



# PENNSYLVANIA POWER

## ENERGY FUELS CHANGE

By Kevin Patrick, Rick Hoch, Chris Schaney, and Brian Okey





**McConnells  
Mill water-powered  
grist mill, 2008.**

All modern photos by Kevin Patrick.

If you're driving from Indiana County to Pittsburgh, somewhere west of Saltsburg you will notice the sky ahead is glowing orange. Getting closer, you will see a massive tongue of fire flickering above the darkened tree tops. It's the new Marcellus gas flare stack set ablaze to test the pressure in the well after the drilling phase. It is unearthly, completely controlled yet seemingly out of control, a symbol of Pennsylvania's latest energy boom.

The energy industry is not new to Western Pennsylvania. Not far away in Murrysville, a forgotten monument marks the site of the Haymaker Well. Inspired by Edwin Drake's first well in 1859, Michael and Obediah Haymaker were searching for oil but struck a huge

natural gas pocket instead. With no capping technology available, the well roared uncontrollably for three years, caught fire, and burned for another year and a half as the region's most famous tourist attraction. The Haymaker well is part of Pennsylvania's far-reaching energy heritage. Oil and gas stand on the shoulders of humble wood, charcoal, and water power. These are all tied inextricably to bituminous coal and coke. Today, they allow us to look forward to new energy resources. From the wood lots of 18th-century frontiersmen to 21st-century wind turbines making electricity from the breezes that blow over its ridges, Western Pennsylvania is tied to an energy economy of its own making.

#### Learn More Online



Video tracing the history of converting natural resources into energy in Pa





Buena Vista Furnace in  
Indiana County, 2007.

## WOOD AND WATER FROM FOREST TO FARM TO FURNACE

The vast forests that Pennsylvania pioneers pushed into west of the Allegheny Mountains were the region's first energy resource, easily accessed with unlimited potential to light cooking fires and heat homes. Soon an army of axmen descended upon Penn's Woods to chop, then float, the timber down the Allegheny River to Pittsburgh and into the Ohio Valley. Although the timber rafts included cord wood, most of this was lumber to build cities rather than heat them. Fuel wood harvesting occurred on a more localized scale. In rural areas, woodlots for home heating and cooking fuel were part of nearly every farmstead, with the average colonial household burning the equivalent of one acre of woods every year.

Forests also fueled the first stage of Pennsylvania's iron industry as wood was cut and roasted into charcoal to fuel the furnaces that smelted iron out of local iron ore. The first charcoal-burning ironworks was established near Pottstown in 1716, and the technology made its way west, to Fayette, Greene, Westmoreland, and Allegheny Counties, before shifting northward to Armstrong, Clarion, and Venango Counties where forest fuel was readily available, and iron bars could be shipped down the Allegheny River to markets in Pittsburgh and beyond.<sup>1</sup>

In addition to wood for heat, the early industrial age was fueled by water for mechanical power. The harvesting of falling water required a dammed stream from which a ready supply of water could be diverted. The weight of the falling water turned a power wheel, which turned a central power shaft connected to machinery that either reciprocated (like a saw blade or textile loom), turned (like a grinding wheel or circular saw), or hammered (as in a forge or bloomery).

**Forests also fueled the first stage of Pennsylvania's iron industry as wood was cut and roasted into charcoal to fuel the furnaces that smelted iron out of local iron ore.**





Even iron furnaces required water power to operate the bellows that provided the blast.

The forests of Western Pennsylvania were converted to farmland through the use of water power. Nearly every good-sized stream was dammed for saw mills and grist mills. The water-powered saw mill/grist mill combination was the foundation of village manufacturing in the rural countryside. The restored McConnells Mill in Lawrence County is Western Pennsylvania's best surviving example of a water-powered flour mill dating back to 1852, when Daniel Kennedy built it on the steep, stony shores of Slippery Rock Creek. By 1860, a water-powered saw mill was operating next to the grist mill. Thomas McConnell bought the mill in 1875, replacing the waterwheel with a turbine, and the grind stones with iron rollers to increase the mill's efficiency and allow it to stay in business until 1928.

By 1849, Pennsylvania had 228 charcoal iron furnaces and 112 charcoal iron forges, nearly 80 percent of them powered by water.<sup>2</sup> The industry, however, was on the verge of

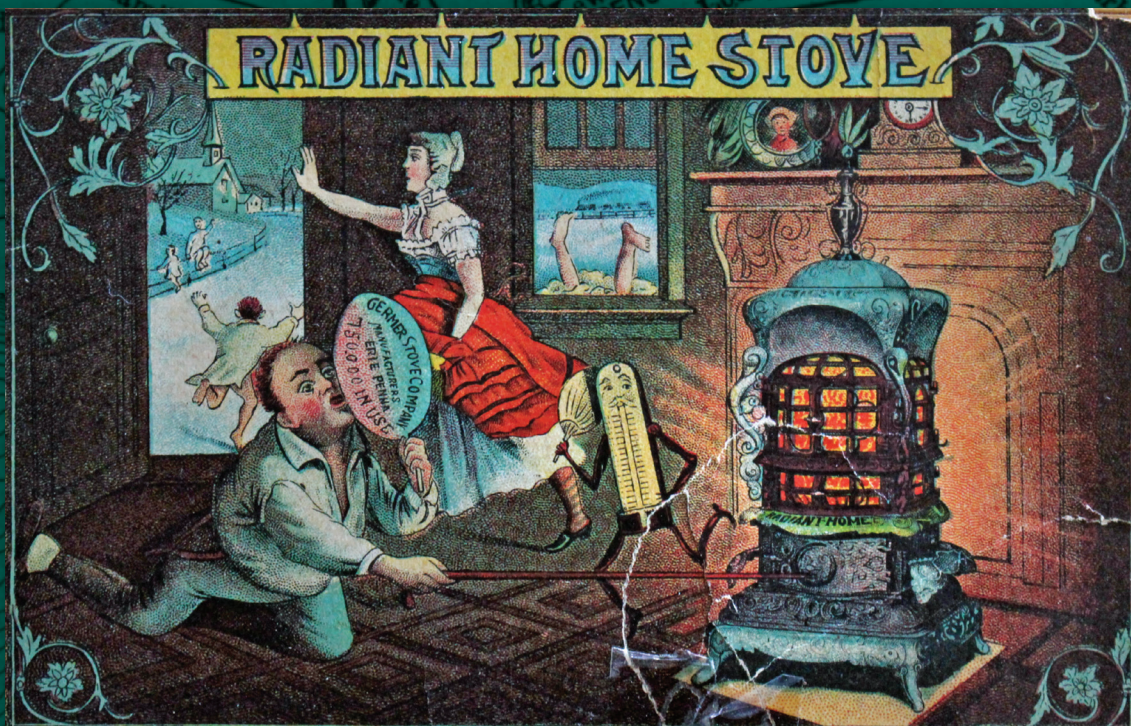
a radical change as it actively scaled up to produce much larger batches of higher quality blast furnace iron. This required a switch in fuel from charcoal to coke made from bituminous coal, another Western Pennsylvania treasure.

## KINGDOM OF COAL AND COKE

Western Pennsylvania's bituminous coal seams are essentially fossilized forests that grew in the tropical heat of extensive coastal swamps some 300 million years ago. The coal formations are stacked youngest to oldest from the southwestern corner of the state where the Pittsburgh seam (the richest mineral deposit on the planet by the total value of rock extracted) outcrops in Fayette, Washington, Allegheny, and Westmoreland Counties towards the east, and northeast where the Freeport and Kittanning seams outcrop in Cambria, Somerset, Armstrong, Indiana, and Clearfield Counties, plus in isolated patches farther north.

By 1800, Pittsburgh was already being described as a "smoky city" due to its coal fires.<sup>3</sup> It took a lot of effort to chop, cord, and tote wood, but coal dug from Coal Hill across the Monongahela River sold cheaply on the streets of Pittsburgh. Unlike hard-to-burn anthracite from northeastern Pennsylvania, bituminous coal readily caught fire, requiring no special stove. Even in the countryside, house coal mines—called "country banks"—were common to many farmsteads.

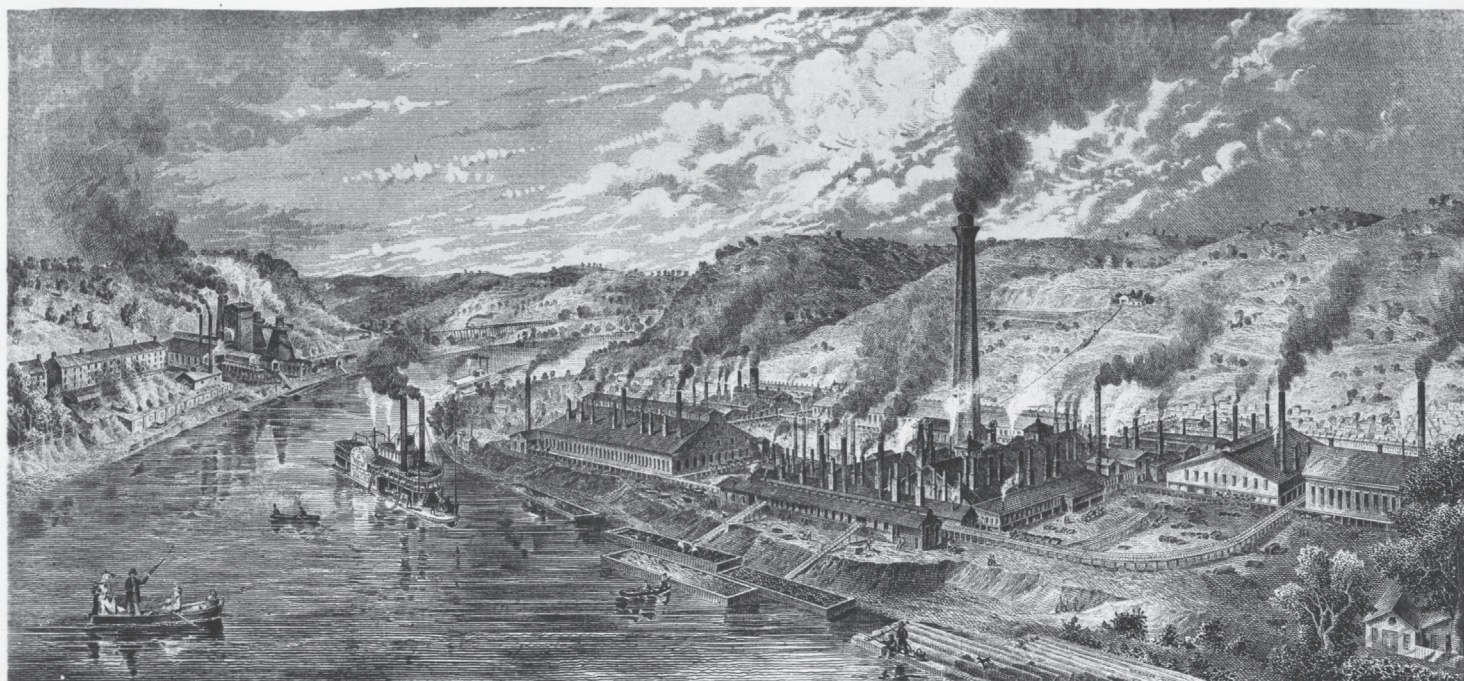
Western Pennsylvania's bituminous coal was also used to manufacture gas for light in the 19th-century cities of the Ohio Valley, and to fuel steam engines that replaced the water-powered mills of early manufacturing. Railroads opened the region's bituminous fields, carrying the steam coal to markets north, west, and east. Along the tendrils of tracks came the company coal patches, and their modest, lookalike houses thrown up at the mine portals that attracted wave upon wave of Eastern and Southeastern European laborers. By 1880, the Connellsville Coke District, a corridor of coal mining that stretched along



The Radiant Home Stove made by the Germer Stove Company in Erie captured the shift from wood to coal as a home heating fuel.

Author's collection.





## AMERICAN IRON WORKS, PITTSBURGH, PA. JONES & LAUGHLINS.

American Iron Works, c. 1875, with coal-fired steam power represented by steamboats, trains, and the central power plant at the J&L Mill identifiable by its tall smokestack.

HHC Detre L&A, Jones & Laughlin Steel Corporation Collection  
Photographs, MSP33.B007.F10.J01.

the west side of Chestnut Ridge through Fayette and Westmoreland Counties, had 54 new coal patch communities, such as Bessemer, Buckeye, Frick, Henry Clay, Tip Top, West Overton, and Wheeler. By 1916, there were almost 150 settlements.<sup>4</sup> Bituminous coal production and employment peaked in 1918 with approximately 170 million tons of coal mined by more than 187,000 miners.<sup>5</sup>

Although the Freeport and Kittanning seams were also mined in the Connellsville Coke District, the low-ash, low-sulfur coal from the overlying Pittsburgh seam was the real money-maker, being the perfect metallurgical coal to fuel a new generation of larger iron-making blast furnaces needed for the flourishing steel industry. With the adoption of the Bessemer Converter used to make large batches of steel from molten iron in the 1860s, the steel industry shifted away from the anthracite furnaces of Eastern Pennsylvania and re-centered

# The Connellsville Coke District peaked at 38,986 beehive coke ovens in 1918.



around Pittsburgh to be near the source of Connellsville's superior blast furnace fuel.

Much as wood is turned into charcoal to increase its heating potential, coal is baked into coke in ovens deprived of oxygen. The carbon-rich coke is structurally stronger, and more able to bear the weight of larger batches of iron ore and limestone in the blast furnace.<sup>6</sup> The first pair of beehive coke ovens was constructed at Hickman Run down

the Youghiogheny River from Connellsville in 1842.<sup>7</sup> The design became an industry standard, built in single rows or double banks at the mine site until the adoption of the more sophisticated by-product coke plant. Arriving first at Connellsville's Dunbar Furnace in 1894, the by-product oven, which used the gases driven off the roasting coal to produce a wide range of chemical by-products, ultimately shifted production of coke from the mine

to the steel mill site. The Connellsville Coke District peaked at 38,986 beehive coke ovens in 1918, most of them built by the H.C. Frick Company before its 1901 merger into U. S. Steel.<sup>8</sup> In 1914, the Koppers Company moved to Pittsburgh to build by-product coke plants for the steel industry, and five years later U. S. Steel opened the world's largest coke plant at its Clairton Works on the Monongahela River. In 1915, 54 percent of the nation's coke came



The significance of the coke industry in early 20th-century Western Pennsylvania is illustrated by the double coke arch that H.C. Frick workers built over Connellsville's main intersection for the Fayette County Centennial in 1906.

Coal and Coke Heritage Center, Penn State Fayette Library, Lemont Furnace, Pa.



This 1949 photo shows the six blast furnaces at U. S. Steel's Carrie Furnace site in Rankin, which smelted all of the iron for the Homestead Steel Works in the distance. The magnitude of the operation illustrates how coke led to the relocating of iron and steel industries from rural charcoal furnaces to integrated steel mills closer to Pittsburgh.

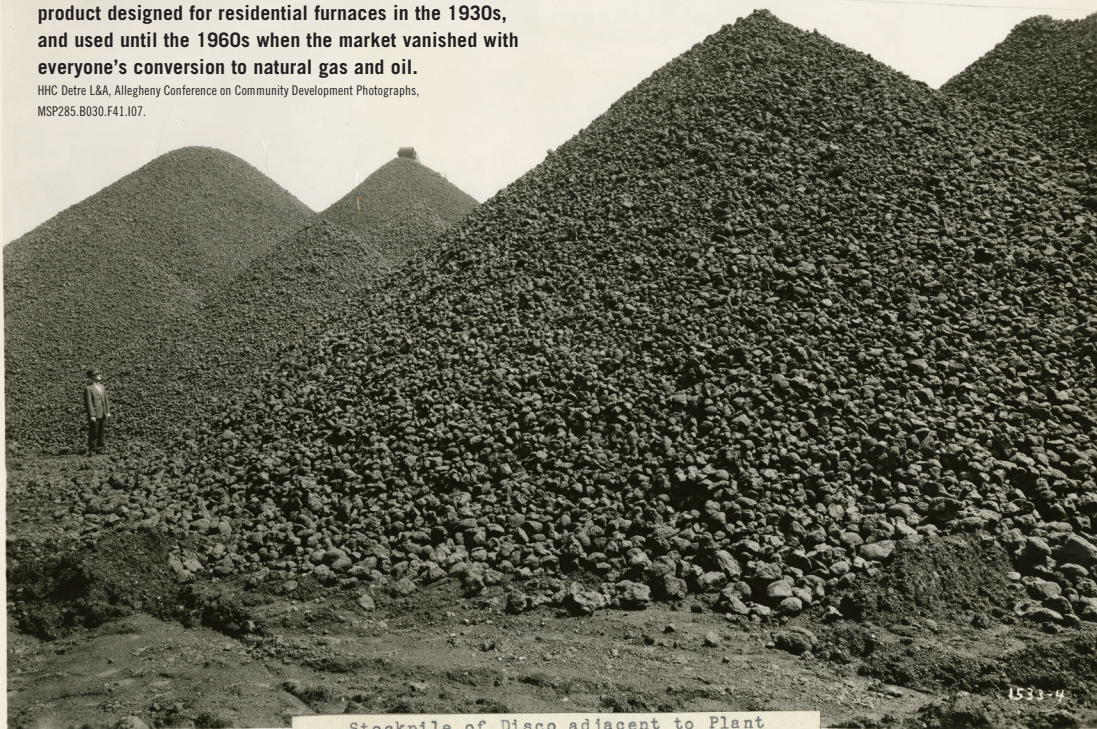
University of Pittsburgh Archives Service Center, William J. Gaughan Collection, 943.64945.GN.





Piles of DISCO from the Champion plant near Burgettstown, 1950. DISCO was a smokeless coke product designed for residential furnaces in the 1930s, and used until the 1960s when the market vanished with everyone's conversion to natural gas and oil.

HHC Detre L&A, Allegheny Conference on Community Development Photographs, MSP285.B030.F41.J07.



Stockpile of Disco adjacent to Plant  
Approximately 30,000 Tons in Storage  
As of May 15, 1950

from beehive ovens in the Connellsville Coke District, but as the steel industry expanded into the Great Lakes region using by-product coke plants, Western Pennsylvania's beehive coke industry collapsed. Shoaf in Fayette County had the last operating beehive coke plant, shut down in 1972 for not being able to comply with new clean air standards.

Production of Pennsylvania coal declined after World War II, suffering from competition by natural gas, oil, and other sources of coal. In 2014, Pennsylvania produced 61 million tons of coal, ranking it fourth among states after Kentucky, West Virginia, and Wyoming.<sup>9</sup> Western Pennsylvania employed 7,287 miners in both surface and underground mines in 2013, and two-thirds of its coal is used to produce electricity, half of which is sent to cities outside the state, with much of the remainder exported overseas.

## OIL AND GAS IN THE AGE OF ILLUMINATION

Oil and natural gas were not first discovered in Pennsylvania. Several ancient cultures used easily extracted or collected oil and gas, including the region's Native Americans, who trapped oil from natural seeps for medicinal purposes. The significance of Drake's Well, brought into production on August 27, 1859 just outside of Titusville, was instead the technology used to create the first commercially

**In 2014,  
Pennsylvania  
produced  
61 million  
tons of coal,  
ranking it fourth  
among states.**



productive well, and subsequently touch off what became the first American oil boom.

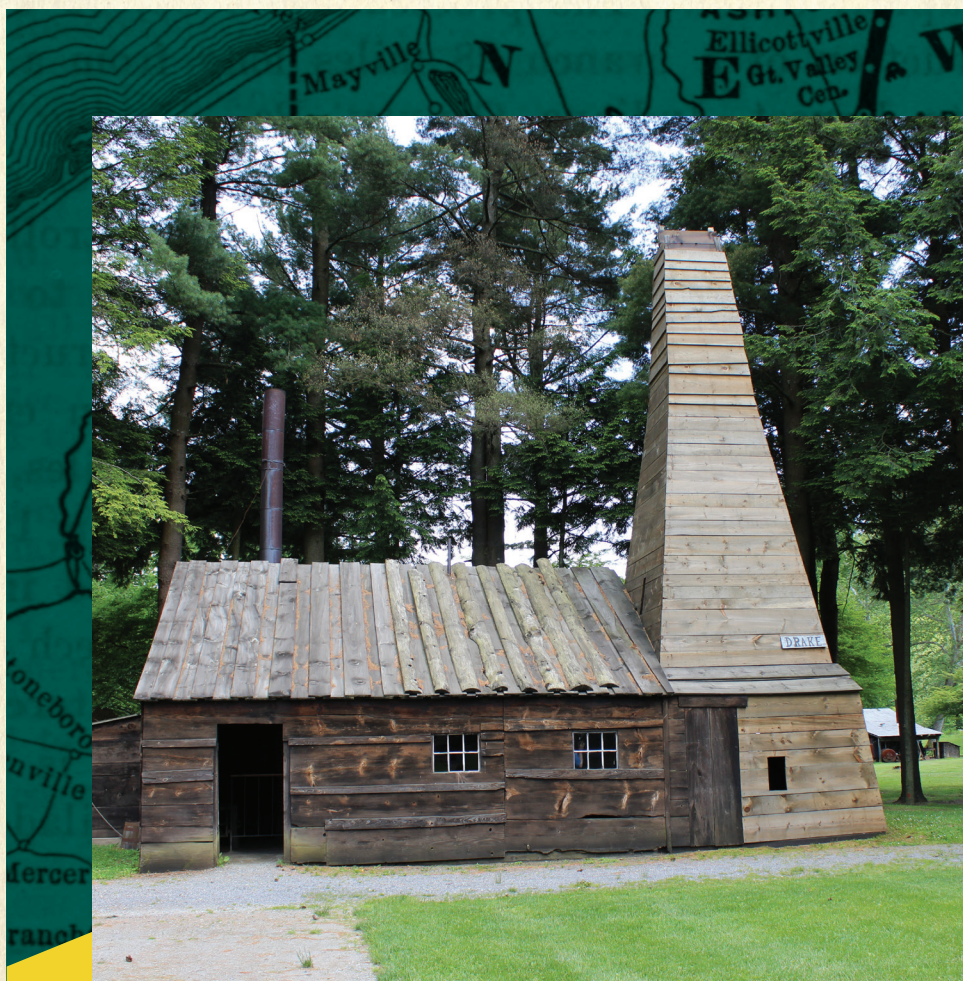
Mid-19th century America was in the midst of its first energy crisis—it sourced its best lamp oil from whales, which were being driven to the edge of extinction in far-flung oceans. Increasing industrialization was also driving up demand for a cheap, reliable illumination fuel to keep factories running at night, as well as strengthening the need for lubricating oils used in machines. Oil had been fouling the salt wells of Western Pennsylvania for decades, most of it drawn off and dumped before Samuel Kier tested some of the oil poisoning his Tarentum wells and found it could be distilled into lamp oil. In 1853, Kier opened a one-barrel still on Seventh Avenue in Pittsburgh, the first U.S. oil refinery.<sup>10</sup>

Once it was determined that the region's crude oil could be distilled into lamp oil, the Pennsylvania Rock Oil Company was formed, the first oil company in the United States. Bankrolled by investors from Connecticut, the company (reformed in 1858 as Seneca Oil) sent Edwin Drake to investigate oil seeps in Titusville. Drake was completely inexperienced, but resourceful. After his first attempt at digging a hole in an oil seep failed because of groundwater infiltration, he hired an experienced salt well driller, William "Uncle Billy" Smith, and devised a method of casing the well with pipe to keep the water out. Seneca Oil withdrew its funding, but Drake pressed on and, with a steam engine as a power source, he struck oil at 69.5 feet, an astounding stroke of luck that could have happened only at the site he was drilling. Most subsequent wells would not find oil within 500 feet. Oil production quickly spread throughout the Venango County area during the 1860s.<sup>11</sup> While Seneca expanded into many more wells, Drake failed to purchase more land or patent his invention, and he lost his investments.

As the early Venango Field played out in the late 1860s, the oil industry shifted farther down the Allegheny watershed to the Butler-Clarion Field, opening wells at Parker's Landing in 1869, Brady's Bend in 1871, and at Karns City and Petrolia in 1872.<sup>12</sup> Then in 1875, the Crocker Well started a boom in the Bradford Field farther north in McKean County that dominated for the next 10 years. By 1881, the Bradford Field was producing 100,000 barrels a day, 83 percent of all the crude oil produced in the U.S. and 77 percent of that produced on the entire planet.<sup>13</sup> Pennsylvania's last great gusher came in 1937, surprising even the Niagara Oil

Company responsible for drilling the well at Music Mountain in McKean County, where it tapped into the narrow, previously unknown Sliverville Sand responsible for a flow of 500 barrels an hour.<sup>14</sup>

Throughout the oil industry's early age of illumination, the main product was kerosene, used primarily as a lamp oil. Control of the industry quickly shifted from producers to refiners after the formation of John D. Rockefeller's Standard Oil Company in 1870. Its subsidiary South Penn Oil eventually controlled a quarter of Pennsylvania's output, as well as much of the state's crude oil pipelines through its Oil City-based National Transit



**Drake's Well was reconstructed in 1945 as the centerpiece of the Drake Well Museum in Titusville.**

*Photo by Kelly Anderson Gregg.*



# In 1853, Samuel Kier opened a one-barrel still in Pittsburgh, the first U.S. oil refinery.

Company. Even after the oil industry shifted to the Gulf Coast, and turned from making kerosene to gasoline, Pennsylvania Grade crude was valued for its properties as a lubricating oil. Wolf's Head Oil, Pennzoil, and Quaker State were at one time all headquartered in Oil City with refineries nearby. Although these brand names are no longer refined in Pennsylvania, Kendall Oil is still produced in the Bradford refinery of its 1881 origin. Founded in 1902, Warren's United Refining Company continues to make gasoline for Kwik Fill and Keystone. In Butler County, the Bear Creek refining complex at Karns City and Petrolia specializes in white mineral oil for cosmetics and pharmaceuticals.

With natural gas, the Haymaker brothers weren't the only ones to light up the Western Pennsylvania sky: George Westinghouse did it too. Natural gas had been a fickle, hard-to-find and harder-to-control energy resource that was as explosively dangerous as it was useful. It was initially used at the point of production or piped short distances to a specific end user. In 1884, natural gas was piped to the Painter



An extremely rare, virtually intact oil well from the 1910s in Heidelberg.



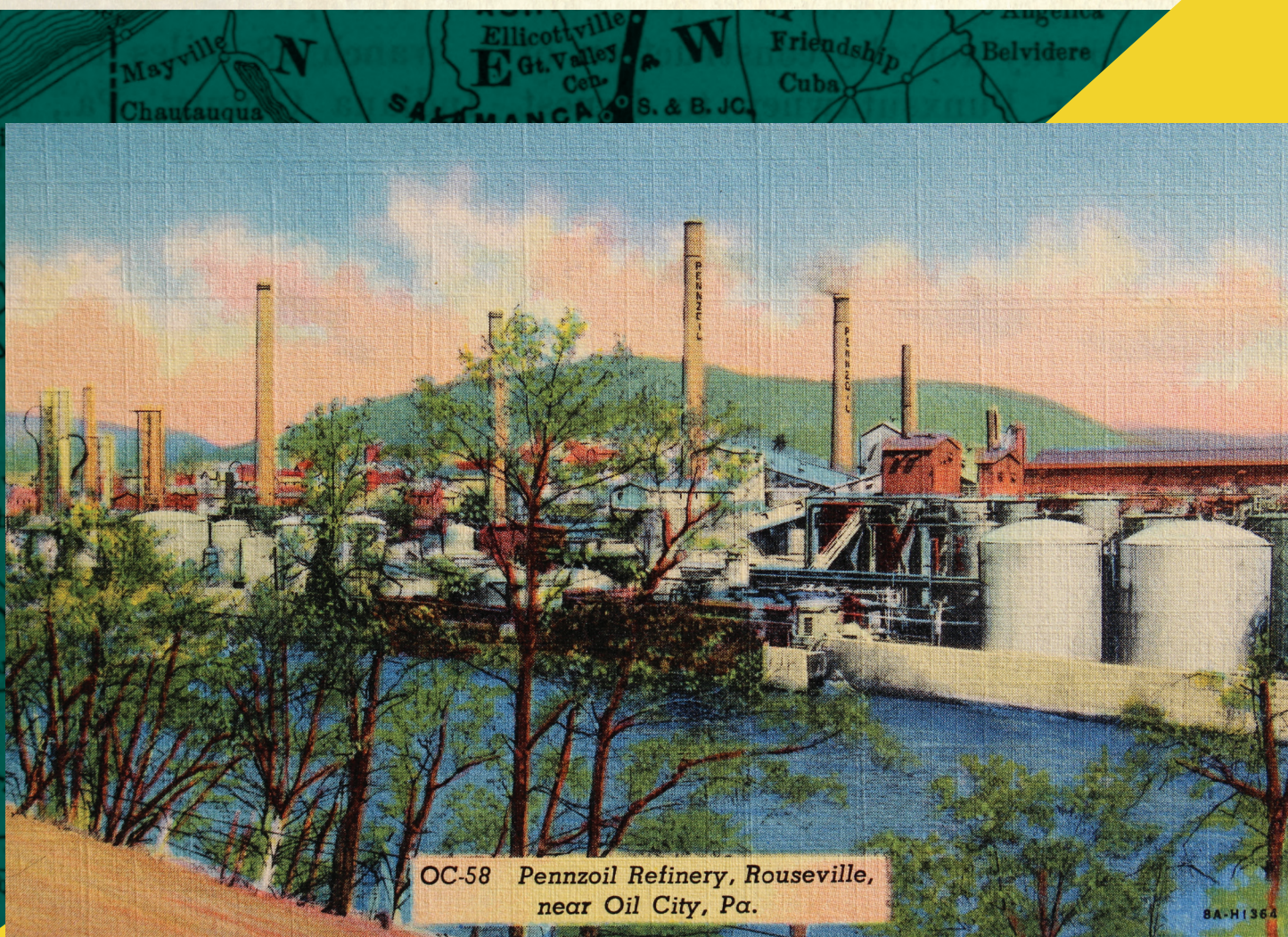
Iron Works, and nearby Taylor Salt Works on Pittsburgh's South Side from the McGuigan #1 Well located 22 miles away in Washington County, also serving an additional 50 houses along the route.<sup>15</sup> Even the wild Haymaker well was brought under control in 1883, and the gas piped 16 miles west to 16th Street in Pittsburgh, making it the first major city to be served by natural gas.<sup>16</sup>

George Westinghouse was so intrigued by the potential of natural gas that when geologists told him his mansion, Solitude, in Pittsburgh's Point Breeze neighborhood, sat over a gas deposit he had four gas wells drilled in his backyard to experiment with natural gas production, control, and distribution

equipment. The pressurized gas he struck on May 29, 1884, obliterated the well and scattered the twisted junk throughout his yard. The ire of his wealthy neighbors (H.J. Heinz and Henry Frick among them) was subdued by the free gas he piped to their homes. Within a year, Westinghouse had patented 28 new gas delivery related inventions to distribute this cleaner form of home heating and cooking fuel.

With new technology available and an expansion in pipeline networks, gas production increased throughout Western Pennsylvania during the late 19th and early 20th centuries, culminating in the McKeesport gas boom of 1919. The Hamilton #3 Well working the Devonian Speechley Sand in

Snake Hollow roared to life on August 30, 1919. Producing twice the amount of the best Marcellus gas wells now, the gas gusher touched off a frantic scramble to drill wells. A forest of derricks went up in the established town of Versailles, where people leased their back yards and tore down their houses for gas wells. With 22,000 wells poked into the same deposit, it was sucked dry by 1921. In the end, \$35 million was invested for \$3 million worth of gas. The effects of the boom plague Versailles Borough even now, where legacy gas accumulates beneath the houses and requires venting.<sup>17</sup>



Postcard showing the old Pennzoil refinery near Oil City, when all the lubricating motor oils had refineries in the region.



## PENNSYLVANIA POWER TO MAKE ELECTRICITY

Thomas Edison's greatest invention was not the lightbulb, but the complicated system needed to generate and distribute the electricity that bulbs needed. Ever-larger central power plants spread to other municipalities, producing electricity by using coal-fired boilers to generate steam to turn turbines that spun generators. Electric lights quickly supplanted kerosene and gas lamps. George Westinghouse, heavily involved in municipal utilities, soon became more famous for his company's electric power equipment and appliances than for his natural gas distribution innovations.

It should be recognized, however, that electricity is a second-stage power resource requiring the conversion of some primary power source like the falling water used at a hydroelectric dam to turn the turbine, or the wind against a wind turbine blade, or oil / gas / coal / uranium fuel rods used to boil water for steam turbines. Western Pennsylvania's electricity generation is a function of its primary power source: coal.

Prior to World War II, coal was railed from the bituminous fields of Western Pennsylvania to municipal power plants operating in eastern cities. After the war, the development of a national power grid allowed the electricity to be shipped by wire from even larger generating stations located at the fuel source in the bituminous fields, or along the Ohio River and its navigable tributaries where Appalachian coal can easily be barged to the power plant. The largest generating station in Western Pennsylvania is First Energy's Bruce Mansfield coal-fired power plant on the Ohio River at Shippingport. Built between 1976 and 1980, Bruce Mansfield's three units have the capacity to generate 2,490 megawatt



Penreco's current white oil refinery in Karns City makes mineral oil for cosmetics and pharmaceuticals.

**Gas production in Western Pennsylvania culminated in the McKeesport gas boom of 1919.**



(MW) hours of electricity per year, enough to service over 16 million homes.<sup>18</sup> First Energy also owns the adjacent 1,815 MW Beaver Valley power plant, Western Pennsylvania's only nuclear generating station.

In the 1960s and '70s, three large mine-mouth power plants opened in Indiana and Armstrong Counties. The 1,711 MW Keystone generating station opened at Shelocta in 1968, followed by the first two units at Homer City in 1969. A third Homer City unit in 1977 brought its generating capacity up to 1,884 MW. The Conemaugh generating station opened at New Florence in 1971 with a capacity of 1,872 MW.<sup>19</sup> As the nearby mines exhaust their coal, the railroads built in the early 20th century to take coal out are now being used to bring coal in.

With the rising interest in

environmentally friendly "green energy" there has been a renewed appreciation for water power, specifically small hydroelectric generators retrofitted to pre-existing U.S. Army Corps of Engineers flood and navigation dams. Since 1989, Allegheny River Lock & Dams 5 (Freeport), 6 (Clinton), 8 (Templeton), and 9 (East Brady) have all been fitted with run-of-river generators. That year, Armstrong County's Mahoning Dam (1941), the Youghiogeny Dam above Confluence (1943), and Indiana County's Conemaugh Dam (1952) were also retrofitted with hydroelectric generators. While the power produced by these dams can service thousands of homes, their electrical output is relatively small. The four Allegheny River navigation dams plus the three headwater flood control dams collectively generate

about 70 MW-hours of electricity per year—less than four percent of a Homer City power plant.<sup>20</sup> The region's largest hydroelectric facility is the Seneca Pumped-Storage Generating Station at the Kinzua Dam site above Warren. The facility built c. 1970 generates 435 MW-hours of electricity per year.

## SHALE GAS BONANZA

Pennsylvania's current energy boom in deep shale gas from the Devonian-aged Marcellus formation, and the even deeper Utica shale, has propelled the state to number two in natural gas production after Texas. Four trillion cubic feet of gas was brought to the



Haymaker Gas Well monument in Murrysville.

**A primitive form of fracking was pioneered in Pennsylvania in the 1860s when nitroglycerin torpedoes were used in "shooting" oil wells to increase production.**



surface in Pennsylvania in 2014, double what was produced two years earlier. Most of that increase was from Marcellus shale, which is located beneath the Allegheny Plateau in Northern and Western Pennsylvania.<sup>21</sup>

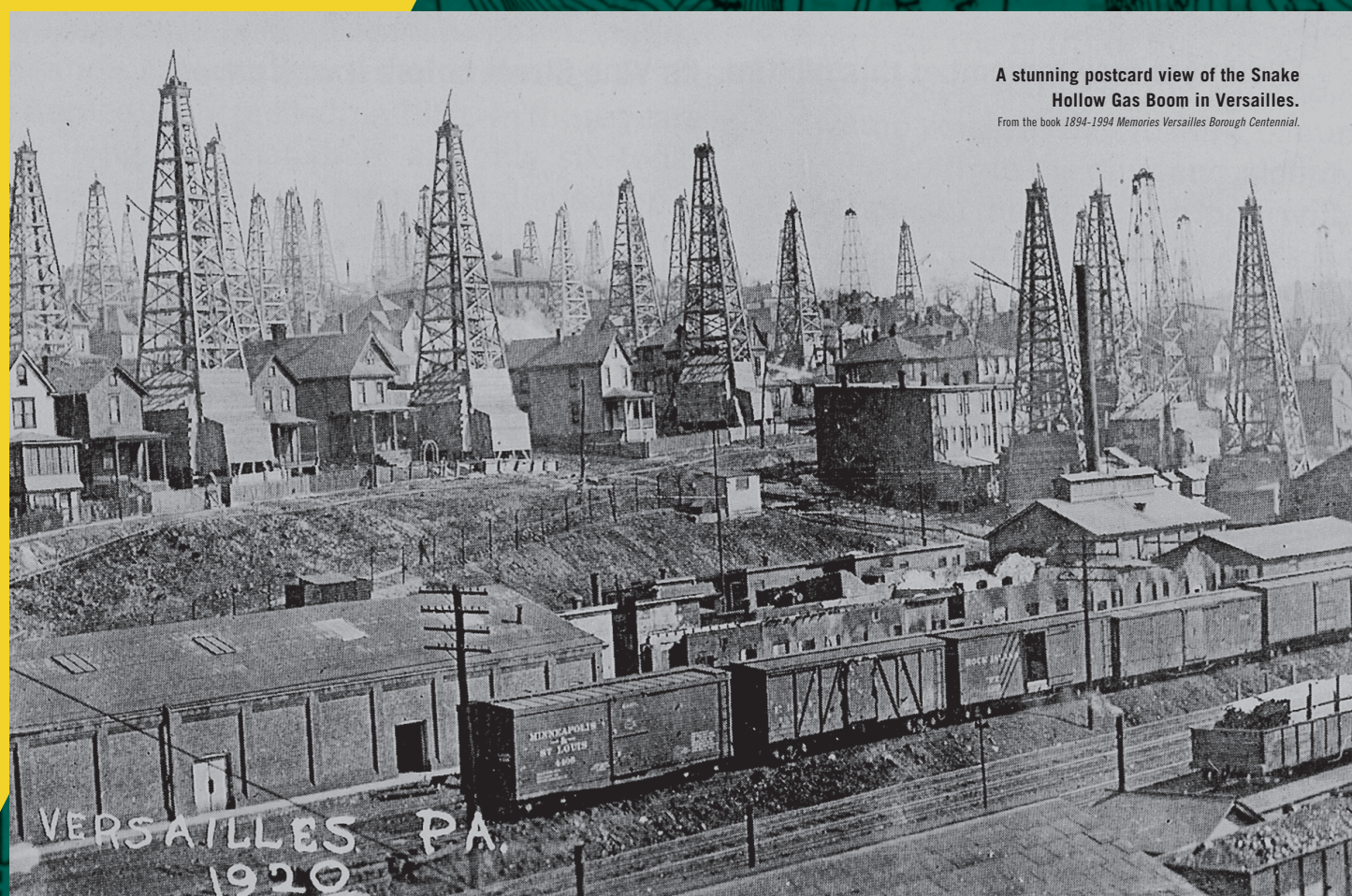
Geology, however, isn't the only reason why Pennsylvania is experiencing this shale gas boom. Much of the research and development for exploiting shale gas resources began back in the 1970s at the U.S. Department of Energy (DOE) in Morgantown, West Virginia. The DOE's Unconventional Gas Research Program was stimulated by the Energy Crisis of 1973. It laid the foundation for the Eastern Gas Shales Project, an initiative whose research and technological developments resulted in five test wells drilled in Pennsylvania to provide data on the geologic characteristics of the Marcellus formation.<sup>22</sup> Tools such as

nitrogen stimulation to release gas from the shale, seismic testing, directional drilling, and hydraulic fracturing advanced in use after the federal investment and research was conducted.<sup>23</sup>

Fracking, using a pressurized fluid to shatter the rock around a drill hole to facilitate the movement of gas or oil, is not new. A primitive form of fracking was pioneered in Pennsylvania in the 1860s when nitroglycerin torpedoes were used in "shooting" oil wells to increase production. Directional drilling, however, is a critical recent innovation in which the bit, having descended through more than a mile of layered rock, can be turned to drill horizontally through the productive shale strata, allowing the subsequent fracking to shatter more rock to release the gas into

several drill holes.

In Pennsylvania, the Marcellus gas boom struck first at opposite ends of the Allegheny Plateau: to the northeast in Bradford, Susquehanna, and Tioga Counties where the Marcellus shale is thick, yet relatively shallow; and to the far southwest in Greene and Washington Counties where "wet gas" comes to the surface with other liquid valuables like ethane, propane, pentane, and butane. Greene and Washington Counties also contain the state's largest underground longwall coal mines, which have chewed beneath more than half of both counties. The coal, gas, and wet gas byproducts produced here have turned this corner of Pennsylvania into a great carbon energy field of international significance with much of the fossil fuel bound for overseas markets.







# The coal-fired Homer City Generating Station can supply approximately 2 million homes.

Coal coming into the Homer  
City power plant by rail  
(passing a shallow gas well),  
and energy being exported  
out of the region by wire  
(photo 2006).



One of the new hydroelectric plants at Allegheny River Lock & Dam 8, 2010.



Marcellus gas derrick in Washington County, 2011.



## LOOKING TO THE FUTURE

Pennsylvania's commercial wind energy was ushered in at the turn of the millennium following the deregulation of electric utilities. This opened up competition among electricity suppliers and allowed for consumer choices, including "green" energy from renewable resources like wind. Compared to the rest of the country, Pennsylvania possesses adequate wind speeds for commercial power generation and, more importantly, a good relative location amidst the concentrated demand of the northeastern population centers. Pennsylvania wind energy development is

closely tied to the Allegheny Mountains, resulting in clusters of turbines that exploit updrafts along ridgetops extending from the Laurel Highlands to the Pocono Mountains. The greatest concentration of wind farms is in Somerset County, where elevations are highest. According to the state Department of Environmental Protection, a total of 27 facilities with an installed capacity of over 1,300 MW can power approximately 350,000 homes. By comparison, the coal-fired Homer City Generating Station can supply approximately 2 million homes.

Green Mountain, a Vermont-based company that markets renewable energy, paved the way for Western Pennsylvania's first wind farm at Garrett in 2000. Construction of

wind energy facilities was predicated on bulk power purchasing agreements with institutions, due to the higher generation cost per kilowatt compared to conventional sources. Carnegie Mellon University was the first to demonstrate its environmental commitment by purchasing power from Garrett, and was soon followed by Penn State and other colleges and universities that supported the expansion of the industry. Federal production tax credits were also instrumental in achieving this outcome.

While initially viewed as a novelty, and even a tourist attraction, fault lines over wind energy emerged among public stakeholders by 2002. The wind farms' large footprint and the size of the turbines themselves aroused concerns over aviation,

Learn More Online



Shippingport Atomic Power Station





**Left:**  
Gas from the Snake Hollow Boom continues to accumulate beneath people's houses in Versailles, leading homeowners to use legacy gas vents.

Kevin Patrick

**Below:**  
Wind turbines in Somerset County, 2007.





aesthetics, and ironically, environmental harm. The slow march of turbines along the ridges into the central portions of the state has continued, albeit more gradually following the boom in shale gas production and a lapse in the federal tax credit.

With the many possibilities that the future holds for the nation's energy industry, it is clear that Pennsylvania will play an important role in that conversation. Its incredible natural resources, as well as its long history of innovation in the field, indicate that Western Pennsylvania will be part of the national and international energy economy for decades to come.



The authors are professors in the Indiana University of Pennsylvania Geography and Regional Planning Department with interests in cultural and historic landscapes, energy, sustainable development, and environmental studies.

<sup>1</sup> Gerald G. Eggert, *The Iron Industry in Pennsylvania*, Pennsylvania Historical Studies No. 25, (Middletown: The Pennsylvania Historical Association, 1994), 30.

<sup>2</sup> Ibid., 47.

<sup>3</sup> Frederick M. Binder, *Coal Age Empire: Pennsylvania Coal and Its Utilization to 1860* (Harrisburg: Pennsylvania Historical and Museum Commission, 1974), 25.

<sup>4</sup> Carmen DiCiccio, *Coal and Coke in Pennsylvania* (Harrisburg: Pennsylvania Historical and Museum Commission, 1996), 71-72.

<sup>5</sup> W.E. Edmunds, *Coal in Pennsylvania* (Harrisburg: Pennsylvania Department of Conservation and Natural Resources, 2002).

<sup>6</sup> Barbara Freese, *Coal: A Human History* (New York: Penguin, 2003), 65.

<sup>7</sup> DiCiccio, 43.

<sup>8</sup> Ibid., 153.

<sup>9</sup> National Mining Administration, *U.S. Coal Production by State and Rank*, 2014, [www.nma.org/pdf/c\\_production\\_state\\_rank.pdf](http://www.nma.org/pdf/c_production_state_rank.pdf).

<sup>10</sup> Ernest C. Miller, *Pennsylvania's Oil Industry*, Pennsylvania History Studies #4 (Gettysburg: Pennsylvania Historical and Museum Commission, 1974), 7.

<sup>11</sup> Philip W. Ross, *Allegheny Oil: The Historic Petroleum Industry on the Allegheny National Forest* (USDA Forest Service, 1994), 7.

<sup>12</sup> Ibid., 14.

<sup>13</sup> Jon Sherman, *Drake Well Museum and Park*, Pennsylvania Trail of History Guide (Mechanicsburg: Stackpole Books, 2002), 19.

<sup>14</sup> Ross, 58.

<sup>15</sup> John F. Carll, *Annual Report, Geological Survey of Pennsylvania, Part II, Report on Oil and Gas Regions* (Harrisburg: Second Geological Survey of Pennsylvania, 1886), 680.

<sup>16</sup> Hax McCullough and Mary Brignano, *The Vision and Will to Succeed; The Centennial History of the Peoples Natural Gas Company* (Peoples Natural Gas Company, 1985), 9-10.

<sup>17</sup> Anya Litvak, "Stranded methane gas in Versailles a century in the making," *Pittsburgh Post-Gazette*, June 14, 2014.

<sup>18</sup> U.S. Energy Information Administration, Pennsylvania State Profile and Energy Estimates, [www.eia.gov/state/maps.cfm](http://www.eia.gov/state/maps.cfm). One MW = 650 homes.

<sup>19</sup> Ibid.

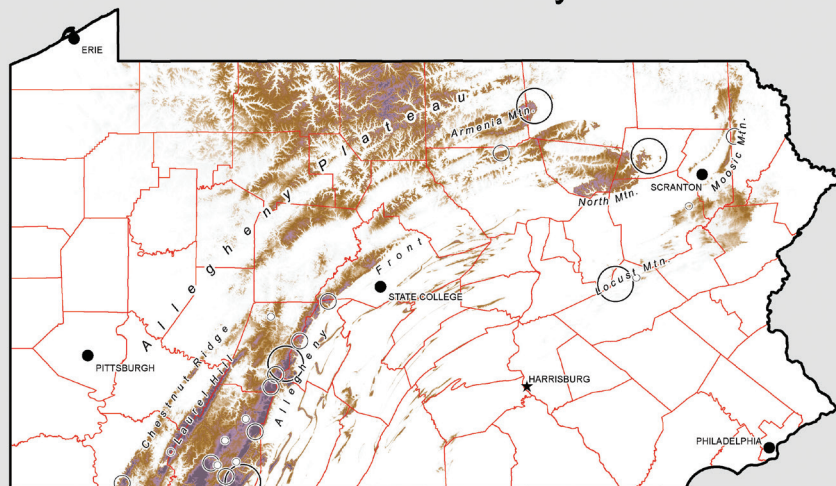
<sup>20</sup> Ibid.

<sup>21</sup> Ibid.

<sup>22</sup> U.S. Department of Energy, Unconventional Gas Research Programs 1976-1995, An Archive of Important Results, Strategic Center for Natural Gas and Oil, National Energy Technology Laboratory, January 31, 2007.

<sup>23</sup> Pennsylvania Department of Conservation and Natural Resources, *Pennsylvania Geology* 38, no. 1 (Spring 2008).

## Wind Farms in Pennsylvania



Source: Penn Future, NASA, NIMA, and PennDOT  
Michael Heesh  
2016

Wind farms in the state, 2016.

By Michael Heesh, with wind turbine data from pennfuture.org.

The wind farms' large footprint and the size of the turbines aroused concerns.