US COAL MARKETS AND THE CURRENT COAL SUPPLY SHORTAGE

PJM Stakeholder Process

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ENERGY VENTURES ANALYSIS

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DRIVERS OF US THERMAL COAL MARKET SUPPLY SHORTAGES

- **The seeds of 2021-22 coal supply shortages were planted in the COVID market slump in 2020**
  - Domestic coal burn dropped sharply due to reduced electricity demand and low natural gas prices
  - US mines closed or reduced output and employment
- **Every factor reversed in mid-2021 and a coal supply shortage was born**
  - World thermal coal demand soared, and prices touched record highs, as LNG supply could not meet demand
  - Domestic power burn recovered all its losses on the back of increased electricity demand and high gas prices
  - Domestic power coal stockpiles melted away in the summer of 2021
- **In 2022, world market demand was boosted further by prospective bans on Russian coal**
  - Eastern US coal exports respond to world coal demand and prices
- **Coal demand can increase faster than supply – it is much easier to cut production than increase**
  - Coal is much different from gas and power – it is highly labor-intensive for both production and transportation
- **Coal generation can swing to support gas-to-coal switching – using inventories, not production**
  - Coal production must be stable – in the past, most coal plants ran baseload and signed long-term contracts for steady coal deliveries, ensuring coal supply capacity was in place

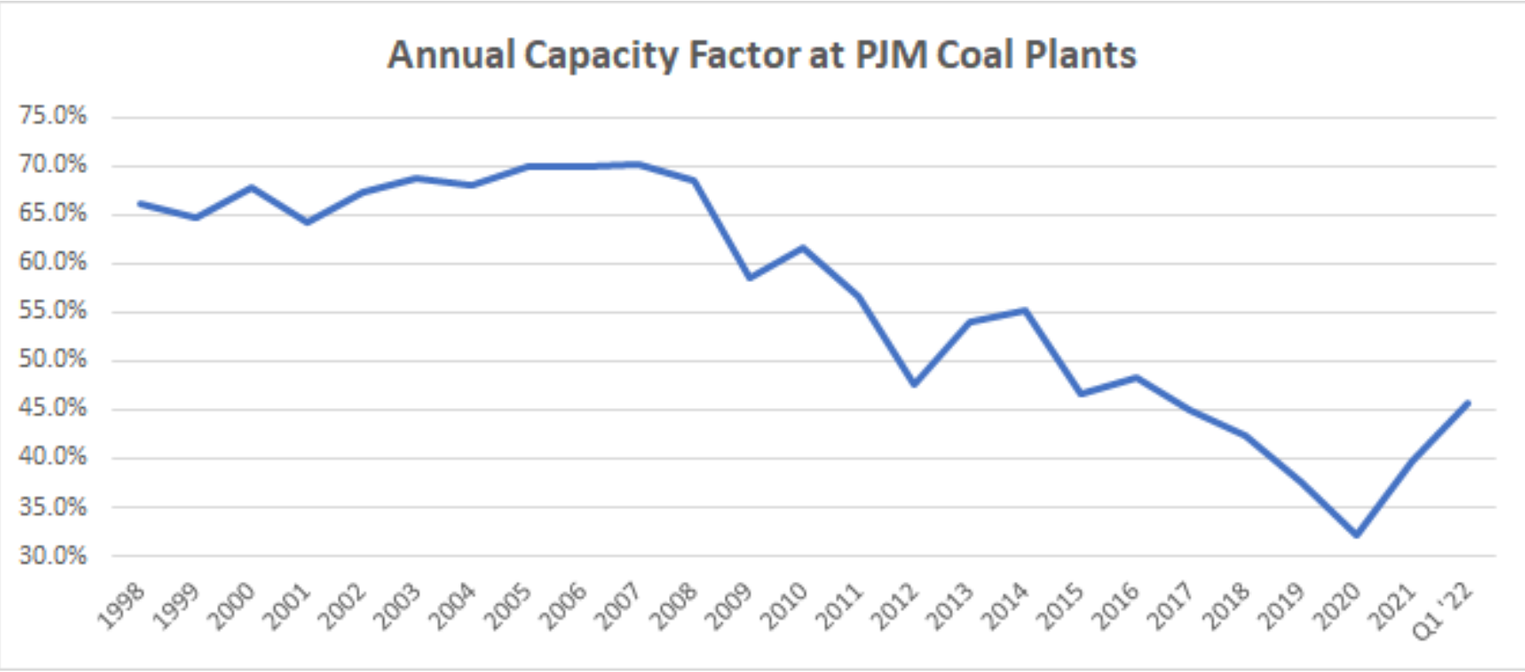
US COAL MARKETS HAVE BEEN WHIPSAWED BY SWINGS IN DEMAND

- **Domestic power burn rebound**
  - Power burn fell 195 mm tons from 2018 to 2020 but rebounded 65 mm in 2021
  - Buffered by customer coal stockpiles
- **Thermal coal exports followed a similar swing**
  - Dropped 50% from 2018 to 2020
- **US coal production was slashed by 170 mm tons from 2019 to 2020**
  - Increased demand brought 43 mm tons back into production in 2021
- **2021 power burn was met by draw of 45 mm tons of inventory**
  - Low stocks cannot support this again

US Coal Balance (mmt)	2017	2018	2019	2020	2021
Production	771.0	753.2	701.9	531.2	574.0
Imports	6.6	3.9	4.2	3.3	3.3
Total Supply	**777.5**	**757.1**	**706.1**	**534.5**	**577.3**
Electric Power Burn	**652.2**	**623.0**	**528.1**	**428.3**	**493.9**
Consumer stock change	*(26.6)*	*(38.3)*	*18.1*	*(0.2)*	*(45.1)*
Electric Power Receipts	**625.6**	**584.7**	**546.1**	**428.1**	**448.8**
Coke Ovens	17.6	18.5	18.5	13.8	17.7
Industrial/Commercial	34.5	32.5	30.0	26.1	26.6
Domestic Demand	**677.7**	**635.7**	**594.7**	**468.0**	**493.0**
Export metallurgical	50.7	58.9	52.3	42.8	45.9
Export thermal	52.1	64.3	48.3	32.2	45.7
Total Exports	**102.8**	**123.2**	**100.5**	**75.0**	**91.6**
Total Demand	**780.5**	**758.9**	**695.2**	**543.0**	**584.6**

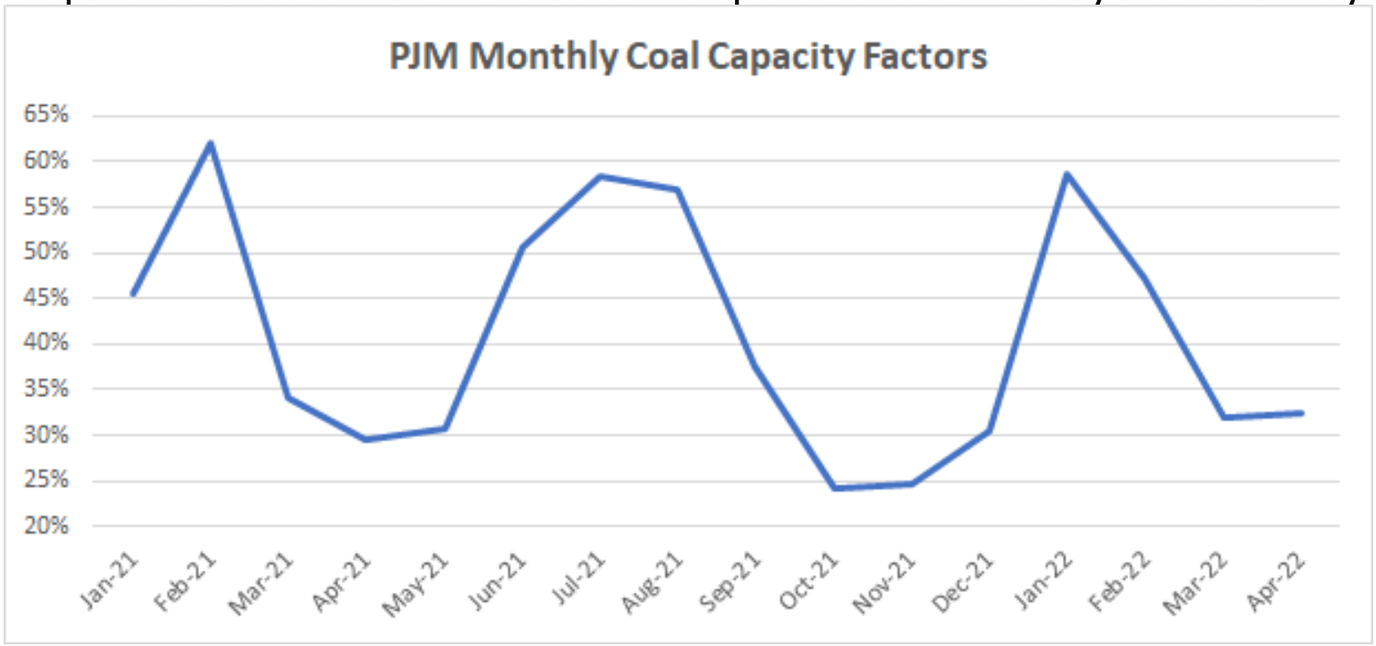
PJM COAL GENERATORS HAVE CHANGED FROM BASELOAD TO VARIABLE OPERATION

- **Prior to the fracking revolution, PJM coal plants ran at 60% - 70% capacity factors**
  - Power companies signed long-term coal contracts at high levels with confidence they would burn the coal
- **Since 2015, coal plants have run at 30% - 50% capacity factors on average**
  - Many coal plants are dispatched after gas CCGT plants and are run for reliability
- **Coal burn fell from 77 mm tons in 2019 to 61 mm in 2020, then jumped to 74 mm tons in 2021**



PJM COAL PLANTS CAN RAMP UP TO PROVIDE RELIABILITY

- **Even at lower annual capacity factors, coal plants can ramp to high rates when load is high or when natural gas is in short supply**
  - Coal plants ran hard in February 2021 and January 2022 when gas was expensive and limited
  - Coal plants run hard to meet high demand in the summer months
- **However, some generators have not contracted enough coal to run hard for months at a time**
  - Plants contract for expected burn based on the forward price curve and rely on inventory for periods of high burn



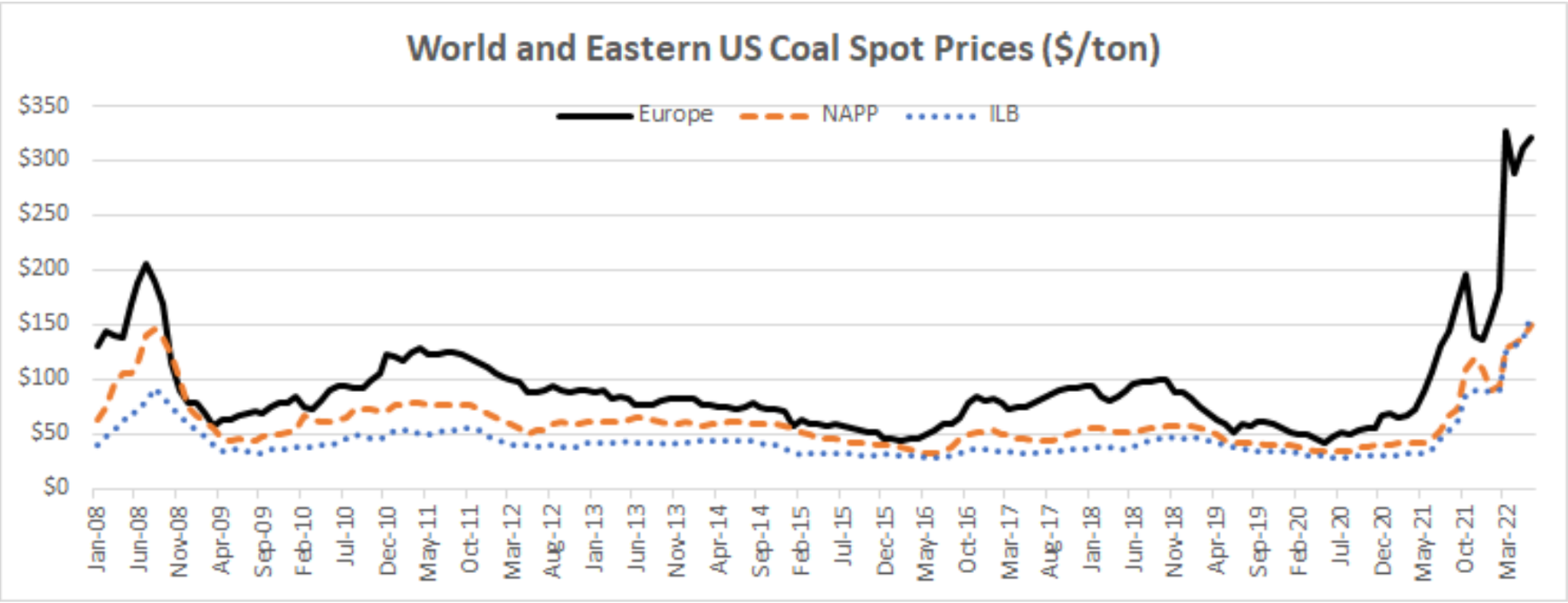
PJM COAL SUPPLY IS UNIQUELY DEPENDENT ON NORTHERN APPALACHIA COAL

- **Because of location, most of the PJM coal fleet depends on Northern Appalachia (NAPP) coal**
  - The coal plants in the ComEd zone plus AEP's Rockport plant use western coal (Powder River Basin)
  - Other power markets primarily burn lower-cost western and ILB coals
- **Appalachian coal is closely connected to world coal markets because of location and coal quality, with exports through the East Coast ports of Baltimore and Hampton Roads**
  - PRB coal is not well connected to world markets, with few exports
  - ILB coal is also exported in large volumes through New Orleans

2021 Coal Purchases	Total 1000 tons	Northern App	Central App	Illinois Basin	PRB	Other West	Import
PJM	**65,426**	**47,152**	**3,709**	**6,434**	**7,934**	**198**	**-**
Southeast	69,225	9,215	5,904	26,193	22,861	3,208	1,845
MISO	138,314	2,307	52	27,167	86,916	21,871	-
SPP	63,774	-	-	-	61,582	2,192	-
ERCOT	49,204	-	-	-	33,295	15,908	-
WECC	61,802	-	-	-	28,730	33,073	-
Lower 48	**447,764**	**58,692**	**9,665**	**59,794**	**241,318**	**76,451**	**1,845**

WORLD COAL SUPPLY SHORTAGE HAS PULLED EASTERN COAL INTO THE EXPORT MARKET

- **World thermal coal prices have hit record highs after the war in Ukraine as European buyers scramble to replace Russian coal with Eastern US coal exports**
- **Uncommitted Eastern coals (NAPP, CAPP, ILB) have been sold to export customers, limiting available supply for domestic markets**



NORTHERN APPALACHIA COAL SUPPLY RESPONSE TO INCREASED DEMAND IS LIMITED

- **Large Pittsburgh seam longwall mines provide almost all the thermal coal**
  - Thermal coal production from other small mines in OH, PA, and MD has fallen to very low levels due to high costs and depleting reserves
- **Remaining 9 Pittsburgh seam mines are running at full capacity**
  - Since 2017, 3 large Pittsburgh seam mines have been closed permanently
  - Remaining mines rebounded in 2021, adding 12 mm tons of production to reach 70 mm tons
  - Maximum potential output is 72 mm tpy
- **With exports of 13 – 15 mm tons, NAPP supply for domestic thermal markets is not enough to support 2021 burn, let alone increased burn**

Northern Appalachia Coal Demand (mm tons)

	2017	2018	2019	2020	2021
Thermal Coal					
Electric Power Burn	80.0	75.7	66.0	56.7	65.7
Consumer stock change	*(4.5)*	*(3.5)*	*6.2*	*(4.2)*	*(7.1)*
Electric Power Receipts	**75.5**	**72.1**	**72.3**	**52.5**	**58.7**
Industrial/Commercial	2.1	1.9	1.8	1.6	1.8
Domestic Demand	**77.6**	**74.1**	**74.1**	**54.1**	**60.5**
Export thermal	11.8	11.1	11.5	10.0	13.3
Total Thermal	**89.4**	**85.2**	**85.5**	**64.1**	**73.8**
Metallurgical Coal					
Domestic	3.0	3.4	4.3	3.6	4.5
Export	10.2	13.0	12.4	8.8	9.0
Total Metallurgical	**13.3**	**16.5**	**16.7**	**12.4**	**13.5**
Total Demand	**102.7**	**101.7**	**102.2**	**76.5**	**87.2**
Coal Production					
Pittsburgh seam	81.5	81.3	81.5	57.7	69.6
Other Thermal	11.7	10.5	8.5	5.8	5.8
Total Thermal	**93.2**	**91.8**	**90.0**	**63.5**	**75.4**
Met Coal	11.8	12.4	13.5	12.1	13.2
Total Production	**105.1**	**104.2**	**103.5**	**75.6**	**88.6**

IMPROVING THE RELIABILITY OF COAL SUPPLY

- **Due to logistics, coal supply must be contracted in advance**
  - Entering any calendar year, most coal generators have contracted for 80% - 90% of expected burn
  - **There is no real "spot" coal market** – Even short-term coal purchases are contracted in advance –
  - Coal producers and transportation companies need customers to deliver coal ratably (roughly even deliveries every month) to support steady performance – they cannot lay off employees and bring them back quickly
- **It is difficult for utility and merchant plants to contract for uncertain levels of burn**
  - Coal generators manage the swing in burn using coal inventories at the plant while maintaining steady deliveries
  - If natural gas prices fall to low levels, coal generators have the risk of being over-contracted, as happened in 2020
  - Coal suppliers need higher levels of longer-term contracts to support investments to increase production
- **In the short term, coal supply is not adequate to support increased burn in 2022 or 2023**
  - Existing large mines in the Pittsburgh seam are already running hard
    - There will be an increase at one existing mine as Consol restores a 5th longwall face at Enlow Fork mine
  - Increased output at small mines in PA, OH and MD will require capital, labor & equipment, all in short supply
    - "ESG" restrictions are limiting capital available for coal supply from banks and equity investors
    - Increased coal production will take time and certainty of long-term demand