Argonne NATIONAL LABORATORY

ANL/ESD-15/6

# Coal-by-Rail: A Business-as-Usual Reference Case

Energy Systems Division

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# Coal-by-Rail: A Business-as-Usual Reference Case

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Their reviews provided a valuable check on data and materially improved the accuracy of the final document. We thank them for their assistance.

# ACRONYMS

| | |
|---|---|
| AAR | Association of American Railroads |
| AEO | *Annual Energy Outlook* (yearly DOE-EIA publication) |
| AER | Annual Energy Review |
| BNSF | Burlington Northern Santa Fe Railroad |
| CFR | Code of Federal Regulations |
| CN | Canadian National Railroad |
| CSX | Chessie System Railroad (called CSX since the 1990s) |
| DOE | United States Department of Energy |
| EIA | Energy Information Administration, DOE |
| GW | gigawatts ($10^9$ watts) |
| MCHD | Multnomah (OR) County Health Department |
| NDC | Navigation Data Center (USACOE) |
| $NO_x$ | Oxides of Nitrogen |
| NS | Norfolk Southern Railroad |
| PL | Public Law |
| PM10 | Particulate matter of 10 microns or more |
| QCR | Quarterly Coal Report |
| RCAF | Rail Cost Adjustment Factor |
| STB | Surface Transportation Board (U.S. Department of Transportation) |
| UCS | Union of Concerned Scientists |
| USACOE | United States Army Corps of Engineers |

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# 1. INTRODUCTION

As proposed carbon emission standards reduce domestic coal use, the role of coal in the U.S. energy mix may be expected to decline. If such a decline were to occur, how would it affect rail traffic? Today, coal represents a major share of rail tonnage and gross revenue. While growth in other traffic—most notably, crude oil—may offset some of any potential decline in coal shipments, would it be sufficient? This paper explores trends in coal production volumes and use, rail tonnage and revenue, and the distribution of traffic origins and destinations in order to consider the impact of potential changes in future coal traffic. Rather than modeling discrete flows, it draws on historical data and forecasts maintained by the U.S. Department of Energy's Energy Information Administration (EIA), industry studies and analyses, and background knowledge of the rail industry, specific routes and service territories, and commodity-level traffic volumes.

# 2. COAL PRODUCTION VOLUMES AND TRENDS

## 2.1 Major Sources

Figure 1 shows the major coal-producing regions and basins (or sub-regions) in the continental U.S. Reserves and production are most concentrated in the Powder River Basin (part of the Northern Great Plains Region) that spans northeastern Wyoming and southeastern Montana; Northern and Central Appalachia, including portions of Ohio, Pennsylvania, Kentucky, West Virginia and Tennessee; and the Illinois Basin (part of the Eastern Interior Region), which includes Illinois and parts of western Indiana and Kentucky.

Figure 2 illustrates the concentration of current production in 10 states that account for nearly all U.S. coal output. Wyoming, where average annual production accounts for approximately 40% of the U.S. total, is the largest source of U.S. production. Illinois, a major source of Illinois Basin coal, is the only state where production has grown in the past several years. Lignite production in North Dakota and Texas rounds out the list of top coal-producing states outside the Appalachian, Powder River and Illinois sub-regions.

Figure 3 shows EIA's most recent forecast of coal output by region. Within these regions, production is most likely to grow in those basins that have experienced the most growth in recent years (i.e., the Powder River and Illinois basins). Although Powder River production has declined in the past few years as a result of the recession and competition from natural gas, it is expected to continue to dominate U.S. production in EIA's Reference Case, albeit tempered by slow growth in coal use for electricity generation and by competition from coal producers in the Interior region. Illinois Basin production is expected to remain strong as scrubbers installed at existing coal-fired power plants allow them to burn the region's higher-sulfur coals with lower delivered costs. Appalachian coal production is expected to decline by 14% from 2012 to 2016, as coal from those extensively mined, higher-cost reserves is supplanted by lower-cost coal produced elsewhere.

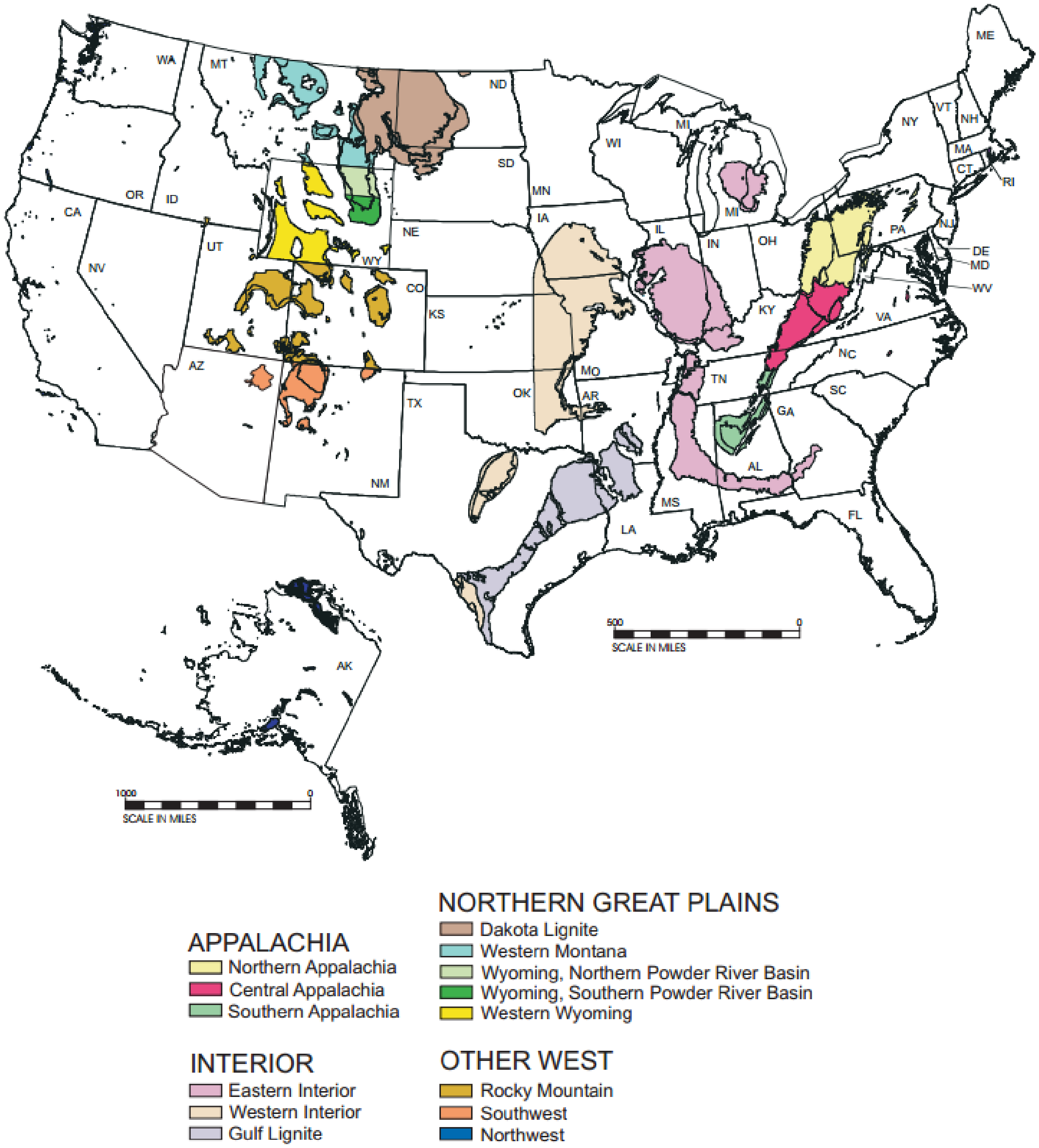


Figure 1. Major U.S. Coal-Producing Regions

(Source: EIA-AEO 2014, Figure F6, http://www.eia.gov/forecasts/aeo/pdf/f6.pdf.)

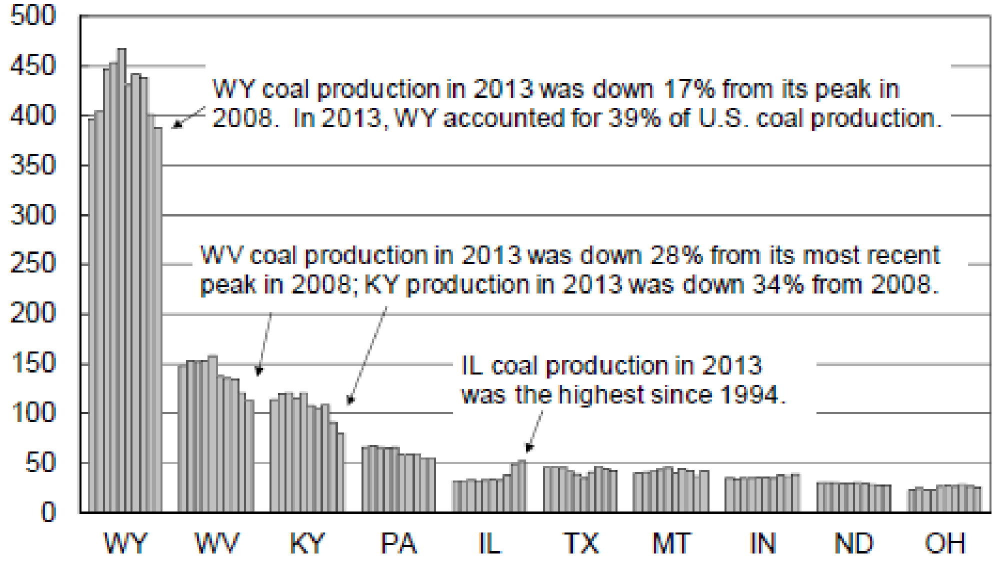


Figure 2. Coal Production by State, 2004–2013, million tons
(Source: EIA-AEO 2014.)

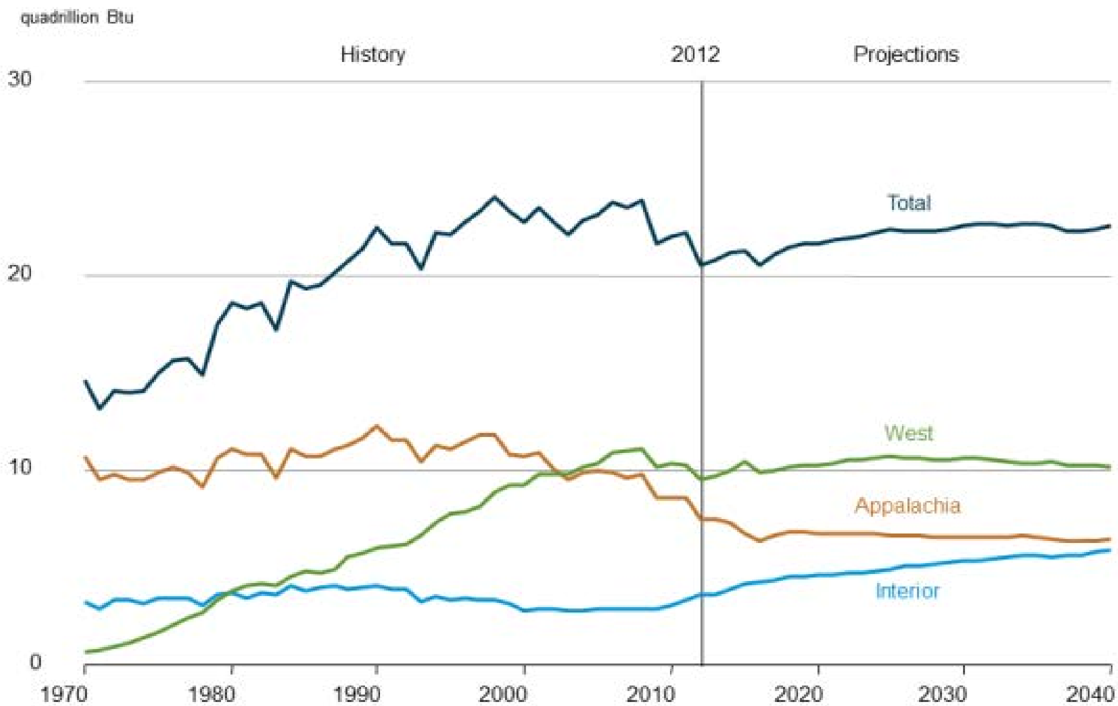


Figure 3. Coal Production by Region, 1970–2040
(Source: EIA-AEO 2014, Figure MT-60, http://www.eia.gov/forecasts/aeo/MT_coal.cfm?src=Coal-b4.)

## 2.2 Production Volumes

In concert with the shift in production from Appalachia to sources in the interior and western U.S., the makeup of U.S. coal production also has shifted over the past decades. As shown in Figure 4, sub-bituminous coal production has supplanted a share of bituminous production because of its lower sulfur content. Today, U.S. production is fairly evenly split between bituminous and sub-bituminous grades, with lignite and anthracite, respectively, accounting for approximately 10% and less than one percent of production. According to EIA's 2014 Annual Energy Outlook (AEO), this distribution is expected to continue.

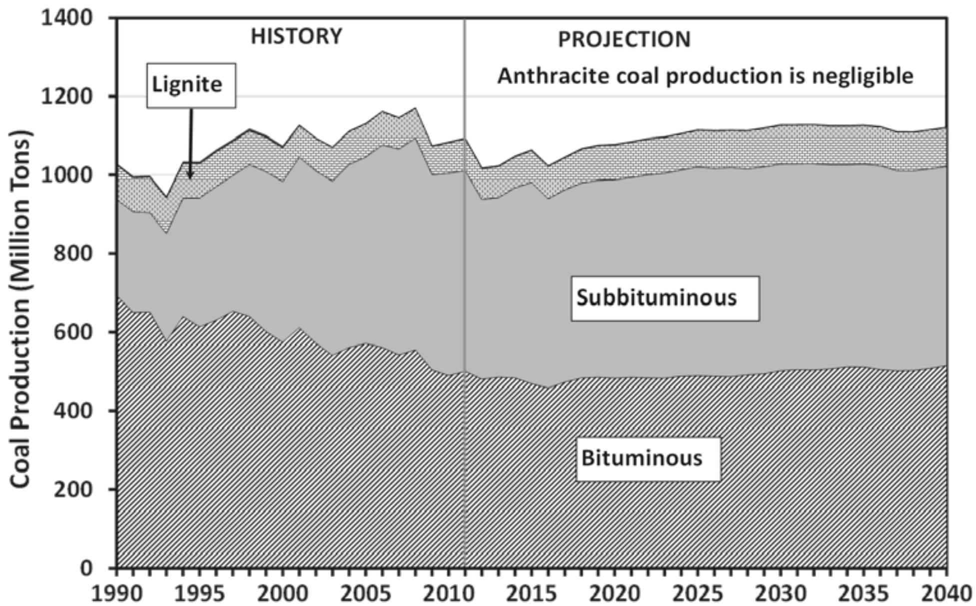


Figure 4. U.S. Coal Production by Grade, 1990–2040

(Source: EIA-AER 2014, Table 7.2, and EIA-AEO 2014, Table 15. Note that anthracite production barely registers as the thin line above lignite.)

## 2.3 End-Use

The vast majority of U.S. coal is consumed by the electric sector (Figure 5). Of the approximately 1,000 million tons produced in 2012, over 90% was used to produce electricity at 1,308 coal-fired generating units (located at 557 power plants). As shown in Figure 6, many of these power units have been operating for 40 years or more and must meet increasingly stringent environmental standards. In the three most recent years for which data are available, 145 units representing 10% of coal-fired units (but only 4.4% of net summer capacity) were retired (Table 1). As shown in Figure 7, an additional 60 GW of coal-fired capacity (19.4% of 2012 net summer capacity) is expected to be retired by 2020. Beyond the capacity included in these announcements, a recent analysis by the Union of Concerned Scientists (UCS, 2013) suggests that another 40 GW of coal-fired capacity may be ripe for retirement.

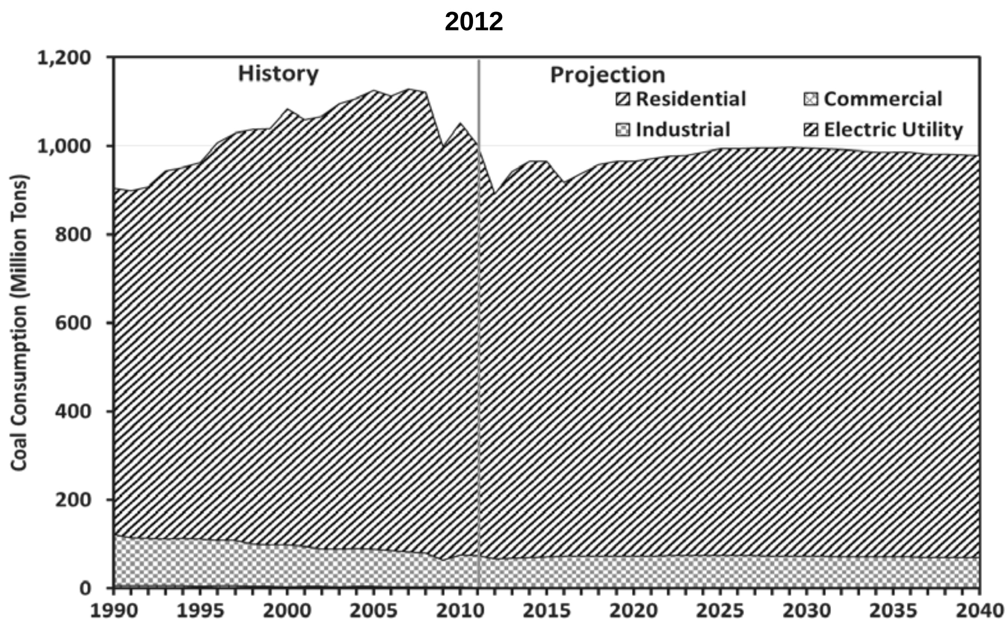


Figure 5. U.S. Coal Consumption by End-Use Sector, 1990–2040

(Source: EIA-AER 2014, Table 7.3, and EIA-AEO 2014, Table 15.)

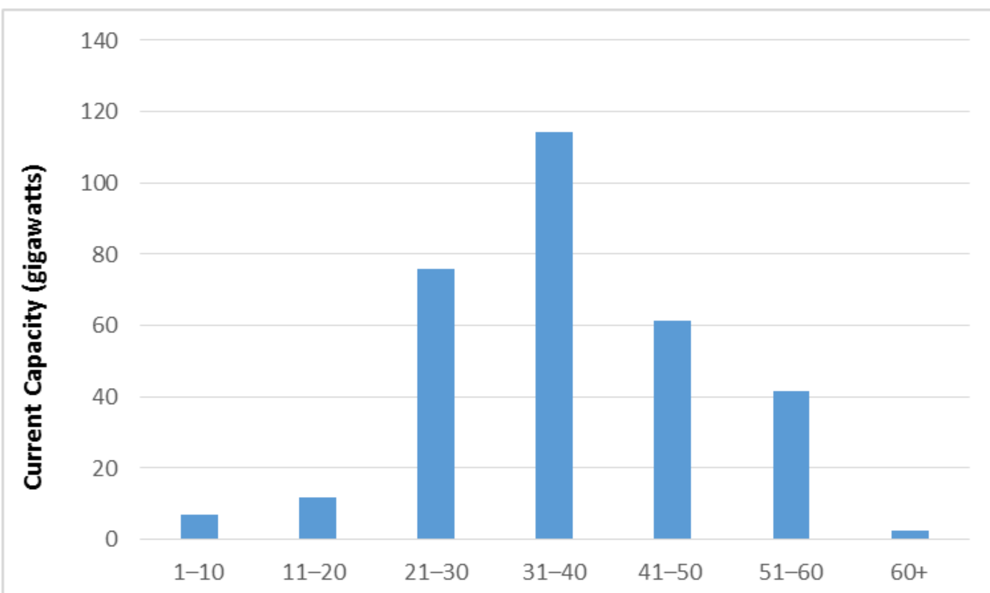


Figure 6. U.S. Coal-Fired Generating Units by Age (percentages shown reflect the percentage of units in each age range)

(Source: EIA data; age is as of 2010, http://www.eia.gov/todayinenergy/detail.cfm?id=1830.)

Table 1. Retirements at Existing Coal-Fired Generating Units, 2010–2012

| | Existing coal-fired capacity (2012) | Retirements | | |
|---|---|---|---|---|
| | | 2010 | 2011 | 2012 |
| Total net summer capacity (MW) | 309,519 | 1,418 | 2,456 | 10,214 |
| Number of units | 1,308 | 29 | 31 | 85 |
| Average net summer capacity (MW) | 239 | 49 | 79 | 123 |
| Average age at retirement | N/A | 58 | 63 | 51 |
| Average tested heat rate (Btu/kWh) | 10,168 | 11,094 | 10,638 | 10,353 |
| Capacity factor | 56% | 36% | 33% | 35% |

(Source: EIA-TE 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=1503.)

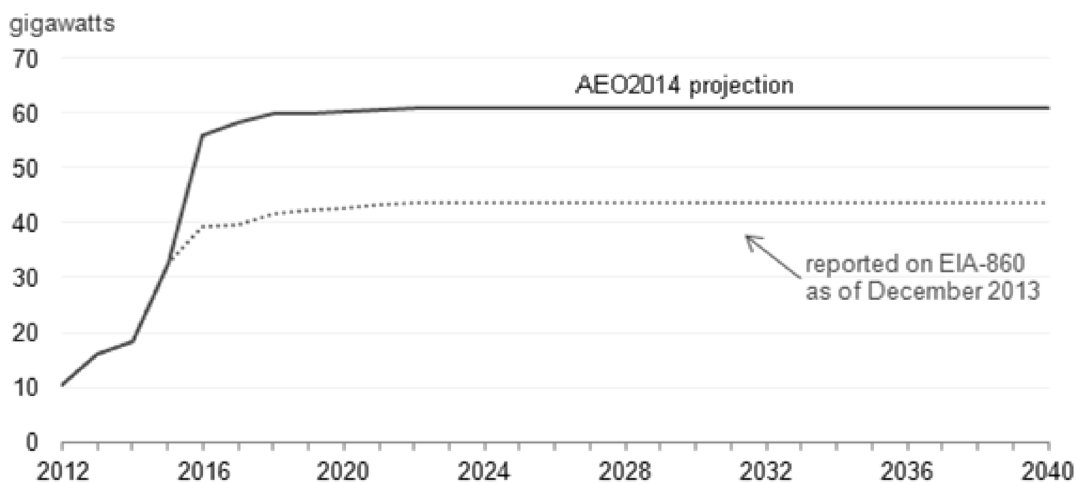


Figure 7. Projected Cumulative Retirements of Coal-Fired Capacity, 2012–2014
(Source: EIA-AEO 2014 and EIA-TE 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=15031.)

Figure 8 illustrates recent trends in national delivered fuel prices to the electric sector. Across regions, gas-on-coal competition depends on relative delivered fuel prices and the mix and utilization of available generating capacity. The Southeast saw the most switching towards dispatch of gas-fired units in 2012, when gas prices reached historic lows (http://www.eia.gov/todayinenergy/detail.cfm?id=9090). In EIA's 2014 Reference Case, factors such as compliance with upcoming mercury and air toxics standards, stagnant nuclear capacity growth, and increased generation from renewables that supplant coal firing contribute to more flexible natural gas overtaking coal as the leading fuel for electric power generation on an annual basis by 2035; the projected crossover comes much sooner, almost immediately, in EIA cases with relatively lower gas prices.

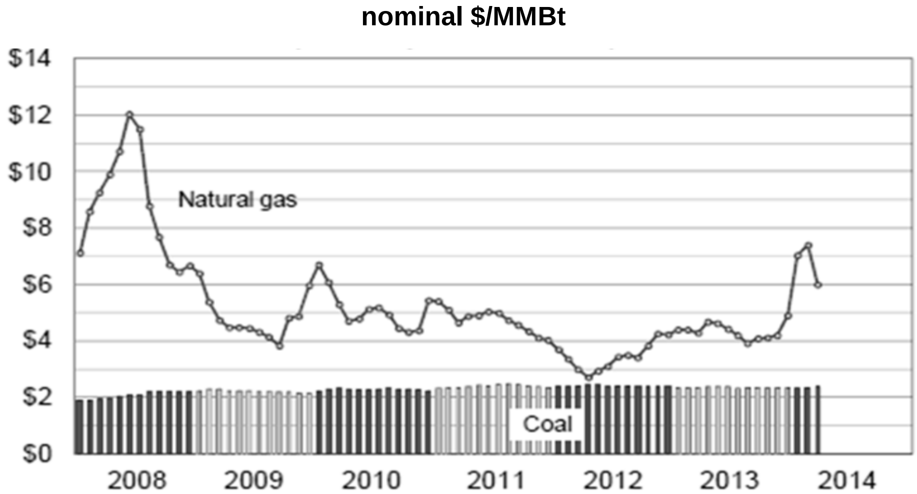


Figure 8. Average Delivered Price of Fuel to the U.S. Electric Power Industry, January 2008–March 2014

(Source: EIA data.)

## 2.4 Exports

As shown in Figure 9, a small but growing share of production is exported to a diverse mix of countries. Historically, exports have been bound primarily for destinations in Canada and Latin America. More recently, European and Asian markets have become significant buyers. Today, major destinations for U.S. coal include China, South Korea, Japan, Brazil, Italy, the Netherlands, France, Germany and the United Kingdom. As per EIA, U.S. coal exports have declined lately due to lower European demand and increased global supply (http://www.eia.gov/todayinenergy/detail.cfm?id=18251).

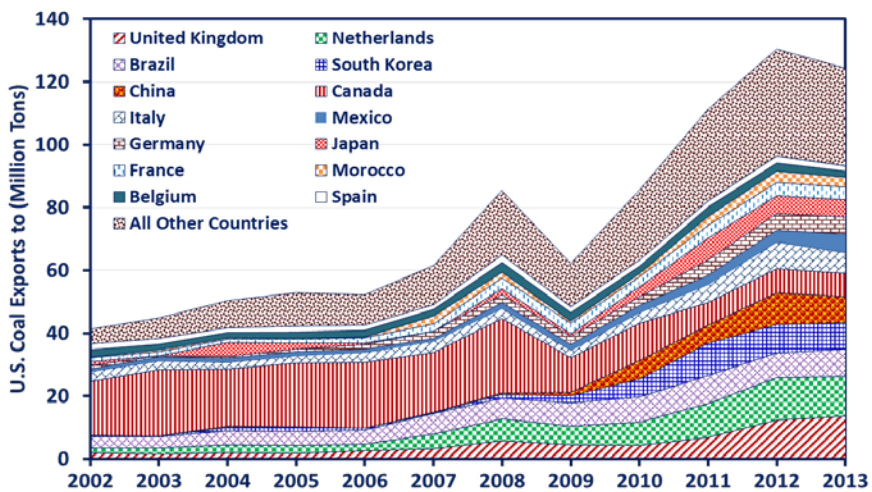


Figure 9. U.S. Coal Exports by Destination, 2002–2013

(Source: EIA-QCR 2014.)

Shifts in export destinations have produced associated shifts in the mix of ports serving the coal trade. As shown in Figure 10, declining exports to Canada have sharply reduced coal tonnage passing through Great Lakes customs districts including Duluth, Detroit and Cleveland, while rising exports to Europe and the Far East have increased tonnage through Norfolk, Baltimore, New Orleans and Seattle.

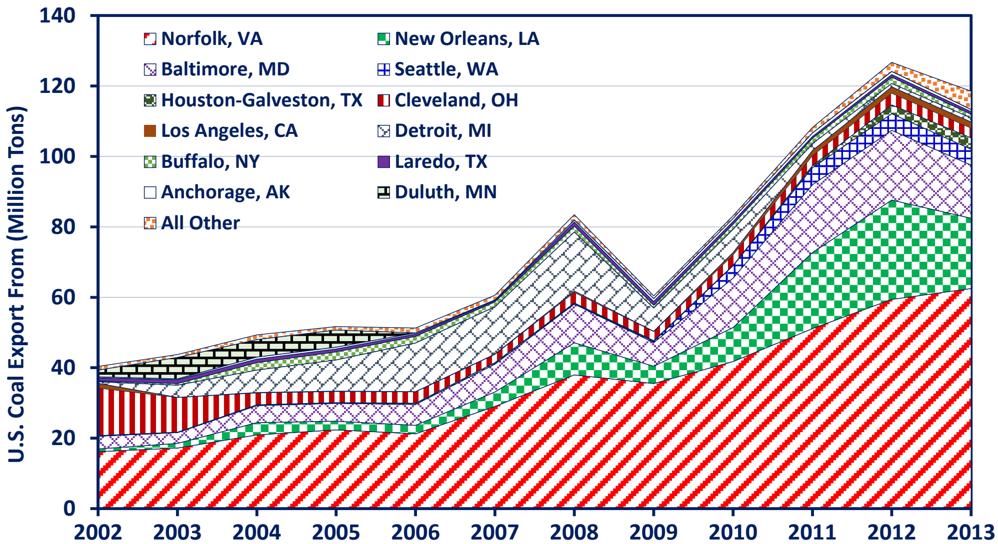


Figure 10. U.S. Coal Exports by Customs District, 2002–2013
(Source: EIA-QCR 2014.)

## 3. COAL TRANSPORT

Figure 11 illustrates the disparity between coal-consuming and -producing states. As noted above, Wyoming far exceeds all other states in production, but with relatively modest internal use, most coal is transported to large consuming states in the Midwest, East, and South, or to West Coast, Great Lakes, or Gulf Coast ports for export. The next-highest producers, West Virginia and Kentucky, also ship significant coal volumes to out-of-state electric utilities and ports, primarily on the East and Gulf Coasts.

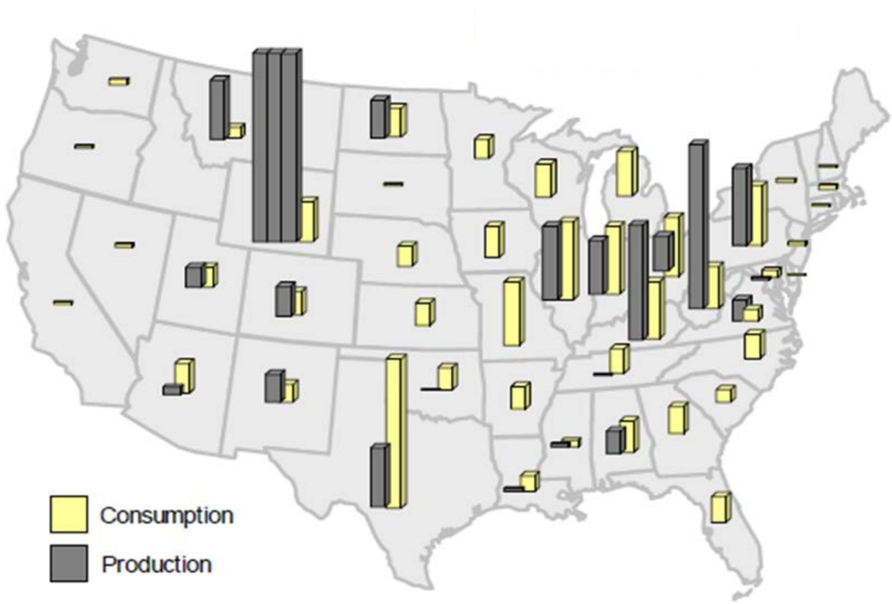


Figure 11. Coal Production vs. Consumption by State, 2013

## 3.1 Tonnage Moved by Rail and Water Modes

As shown in Figure 12, approximately 720 million tons of coal were transported by Class 1 railroads[1] in 2012. This tonnage represents 71% of all coal produced in the U.S., a share that has been relatively constant since 2001. The share of coal moved by barge has trended downward somewhat over this period (from 20% to 18%) in response to shifts in production from Appalachian to Interior and Western sources that tend to be distant from barge routes, combined with reduction in barge-to-rail traffic along the Mississippi. Barge traffic is concentrated in the Mississippi and Ohio River systems and the Great Lakes. Coal can be moved exclusively by barge or intermodally (i.e., rail-to-barge using major transshipment points along these systems). "Other" modes that account for a significant share of coal transport include trucks, conveyers and tramways, primarily for short distances between mines and nearby power plants, as well as smaller (i.e., non-Class 1) railroads.

1 As of 2011, the Association of American Railroads (AAR) defined Class I railroads as having operating revenues exceeding $433.2 million annually. Class 1 railroads with significant coal traffic include the Union Pacific, Burlington Northern Santa Fe (BNSF), CSX, Norfolk Southern (NS), and Canadian National (CN) systems.

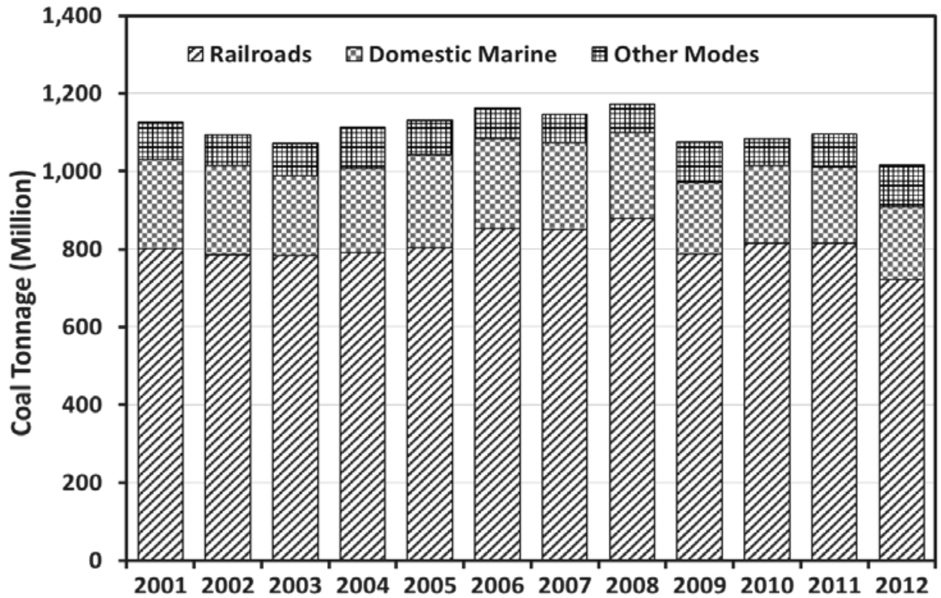


Figure 12. Coal Transport by Mode, 2001–2012
(Source: AAR-RF, EIA-MER 2014, and USACOE-NDC 2014.)

With movement of Powder River Basin coal dominating domestic production and shipping origin, the share of barge (and, certainly, truck) tonnage shipped is not likely to grow significantly. However, the widening of the Panama Canal (scheduled for completion this year) could change that. It could increase the tonnage now moving by rail to Midwestern and Eastern power plants by routing some to barge loading facilities on the Mississippi or even the Missouri. There, the coal would be transshipped to the waterway and down to Gulf Coast ports for movement on bulk vessels heading for Asia. This is an even more likely scenario if there is continued local resistance to creation/expansion of West Coast coal loading ports. In that case, more Powder River, Illinois Basin and possibly Utah's Rocky Mountain coal would be involved, as Appalachian coal may already have increased haul volumes to southeastern ports for the expanded Panama Canal trade. There is a slim chance that power plants located on navigable waterways would also look to increased waterborne deliveries if service remained unreliable from railroads affected by crude oil-by-rail congestion; even then, those plants might not be able to obtain a favorable delivery schedule, especially in winter.

Coal comprises the largest share (39%) of rail gross tonnage, but, because coal gondolas and hoppers have greater capacities than most other rail cars, it represented a lower share (21%) of carloads originated by Class 1 railroads in 2013 (Figures 13 and 14).

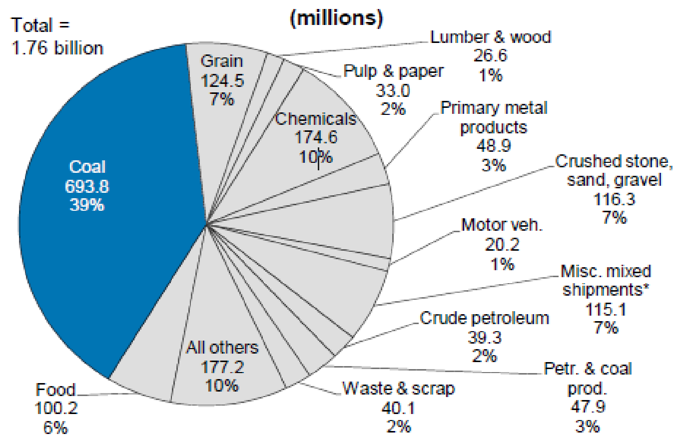


Figure 13. Tons Originated by Class 1 Railroads by Commodity, 2013

(Source: AAR 2014.)

*Miscellaneous mixed shipments are predominantly intermodal.

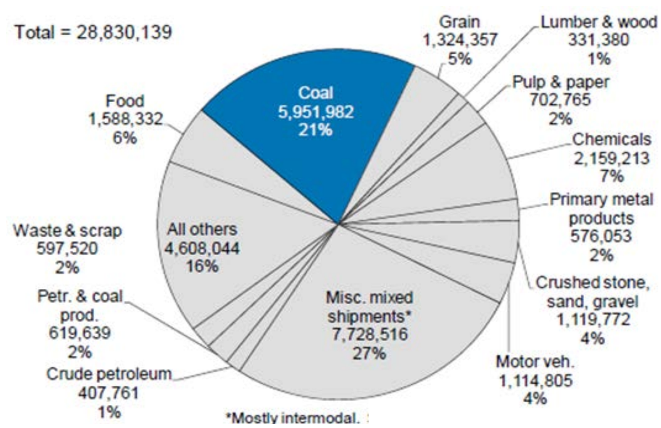


Figure 14. Carloads Originated by Class 1 Railroads by Commodity, 2013

(Source: AAR 2014.)

*Miscellaneous mixed shipments are predominantly intermodal.

## 3.2 Major Flows

Figure 15 displays the U.S. network of Class 1 railroads that transport significant volumes of coal, along with the locations of coal-fired power plants with capacities of 200 MW or more and major coal mines. Only the top 15 mines, based on 2012 coal production, are shown. These tend to be clustered together and in close proximity to rail lines (and, in Appalachia, to barge routes). Large mines also tend to have significant capabilities to store loaded railcars (many of which are owned by the mine or major customers) or entire unit trains to facilitate timely dispatch.

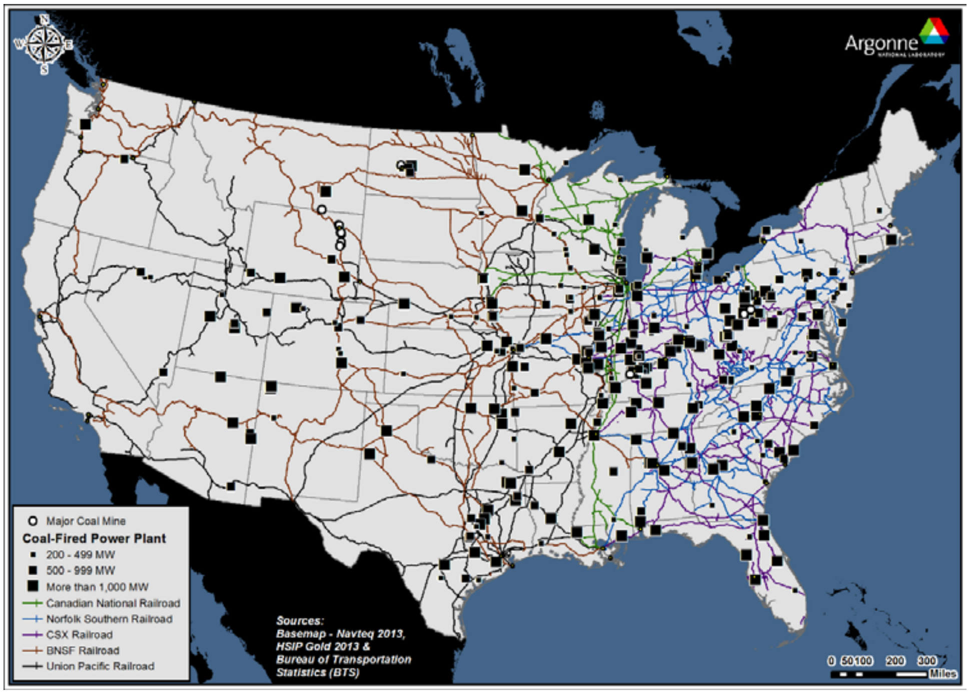


Figure 15. Existing Rail Networks, Large Coal-Fired Power Plants and Major Coal Mines

Most coal traveling longer distances by rail moves in unit trains consisting of 100 or more gondola and hopper cars from a single origin to one or a handful of major destinations (http://www.eia.gov/todayinenergy/detail.cfm?id=16651). Modern aluminum coal gondolas have approximately a 120-ton payload capacity, so a standard 120-car unit train can carry 14.4 thousand tons of coal (BNSF 2014). At the largest surface mine operations, coal is loaded directly from overhead silos with storage capacity as high as 48,000 tons into gondola cars that move along a track loop that can accommodate multiple unit trains at once. Once loaded, the train moves back onto the trunk line, which thus serves much as a conveyor belt with empties arriving and loaded trains departing.

# 4. RAIL REVENUE AND INVESTMENT TRENDS

## 4.1 Revenue from Coal and Other Traffic

Since its deregulation pursuant to the Staggers Rail Act of 1980 (PL 96-448, 94 Stat. 1895, Approved 1980-10-14), the railroad industry has shed unprofitable routes, upgraded equipment and infrastructure, rationalized services, and improved overall asset management. While coal still accounts for the largest share of gross revenue (Figure 16), that share has declined. Coal is substantially less profitable per ton or per carload than most other commodities, owing to its bulk nature and low value-to-mass and -volume ratios, as well as the concentration of coal traffic in more heavily loaded cars and longer unit trains.

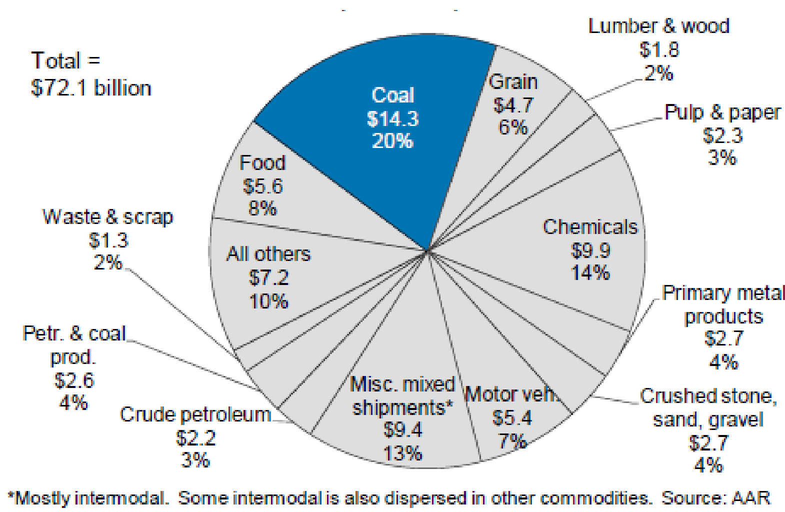


Figure 16. Gross Revenue (billion $) of Class 1 Railroads by Commodity, 2013

(Source: AAR 2014.)

On a ton-mile basis, rail revenue fell in the 1990s but has tracked the overall Rail Cost Adjustment Factor[2] for the past decade. The move to longer trains and larger capacity cars permitted coal-shipping rates to decline through the 1990s (Figure 17). More recently, increases in coal rates have stayed significantly below those for petroleum and coke products, but have mirrored the trend for all other commodities (Figure 18).

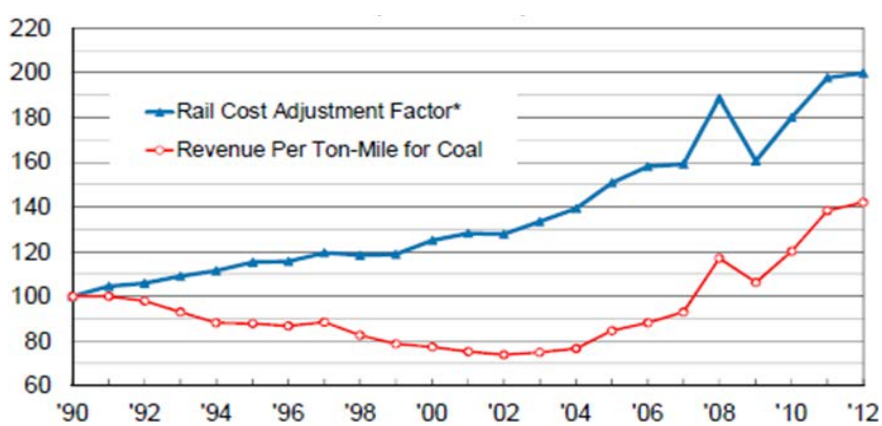


Figure 17. Average Rail Revenue per Ton-Mile for Coal and Rail Cost Adjustment Factor, 1990–2012 (1990 = 100)

(Source: STB 2009 and AAR 2014.)

[2] The Rail Cost Adjustment Factor (RCAF) is a forecast of rail input prices prepared at the direction of the Surface Transportation Board (STB). It measures the rate of inflation in railroad inputs such as labor and fuel. The RCAF, which was created for regulatory purposes, is calculated by the AAR and submitted to the STB for approval.

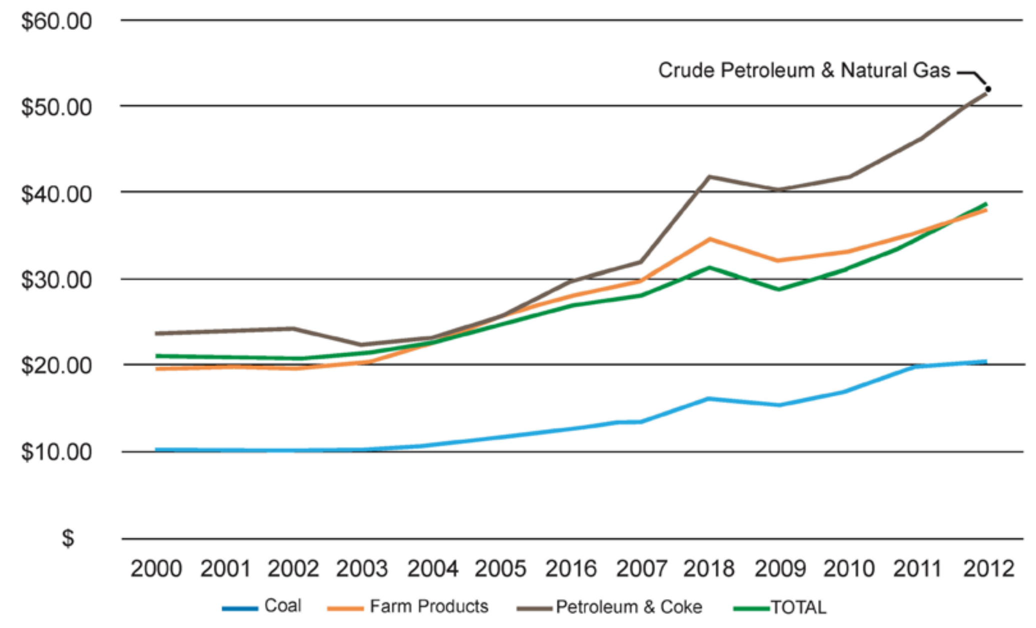


Figure 18. Class 1 Railroad Revenue per Ton (nominal $) for Select Commodities
(Source: STB 2009.)

As shown in Figure 18, farm products (primarily grain) generate as much revenue per ton as the average for all commodities, while coal generates less revenue and petroleum/coke generate more. The sharp rise and fall in revenue per ton in 2008–2010 correspond to the recession and recovery and are not long-term trends. Note that recent increases in crude oil shipments have necessitated a change in commodity reporting. Beginning in 2012, statistics are reported for a new category, "Crude Petroleum and Natural Gas," and the category "Petroleum and Coke" is renamed "Refined Petroleum and Coke." On the basis of 2012 data, Crude Petroleum and Natural Gas shipments generate slightly more revenue per ton than Refined Petroleum and Coke shipments. Under the Staggers Act, an increase in rail rates per carload- or ton-mile does not trigger an investigation by the STB unless the increase exceeds 180 percent of variable cost. It is not clear whether crude-by-rail shipments are currently being charged at or near that threshold.

## 4.2 Factors Affecting Rail Tariffs

In addition to volume and the ability of an individual shipper to negotiate favorable rates, several factors affect the shipping cost of individual hauls.

### 4.2.1 Asset Ownership

Private car ownership is a major factor behind the apparent stability of rail rates. As shown in Figure 19, rates for shipping coal in cars owned by mine owners or their customers (primarily electric utilities) declined from 1987 through 2004. During this time, the share of coal ton-miles moving in privately owned cars rose from 55% to 72% (and continued to rise to 74% in 2007, the last year for which data are available). Meanwhile, the share of grain ton-miles moving in privately owned cars dropped from 37% to in 1987 to 26% in 2007.[3]

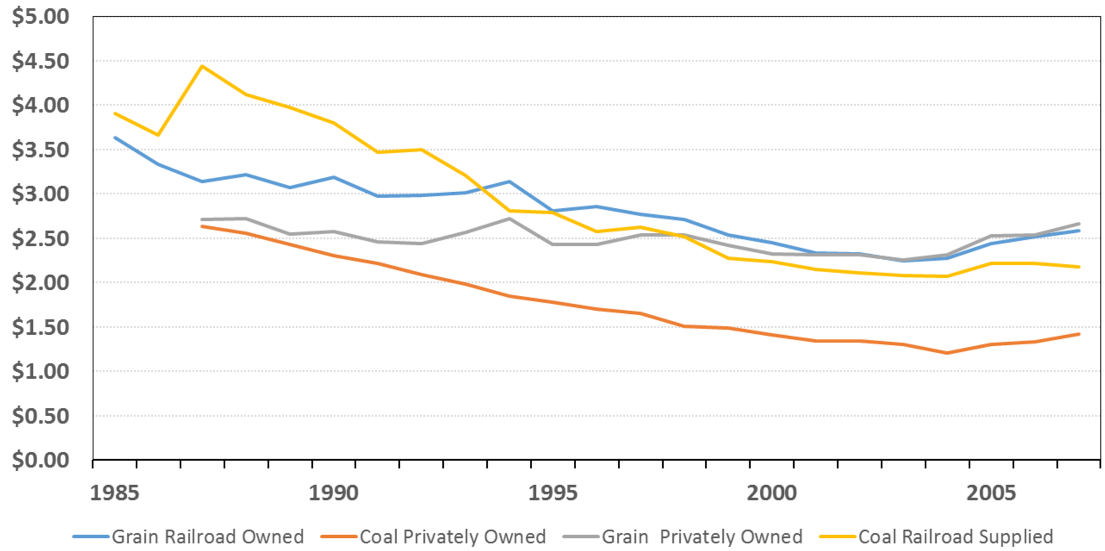


Figure 19. Class 1 Railroad Revenue per Ton (Nominal $) for Coal and Grain Shipments on Private vs. Railroad-Supplied Cars, 1985–2007

(Source: STB 2009.)

### 4.2.2 Length of Haul

Shipping distance also affects rail rates. As shown in Figure 20, while rates have declined for all shipment distances, the decline has been greatest for distances of 1000 miles or more. Rates for shorter hauls (i.e., shipments traveling less than 500 miles) declined from 1985 to 2001 but have risen substantially since 2001. As a result, much of the presumable advantage of short-haul traffic (i.e., cheaper transport, quicker delivery) may be diminished, especially if mines or shippers do not have access to privately owned cars, which permit lower rates and increased flexibility.

[3] Presumably, since revenue per ton for grain shipped on private vs. railroad-supplied cars converged over this period, shippers lost the operational savings from privately owned cars and abandoned their use.

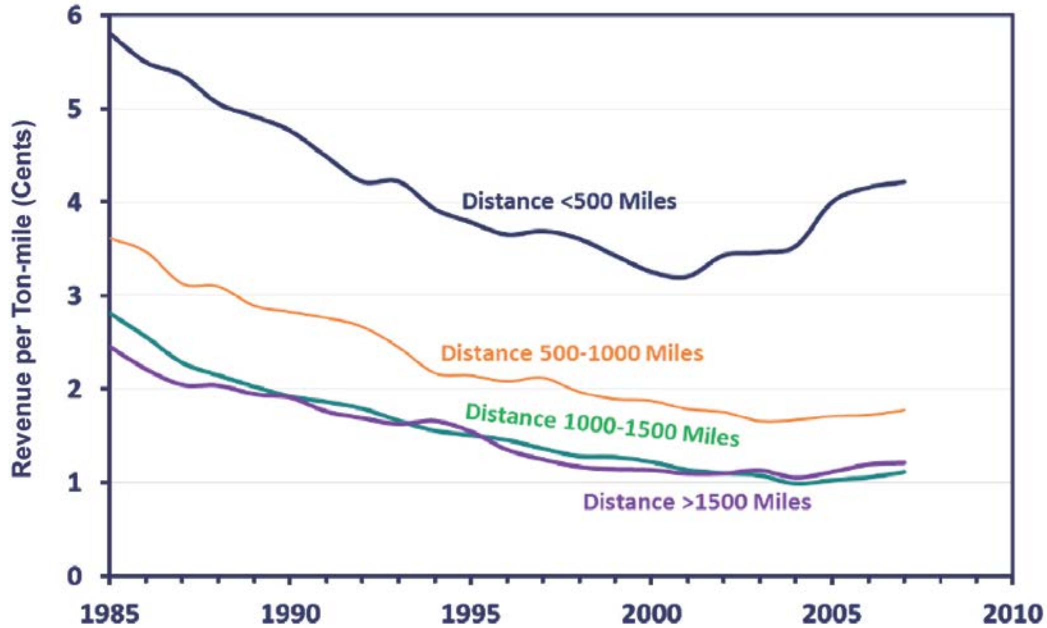


Figure 20. Average Rates (Nominal $) for Coal Shipments by Distance, 1985–2007
(Source: STB 2009.)

### 4.2.3 Storage

Both coal mines and electric utilities maintain considerable stockpiles to manage supply, demand and distribution, and to mitigate any unforeseen disruptions. [EIA total storage values for utilities are available at http://www.eia.gov/beta/steo/#/?v=18&f=A&start=1996&end=2016&ctype=linechart&maptype=0&linechart=CLPRPUS_TON.] As shown in Table 2, the largest coal mines maintain significant on-site storage in the form of silos and tracks for unit trains. Storage also provides shippers with the flexibility to negotiate more favorable rates.

Table 2. Reserves, Production, and Storage Capacity of Major Coal Mines

| Coal Mine Name | State | Recoverable Reserves (Million Tons) | Production (Million Tons) 2012 | 2011 | 2010 | 2009 | 2008 | Storage Capacity (Tons) | Unit Train Capacity |
|---|---|---|---|---|---|---|---|---|---|
| Black Thunder (Arch Coal, Inc) | Wyoming | 1,500 | 93.08 | 104.96 | 116.23 | 81.08 | 88.58 | 258,000 | 15 |
| North Antelope Rochelle Mine (Peabody Energy) | Wyoming | 1,245 | 107.64 | 109.06 | 105.76 | 98.28 | 97.58 | 125,000 | 11 |
| Freedom Mine (North American Coal Corporation) | North Dakota | 550 | 12.97 | 13.64 | 14.59 | 15.05 | 14.57 | 450,000 | 1 |
| Eagle Butte Mine (Alpha Natural Resources) | Wyoming | 471 | 22.47 | 25.37 | 23.23 | 21.48 | 20.44 | 48,000 | 5 |
| Belle Ayr Mine (Alpha Natural Resources) | Wyoming | 406 | 24.23 | 24.58 | 25.77 | 28.40 | 28.71 | 48,000 | 4 |
| Rawhide Mine (Peabody Energy) | Wyoming | 400 | 14.72 | 15.01 | 11.23 | 15.84 | 18.42 | | 2 |
| Caballo Mine (Peabody Energy)§ | Wyoming | 350 | 16.84 | 24.14 | 23.50 | 23.25 | 31.21 | 46,000 | 5 |
| Cordero Mine (Cloud Peak Energy) | Wyoming | 320 | 39.20 | 39.46 | 38.50 | 39.38 | 40.03 | 145,000 | 7 |
| Spring Creek Coal Company (Cloud Peak Energy) | Montana | 290 | 17.20 | 19.08 | 19.33 | 17.61 | 17.95 | 35,000 | 4 |
| Antelope Coal Mine (Cloud Peak Energy) | Wyoming | 268 | 34.32 | 37.06 | 35.91 | 33.98 | 35.78 | 27,500 | 4 |
| Buckskin Mine (Kiewit Mining Group) | Wyoming | 250 | 18.06 | 24.97 | 25.53 | 25.41 | 26.08 | 61,500 | 3 |
| Coal Creek Mine (Arch Coal, Inc) | Wyoming | 179 | 7.56 | 10.01 | 11.41 | 9.77 | 11.45 | 25,000 | 2 |

§ Recoverable Reserves estimated based on last 5 years' production

(Source: BNSF 2013 and EIA-CPD 2014.)

## 4.3 Investment

With real increases in revenue per ton-mile (Figure 18), Class 1 railroads have dramatically increased their spending on maintaining and upgrading their equipment and infrastructure. As shown in Figure 21, capital and maintenance expenditures have risen by 50% (in nominal terms) over the past decade, despite the recession-induced downturn in traffic.

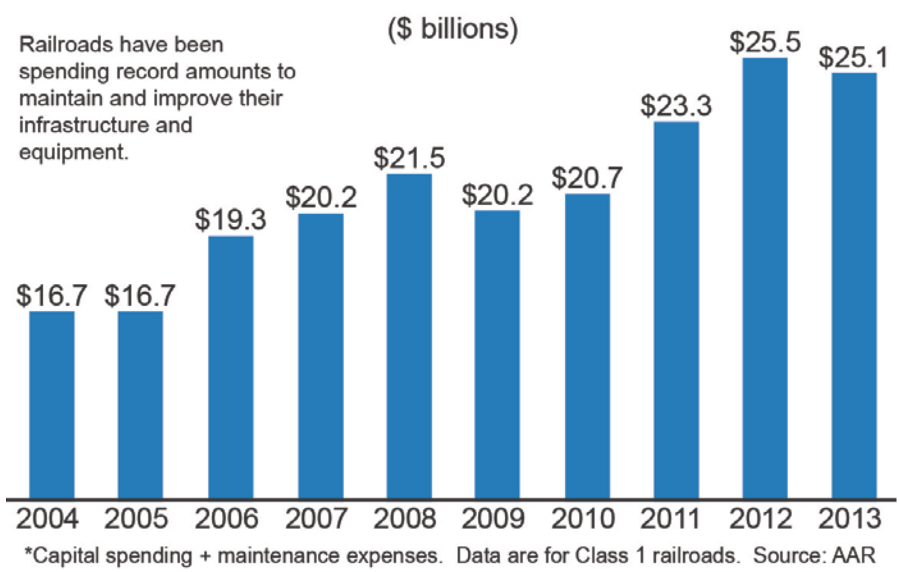


Figure 21. Capital and Maintenance Expenditures (Nominal $) by U.S. Class 1 Railroads, 2004–2013

(Source: AAR 2014.)

## 4.4 Future Volume and Distribution of Coal Traffic

Figure 3 illustrates EIA's 2014 forecast of coal production by region. While total production remains relatively flat, there are some shifts. As shown in Figure 22, these shifts are at least partly related to variations in the escalation of coal prices that are, in turn, tied to changes in mine productivity. Coupled with a moderate rise in exports and selective retirements of older, uneconomic power generators, future coal-by-rail traffic may be expected to flow from the Powder River, Illinois, and Central Appalachian regions to a range of destinations in a manner like that depicted in Figure 23. Though purely illustrative, Figure 23 suggests several corridors where coal-by-rail traffic may become (or already is) most dense. Powder River Basin coal's extensive market footprint is attributable to its low sulfur, moderate-to-high energy density, and relatively low ash content; it has been a favorite of utilities nationwide for many years. It moves east, southeast, and south to coal-burning plants and exporting points east of the Mississippi, and increasingly to West Coast ports for export to Asia. This pattern is expected to hold. Appalachian coal is higher in sulfur. But since it is also high in energy density, it feeds power plants at relatively short distances from mines, as well as seaports around Hampton Roads (VA) for shipment to Europe and Latin America. This, too, should remain a pattern into the future. Illinois Basin coal feeds, and should continue to feed, industrial and power plant destinations predominantly in the Midwest and near South.

The most significant change from current traffic patterns is in movements toward the Gulf Coast, where the combination of coal-fired generating capacity and expanded coal export facilities is likely to increase demand.

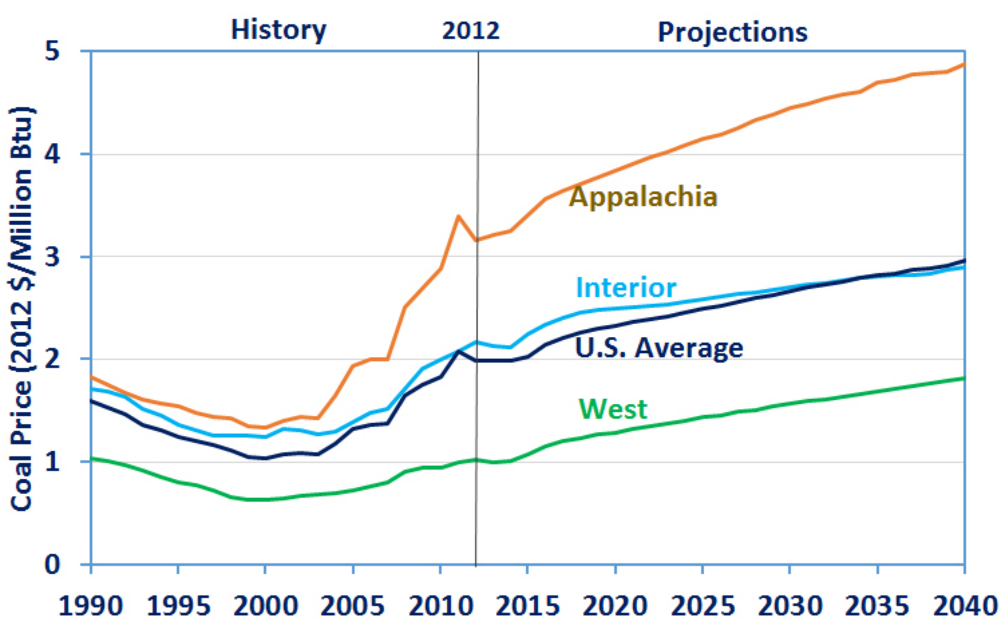


Figure 22. Average Annual Mine-mouth Coal Prices (2012 $) by Region, 1990–2040
(Source: EIA-AEO 2014, Figure MT-62, http://www.eia.gov/forecasts/aeo/MT_coal.cfm#coal_decline.)

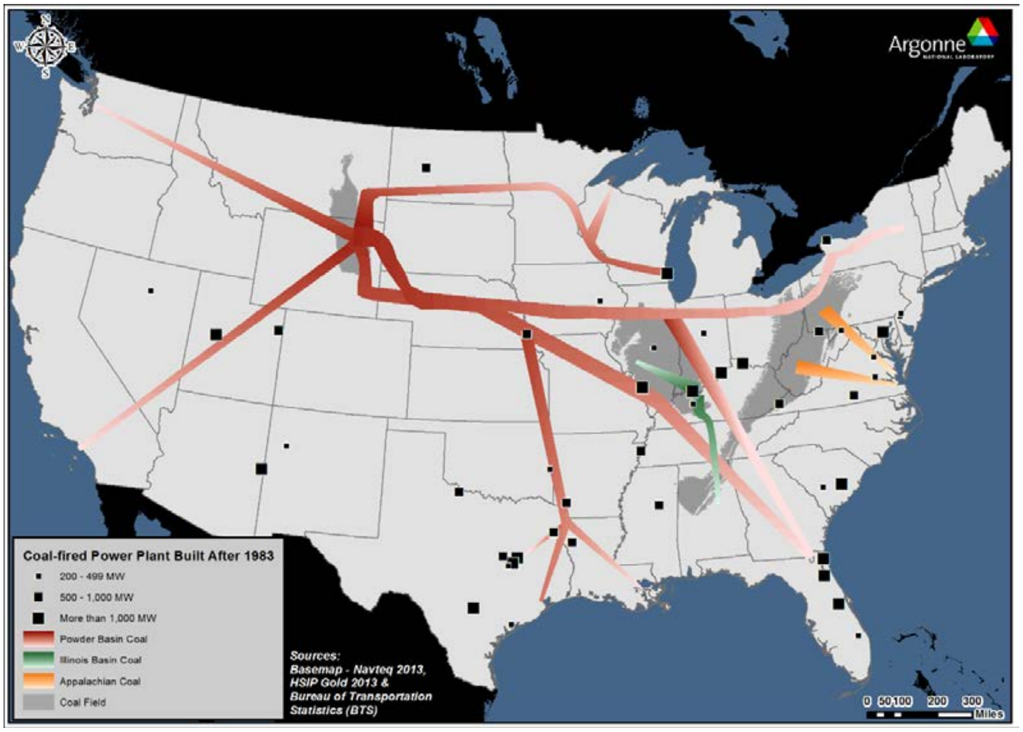


Figure 23. Conceptual Illustration of Present and Projected Coal-by-Rail Flow Vectors (vector width and shading indicate relative importance)

# 5. ADDITIONAL ISSUES AND CONCERNS

## 5.1 Competing Demands for Locomotives and Crews

Current declines in coal stockpiles at utilities are related to the availability of locomotives and crews to move coal unit trains over congested corridors, not to any shortage of coal hoppers or gondolas, which are owned predominantly by utilities and operated in unit train sets. When there is a motive-power shortage, owing either to reallocation/reassignment of locomotives to other traffic or a shortage of crews to operate the locomotives that are available (both situations have recently become chronic problems for some carrier operations), coal may not reach its desired destination in a timely fashion, leading to worrisome reductions in the number of days' worth of coal stockpiled at many power stations served by rail.

## 5.2 Uncertainty of Demand Forecasts

Although railroads are always looking toward future capacity needs, the two principal drivers of current expansion plans are forecast volumes of crude-by-rail and intermodal hauls. Despite strong growth in these movements over the past several years, there is considerable uncertainty about the scope for further growth and its duration. Although railroads expect to be hauling coal far into the future, total volume is expected to diminish as more coal-fired power generators are retired (Table 1). Even if the expected increase in export traffic materializes, no sure bet over the long term, it is unlikely to completely offset domestic declines in ton-mileage.

Railroads have been adding and will continue to add capacity over the next ten to fifteen years, in part to relieve chronic bottlenecks that emerged during the 1990s as a result of massive capacity abandonments and consolidations during the 1980s. Infrastructure investments by the major carriers are targeted chiefly to meet the following objectives:

a) Improve commodity—especially container train—flow to and from West Coast intermodal ports (e.g., Los Angeles-Long Beach, Seattle/Tacoma, Portland) to keep pace with burgeoning Chinese manufactured-goods markets;

b) Reduce the total number of classification yards while constructing new sorting yards designed to facilitate intermodal operations that utilize state-of-the-art and cutting-edge technologies (e.g., North Baltimore, OH; Edgerton, KS; Red Rock, AZ); and

c) Optimize locomotive equipment/staff logistics with advanced dispatching algorithms, adding track and deployment facilities where the algorithms indicate.

While meeting these objectives may benefit coal movements, they are not aimed at enhancing them.

## 5.3 Safety and Environmental Issues

In general, heavier trains require more, and more tightly compacted, ballast material (the rock base or substructure of railroad tracks upon and within which the ties are secured) in the roadbed. At some point in a long coal haul, not only does blowing coal dust affect coarse particulate loading along the route (see below), but its deposition can foul ballast to the point that the ballast can lose its binding integrity and become prone to loosening and voids, which in turn can cause derailments that are an issue for all types of shipments, including Bakken crude. Railroads have been adopting techniques for coal dust suppression, but these measures are not uniformly in place, and some provide only temporary abatement.

Coal dust pollution (irrespective of global warming effects) is becoming a wedge issue for groups opposed to additional coal loading ports in the Pacific Northwest. The negative health effects of such fugitive dust have been evaluated by health professionals in the context of broad public exposure (MCHD, 2013) and are cited in a video produced by an opposition group, which can be viewed at https://www.youtube.com/watch?v=biuUw60jCwU.

Products for coal dust suppression over a broad spectrum of weather conditions have recently become available. An example is presented at http://www.geocheminc.com/dirtglue/Coal_Dust/Coal_Dust_Control.htm (note: this citation does not constitute an endorsement).

## 5.4 Regulatory Issues

Coal-by-rail shipments are not specifically targeted by impending regulation. In the realm of locomotive emissions control generally, the U.S. Environmental Protection Agency's Tier 4 standards, which take effect in 2015 and call for the single largest emission reduction in the control program's timeline, require manufacturers to lower locomotive diesel engines' fine particulate emissions by 70 percent and $NO_x$ emissions by 76 percent, compared to the standards introduced in 2005 (40 CFR 1033.101). In order to meet these stringent limits, carriers such as CSX, NS and BNSF have investigated retrofitting diesel-powered units to operate on liquefied natural gas, an effective emissions mitigation strategy. Early deployments have involved locomotives operating chiefly in urban/metropolitan areas where the need for compliance with air quality standards is most pressing, but at some point a majority of coal trains passing through such areas may be so equipped. At that point, the siting of natural gas supply points sufficiently near major coal generation origins to provide adequate locomotive range could become an issue.

While environmental and safety regulations will affect all types of rail traffic, of greatest concern to coal shipments will be (a) how limitations on carbon dioxide and other greenhouse gases will affect the rate at which coal-fired power plants are retired and consequently their demand for rail shipment of coal, and (b) the degree to which local violations of PM10 (10-micron and smaller particulate matter) standards are influenced by coal dust from passing trains. Should the latter issue become significant, it would accelerate the railroads' need to acquire and deploy cleaner locomotives, which would inhibit their ability to increase capital spending for capacity expansion.

# 6. SUMMARY

In the future, the role of coal in the U.S. energy mix is expected to decline as proposed carbon emission standards reduce domestic coal use. If that decline does, in fact, occur, how will it affect rail traffic? While coal represents a major share of rail tonnage and gross revenue, growth in other traffic—most notably crude oil—has offset much of coal's decline. On net, changes are likely to be most notable for specific coal basins and rail flows.

Surface sub-bituminous mining in the Powder River Basin of Wyoming and Montana has dominated U.S. production and supply of steam coal for many years and will continue to do so, although at diminishing volumes owing to increased competition from natural gas and renewable sources (wind, geothermal, hydro) as power plant fuels. This competition will spur the quest for additional export markets for this coal, especially through Pacific Coast and possibly Gulf of Mexico ports.

Coal movements from all major producing regions (Powder River Basin, Illinois Basin, Appalachia) are dominated by railroad transportation, with unit trains of coal hoppers frequently moving well over 2,000 miles in round-trip (full out, empty in) hauls. This means that coal trains are likely at some point to pass through every community traversed by a rail thru-route, or located on trackage serving a coal-fired power plant or industrial facility. It also means that such communities are exposed to actual and perceived environmental and safety hazards posed by the passage of these trains.

Prospects for long-term growth and stability in steam and metallurgical coal shipments appear to be greater for international (export) than domestic markets, with considerable near-term demand growth in Asia and Europe. However, participation by U.S. coal producers and railroads in meeting this demand may be constrained by popular resistance to new coal-loading terminals in port cities on the West and Gulf Coasts.

Railroads have been expanding capacity and increasing service quality for many years, often applying the latest available technologies. These improvements primarily target markets in which considerable expansion is expected (e.g., intermodal shipment of manufactured goods from Asia, crude oil originating from Bakken and Mississippi shale). For the most part, improvements have not focused on coal traffic, although coal may benefit through expedited delivery to customers.

As a consumer of fossil and other forms of propulsion energy, railroads remain (with barges) the most fuel-efficient form of surface freight transport with respect to tonnage moved. Improve-ments in locomotive technology (such as advanced traction) have steadily increased this efficiency since the 1980s, but this trend may slow as locomotives produced from 2015 onward must meet stringent new emission standards for $NO_x$ and fine particulate matter. Further, if accelerated acquisition of such locomotives is needed to retire non-compliant units, this requirement could absorb capital that rail carriers would otherwise devote to capacity and service improvements, or to new transshipment facilities.

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