THE IMPACT OF EARLY COAL RETIREMENTS ON KEY POWER MARKETS

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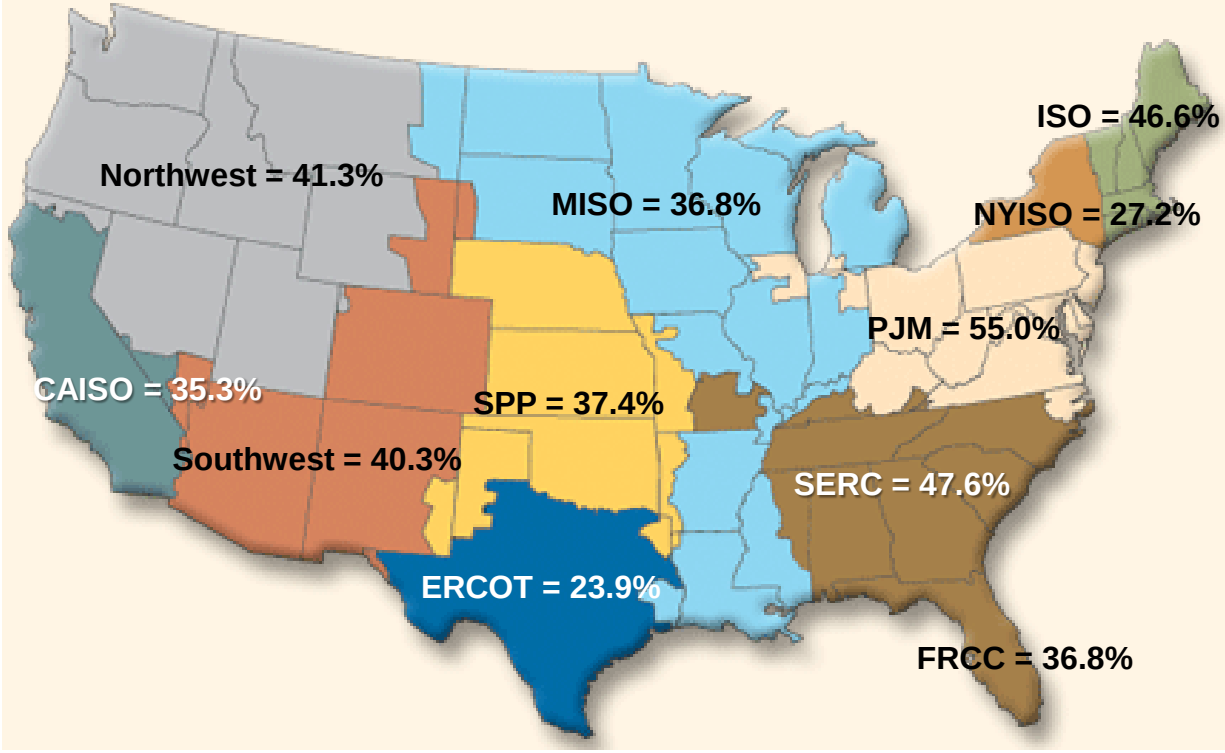

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OUTLINE

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PROBLEM STATEMENT

The winter of 2013-14 posed a large challenge to the power and natural gas markets. The U.S. had its 11th coldest winter in history, record high natural gas demand and average peak power prices that were more than double than what has been observed in the past 5-years. Additionally, the market witnessed record high gas storage withdrawals, and short term gas price spikes reaching as high as $135/MMBtu at some Northeast trading points.

Across the Eastern U.S there was simultaneously strong demand for electricity and natural gas to heat homes and businesses. Every bit of natural gas in storage and every electricity generation asset was needed to meet demand. However, there were gas supply constraints in particular areas and some generation assets were unable to perform as expected because of the frigid temperatures. Because of these situations, coal-fired assets were relied upon heavily to provide dependable electricity across the region.

EPA's Mercury and Air Toxics standards will force 26 gigawatts of coal capacity to exit the power markets between the latter half of 2014 and 2016. The majority of the these coal-fired retirements will occur in the regions where they were relied upon to provide electricity this past winter (New England, East North Central, Middle Atlantic, South Atlantic, East South Central).

If these coal-fired plants were not available during the winter of 2014, there would have been severe reliability issues within key electric power markets, because of the constraints in natural gas supply and power generation outages. Additionally, the seasonal spikes in regional natural gas prices that occur, would have been even greater than what was experienced this past winter, causing average peak electricity prices to surge more than 40 percent more than what was observed.

The purpose of this study is to examine the impact to the power and natural gas markets if the coal-fired assets that will retire in the 2014-2016 period had not been available for the winter of 2014. Additionally, if these coal-fired assets were not available during a hot summer, this study analyzes how the power and natural gas markets would be impacted.

INTRODUCTION

POWER MARKET RESERVE MARGIN SUMMARY PRE and POST COAL RETIREMENTS

Region	Base Capability	Demand	Base Reserve	Retiring Coal Capacity	Post Retire Reserve	Diff.
ISONE	32,631	26,505	23%	1,500	17%	-6%
NYISO	35,000	29,971	17%	75	17%	0%
PJM	180,000	160,000	13%	11,646	5%	-7%
SERC	175,053	135,666	29%	10,614	21%	-8%
FRCC	50,000	43,288	16%	0	16%	0%
MISO	103,945	87,578	19%	4,700	13%	-5%
ERCOT	78,000	67,000	16%	0	16%	0%
SPP	56,326	36,729	53%	1,970	48%	-5%
CAISO	55,000	46,000	20%	101	19%	0%

- EVA identified the power markets having the greatest power reliability risk from the retiring coal units from the change in their reserve margins and fuel delivery constraints.

- Reliability assessment to focus on PJM, MISO and ISO-NE.
  - PJM, because it has the most coal-fired retirements and its reserve margin dropping to only 5%-- well below the 15% target
  - MISO because it has a large amount of coal retirements and reserve margin falls bellow its 15% target
  - ISO-NE because the region is at risk for reliability during periods of constrained gas supply. At critical junctures, only 3,500 MW of ISO-NE's 18,000 MW gas-fired capacity was available this winter because of gas constraints.

- The coal retirements also have an impact on SERC's and SPP's reserve margins, but even after the retirements, these regions have sufficient surplus capacity remaining to remain above reserve margin targets

INTRODUCTION

- In order to systematically and correctly evaluate the issues laid out in the problem statement, EVA designed three sets of scenarios for both the winter and summer reliability assessment (see table below)
- For each scenario, EVA analyzed the PJM, MISO and ISO-NE power markets
- For the ISO-NE winter scenarios, EVA modified its business process from the other two power markets. EVA selectively restricted gas-fired generation assets in ISO-NE that are connected to the Algonquin pipeline, as they were unable to operate during the 2014 winter because of constrained gas supply.

REVIEW OF SCENARIOS PERFORMED	
Winter Assessment	
Base Case - Wint.	Re-Simulation of natural gas and power markets in Winter 2014 (Jan-Feb)
Case #1	Base Case - Wint. *minus* 2014 to 2015 MATS related coal retirements
Case #2	Base Case - Wint. *minus* 2014 to 2016 MATS related coal retirements
Summer Assessment	
Base Case - Sum.	Simulation of natural gas and power markets for extreme summer weather in 2014 (June- Aug)
Case #3	Base Case Sum. minus 2014 to 2015 MATS related coal retirements
Case #4	Base Case Sum. minus 2014 to 2016 MATS related coal retirements

IMPACT OF COAL RETIREMENTS ON SYSTEM RELIABILITY - WINTER

PJM

- During this past winter, record high electricity demand and generation outages led to several instances in which PJM was low on resources and narrowly avoided load shedding to maintain system reliability
- If the coal plants scheduled to be retired from 2014 to 2016 were not available in PJM during the winter of 2014, there would have been 34 hours where the reserve margin was less than 5% and 4 hours where there would have been a negative reserve margin (insufficient supply) and would have forced power curtailments

NUMBER OF HOURS IN JANUARY 2014 BELOW KEY RESERVE MARGIN LEVELS

		Reserve Margin		
		<10%	<5%	<0%
ISO-NE	Base Case	2	0	0
	2014-15 Retirement	30	16	16
	2014-16 Retirement	30	16	16
PJM	Base Case	16	0	0
	2014-15 Retirement	57	31	3
	2014-16 Retirement	55	34	4
MISO	Base Case	0	0	0
	2014-15 Retirement	1	0	0
	2014-16 Retirement	2	0	0

MISO

- In MISO, despite record high demand due to sustained cold weather, the reserve margin did not become precariously tight
- Under EVA's scenario analysis, no real reliability issues were predicted if the retiring coal plants were not available during the winter of 2014. EVA only estimated 2 hours where there would have been a reserve margin between 5% and 10%

ISO-NE

- In ISO-NE, select gas-fired generators were unable to perform as expected as natural gas pipeline capacity in the Northeast was constrained.
- The reserve margin for ISO-NE would have been negative for 16 hours in January 2014 (without the coal capacity that is expected to retire over the next two years) and would have forced power curtailments.

IMPACT OF COAL RETIREMENTS ON WINTER POWER PRICES (JANUARY-FEBRUARY 2014)

- In addition to threatening system reliability, early coal retirements drove higher wholesale power prices in all three markets, though the impact in PJM in ISO-NE was greater
- The table to right illustrates what the average wholesale power price would have potentially been in January-February 2014, if the coal plants scheduled to retired would not have been available.
- PJM wholesale prices would have been 40% greater without the coal plants, while ISO-NE wholesale prices 50% greater.
- The detailed power analysis section of this report will provide more color on how the power prices would have been effected in the absence of the coal plants

AVG. WHOLESALE POWER PRICE FOR EACH WINTER SCENARIO ($/MWh)

	Base Case	2014-15 Retirements	2014-16 Retirements
ISO-NE	$120	$180	$180
PJM	$102	$143	$145
MISO	$41	$58	$60

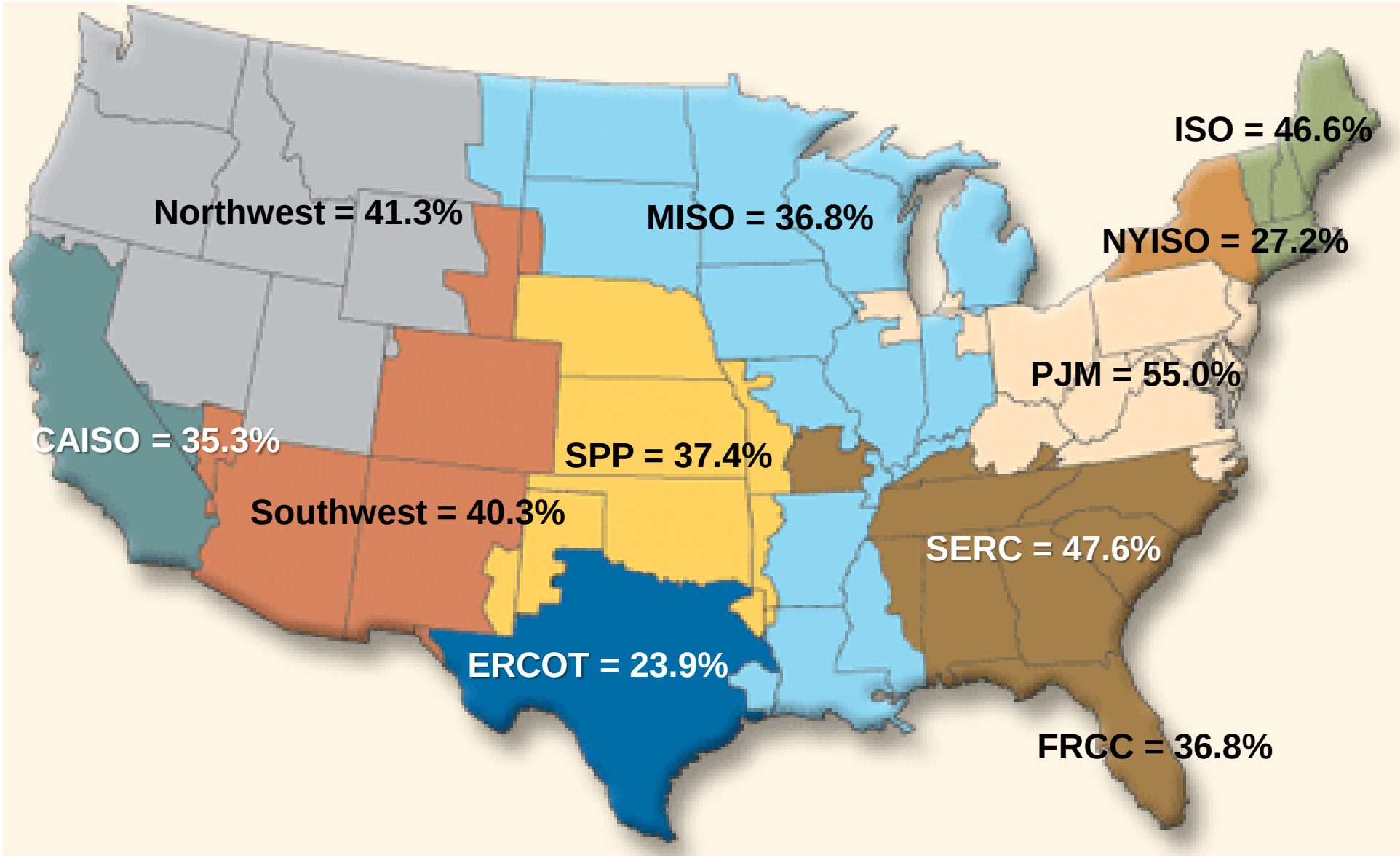
IMPACT OF COAL RETIREMENTS ON WINTER POWER PRICES – JANUARY 2014

AVERAGE MONTHLY POWER PRICES – MAJOR U.S. MARKET REGIONS

Region	Base Power Prices	Power Prices with Retirements	% Change
ISONE	$130	$190	46.6%
NYISO	$120	$152	27.2%
PJM	$103	$159	55.0%
SERC	$56	$83	47.6%
FRCC	$41	$56	36.8%
MISO	$39	$53	36.8%
ERCOT	$67	$83	23.9%
SPP	$38	$53	37.4%
CAISO	$50	$68	35.3%

- Although the majority of coal retirements affect the Eastern U.S. power markets (PJM, MISO and ISO-NE) the most, the resulting increase in gas demand leads to a rise in the national natural gas prices.
- The table to the left illustrates the effects of the increased price in natural gas on wholesale power prices in other US power markets.
- For example, the California power market, CAISO, would have experienced a 35% power price increase if the coal-fired facilities were retired prior to this past winter.

IMPACT OF COAL PLANT RETIREMENTS ON WINTER POWER PRICES – JAN-FEB 2014

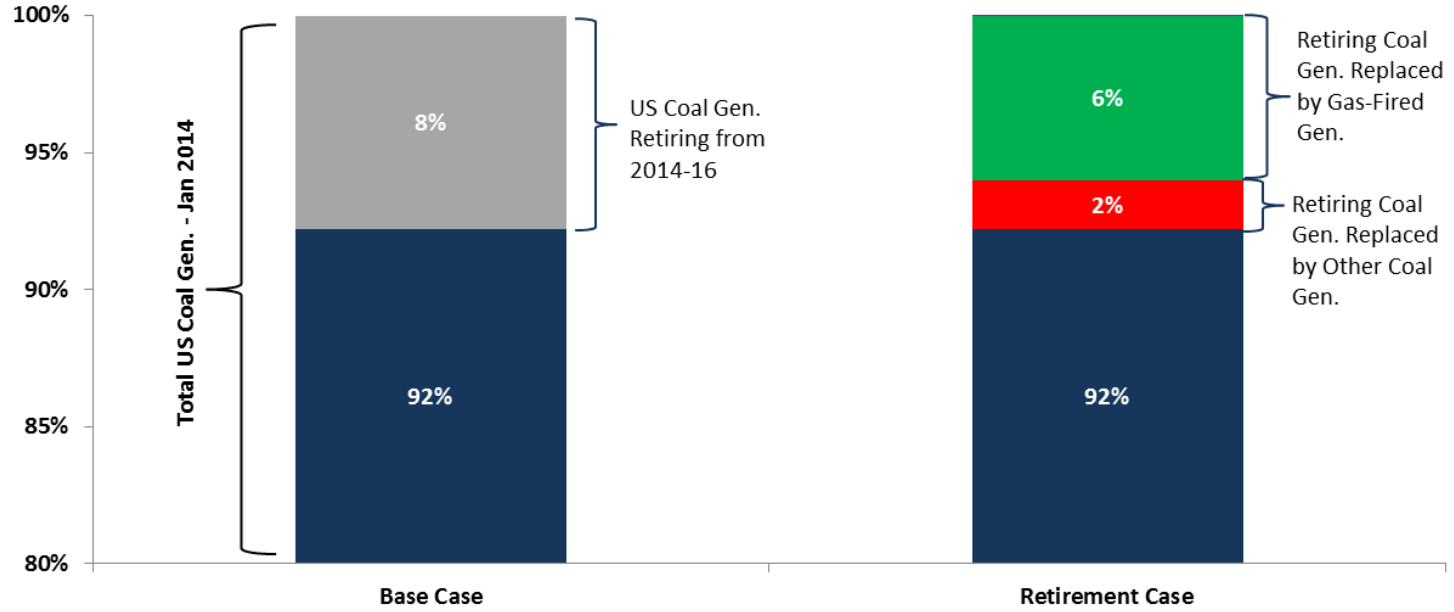


IMPACT OF COAL RETIREMENTS ON POWER GENERATION

- Of the total Base Case coal generation in January 2014, 92% came from remaining units while 8% came from units slated for retirement.

- With the early retirements, coal's 8% was replaced with three-fourths natural gas and one-fourth incremental coal generation along with a small amount (0.01%) of Demand Side Curtailment.

ESTIMATED REPLACEMENT GENERATION FOR RETIRED COAL GEN. FOR JANUARY 2014



IMPACT OF COAL RETIREMENTS ON GAS INDUSTRY - WINTER

- Even without the projected coal retirements, the gas industry was at a precipice.
  - Record demand, storage withdrawal, prices etc.
  - Pipeline, LDCs and storage operators restrict supplies to non-firm customers.
  - Gas-fired generating capacity lost in several regions due to curtailment of gas supplies.
  - Near record low storage inventories at the end of winter leave industry with a challenge to refill storage to adequate levels.

- With the project coal retirements, the conditions for the gas industry would have been worse
  - Winter Assessment
    - Records for demand, storage withdrawals and prices would have been reset to higher levels.
    - Additional pipeline, LDC and storage operator curtailments likely would have occurred.
    - More power plants likely would have had gas supplies curtailed.
  - In NEPOOL it is unlikely pipeline capacity would have been adequate.
    - As a result NEPOOL would have been faced with selecting from the following alternatives:
      - Increase oil-fired generation (i.e., an additional 1.8 MM barrels).
        - However, NEPOOL outstripped its capability to resupply fuel oil in January in the base case.
      - Increase imported power.
        - Difficult to determine which neighboring regions would have additional power to export.
      - Commence with load shedding.
    - Impact on other regions would not have been as severe as those for NEPOOL.
    - However, curtailment of gas supplies for an additional power plants would be likely.
    - Additional cost to consumers for winter supplies would have been about $35 billion.

IMPACT OF COAL RETIREMENTS ON SYSTEM RELIABILITY – SUMMER- JULY 2014

- To gauge the impact of these coal retirements during a warmer than normal summer period, EVA created a high demand scenario based upon historical data during peak summer months

PJM

- In PJM, EVA found that the early retirement of this coal capacity could lead to 35 hours of reserve margins below 0% based on installed capacity
  - PJM reports having over 10 GW of demand response capability that can mitigate the risk of blackouts, but in some instances the shortage would be greater than 10 GW.
  - Additionally, demand response resources are only required to perform up to 10 times each year.

MISO

- In MISO, 31 hours were found to have reserve margins below 0% based on installed capacity, while 68 hours had reserve margins below 5%

NUMBER OF HOURS IN JULY 2014 BELOW KEY RESERVE MARGIN LEVELS

		Reserve Margin		
		<10%	<5%	<0%
ISO-NE	Base Case	16	25	25
	2014-15 Retirement	8	17	17
	2014-16 Retirement	11	22	22
PJM	Base Case	27	16	5
	2014-15 Retirement	57	32	34
	2014-16 Retirement	58	34	35
MISO	Base Case	69	34	4
	2014-15 Retirement	60	71	18
	2014-16 Retirement	71	68	31

ISO-NE

- In ISO-NE, capacity shortages exist in all cases due to the high summer demand and the loss of retired coal plants

- With the loss of Salem Harbor and Brayton Point, New England likely would need to rely on either Demand Response, increased imports, or more oil-fired generation to meet peak load

IMPACT OF COAL RETIREMENTS ON POWER PRICES – SUMMER- JUNE-AUGUST

- EVA estimated the effects of extreme summer weather without the coal plants on wholesale power prices during June-August. The results are summarized in the table to the left. A more detailed summary of the effects are presents in the detail power analysis section.

PJM

- Price impacts in PJM are significant during the summer as higher heat rate units and demand response are called upon to meet load
- Wholesale power prices in PJM are estimated to increase 33% in an extreme summer without the coal units

MISO

- In MISO, the price impact is more muted due to fewer retirements and a healthier reserve margin
- EVA estimates that the average wholesale power price for MISO would increase 8% without the coal plants

AVG. WHOLESALE POWER PRICE FOR EACH SUMMER SCENARIO ($/MWh)

	Base Case	2014-15 Retirements	2014-16 Retirements
ISO-NE	$55	$69	$70
PJM	$49	$64	$65
MISO	$39	$42	$42

ISO-NE

- The prices in the Base case are driven up due to the high demand during the hot summer. With summer peaks approaching the available capacity in New England, the power prices are dictated by the high cost marginal resources in the region
- Without the coal plants and the extreme warm weather, ISO-NE power prices increase 27% compared to the base case.
- EVA did not assume any constrained gas-fired capacity in ISO-NE for the summer scenarios

IMPACT OF COAL RETIREMENTS ON POWER PRICES – JULY 2014

AVERAGE MONTHLY WHOLESALE POWER PRICES – MAJOR U.S. MARKET REGIONS

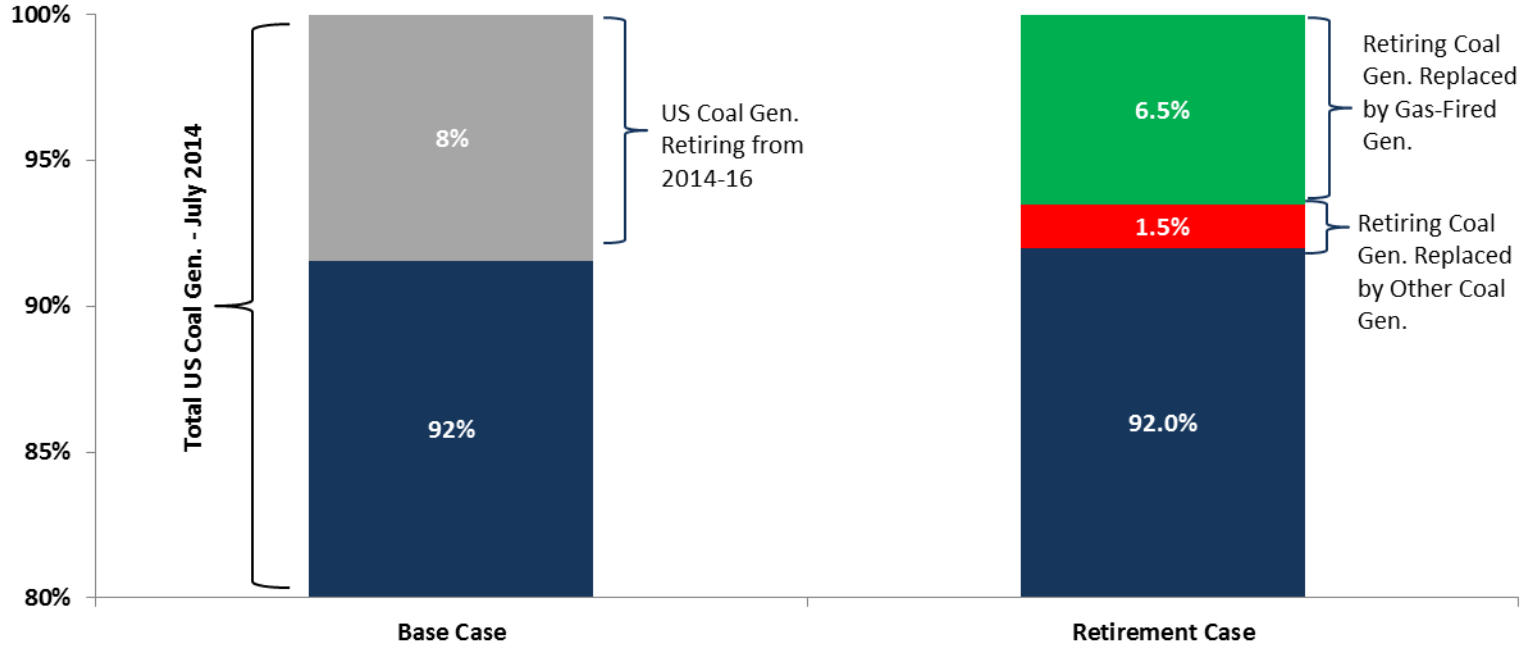
Region	Base Power Prices	Power Prices with Retirements	% Change
ISONE	$74	$106	43.7%
NYISO	$69	$104	49.9%
PJM	$63	$97	54.5%
SERC	$42	$45	8.8%
FRCC	$45	$48	7.0%
MISO	$41	$45	10.4%
ERCOT	$41	$44	6.4%
SPP	$40	$44	10.6%
CAISO	$49	$52	6.3%

- The high withdrawal of natural gas during the winter resulted in storage depletion and lower summer gas storage inventory
- This caused natural gas prices to rise during the summer resulting in higher power prices in EVA's Base Case
- With the coal units not available to provide base load power needs, more gas units are at the margin, which drives up the power prices in PJM, MISO, ISO-NE and SPP
- NYISO is a gas-dominated region that experiences winter basis blowouts which drive much higher prices in the retirement cases

IMPACT OF COAL RETIREMENTS ON POWER GENERATION - SUMMER

- In the summer, the Base Case mix was the same: 92% from remaining units and 8% from retiring units.
- When the early retirements kick in, coal again supplies one-fourth of the replaced generation while gas accounts for roughly 6.5%.
- 10 times the amount of Demand Side Curtailment is required in the summer.

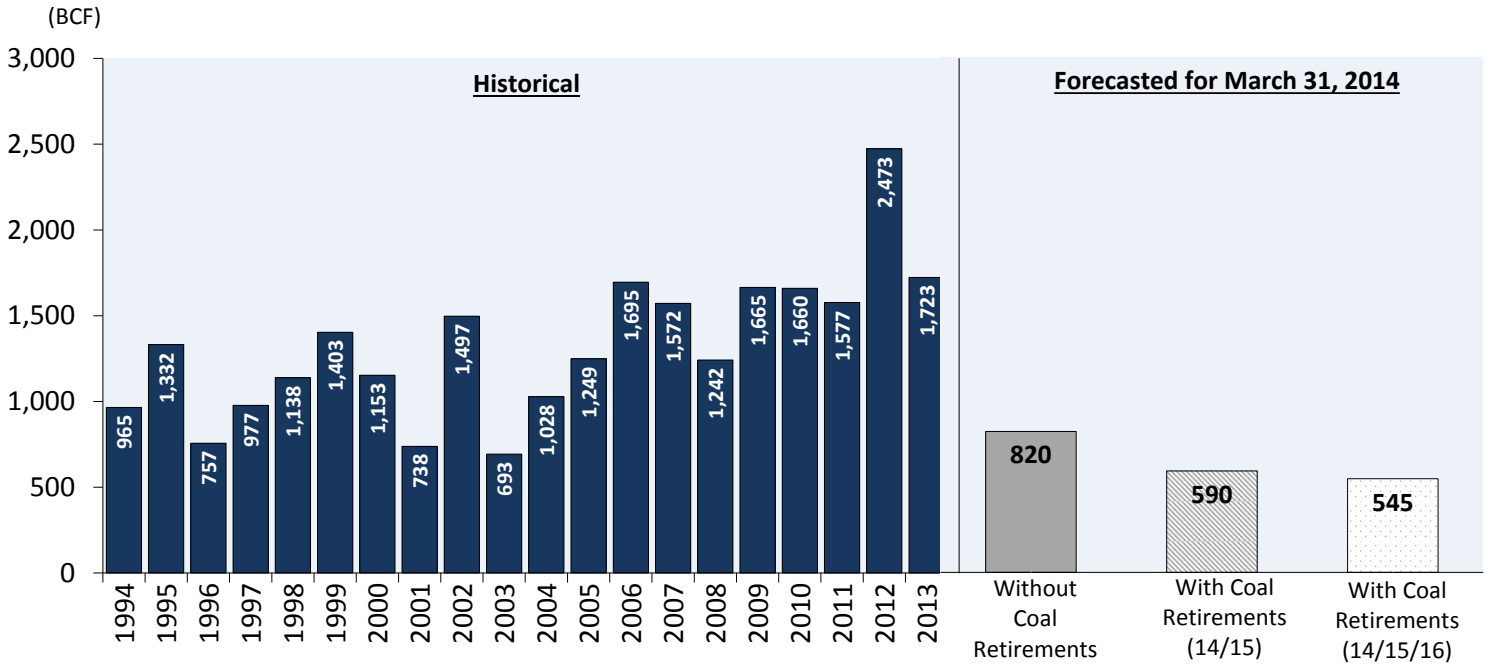
ESTIMATED REPLACEMENT GENERATION FOR RETIRED COAL GENENERATION FOR JULY 2014



IMPACT OF COAL RETIREMENTS ON GAS INDUSTRY - SUMMER

- The winter impact would have resulted in record low storage levels at the beginning of spring (April 1, 2014).

STORAGE LEVELS AT THE END OF WINTER (MARCH 31)

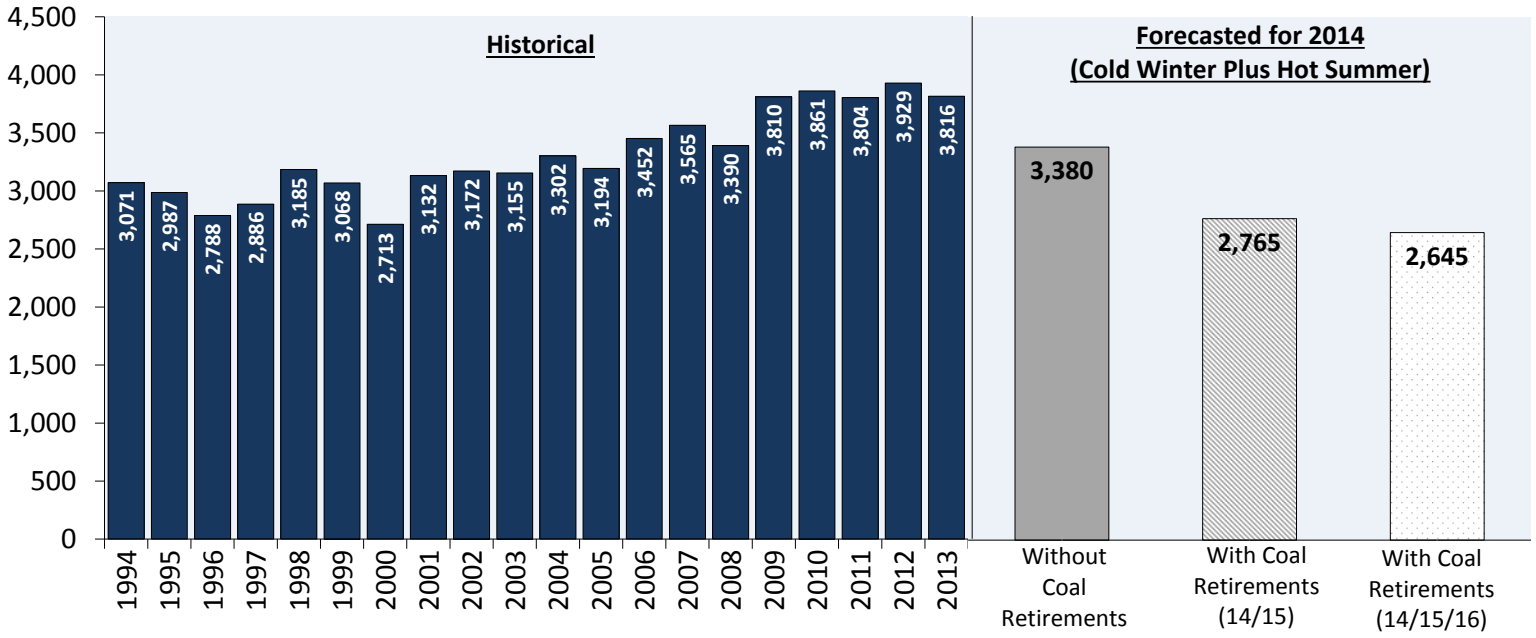


IMPACT OF COAL RETIREMENTS ON GAS INDUSTRY - SUMMER

STORAGE LEVELS AT THE BEGINNING OF WINTER 2014/15

- Storage injections would have been reduced to about 10.4 BCFD because additional summer gas demand.
- Storage refill for next winter likely would have been inadequate unless the winter of 2014/2015 is very mild.
- A supply response likely would occur.
  - However, it would have a minimal impact on 2014 storage injections.
    - Nonetheless, the increased supply would help meet demand during the winter of 2014/2015.
  - Higher gas prices would be required for a supply response.
    - Cost to consumer because of higher gas prices would be in between $11 and $59 billion depending upon timeframe.
  - Total cost to consumers for winter and summer impacts could reach about $90 billion(1).

STORAGE LEVELS AT THE BEGINNING OF WINTER (NOVERMBER 1)



(1) Total cost to all consumers for both gas and power is approximately $100 billion.

CONCLUSIONS

POWER MARKET CONCLUSIONS

- Potential capacity shortages in PJM and ISO-NE during winter due to the early coal retirements.
- Potential capacity shortages in PJM, MISO and ISO-NE during a hot summer due to high demand and early coal retirements.
- High wholesale power prices during both winter and summer months resulting in a potential addition of $35 billion to the energy costs of consumers in 2014.

CONCLUSIONS

NATURAL GAS MARKET CONCLUSIONS

- Without projected retirements gas industry already at a precipice.
  - Pipelines, LDCs and storage operators restrict supplies to non-firm customers.
  - Gas-fired generating capacity lost in several regions due to curtailment of gas supplies.
  - Near record low storage inventories at the end of winter leave industry with a challenge to refill storage to adequate levels.

- With projected retirements
  - Winter
    - Records for demand, storage withdrawals and prices would have been reset to higher levels.
    - Additional pipeline, LDC, and storage operator curtailments likely would have occurred.
      - More power plants likely would have had gas supplies curtailed.
    - Inadequate pipeline capacity in NEPOOL.
      - Alternatives for either increased oil-fired generation or imported power would have been unlikely.
      - Remaining alternative is to curtail electricity demand.
  - Summer
    - Storage levels at the start of next winter (Nov 1, 2014) at unprecedented low levels and likely inadequate, except in the case of a mild winter.
    - Higher gas prices on a sustained basis.

- Total cost to consumers for all sectors for 2014 is approximately $70 billion, and for the period 2014-2016 is $100 billion.