. These various research programs discovered that coal dust could be used as a filtration agent. They also investigated possible uses of ash as fertilizer and its potential as a lightweight aggregate in concrete mix. There were hopeful studies that claimed hard coal might again find a market as blast-furnace fuel.
53. An early Reading ad is "A Name Worth Knowing," *Brooklyn Eagle*, November 22, 1927. "Let a little . . ." is from "The Battle Song of the Cities," *Chicago Tribune*, March 13, 1928. "How Anthracite Attacks Sales Problems," *Coal Age* 33 (August 1928): 467–69. "Announcing 'Fyrewell' It Makes the Best Fire Better," *Boston Globe*, September 25, 1938. "Blue Coal Is Here," *Boston Globe*, May 14, 1929.