AMERICA'S POWER

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June 22, 2019

Mr. Mike Bryson
Senior Vice President – Operations
PJM Interconnection, LLC
2750 Monroe Boulevard
Audubon, PA 19403

Dear Mike,

America's Power appreciates the opportunity to provide these comments which we hope will help PJM to assure that its grid has sufficient fuel-secure resources in the future. We want to commend PJM for its willingness to tackle a difficult but critically important issue and for its openness to input.

America's Power represents the coal fleet, which, along with nuclear power, provides more fuel security than any other electricity source. However, coal-fired generation is not being compensated for providing fuel security, even though everyone agrees that fuel security is essential to grid resilience. Unless PJM develops a mechanism designed specifically to compensate fuel security, it is all but certain that coal retirements will increase and fuel security will decline.

In the past, we provided PJM with information regarding the substantial supplies of coal stockpiled at coal-fired plants in the PJM footprint (first attachment) and information that explains why the delivery systems for coal are highly reliable (second attachment). Large on-site coal stockpiles are the single best insurance against possible fuel supply disruptions because coal-fired power plants can operate for days to weeks without re-supply, if necessary.

Our comments below briefly address two issues on which PJM requested comment. The first is the extent to which existing mechanisms might promote fuel security. The second is additional scenarios that PJM should consider as it evaluates fuel security risks.

Existing Mechanisms

PJM has identified six market mechanisms that might unintentionally promote fuel security: capacity performance, reserve products (current), reserve products (price formation), regulation, gas/electric coordination and black start service. Our perspective on each of these mechanisms is summarized in the table below. In our view, none of these individually—or even collectively—provides a degree of fuel security that should be acceptable.

Mechanism	Helpfulness in Promoting Fuel Security
Capacity Performance	**Little help, if any** A Capacity Performance (CP) resource is <u>not</u> required to be fuel secure. In fact, a fuel security requirement was explicitly rejected when CP was designed in 2014. Lack of a fuel security requirement gives a competitive advantage to new resources that are not fuel secure. Penalties for non-performance are not adequate to guarantee performance during a high-impact, low-frequency event.
Reserve Products (Current)	**Minimal help, at best** Revenue can help support continued operation of fuel-secure resources but (1) does not necessarily prevent retirement of fuel-secure resources, (2) does nothing to directly promote fuel security, and (3) does not ensure a desired amount of fuel-secure resources.
Reserve Products (Price Formation)	**Minimal help, at best** Same as above.
Regulation	**Minimal help, at best** Same as above.
Gas/Electric Coordination	**Slight potential to be helpful** Has some potential to promote fuel security to the extent coordination facilitates advance supply arrangements for gas-fired generators. However, it does nothing to directly promote fuel security or to ensure a desired amount of fuel-secure resources.
Black Start Service	**Limited help** Black start units are fuel secure. However, there are only enough black start units to restore critical loads.

There are at least two major gaps in PJM's Capacity Performance (CP) mechanism with respect to fuel security. First, there is no fuel security requirement for any resource that wants to qualify as a CP resource. Second, the CP is designed to achieve resource adequacy at the lowest cost, not to value fuel security.

According to initial versions of PJM's CP proposal, on-site fuel was expected in the case of coal, and oil backup was expected for gas-fired sources. However, the final version did not include a requirement to demonstrate fuel security.[i] Instead, the final version simply included a provision in the PJM Tariff indicating that, by offering into the auction as a CP resource, the capacity market seller is representing that it has taken sufficient steps to ensure the resource can provide energy when needed.

The cost of demonstrating fuel security would have been included in the offer price into PJM's capacity auctions. On the other hand, there is no cost associated with making a representation that sufficient steps have been taken, only the risk of paying a non-performance penalty for failure to comply during a performance assessment event. By replacing a *requirement* to demonstrate fuel security with a *representation* of fuel security, CP has given a competitive advantage to non-fuel secure resources, which diminishes fuel security overall. Unless PJM modifies its markets to explicitly value fuel security, its markets will continue to promote the development of non-fuel secure gas capacity and the retirement of fuel-secure coal capacity.

Reserve products (current), reserve products (price formation), regulation, and black start service can provide revenue to help support the continued operation of fuel-secure resources, but they do nothing to directly promote fuel security, except for black start service. While these products can help the financial viability of resources that are fuel secure, three do not have fuel security requirements associated with them. It follows then that like CP, which also has no fuel security requirements, PJM can have an adequate or even excess supply of reserves and regulation but not be fuel secure.

Gas/electric coordination can improve fuel security to the extent it facilitates advance supply arrangements for gas generators. This issue is being addressed currently by ISO-NE where generators that do not run often do not make advanced fuel supply arrangements either because it economically disadvantageous, or they fail to recognize an impending high demand. While it is important to address this issue, this far from guarantees fuel security. In the case of ISO-NE, even if they address this failure to make advanced fuel supply arrangements, they are fed by three pipelines, and the loss of any single pipeline will cause load shedding. While better gas/electric coordination can improve the availability of gas-fired generation during periods of high gas demand, it is no substitute for on-site fuel.

Additional Scenarios

PJM's market structure has incented excess capacity reserves comprised mainly of gas-fired resources, while simultaneously encouraging the retirement of fuel-secure coal-fired generation. (As you know, there are more coal retirements in PJM than in any other ISO/RTO. So far, retirements and announced retirements total more than 36,000 megawatts (MW) through 2020.) Further, the coal fleet will continue to face environmental challenges in the future that could cause even more retirements. We provided information in August of last year showing that almost 17,000 MW of coal-fired generation in PJM faced a serious risk of retirement because of future air quality regulations. That figure is conservative because we did not assume any new carbon constraints, nor did we consider costs to comply with EPA's Coal Combustion Residuals or Effluent Limitations Guidelines rules. For these reasons, we urge PJM to model a scenario that assumes the retirement of all of its coal resources. If it would be helpful, we can provide suggestions regarding a timeline for these additional coal retirements. If an all-retirements scenario results in PJM reserves falling below the Installed Reserve Margin (IRM), then the addition of new gas and renewable generation should be assumed in order to maintain the IRM.

Thank you for the opportunity to submit these comments. Please let us know if you have any questions.

Sincerely,

Michelle Bloodworth
President and CEO
America's Power

Paul Bailey
Chief Policy Officer
America's Power

Attachments (2)

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[i]Capacity Performance Product Generation Capacity Resources, Demand Resources, and Energy Efficiency (EE) Resources may be eligible to be considered a Capacity Performance Product so long as the resource in question meets the following criteria. 1. Generation Capacity Resources are able to operate at their Capacity Performance Installed Capacity (ICAP) value for at least 16 hours per day for three consecutive days throughout the delivery year. In order to satisfy this criterion, it is expected that Generation Capacity Resources will have fuel on-site in the case of coal, or oil backup for gas-fired resources. In the case of gas-fired resources, it is assumed appropriate transportation arrangements to ensure delivery of fuel when it is needed through any combinations of firm transportation, storage, balancing agreements, use of park and loan service, either directly or through a third party via asset management agreement. The Capacity Performance Product does not mandate how fuel availability is ensured, but rather the decisions are left up to the individual resource owner on how to best manage fuel availability risks. August 20, 2014 PJM paper at http://www.pjm.com/~/media/committees-groups/committees/elc/20140822/20140822-pjm-capacity-performance-proposal.ashx

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DATE: August 1, 2018

TO: PJM

SUBJECT: Days of Coal Burn

The purpose of this short memo is to follow up on our discussion regarding how EIA calculates days of coal burn. We're using Bruce Mansfield as a random example and EIA data for 2016, the most recent full-year data available from EIA. Our explanation is based on discussions with EIA. We can provide spreadsheets to back up our calculations if that would be helpful.

EIA collects information via Form 923 that includes (1) the amount of coal burned each month by each coal-fired power plant in the U.S. and (2) the amount of coal stockpiled at each power plant at the end of each month.

In 2016, the amount of coal Bruce Mansfield burned ranged from 538,000 tons in September to 36,000 tons in March. The coal stockpile ranged from 17.5 million tons in January to 15.5 million tons in September.

EIA uses the information to calculate the number of days the coal stockpile would last if it was not replenished. This is referred to as *days of coal burn*.

EIA computes days of coal burn in the following manner:

- For each month, EIA computes the *daily* coal burn rate (the average amount of coal burned each day) for each power plant over a 3-year period by dividing the monthly burn rate (tons per month), which is provided on Form 923, by the number of days in a particular month (28, 30 or 31 days).
- The January burn rate in the table below for Bruce Mansfield represents the average of the daily January burn rates over the previous 3-year period 2013-2015. Burn rates are calculated the same way for the other 11 months.
- For Bruce Mansfield, the 3-year average (2013-2015) daily burn rates are as follows:

MONTH	AVERAGE DAILY COAL BURN FOR 2013-2015
January	17,447 tons/day
February	17,192
March	16.653
April	16,294
May	16,095
June	15,876
July	15,732
August	15,578
September	15,500
October	15,598
November	15,547
December	15,282

- EIA then uses these daily burn rates to compute days of coal burn for any given month based on the size of the coal stockpile for that month. For Bruce Mansfield, the days of coal burn for January 2016 would be calculated as (1.51 million tons of coal stockpiled in January)/(17,447 tons of coal burned/day in January per the table above), which would be 87 days of coal burn for the January 2016 stockpile. Similarly, days of coal burn for August would be (1.56 million tons stockpiled in August)/(15,578 tons of coal burned/day in August per the table above), which would be 100 days of coal burn for the August 2016 coal pile. Monthly coal stockpiles are taken from Form 923.

- The explanation above illustrates how days of coal burn are calculated for Bruce Mansfield for a single month. The attached table shows how days of coal burn vary from plant to plant. The table includes 28 coal-fired power plants in PJM that are greater than 1,000 MW. The days of coal burn for 2016 range from 6 days for Homer City in August to 184 days for both Gavin (May) and Cardinal (June). The reasons for these variations are beyond the scope of this paper.

Attachment: "Days of Coal Burn in 2016 for PJM Coal-Fired Power Plants Larger than 1,000 MW"

OCTOBER 2018

ENERGY VENTURES ANALYSIS

Coal Supply Disruptions and Customer Coal Inventories for Plants in the PJM Interconnection

October 2018

Prepared by:

ENERGY VENTURES ANALYSIS

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Summary

As opposed to most other power sources, coal-fired power plants provide fuel supply security because they maintain on-site coal inventory (stockpiles). In case of disruptions in coal supply, on-site coal inventory will allow coal plants to provide power for an extended period. This study found that:

- Coal-fired power plants maintain large on-site coal stockpiles – typically 30 – 40 days of peak burn.[1]
- Coal supply interruptions due to transportation problems or commodity shortages are extremely infrequent with short duration and small impacts on customer inventories.
- The largest impact on coal inventory levels comes from changes in burn, not interruptions of supply.
- Extreme cold winter weather events pose the largest risk of reduced coal inventories, but even during the extended coal weather events of 2014 and 2004, average stockpile levels in PJM never fell below 22 days of peak burn (or below 33 days of average burn).
- There is a long history of the power industry planning to maintain coal inventories adequate to provide security for periods of increased burn or supply interruptions. There is every reason to believe that the industry will continue to maintain adequate inventory in the future.

These conclusions support the fact that coal plants provide a source of resilience for PJM which is not provided by other forms of generation.

- On-site coal inventories provide a very high degree of fuel security. The risk of coal supply interruption is low, the impact on customer inventories is small, and the industry has shown an ability to recover rapidly from any interruptions.
- On-site coal inventories provide the entire PJM Interconnection with increased reliability. The high level of on-site coal inventories allows coal plants to respond with increased generation to meet increased load or to replace other sources of generation which are unavailable due to forced outages or fuel supply problems.
- The resilience of the coal fleet provided the extra power to meet customer load during recent periods of extreme cold weather in 2014 and 2018 when other sources were not available to increase generation. The on-site coal inventories are a critical component in this resilience as they allow coal plants to increase burn before the coal supply system (production and transportation) can increase deliveries to provide more coal.
- The resilience provided by the combination of on-site fuel inventory and available capacity to increase generation is only provided by the coal fleet in PJM.

Introduction

America's Power (ACCCE) commissioned this report by Energy Ventures Analysis, Inc. (EVA) to analyze the fuel security provided by on-site coal inventories. This report addresses the frequency of coal supply interruptions and the impact on coal inventories maintained at coal plants in the PJM Interconnection,[2] which is the largest merchant power market in the U.S. PJM is home to about 56,000 MW of coal capacity, which is over 20 percent of the entire U.S. coal fleet.

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[1] There is no standard measure of "days of burn" for coal inventories. This study presents inventories measured in days of peak burn, days of maximum sustained burn, and days of average burn, as all three measures can have valuable information.

[2] The PJM Interconnection, originally covering most of the states of Pennsylvania, New Jersey, Maryland and Delaware, has expanded to include power generation across much of Ohio, Kentucky and Illinois. PJM is an independent system operator and manages the dispatch of power plants across this entire region so that generation matches load on a real-time basis. Some of the power plants in PJM are owned by regulated electric utilities and receive cost-of-service recovery in their retail rates, but most of the generators in PJM are merchant power plants which receive compensation for energy sales and capacity commitments at market prices established by PJM.

There has been increased attention to the issue of fuel supply security for power generation, in part due to the unavailability of natural gas units during recent cold weather events in January 2014 (the "Polar Vortex") and the first week of January 2018 (the "Bomb Cyclone"). PJM issued a report analyzing the performance of the grid and the generation fleet during the 2018 Bomb Cyclone with a comparison to the performance during the 2014 Polar Vortex.[3] With regard to the performance of fossil-fuel power plants during the Bomb Cyclone, PJM found that, on the peak day of generator outages (January 7, 2018), 5,913 MW of gas-fired generation had forced outages due to a "gas supply issue", while just 422 MW of coal-fired generation had forced outages due to a "coal supply issue".[4] Further, an additional 9,500 MW of plants with gas as their primary fuel switched to oil, primarily due to the unavailability of natural gas.[5] Including natural gas plant outages (8,096 MW), fully half of the total gas-fired capacity in PJM did not operate on natural gas during the January 7, 2018 (23,939 MW was operating on natural gas, while 23,500 MW was off-line or burning oil).

In contrast, the coal fleet was highly reliable. Out of 56,500 MW total coal capacity, only 6,935 MW (12.3%) was off-line due to outages, with just 422 MW (under 1.0%) related to coal supply. PJM reported that "coal supply" issues included "coal quality" issues related to freezing issues during conveyance of coal to the boiler, not the unavailability of coal on site for power generation.[6]

This report analyzes the long-term history of coal supply to power plants in PJM, the quantity of coal inventory levels maintained on site for fuel security, and the impact of disruptions of coal transportation on coal supply and inventories.

Adequacy of Coal Inventory Levels at PJM Power Plants

EVA analyzed the level of inventories across all the coal plants in PJM using monthly data on coal burn, receipts and stocks from EIA 923 data for the period from 2003 through 2016. Inventory levels were measured using days of burn under 3 metrics, each of which provides useful information:

- Days of average burn, using the monthly burn over the trailing 12 months
- Days of peak daily burn, calculating the highest daily burn from the monthly data
- Days of maximum sustained burn, using the maximum burn in any 3-month period

Days of average burn is a measure of how many days of inventory the plant has on site if the plant continues to operate at the same average level as it had been over the prior year. It is the best measure of how long a plant could continue operating at current levels if all coal deliveries ceased.

Days of peak burn is a measure of reliability under the most extreme conditions: the plant would run at maximum levels and all coal deliveries would cease. This is the measure of how many days the plant could run at 100% of its peak hourly burn.

Days of maximum sustained burn is similar to days of peak burn, but with a more realistic measure of maximum burn. No coal plant in PJM runs at 100% output all the time (as nuclear plants do, when available), because coal plants typically back down in off-peak periods.

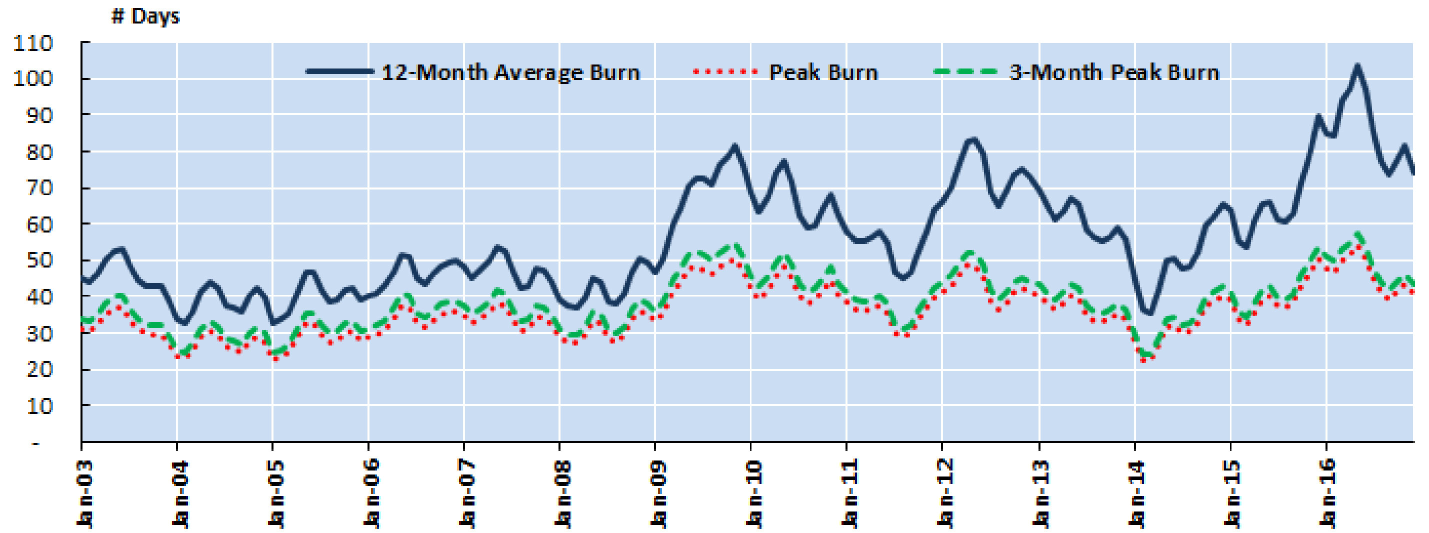
[3] PJM Interconnection, "PJM Cold Snap Performance Dec. 28, 2017 to Jan. 7, 2018," February 26, 2018.

[4] Id at 17.

[5] Id at 13-14; "the majority of reasons cited for the switch from gas to oil during the 2018 peak were a combination of interruptible gas curtailments by pipelines/LDCs or supply unavailability, with the balance attributable to a pure economic decision due to the significantly higher spot prices of natural gas."

[6] The idea that the reliability of coal-fired power plants is affected by frozen coal inventory is not supported by industry experience. Coal-fired power plants operate reliably in extreme cold weather in the United States and around the world. While the outer surfaces of coal stockpiles can freeze due to moisture on the coal, the frozen edge is easily broken up by regular stockpile maintenance and the interior of coal stockpiles stays warm due to coal oxidation.

PLANT COAL STOCKS: TOTAL PJM



Source: EVA Analysis of EIA data

Prior to 2009, coal inventories were very steady at levels of 33 – 53 days of average burn (23 – 38 days of peak burn). There were normal seasonal swings, as coal inventories would build during the shoulder months in Spring and Fall and then decline during the higher burn levels of Summer and Winter. Coal burn was steady and predictable during this period, as coal plants ran as baseload units because natural gas prices were high and gas units were more expensive to dispatch.

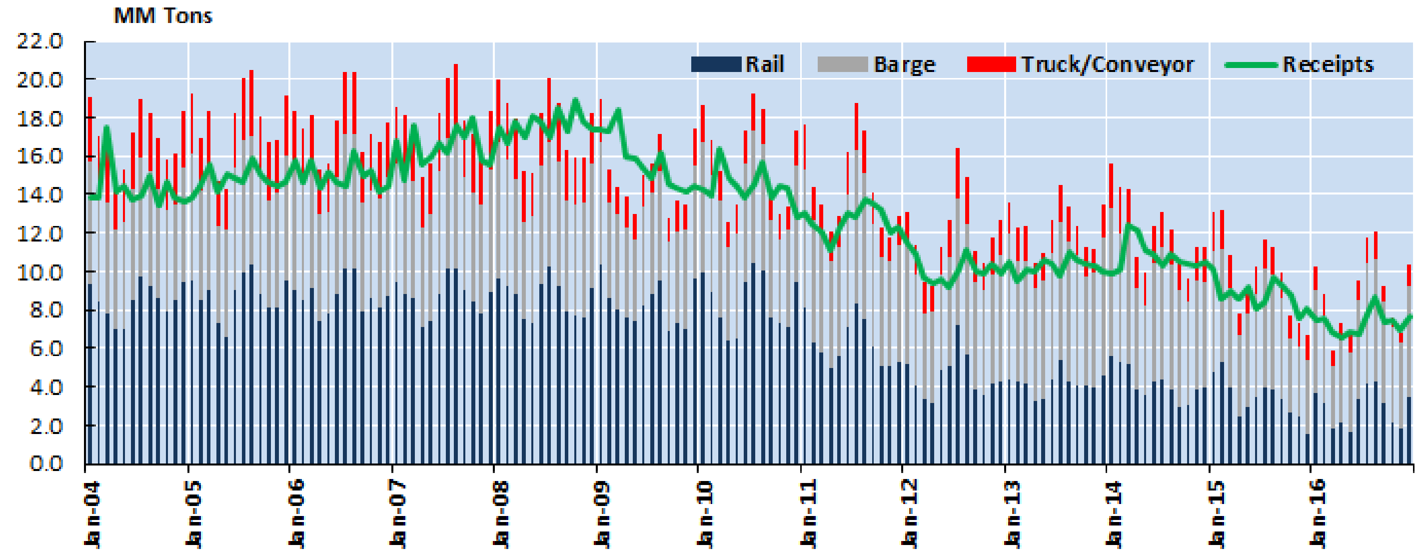
Since the end of 2008, coal inventories have varied due to changes in coal burn, not due to changes in coal supply, deliveries or storage capacity. There have been three periods of low coal burn in 2009 (due to the Recession), 2012 and 2016 (both due to very low natural gas prices caused by mild winter weather). In each of these years, coal inventories rose rapidly, because customers had contracted for coal deliveries based upon expectations for burn to continue at previous levels. In each case, it took another year after the event for customers to bring inventories back down to target levels by reducing purchases below burn.

Since 2008, the only time when coal inventories fell below 29 days of peak burn was briefly in the winter of 2014 during the high burn of the Polar Vortex. During January and February 2014, coal units were called on to operate at high levels to meet high demand for electricity, as no other sources of incremental generation were available (nuclear and renewables already ran as much as available and natural gas units were limited by available gas deliverability due to high demand for heating).

Higher levels of coal burn in PJM occurs both in summer and winter months reflecting periods of increased electric load. In the past, the summer months were the highest coal burn to serve the extended summer power demand. However, the profile of coal burn has shifted in recent years to a greater peak in the winter months. This was caused by the displacement of coal generation by natural gas for much of the year, including the summer months. However, heating demand for natural gas peaks in the winter months, which can trigger high natural gas prices and cause coal burn to increase both to serve increased power demand and to displace gas generation.

The historical PJM monthly coal burn and deliveries are shown below. There is no correlation between the timing of peak burn (in summer and winter months) and reduced coal deliveries due to supply interruptions.

PJM COAL BURN BY PRIMARY TRANSPORTATION MODE AND RECEIPTS



The analysis shows that utility coal inventories in PJM have been adequate to:

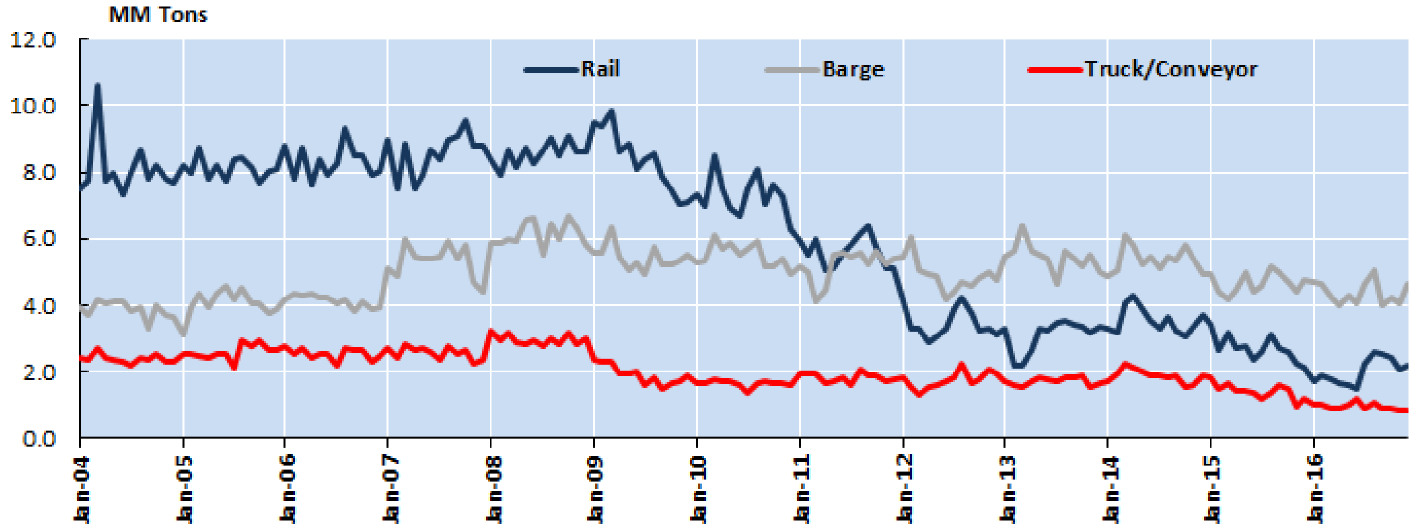
- Meet demand at expected levels;
- Provide security in the event of supply disruptions; and,
- Provide on-site fuel to support increased coal unit dispatch to meet increased demand for generation at high load periods and to provide system reliability if other sources of generation are unavailable.

Historical Events of Coal Transportation Disruptions to PJM Plants

Delivery Modes for PJM Power Plants

EVA analyzed the deliveries of coal to power plants located in PJM by primary delivery mode using the data reported by the power generators on EIA Form 923. Plants in PJM deliver coal by a variety of transportation modes, including rail, barge, truck and conveyor belt. Some plants transport coal using a combination of transportation modes. There are many plants located along the Ohio River system (Ohio, Monongahela, Allegheny and Kanawha Rivers), most of which deliver coal by barge for final delivery. Plants using western coal with delivery by barge first ship coal by rail to a river dock for final delivery by barge. Only plants located close to the coal fields deliver coal directly from the mines by truck or conveyor, although some plants first ship coal by rail with final delivery by truck. The change in PJM coal demand over time due to plant retirements has resulted in a large decline in rail deliveries of coal, with barge deliveries becoming the primary mode since 2011.

PJM COAL RECEIPTS BY PRIMARY TRANSPORTATION MODE



Source: EVA Analysis of EIA data

Disruption of Coal Transportation by Barge

In analysis of coal delivery disruptions via barge to coal-fired power plants located in PJM, EVA utilized daily river flow data from the United States Geological Survey (USGS) as well as monthly lock performance data from the U.S. Army Corps of Engineers (USACE) and monthly coal receipts data by plant from the Energy Information Administration's (EIA) Form 423/923. EVA analyzed 15 years of data, from January 1, 2002 to December 31, 2016. The rivers included in this report as well as associated USGS locations and USACE lock and dam (L&D) names are shown below.

River Name	USGS Location	USACE Lock
Allegheny	Natrona, PA	C.W. Bill Young L&D
Monongahela	Elizabeth, PA	L&D #3
Upper Ohio	Sewickley, PA	Dashields L&D
Lower Ohio	Louisville, KY	McAlpine L&D
Kanawha	Charleston, WV	Winfield L&D

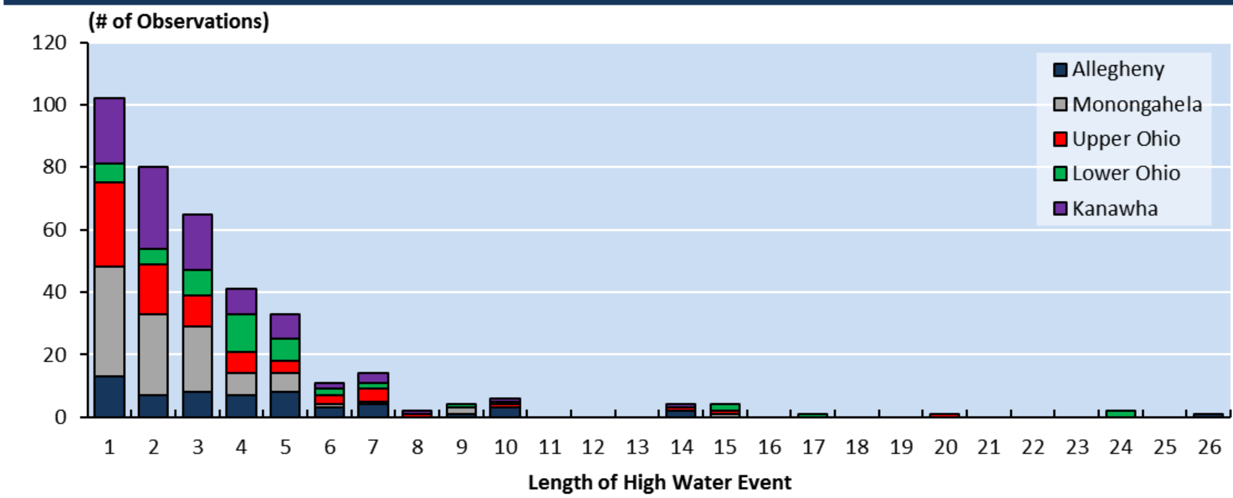
The primary risk of disruption of coal deliveries by barge is from river flooding. During high water events, barge shipments can be disrupted due to lock and dam closures or limited bridge clearance for coal barges. EVA defined high water events as days for which the river discharge data provided by USGS falls above the 95th percentile for the 15 years analyzed,[7] which means that 95% of the data is below that threshold. The average and maximum length of high water days by river are shown below.

[7] January 1, 2002 to December 31, 2016 = 5,478 days of data

River Name	95th Percentile River Discharge (ft3/s)	No. of High Water Days	Avg. Length	Max Length	Date of Max Length Event
Allegheny	58,320	57	4.5	26	March 26, 2011
Monongahela	30,400	100	2.5	15	March 18, 2015
Upper Ohio	99,220	76	3.3	20	March 20, 2011
Lower Ohio	392,000	49	5.4	24	March 21, 2011
Kanawha	49,720	89	3.0	14	March 17, 2015

As the table shows, high water events are generally very short-lived, averaging approximately three to five days of water levels above the 95th percentile threshold. Out of the 371 cumulative high-water occurrences between 2002 and 2016 for the five rivers, only 13 (<4%) have lasted longer than 10 days, and only three (<1%) have lasted longer than 20 days.

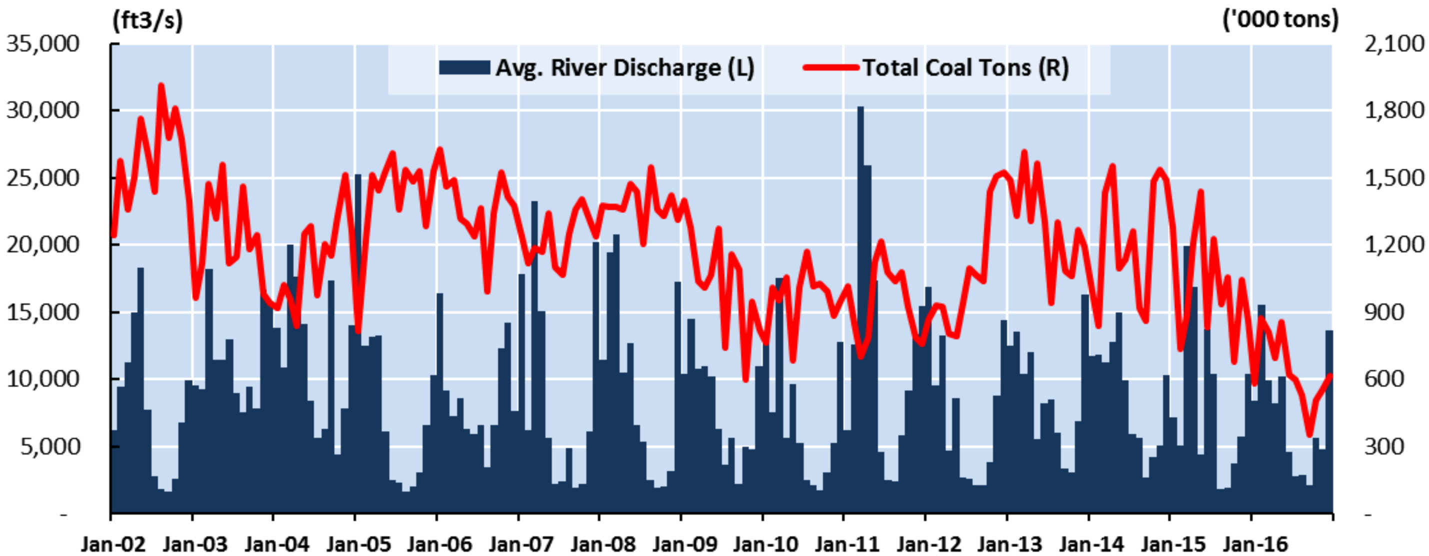
LENGTH OF HIGH WATER EVENTS BY RIVER



Source: USGS River Discharge Data, Jan-2002 through Dec-2016

Most high-water events occur early in the year (January – April), when sudden extreme weather with high precipitation can cause water levels, which are already at its highest during that time due to snow melt, to rise well above normal levels.

UPPER OHIO RIVER AVERAGE RIVER DISCHARGE VS. TOTAL COAL BARGE TRAFFIC



Source: USGS & USACE

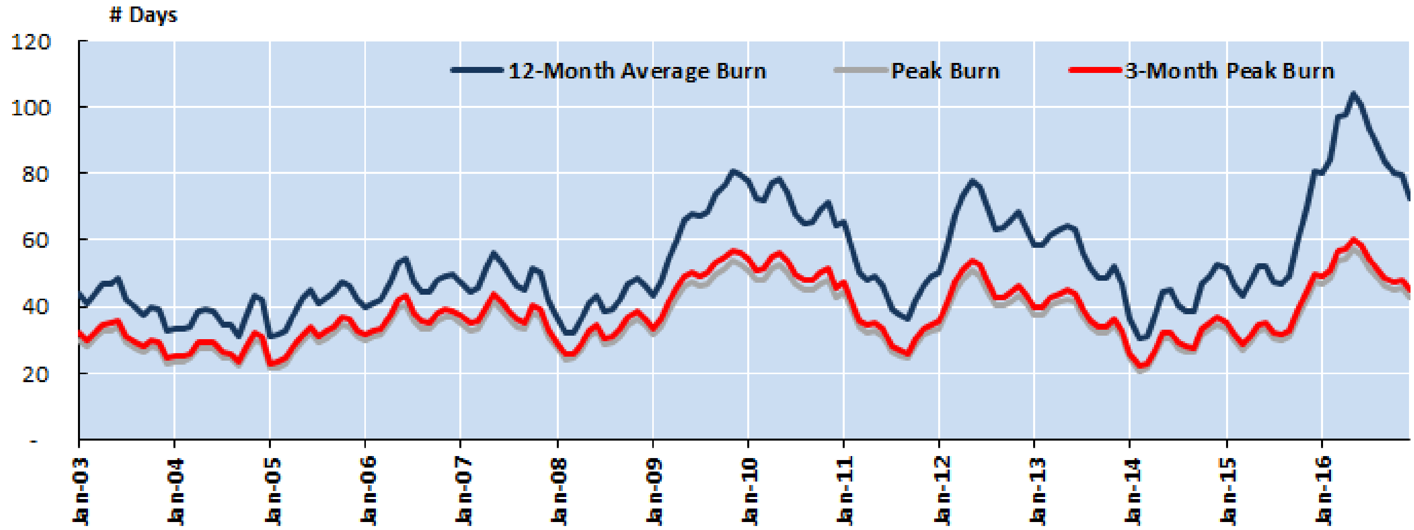
The first 20 days of March 2011 was the longest period of flooding for the Ohio and Allegheny Rivers during the study period. Coal deliveries by barge to PJM plants fell from an average of 5.4 mm tons per month to 4.1 mm tons in March and 4.5 mm tons in April before returning to normal levels. Thus, the worst flooding event over the last 15 years caused a total interruption in coal deliveries equal to 2.4 mm tons, or 22% of expected deliveries over the 2-month period. Coal burn at these same plants totaled 11.7 mm tons over the 2-month period.

However, coal inventories on site were more than adequate to accommodate the temporary drop in coal deliveries. Coal stocks at the PJM barge-delivery plants at the end of February 2011 were 12.4 mm tons, equal to 58 days of average burn (39 days of peak burn). Coal inventories fell by 1.65 mm tons in March 2011 and another 0.5 mm tons in April, a decline of 12% in March and 17% over the 2-month period. Coal inventory levels were still 10.2 mm tons at the end of April 2011, which was 48 days of average burn (32 days of peak burn). None of the PJM coal plants with barge delivery had coal stockpiles fell below 22 days of average burn (15 days of peak burn) at the end of March or April 2011.

The data on coal inventories at PJM power plants with barge delivery show that inventory levels are affected more by changes in coal burn than they are by periods of barge delivery delays. The average inventory for plants with barge delivery never fell below 21 days of peak burn (30 days of average burn) during the 14-year period.

Low inventory levels correlated with periods of high coal burn in early 2008 and the cold winter of 2014 (the Polar Vortex). The only other period since 2005 where inventories for plants with barge delivery in PJM fell below 30 days of peak burn was late summer 2011, which was caused by a combination of strong summer coal burn and the lingering impact of the spring flooding.

COAL STOCKS AT PJM PLANTS WITH BARGE DELIVERY



Source: EVA Analysis of EIA data

Over the entire 14-year period, coal inventories at plants in PJM with barge delivery were more than adequate to provide reliable power plant operations.

Disruption of Coal Transportation by Rail Carriers

EVA analyzed the deliveries of coal to power plants located in PJM which used rail shipments as the primary delivery mode. The analysis first identified instances of railroad shipment interruptions, then evaluated the impact on coal deliveries to plants in PJM and the adequacy of coal inventories to provide fuel supply security.

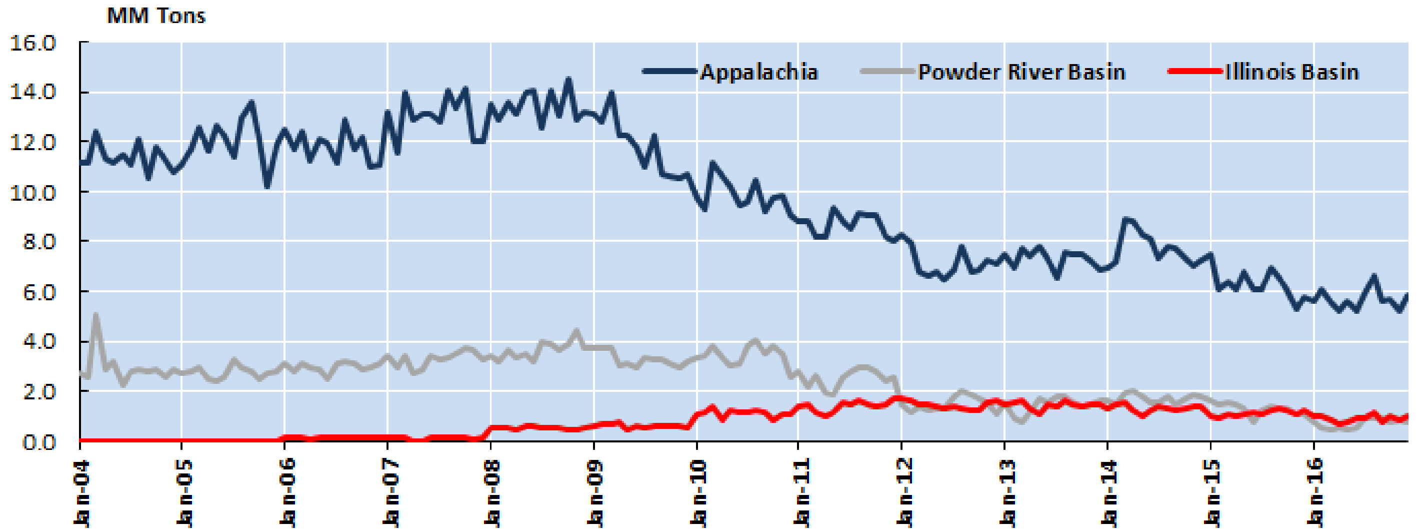
Railroad shipment problems can be associated with two types of events:

- Disruption of railroad shipments due to extreme weather or railroad operational problems (derailments, facilities removed from service, system delays)
- Inability of railroads to supply increased coal demand (from domestic power or export markets) due to capacity limitations (locomotives, railcars, crew)

To identify instances of railroad shipment interruptions, EVA relied upon coal railcar loading data reported to the American Association of Railroads ("AAR") for the period January 2002 to July 2018. Because shipment interruptions due to weather affect entire regions, we grouped the Western and Eastern railroad operators – Union Pacific ("UP") and Burlington Northern Santa Fe ("BNSF") comprise the West and Norfolk Southern ("NS") and CSX Transportation ("CSX") comprise the East. The Western railroads primarily load coal in the Powder River Basin ("PRB") in Wyoming and Montana. The Eastern railroads primarily load coal in Appalachia and the Illinois Basin ("ILB").

The primary source of coal for PJM is from Appalachia (Northern and Central Appalachia), with significant deliveries from the PRB and ILB. The PRB coal is originated by the Western railroads and primarily delivered to plants in Illinois by Eastern railroad short lines or by barge to plants on the Ohio River. The Appalachian coal is originated and delivered by rail, barge, truck or conveyor. The ILB coal is primarily originated by rail or truck and delivered by barge to plants on the Ohio River.

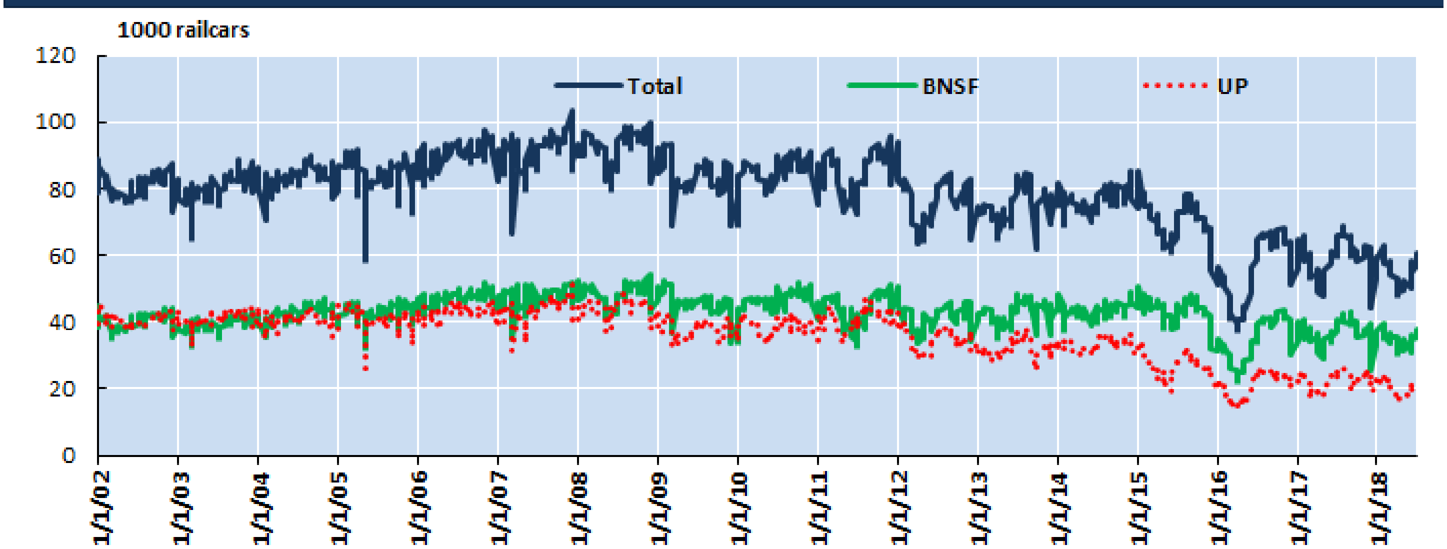
PJM COAL RECEIPTS BY COAL BASIN



Source: EVA Analysis of EIA data

The Western railcar loading data show small variability in weekly coal railcar loadings, with few events where loadings fell well below normal. Out of the entire study period covering 863 weeks, there were only 10 weeks when railcar loading dropped at least 15% below the prior week. Of these unusual low weeks, 5 were simply due to reduced loadings during the Christmas week holiday and the other 5 events could be attributed to loading disruptions. Of the loading disruptions, 4 were due to winter storms which disrupted loading at the mines in Wyoming (4 events during March and 1 during October 2013.[8] The most significant event which affected railroad coal service over the 17-year study period was the service disruption on the Wyoming Joint Line which began in May 2005.

WESTERN COAL RAILCAR WEEKLY LOADINGS



Source: AAR weekly railcar data

The Joint Line is track owned jointly by BNSF and UP built in the late 1970's to service mines in the Wyoming PRB south of Gillette, Wyoming. These mines are the largest source of coal in the United States, producing about 30% of total US coal.

[8] See BNSF Railway service advisories at https://domino.bnsf.com/website/updates.nsf/service-coal?OpenView&Start=1&Count=999

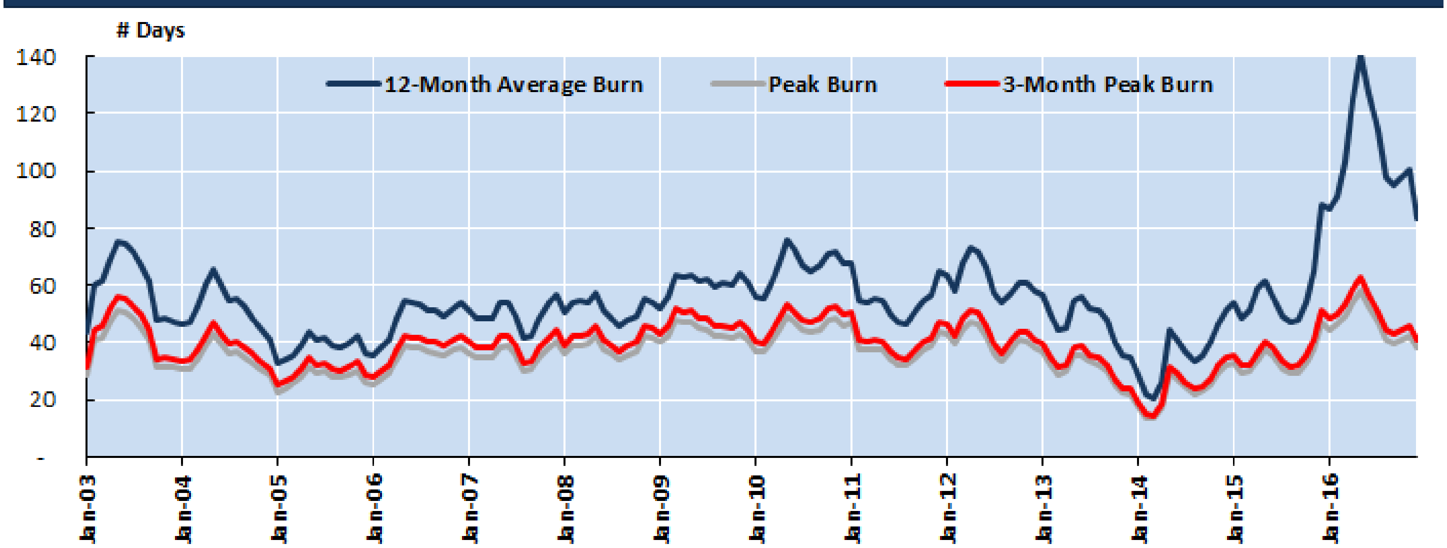
The Joint Line is the busiest rail line in the world, measured by traffic density. The BNSF and UP originate coal from these mines on the Joint Line and ship the coal over their large mainline systems to customers across the United States, including plants in PJM.

The Joint Line disruption began with the partial derailment of 3 coal trains on May 14 and 15, 2005, which damaged the track on all three main lines. The investigation of the cause of these derailments found that there had been a buildup of coal dust in the ballast beneath the tracks which impaired drainage and caused instability during heavy rains. The railroads temporarily reduced shipment levels while the track was undercut and the ballast replaced. UP declared force majeure on coal shipments and refused to accept new customers. The event reportedly reduced deliveries to about 85 percent of normal through late 2005 and service did not fully recover until early 2006.[9]

The AAR railcar loading data show that combined coal originations on the BNSF and UP railroads had been averaging 86,320 cars per week prior to the week ended May 14, 2005. Originations fell to 58,744 cars in the week ended May 21, 2005 and averaged 82,667 cars per week for the balance of 2005. By May 2006, originations averaged over 90,000 cars per week, well above the levels prior to the disruption. Using an average of 118 tons per car, coal loadings were reduced by an average of 431,054 tons per week for the balance of 2005, or a total of 14.65 mm tons over the 34-week period. This was equal to 5.2% of PRB coal production over the last 34 weeks of 2005 or about 19 days of average burn of PRB coal.

Nationwide, utility coal inventories fell 21.7 mm tons from May to the end of September 2005. Most of this decline was normal due to higher coal burn over the summer, but it was partly due to the Joint Line shipment disruption. Western coal originations during this period were about 10.36 mm tons below the prior shipment levels, which accounted for almost 48% of the inventory decline. National utility coal stockpiles fell to a low of 35 days of average burn in September 2005, reduced by almost 4 days of burn due to the Joint Line disruption.

COAL STOCKS AT PJM PLANTS BURNING POWDER RIVER BASIN COAL



Source: EVA Analysis of EIA data

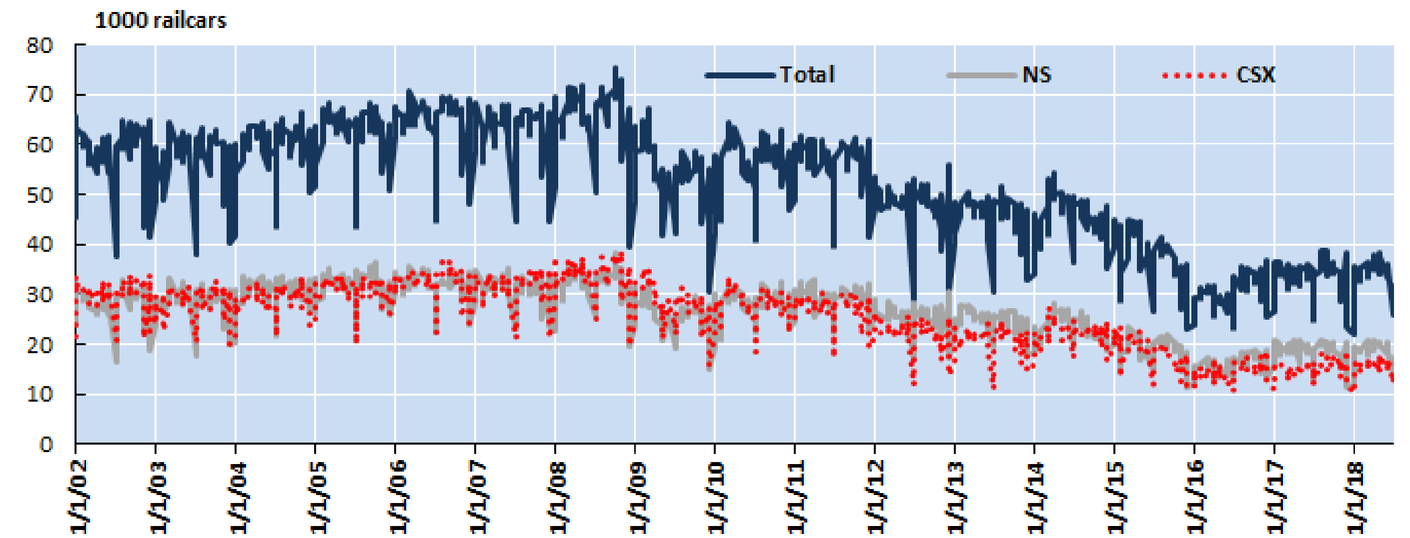
The Joint Line disruption had no measurable impact on coal inventories at PJM plants burning PRB coal. The stockpiles at these plants were already below normal at the beginning of 2005, with just 33 days of average burn at the end of January. However, coal inventories had been rebuilt to 44 days of average burn by the end of May 2005 and declined to 38 days of

[9] US Department of Energy, Office of Electricity Delivery and Energy Reliability, "Deliveries of Coal from the Powder River Basin: Events and Trends 2005 – 2007", October 2007.

average burn by the end of September 2005, which was typical of the impact of higher summer burn. Only two plants fell below 25 days of average burn on site (Rockport and State Line), and both of them had started the year with lower inventories at the end of January than they had at the end of September (23 and 20 days, respectively).

Large weekly declines in coal loadings are more common for the Eastern rail carriers. Out of the 863-week period studied, there were 52 weeks when the combined weekly CSX and NS coal loadings fell 15% or more from the prior week, compared to just 10 weeks for the Western railroads. However, this difference can be entirely explained by the practice of reduced loadings during holidays by the Eastern carriers. Of the 52 weeks where railcar loadings showed a +15% decline, 47 occurred on the holiday weeks of July 4th, Thanksgiving and Christmas, while only 5 occurred on non-holiday weeks (due to weather-related events).

EASTERN COAL RAILCAR WEEKLY LOADINGS



Source: AAR weekly railcar data

In summary, for both Western and Eastern railroads, large weekly disruptions of service occurred very infrequently, just 0.6% of the time over the 17-year period analyzed. Except for the Joint Line disruption, none of these events were extended longer than one week of service.

The greater threat to reliability of railroad service is an unexpected increase in demand. While these events cannot be quantified like service disruptions, they occur when customers request an increase in railroad service above prior levels and above prior expectations. Based upon a review of presentations to the Rail Energy Transportation Advisory Committee ("RETAC"),[10] customer complaints about rail service occurred in 2008, 2011, and 2014. These events were all correlated with demand increases over the prior year, both for utility and export markets. The railroad system had adjusted its level of capacity (locomotives, railcars and crews) down to the level of existing and expected shipments and was not able to respond quickly to sustained increased demand. While shipment levels have been below customer requests during these periods, power plant coal inventories have been adequate to support burn and reliability.

Reliability of Truck and Conveyor Deliveries to PJM Coal Plants

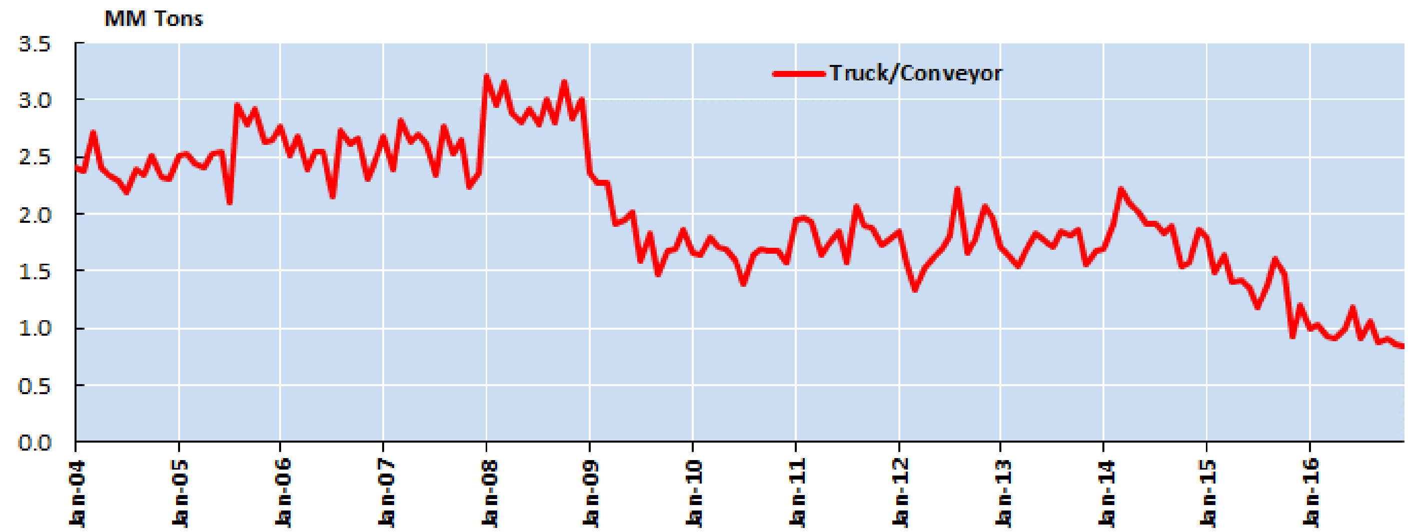
There are a small number of coal-fired power plants in PJM which primarily deliver coal by truck or conveyor belt. All these plants are located close to the coal mines, due to the cost of transportation over longer distances. Many of these

[10] RETAC was created by the Surface Transportation Board in 2007 in response to concerns over the service problems after the Joint Line disruption. Its agenda and presentations are available at https://www.stb.gov/stb/rail/retac.html.

plants have multiple delivery options. The largest active plants in this category are Harrison (conveyor and truck), Mount Storm (truck and rail), Homer City (truck and rail), and Conesville (truck and rail).

Deliveries by truck and conveyor have been very stable, with small monthly variations. There is little risk of disruption of transportation and the primary risks would be related to mine production. While the total deliveries by truck and conveyor have declined over time, this is due to plant retirements and reduced levels of dispatch.

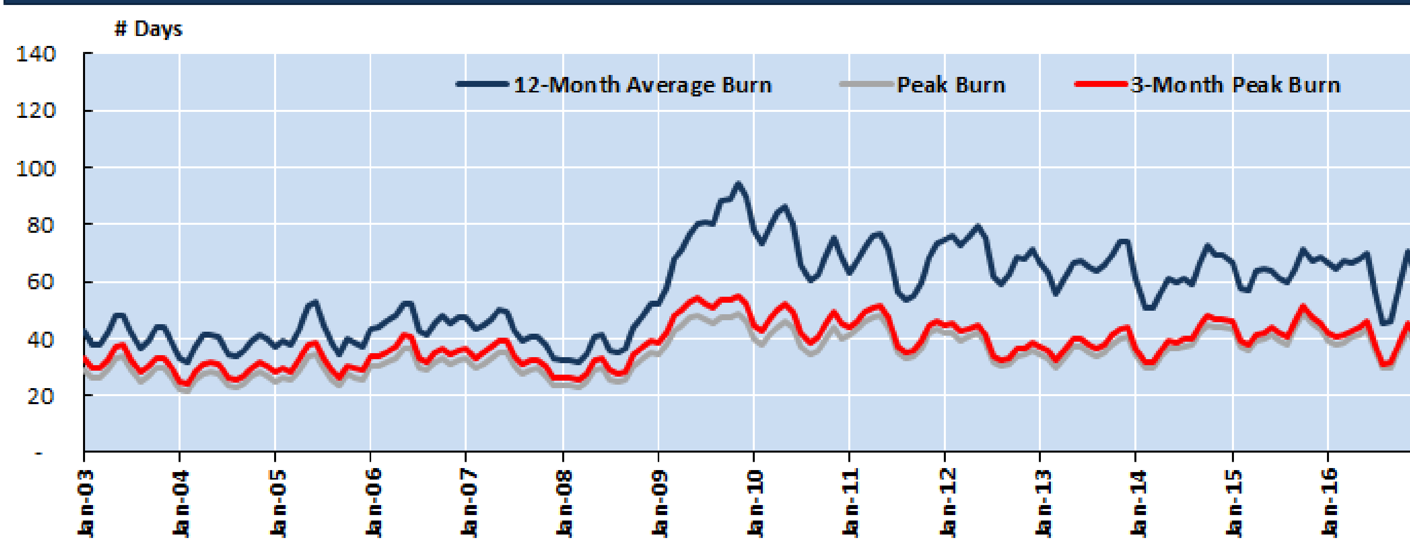
PJM COAL RECEIPTS BY PRIMARY TRANSPORTATION MODE



Source: EVA Analysis of EIA data

As a result, there has been little fluctuation in utility coal stockpiles at plants with truck and conveyor delivery. Coal inventory levels were within a narrow range of 32 – 53 days of average burn (21 – 37 days of peak burn) from 2003 to 2008 before increasing as burn declined at these plants. The only large drop in stockpiles occurred during the summer of 2016, when deliveries to Harrison dropped due to lower receipts from the nearby mine source during the summer peak demand period.

COAL STOCKS AT PJM PLANTS DELIVERED BY TRUCK AND CONVEYOR



Source: EVA Analysis of EIA data

Data Sources and Methods

The primary source of data on utility coal burn, receipts and inventories were the data files from the Energy Information Administration ("EIA") on Form 423 and predecessor forms. The analysis of power plants specific to PJM was made possible by EIA's recent decision to publish plant-specific inventory data. While the inventory data had always been reported monthly to EIA (and to FERC on predecessor forms), EIA had withheld plant inventory data from the public on the basis that it was company confidential and could not be disclosed. EIA's new policy is to publish the inventory data when the annual data has been finalized, which is over one year after the data were reported. The plant inventory data is now available on the EIA final annual forms for the years 2002 – 2016.[11] Inventory data for 2017 and 2018 are not yet available.

EVA analyzed the EIA monthly data using the following process:

- Identify power plants which are within the PJM Interconnection
- Prepare a data base of monthly coal burn, receipts and inventories for the PJM plants
- Screen out power plants for which there were no inventory data reported
    - Plants burning waste coal do not report coal inventory
    - 2 plants did not report coal inventory because the stockpiles were maintained by the coal supplier adjacent to the plants
- Identify additional attributes for the plants and the coal supply
    - Ownership of the plant – regulated utility or merchant generator
    - Coal basin where the coal was produced
    - Transportation mode for the coal deliveries
- Fix obvious data errors – in any data base there can be mistakes in reporting or data entry. EVA made limited corrections to the data base where the monthly data was missing or an order of magnitude off. The data quality improved after EIA consolidated the prior reports beginning in 2008.

EVA relied upon several sources for coal transportation data, including:

- Weekly coal loadings by rail carrier reported to the American Association of Railroads
- Weekly river flow data by river segment reported by the United States Geological Survey
- Monthly coal shipments by lock and dam reported by the Army Corps of Engineers

[11] US Energy Information Administration at https://www.eia.gov/electricity/data/eia923/.