Transmission Expansion Advisory Committee

October 6, 2010

Issues Tracking

Open Issues: None

New Issues:

Aging Infrastructure

- In 2006 we added several spare 500/230 kV transformers to the RTEP based on the condition of the existing transformers and the impact of a failure of one of the transformers

- We have continued to evaluate the need for additional spares in each RTEP since then

- PJM will be expanding the aging infrastructure program to consider EHV lines

Aging Infrastructure

- Portions of the 500 kV system were put in service in the early 1960's time frame
- Similar to what was done for the 500 / 230 kV transformers, the assessment will consider both the condition of the facility and operational impact of the facility
- Mt. Storm – Doubs 500 kV will be the first line evaluated
- More details to follow at subsequent TEAC meetings

MAAC Alternative Analysis Update

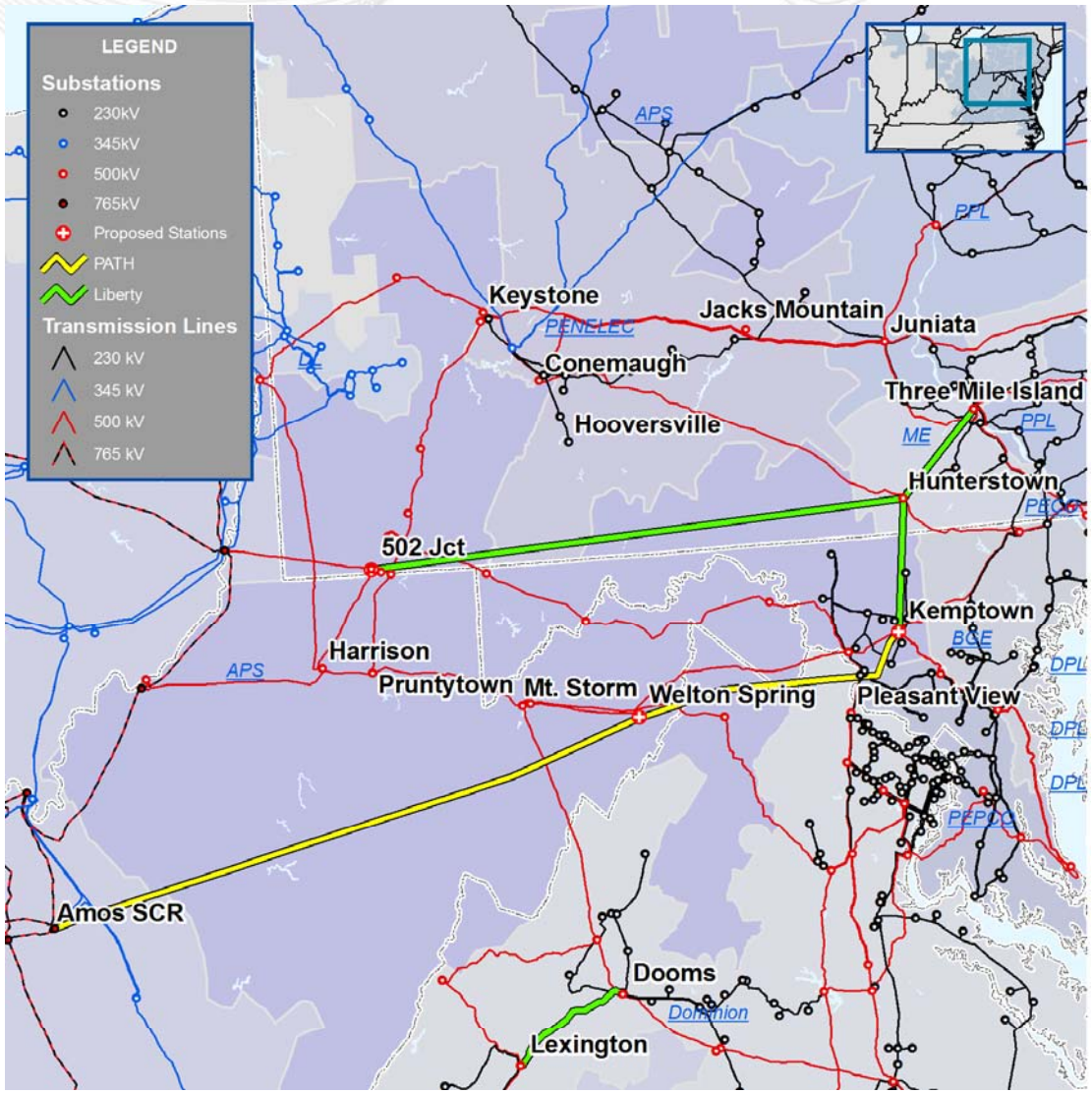
MAAC Alternative Analysis

Revised Liberty / LS Power

- 502J – Hunterstown 500kV (includes 50% series compensation)
- Hunterstown – TMI 500kV
- Hunterstown – Kemptown 500kV
- Lexington – Dooms 500kV

PATH

- Amos – Welton Spring – Kemptown
- Includes baseline reactive upgrades of 1000 MVAR shunt and 500 MVAR SVC at Welton Spring and a 250 MVAR shunt at Kemptown 500kV



MAAC Alternative Analysis

Dominion Alternative #1

- Rebuild Mt. Storm – Doubs
- 50% series compensation on Meadow Brook end of Trail
- Rebuild Mt. Storm – Pruntytown

Dominion Alternative #2

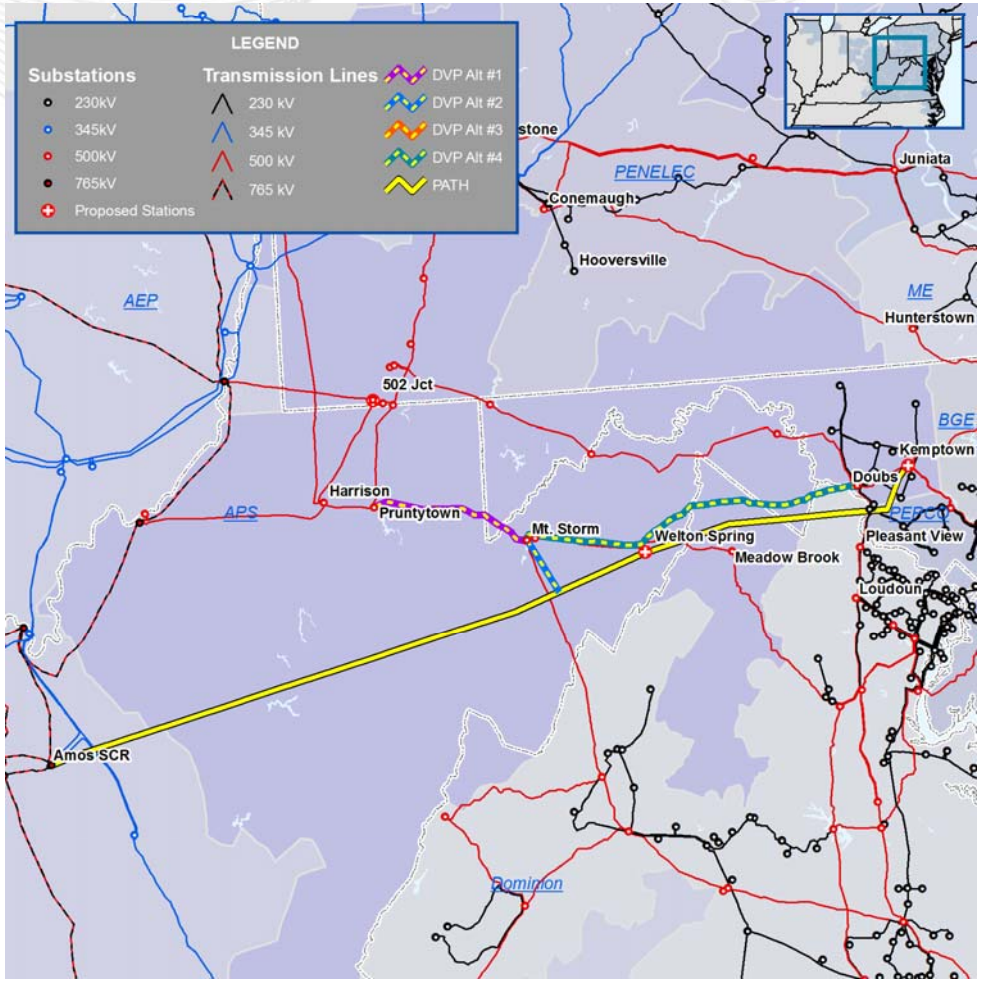
- Rebuild Mt. Storm – Doubs
- 50% series compensation on Meadow Brook end of Trail
- Build a portion of PATH stopping at Mt. Storm (requires a new 765/500kV transformer)

Dominion Alternative #3

- Rebuild Mt. Storm – Doubs
- 50% series compensation on Meadow Brook end of Trail
- Build a portion of PATH stopping at Welton Spring (requires new 765/500kV transformer)

Dominion Alternative #4

- Rebuild Mt. Storm – Doubs
- Build PATH proposal

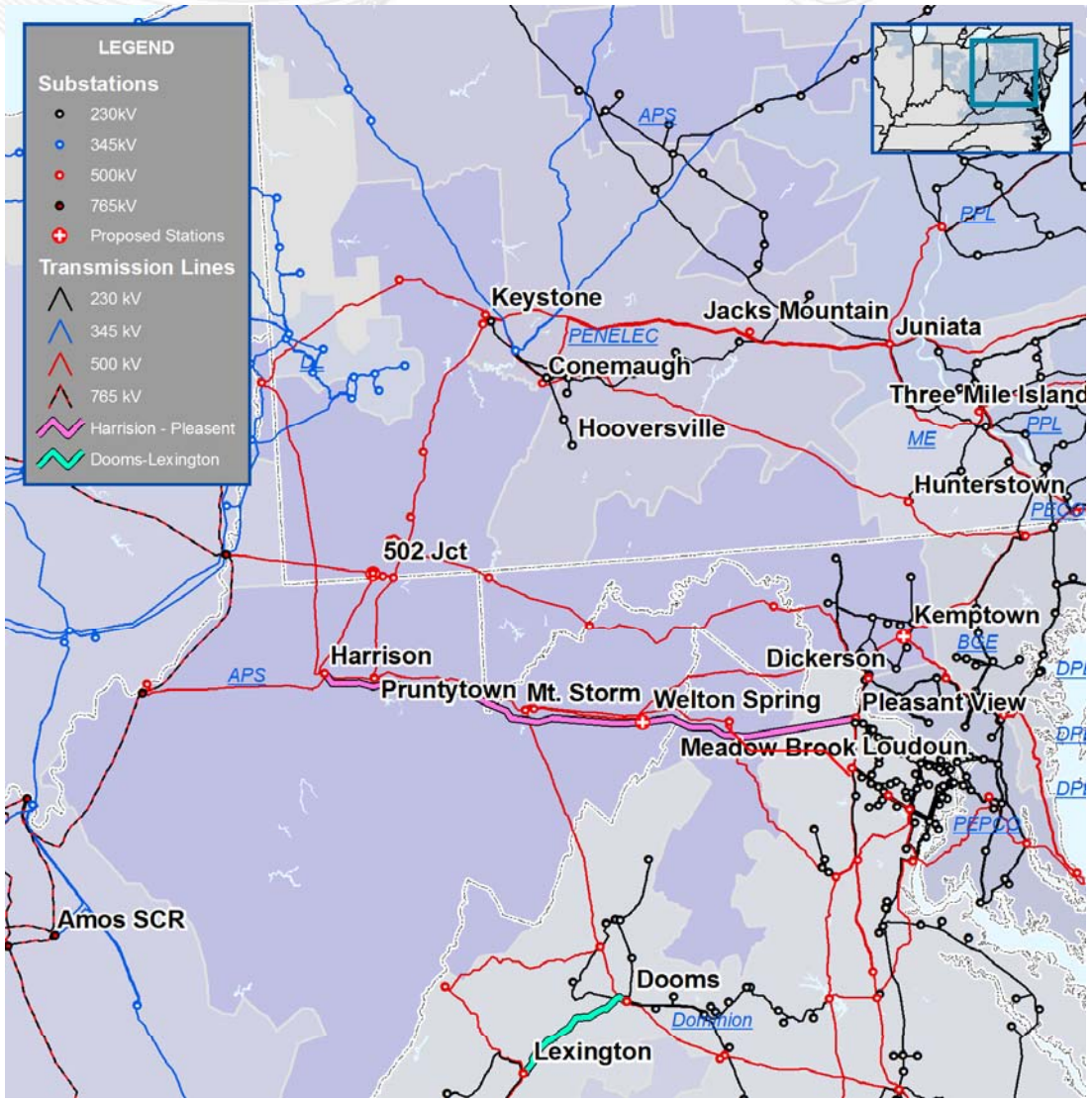


* All Dominion alternatives include 900 MVAR SVC's at Loudoun 230kV and T157 Tap 500kV and 900 MVAR of static capacitors at other locations

MAAC Alternative Analysis

Harrison – Dickerson Alternative

- Harrison – Dickerson New 500kV AC Line
- New Dickerson 500/230kV Station
- Series Comp on Meadow Brook – Loudoun
- Lexington – Dooms 500kV



MAAC Alternatives FCITC Sensitivity Study

		FCITC using 50/50 case (MW)		
		PATH	**Liberty**	**Harrison - Dickerson**
No EMAAC Alternative modeled	non-MAAC to MAAC	7900	7700	6600
	PJM West to MAAC	7500	7400	6400
	PJM West to DVP	6400	6400	5800
	DVP to MAAC	7900	7200	5600
MAPP modeled	non-MAAC to MAAC	7900	8100	8400
Northern Option modeled	non-MAAC to MAAC	6900	7000	3900

	FCITC using 50/50 case (MW)		
	PATH	**Liberty**	**Harrison - Dickerson**
Average FCITC (no EMAAC Alt.)	7425	7175	6100
Average FCITC (All)	7417	7300	6117
Maximum FCITC	7900	8100	8400
Minimum FCITC	6400	6400	3900

* FCITC = First Contingency Incremental Transfer Capability

MAAC Alternatives Losses Calculation

		PATH	Liberty	Harrison - Dickerson
MW Losses	PJM Total MAAC Load Deliverability Case (90/10 load)	4340	4480	4530
	PJM Total RTEP Generator Deliverability Case (50/50 load)	4340	4420	4440
MVAR Losses	PJM Total MAAC Load Deliverability Case (90/10 load)	74270	75290	76020
	PJM Total RTEP Generator Deliverability Case (50/50 load)	73030	73600	73780

- PV Study for the MAAC LDA
- 5,500 MVAR of SVC's were modeled at discrete locations to provide reactive support
- The study modeled a transfer from non-MAAC zones to the MAAC zone
- Analysis determined the limiting condition for each scenario

2015 Voltage Analysis

Alternative*	Maximum Transfer (MW)	Limiting Contingency	Limiting Criteria Violation
Base System – No Alternatives	1500	Keystone - Jacks Mountain	Voltage Drop at Conemaugh 500kV
502 Junction – Hunterstown (Partial Liberty) + MAPP	3170	Hunterstown - Conastone	Voltage Collapse
Harrison - Dickerson + MAPP	3600	Keystone - Jacks Mountain	Voltage Drop at Conemaugh 500kV
PATH + MAPP	4016	Keystone - Jacks Mountain	Voltage Collapse
Liberty + MAPP	4136	Keystone - Jacks Mountain	Voltage Collapse

- 2015 study year
- Total SVC outputs were measured between 4,000 MVAR and 5,400 MVAR for each of the alternatives
- SVC Locations – Juniata, Jacks Mountain, Doubs, Meadow Brook, T157 Tap, Loudoun
- The maximum transfer (MW) is maximum transfer above the 2015 CETO before collapse

* The base system and each alternative modeled 5,500 MVAR of SVC's

MAAC Alternatives Voltage Sensitivity Study

2015 Voltage Analysis

Alternative*	Maximum Transfer (MW)
Base System – No Alternatives	1500
502 Junction – Huntertown (Partial Liberty) + MAPP	3170
Harrison - Dickerson + MAPP	3600
PATH + MAPP	4016
Liberty + MAPP	4136

Future CETO Estimation

Year	MAAC 90/10 Forecast	Delta load from Year 2015 forecast
2015	70091	-
2016	70841	750
2017	71625	1534
2018	71650	1559
2019	72960	2869
2020	73841	3750
2021	74482	4391

- Total SVC outputs were between 4,000 MVAR and 5,400 MVAR for each of the alternative
- Estimate future increases in the CETO purely due to load growth
- Load growth in MAAC exceeds +1559 MW by 2018 and +3750 MW by 2020
- Does not account for increased reactive losses due to required increase in transfer in future years
- At best, a reactive only solution could meet the increased CETO into MAAC through 2016 and would not meet the increased CETO in 2017 and beyond

* The base system and each alternative modeled 5,500 MVAR of SVC's

MAAC Alternative Side by Side Data

	Mileage			States	Series Compensation	Cost ($B)
	Existing ROW	New ROW	Total			
PATH	121.2 (adjacent to existing ROW)	156.1	277.3*	MD, VA, WV	No	$2.10
Revised Liberty	0	Approximately 280 (40% near existing transmission ROW)	280	PA, MD, VA	Yes	$1.336**
Harrison - Dickerson			175	MD, VA, WV	Yes	$1.22 - $1.55
Dominion Alt #1	99 for the rebuild of existing transmission	0 for the rebuild	99 for the rebuild	MD, VA, WV	Yes	$0.62
Dominion Alt #2					Yes	$1.32B (includes $0.9B for portion of PATH)
Dominion Alt #3					Yes	$1.32B (includes $0.9B for portion of PATH)
Dominion Alt #4						$2.52 (includes $2.1B for entire PATH)

* Data based on filed Line Route Evaluations (LRE)
** Estimate provided by developer

- Construction feasibility study to be performed for Liberty to finalize side by side comparison

EMAAC Alternative Analysis Update

EMAAC Alternative Side by Side Data

	Mileage			States	Cost
	Existing ROW	New ROW	Total		
MAPP	97	16*	152	MD, DE, VA (less than 1/2 mile)	$1.20 B
Northern Route (Kemptown)	30.5	94.7	125	MD, PA, DE, NJ	$1.22 B - $1.54 B

* agreements are in place for the entire 16 miles, an additional 39 miles underwater will be built by permit from the State

- Construction Lead Time
  - MAPP
    - Design and permitting activities commenced in January 2008 upon receipt of PJM's approval of the project.
    - 56 months remain, able to meet June 1, 2015 in-service date
  - Northern Option
    - 111 Months (9.25 Years) based on a low-risk schedule

- The MAPP alternative will remain the recommendation to the PJM Board as the preferred alternative for Eastern Mid-Atlantic reliability criteria violations
  - Effectiveness
  - Cost
  - Construction Schedule

Baseline Reliability Update

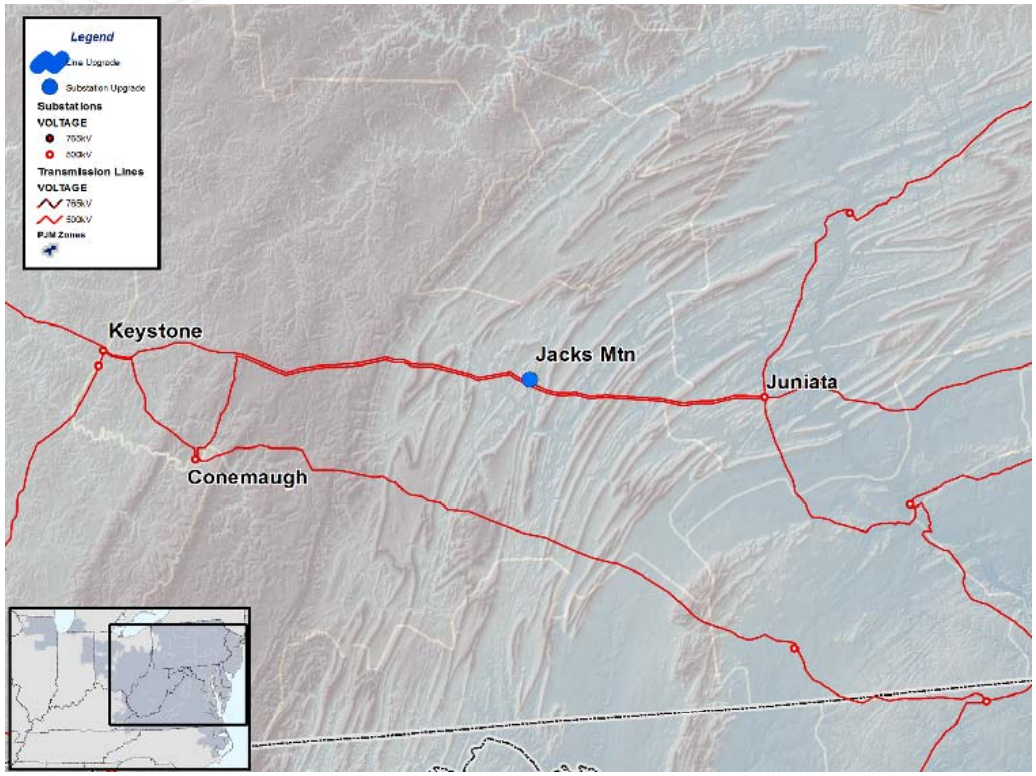
Jacks Mountain Update

Jacks Mountain In-Service Date

- Jacks Mountain

- Modeled in the reactive analysis of 2015 that was performed as part of this year's RTEP, still needed for reliability

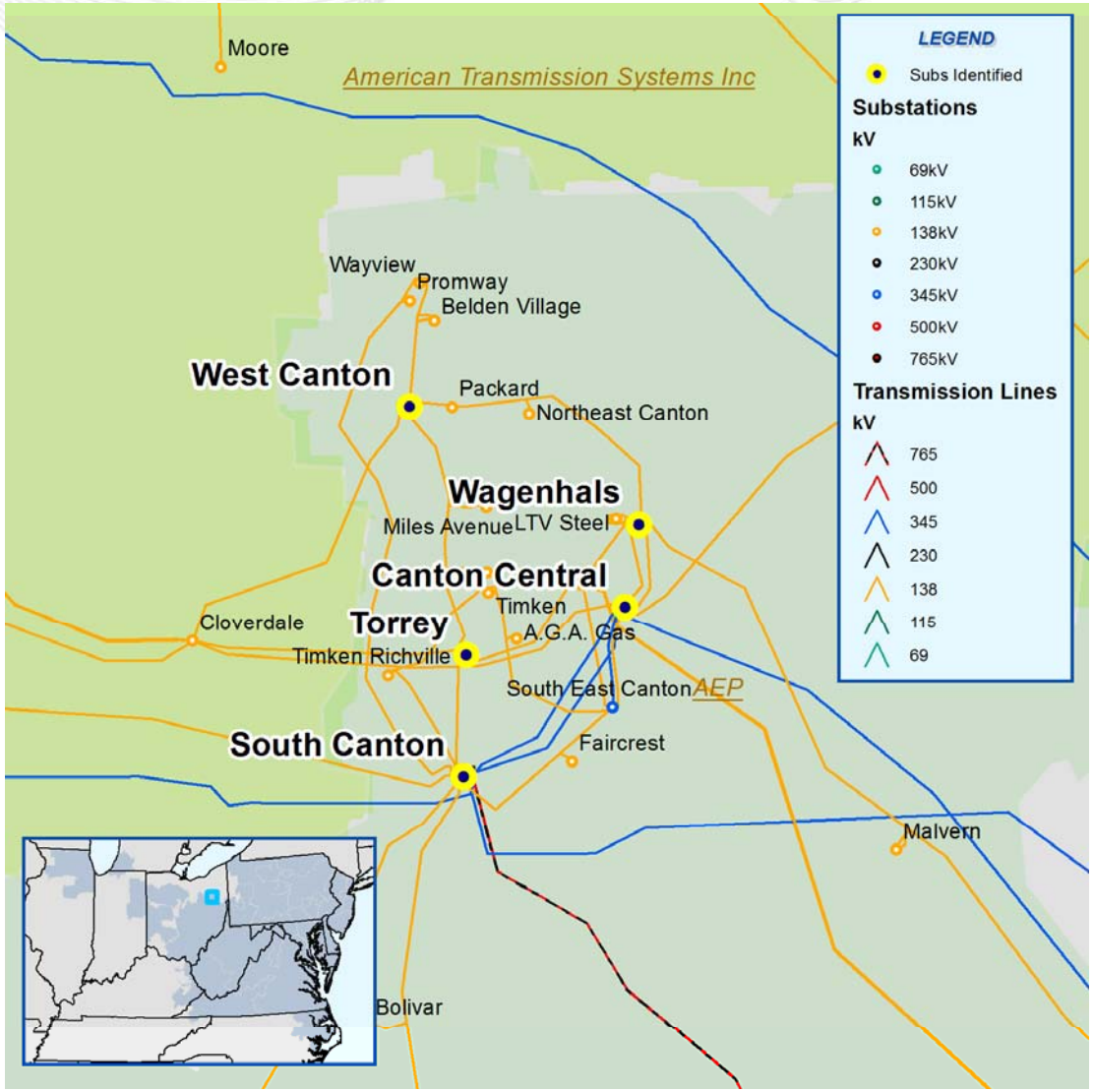
- Updated PJM analysis of 2012 demonstrates that the in-service date of the Jacks Mountain project can be delayed to 6/1/2013 from 6/1/2012



2015 Analysis Update

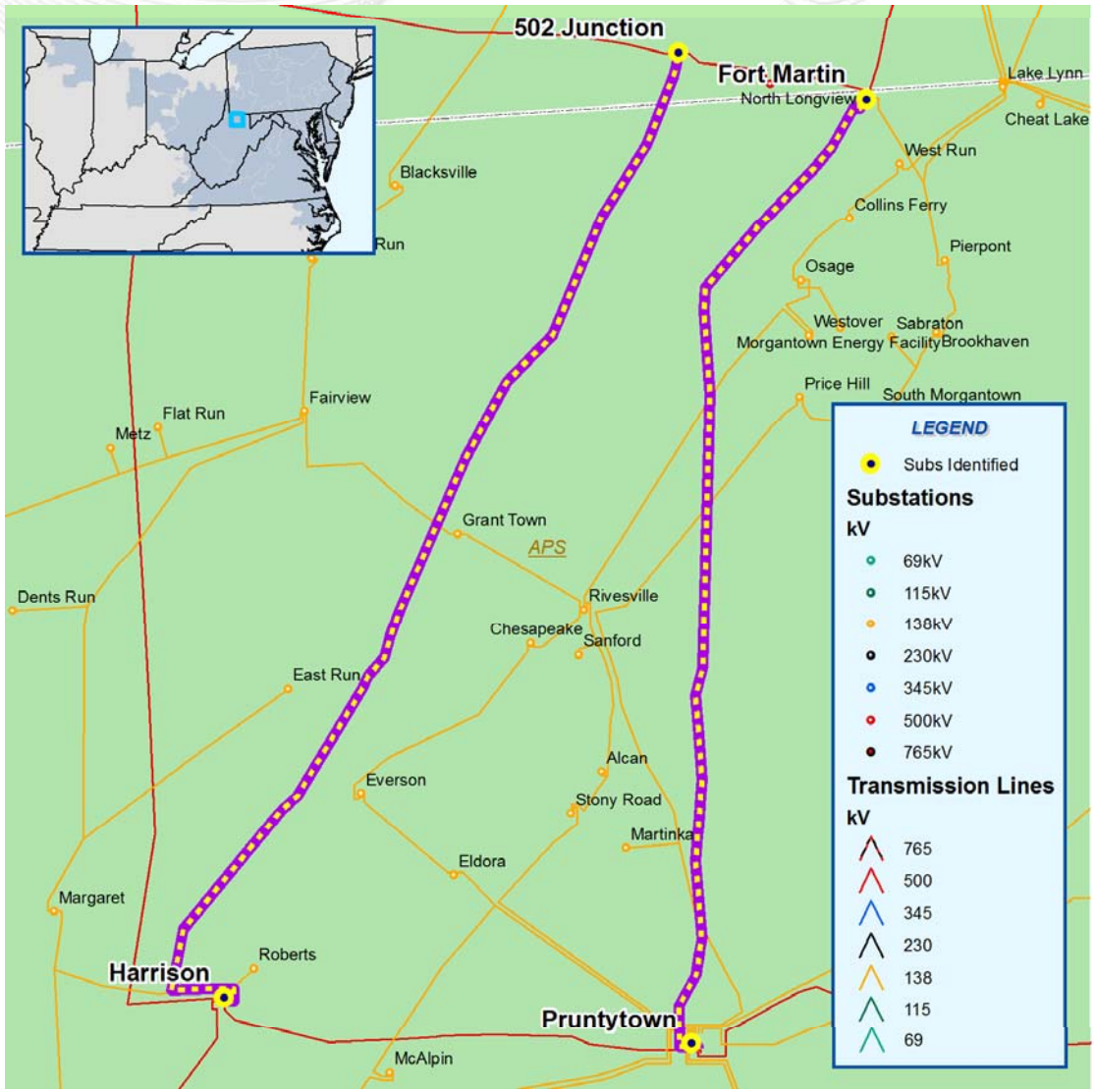
AEP Transmission Zone

- N-1-1 thermal violation for various contingencies
- Proposed Solutions:
  - These projects are additional detail for existing b1034.1 through b1034.4 to add a S. Canton to W. Canton 138kV line
  - Disconnect/eliminate the West Canton 138kV terminal at Torrey Station (b1034.5)
  - Replace all 138kV circuit breakers at South Canton Station and operate the station in a breaker and a half configuration (b1034.6)
  - Replace all obsolete 138kV circuit breakers at the Torrey and Wagenhals stations (b1034.7)
  - Install additional 138kV circuit breakers at the West Canton, South Canton, Canton Central, and Wagenhals stations to accommodate the new circuits (b1034.8)
- Estimated Project Cost: $28 M (includes previously presented b1034.* projects)
- Expected IS Date: 6/1/2014



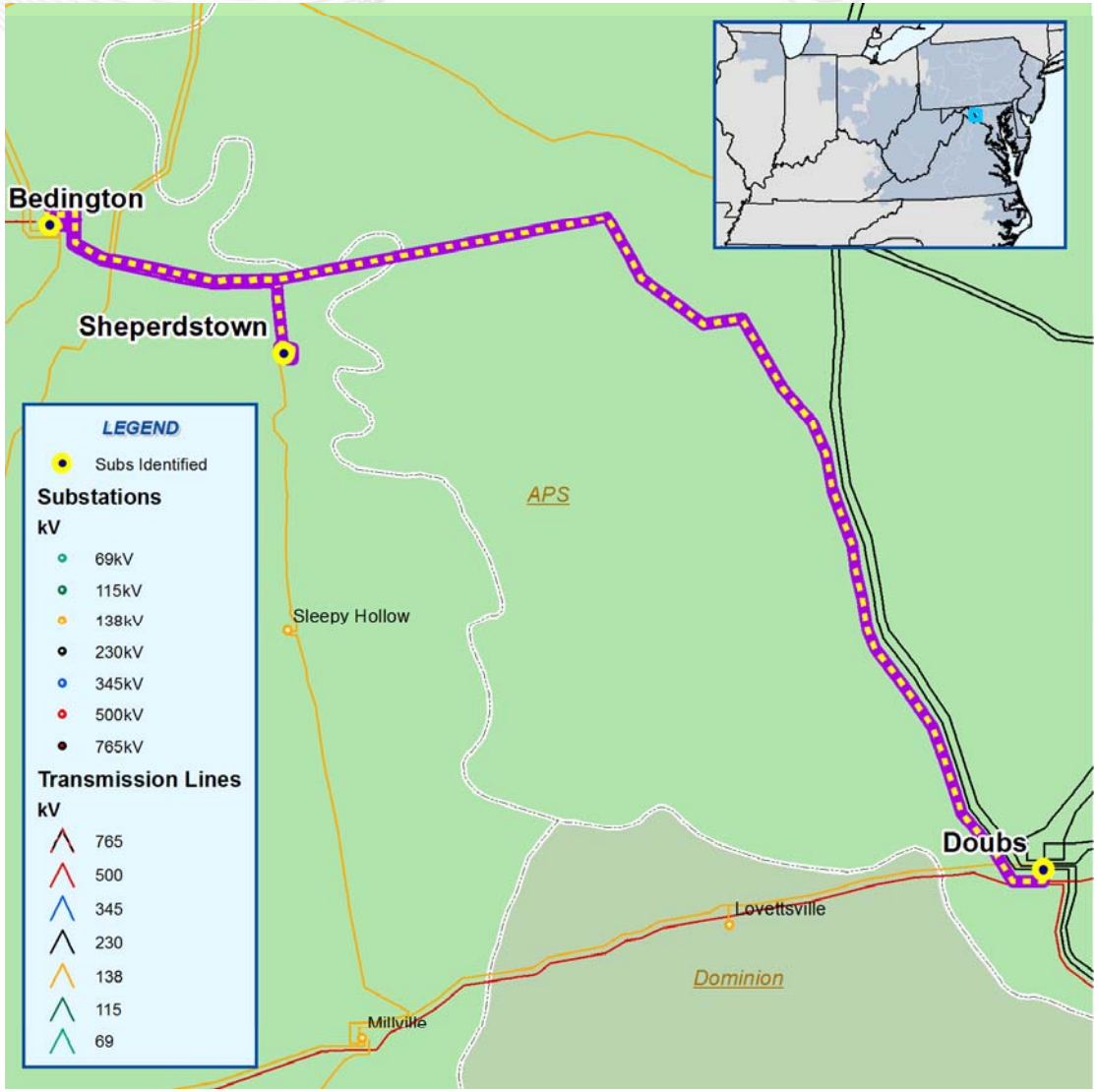
APS Transmission Zone

- N-1-1 Thermal Violation
- The 502 Junction 500/138kV transformer is overloaded for the loss of Harrison – Pruntytown 500kV + Fort Martin – Pruntytown 500kV
- Proposed Solution: Install 2nd 500/138kV transformer at 502 Junction (b1383)
- Estimated Project Cost: $15 M
- Expected IS Date: 6/1/2015



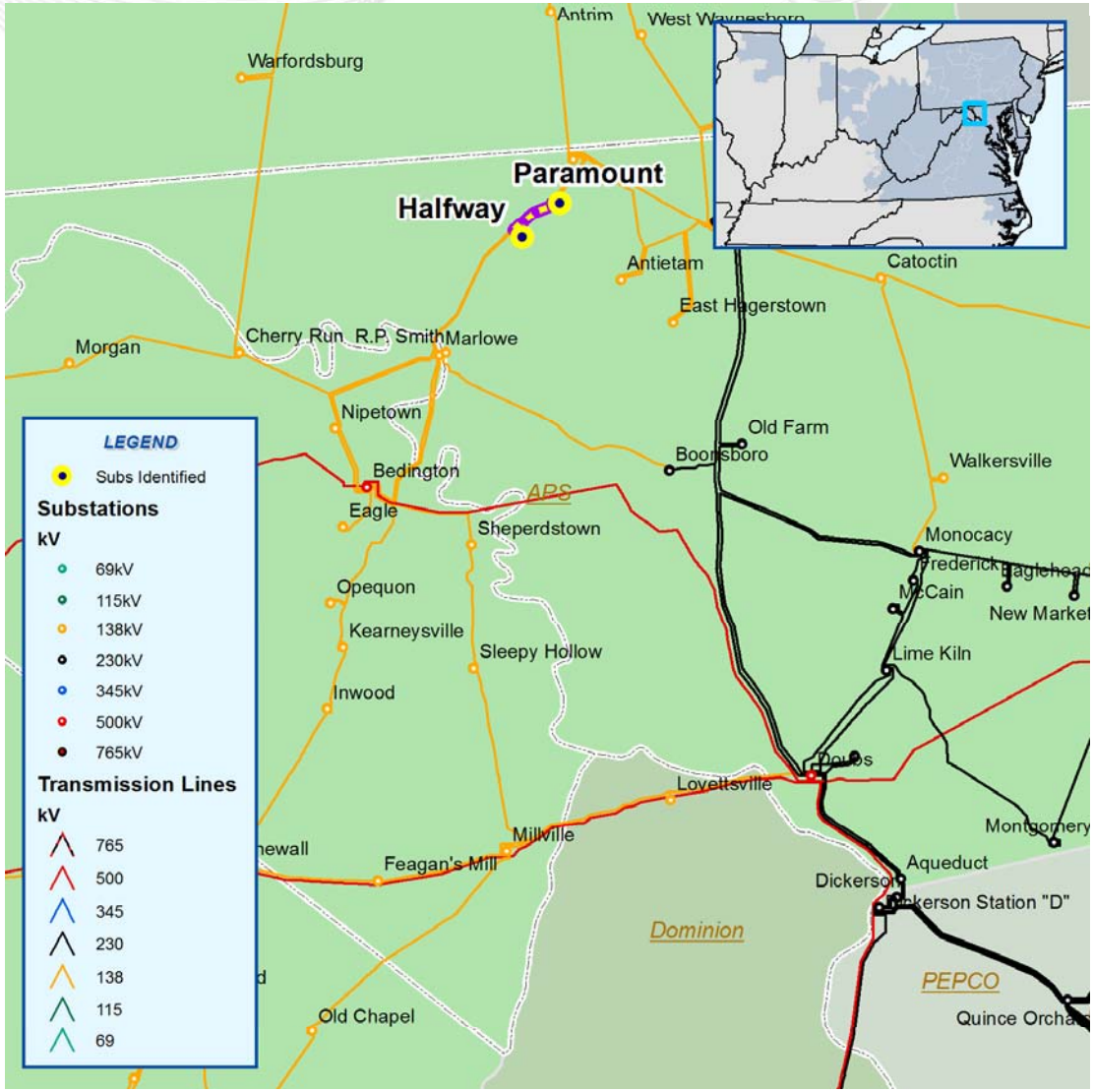
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Bedington – Shepherdstown 138kV for the loss of Bedington – Doubs 500kV + various other second contingencies
- Proposed Solution: Reconductor approximately 2.17 miles of Bedington – Shepherdstown 138kV with 954 ACSR (b1384)
- Estimated Project Cost: $1.75 M
- Expected IS Date: 6/1/2015



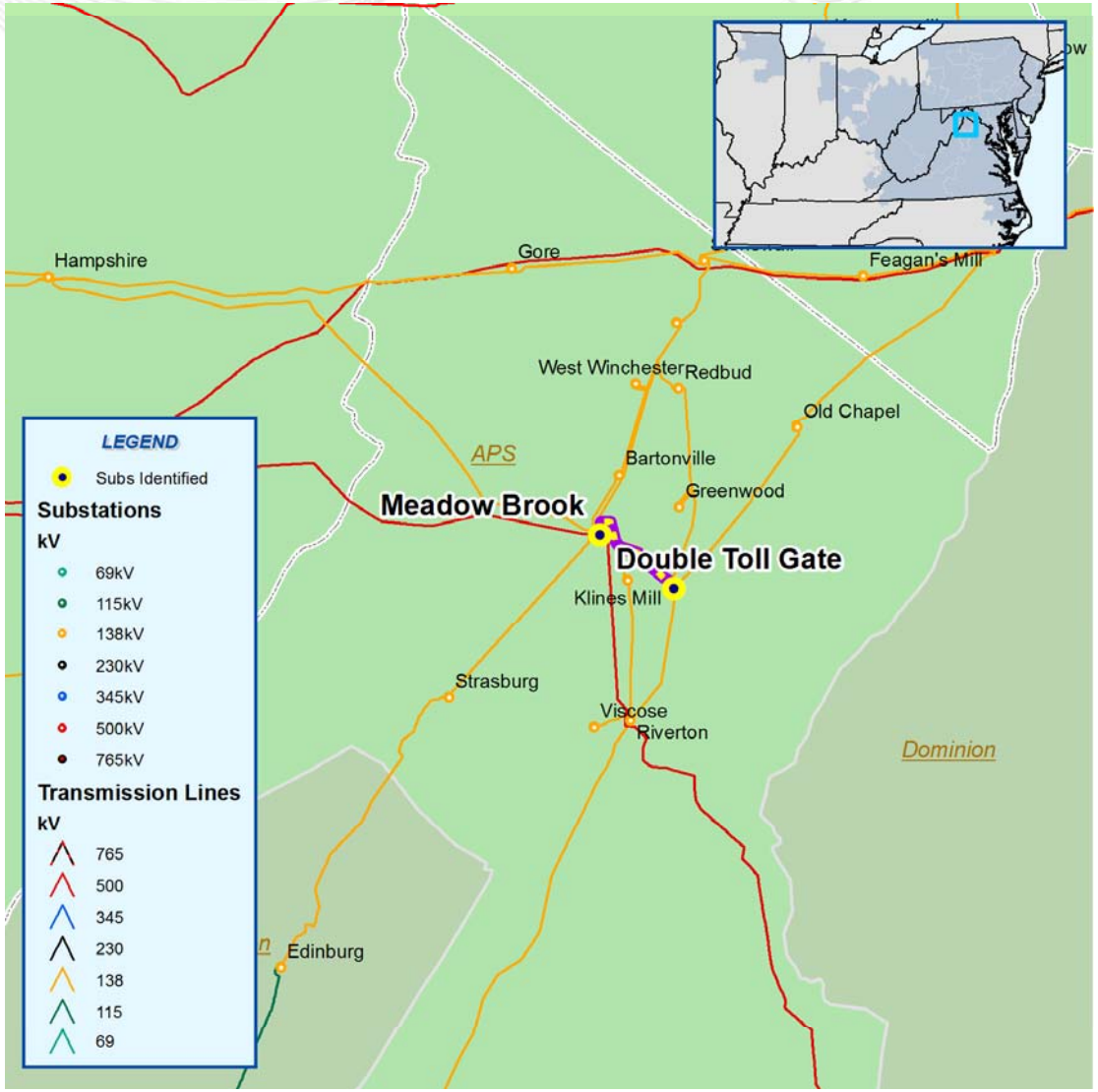
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Halfway – Paramount 138kV for the loss of Bedington – Doubs 500kV + Bedington – Nipetown 138kV
- Proposed Solution: Reconductor Halfway – Paramount 138kV with 1033 ACCR (b1385)
- Estimated Project Cost: $4.75 M
- Expected IS Date: 6/1/2015



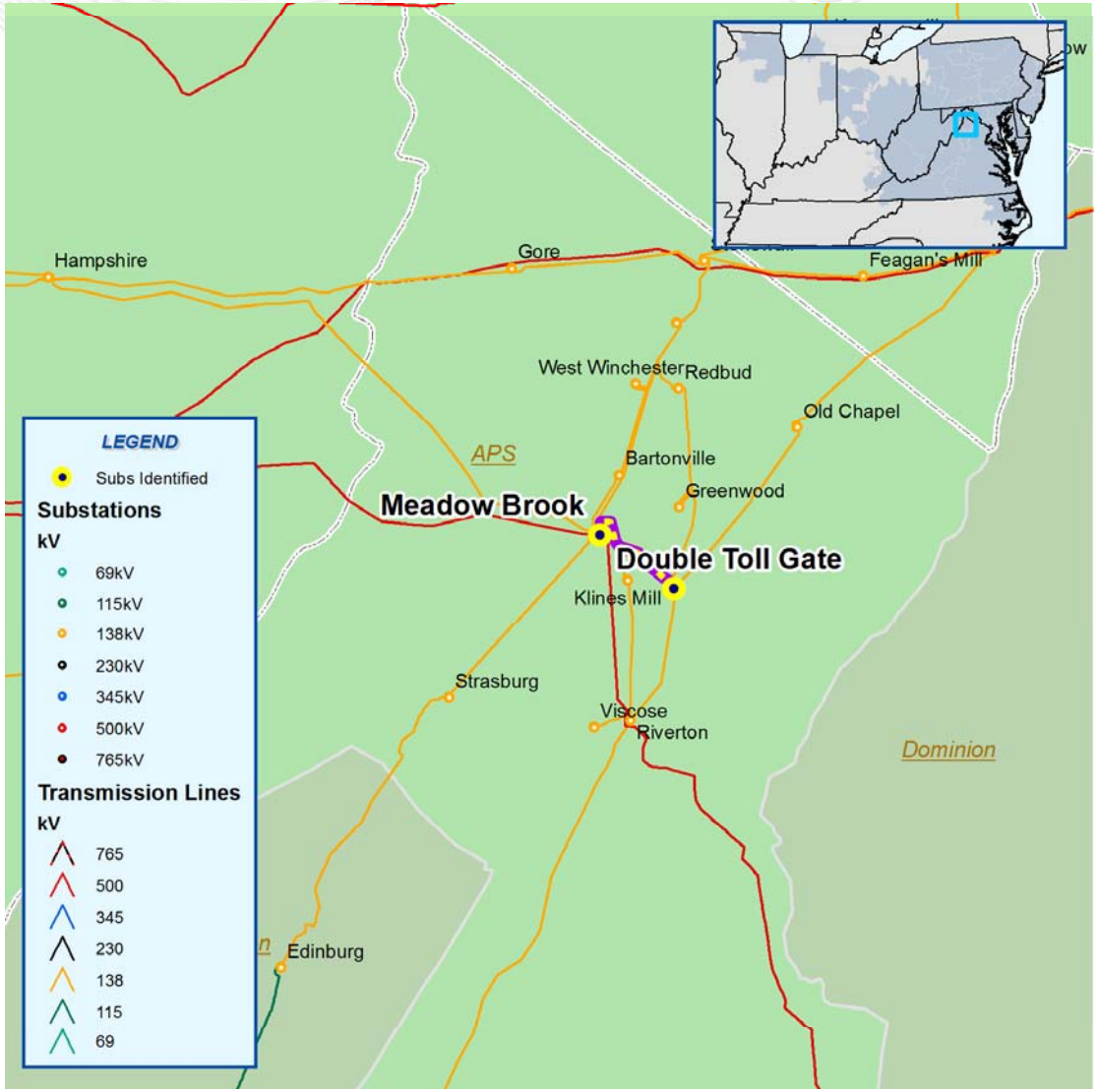
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Double Tollgate – Meadow Brook 138kV #2 for the loss of Double Tollgate – Meadow Brook 138kV #1 + various other second contingencies
- Proposed Solution: Reconductor Double Tollgate – Meadow Brook 138kV #2 with 1033 ACCR (b1386)
- Estimated Project Cost: $9 M
- Expected IS Date: 6/1/2015



APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Double Tollgate – Meadow Brook 138kV #1 for the loss of Double Tollgate – Meadow Brook 138kV #2 + various other second contingencies
- Proposed Solution: Reconductor Double Tollgate – Meadow Brook 138kV #1 with 1033 ACCR (b1387)
- Estimated Project Cost: $9 M
- Expected IS Date: 6/1/2015

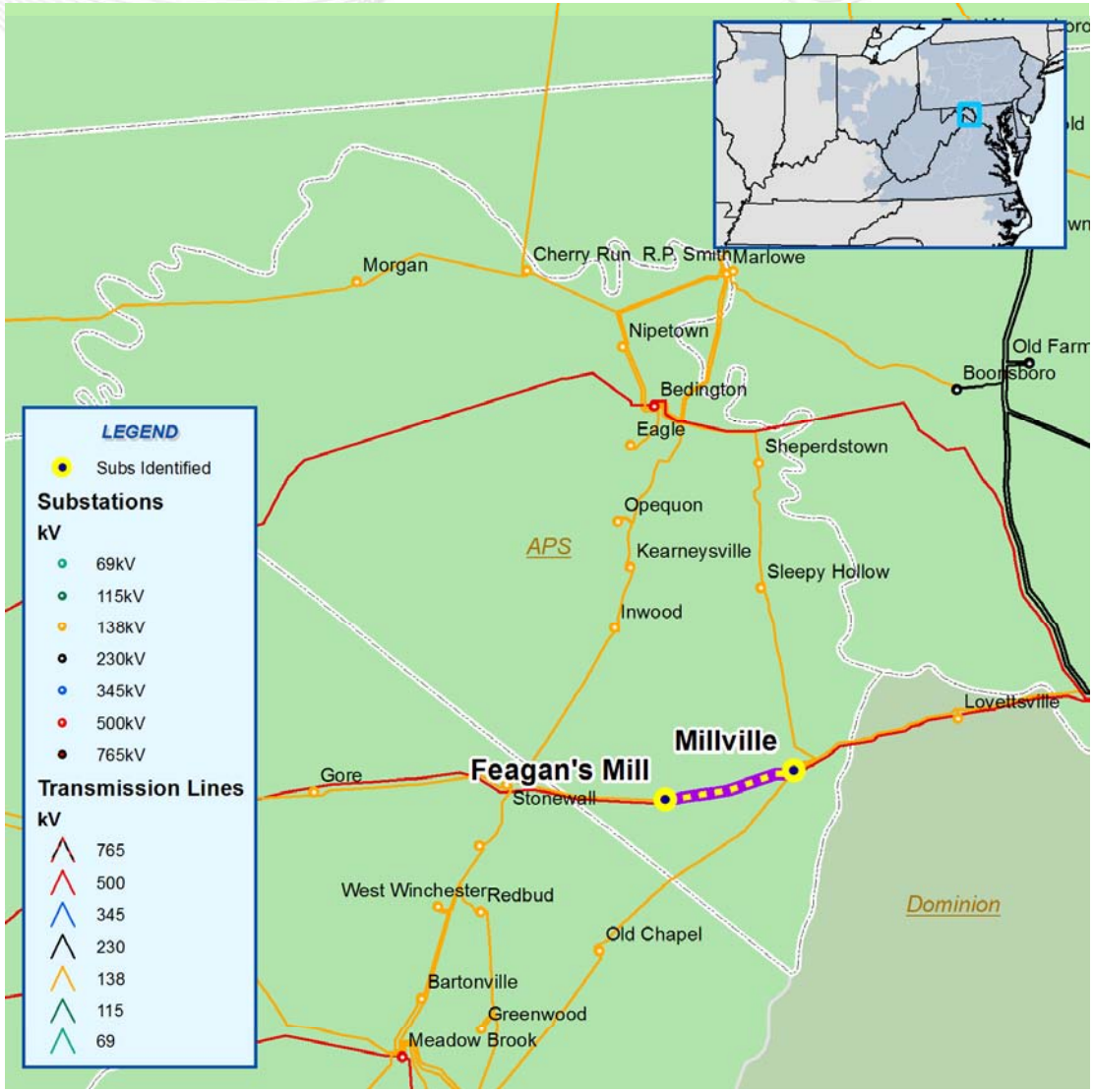


APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Greene - Letterkenny 138kV for the loss of Guilford – South Chambersburg 138kV + East Waynesboro – Ringgold 138kV
- Proposed Solution: Reconductor Greene - Letterkenny 138kV 795 ACSS (Revise baseline project b0680)
- Estimated Project Cost: $1.7 M
- Expected IS Date: 6/1/2013

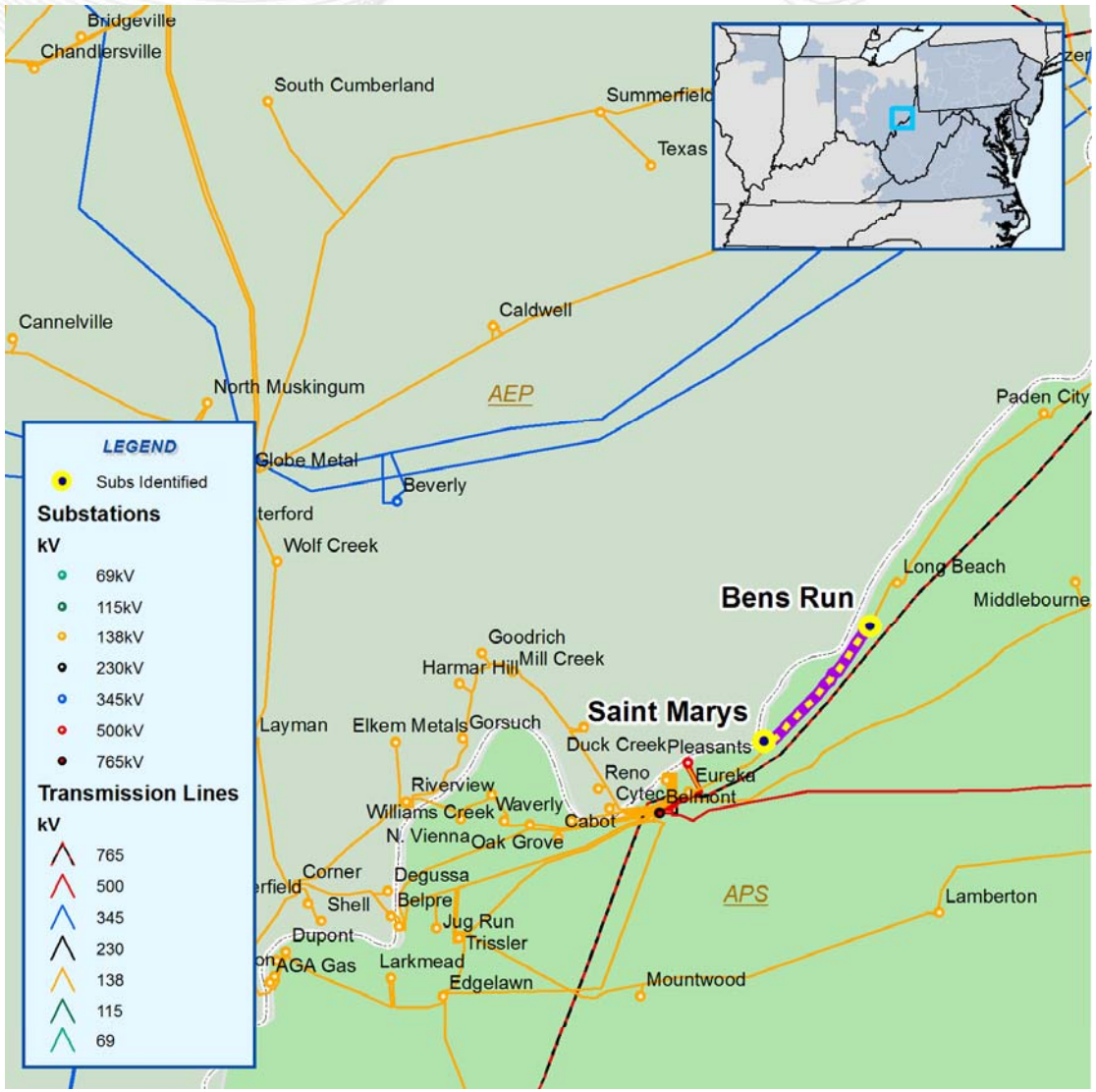
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Feagans Mill - Millville 138kV for the loss of Bedington - Opequon 138kV + Bartonville – Meadowbrook 138kV
- Proposed Solution: Reconductor Feagans Mill - Millville 138kV with 954 ACSR (b1388)
- Estimated Project Cost: $3.5 M
- Expected IS Date: 6/1/2015



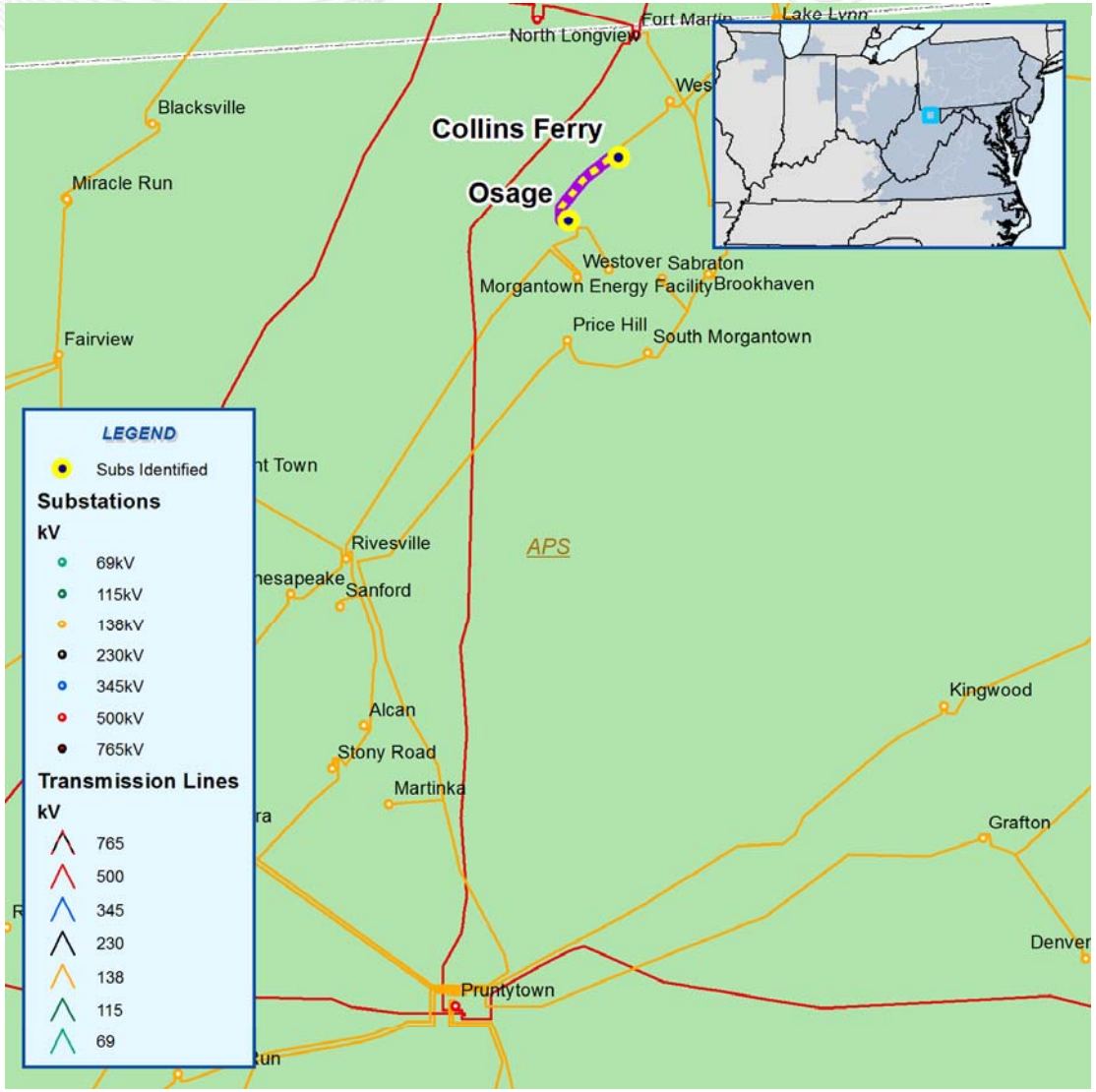
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Bens Run – St. Mary's 138kV for the loss of various contingency combinations around Belmont
- Proposed Solution: Reconductor Bens Run – St. Mary's 138kV with 954 ACSR (b1389)
- Estimated Project Cost: $5.8 M
- Expected IS Date: 6/1/2015



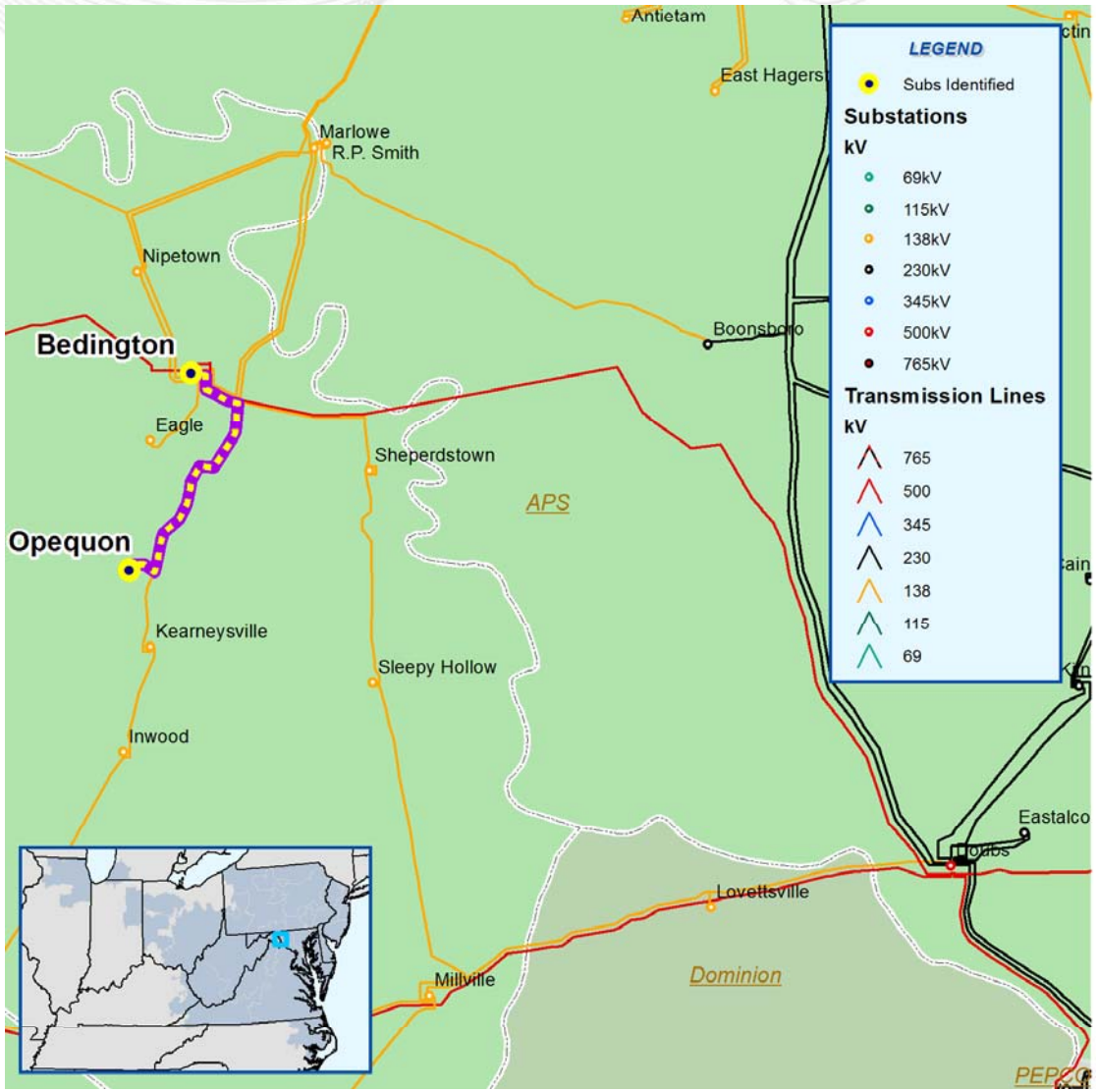
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Osage – Collins Ferry 138kV for the loss of Hatfield – Black Oak 500kV + one of the following circuits:
  - Price Hill – Pruntytown 138kV
  - Martinka – Pruntytown 138kV
  - Martinka – Price Hill 138kV
- Proposed Solution: Reconductor Osage – Collins Ferry 138kV with 954 ACSR (Revise baseline project b1028)
- Estimated Project Cost: $2.3 M
- Expected IS Date: 6/1/2013



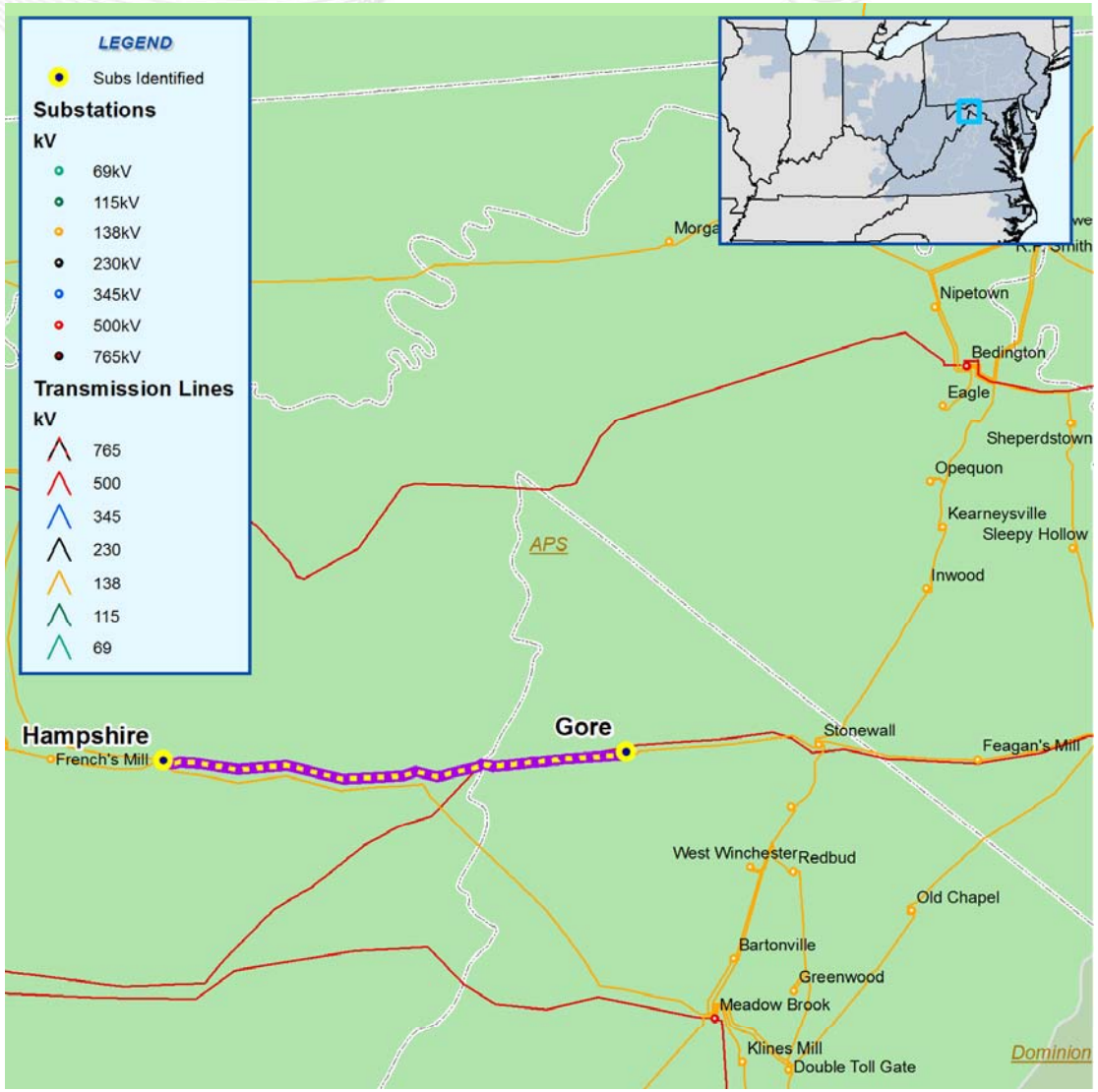
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Bedington – Opequon 138kV for the loss of Bedington – Doubs 500kV + Bedington – Shepherdstown 138kV
- Proposed Solution: Replace Bus Tie Breaker at Opequon (b1390)
- Estimated Project Cost: $0.25 M
- Expected IS Date: 6/1/2015



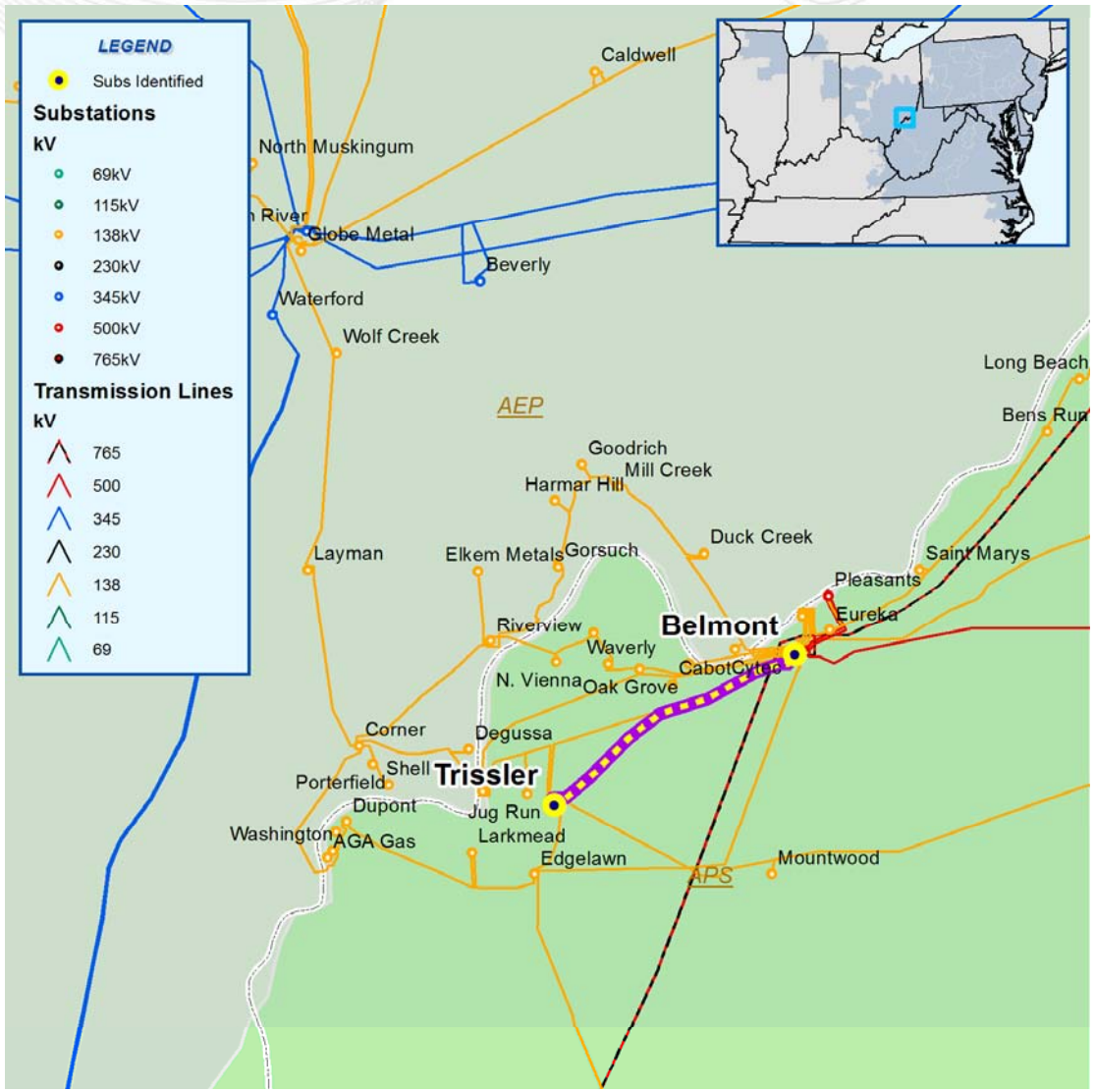
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Gore – Hampshire 138kV for the loss of Bedington – Opequon 138kV + Bartonville – Meadow Brook 138kV
- Proposed Solution: Replace Line Trap at Gore (b1391)
- Estimated Project Cost: $0.25 M
- Expected IS Date: 6/1/2015



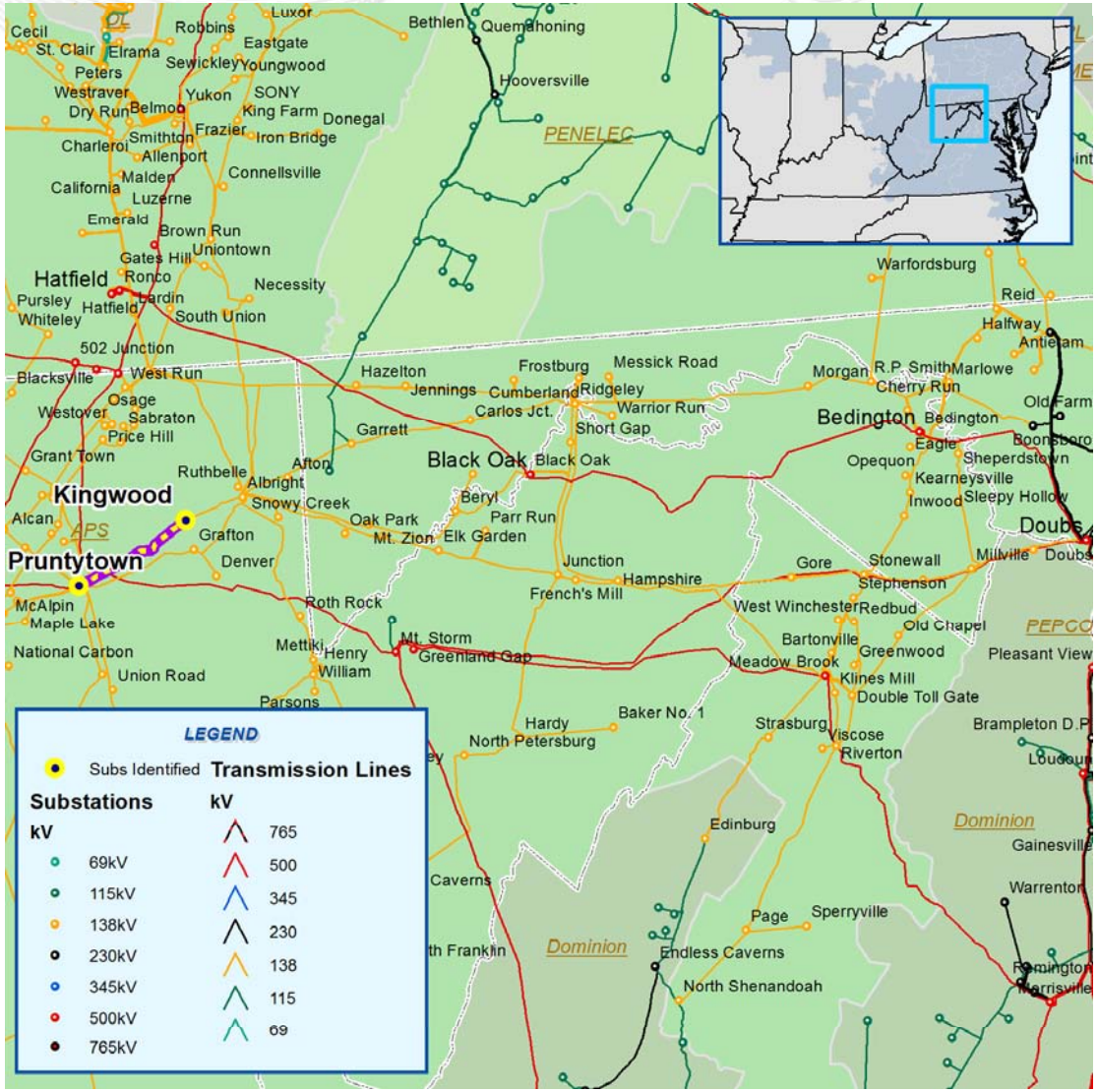
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Belmont – Trissler 138kV #1 for the loss of Belmont – Trissler 138kV #2 and one of the following circuits:
  - Belmont – Edgelawn 138kV
  - Oak Grove – Johns Manville 138kV
- Proposed Solution: Replace structures on the Belmont – Trissler 138kV line (b1392)
- Estimated Project Cost: $0.5 M
- Expected IS Date: 6/1/2015



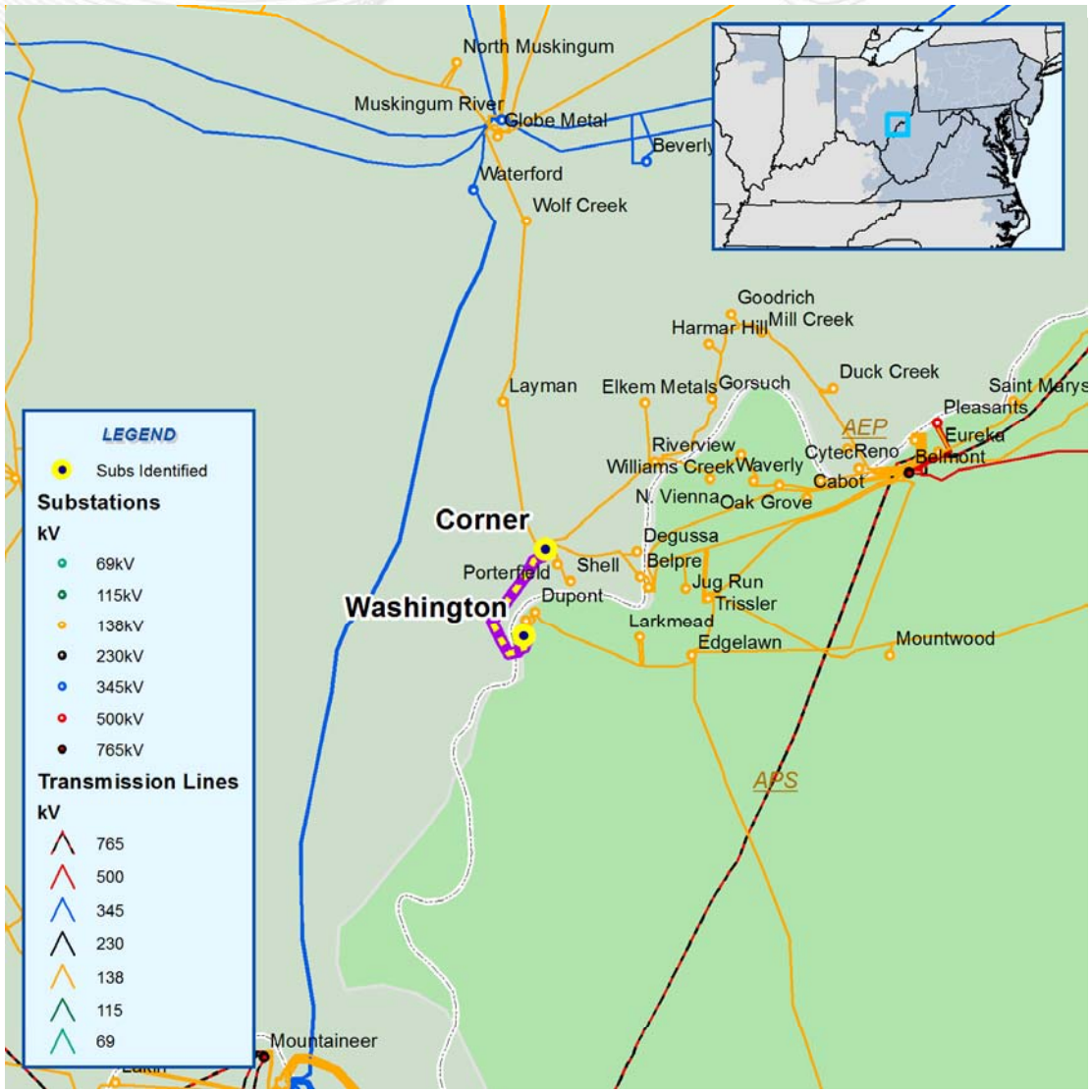
APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Kingwood – Pruntytown 138kV for the loss of Bedington – Doubs 500kV + Hatfield – Black Oak 500kV
- Proposed Solution: Replace structures on the Kingwood - Pruntytown 138kV line (b1393)
- Estimated Project Cost: $1 M
- Expected IS Date: 6/1/2015



APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Washington (MP) – Corner 138kV for the loss of Edgelawn – Trissler 138kV + Belmont – Edgelawn 138kV
- Proposed Solution: Upgrade Relay Circuitry at Washington (b1394)
- Estimated Project Cost: $0.05 M
- Expected IS Date: 6/1/2015

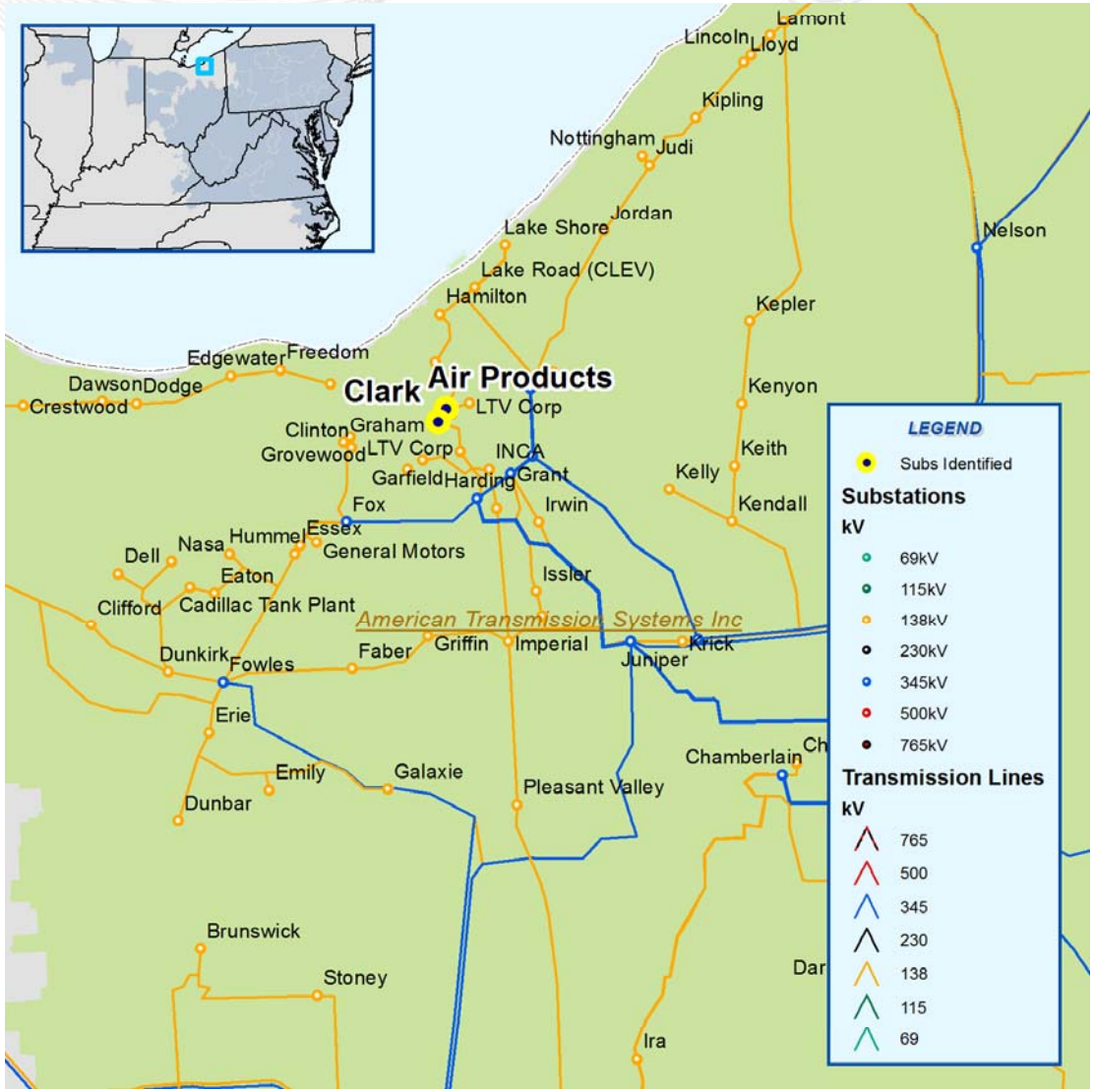


APS Transmission Zone

- N-1-1 Thermal Violation
- Overload of Kittanning – Garretts Run Jct 138kV for the loss of Allegheny Ludlum 4 Junction-Springdale 138kV + Allegheny Ludlum 2-Allegheny Ludlum 2 Junction138kV
- Proposed Solution: Upgrade Terminal Equipment at Kittanning (b1395)
- Estimated Project Cost: $0.05 M
- Expected IS Date: 6/1/2015

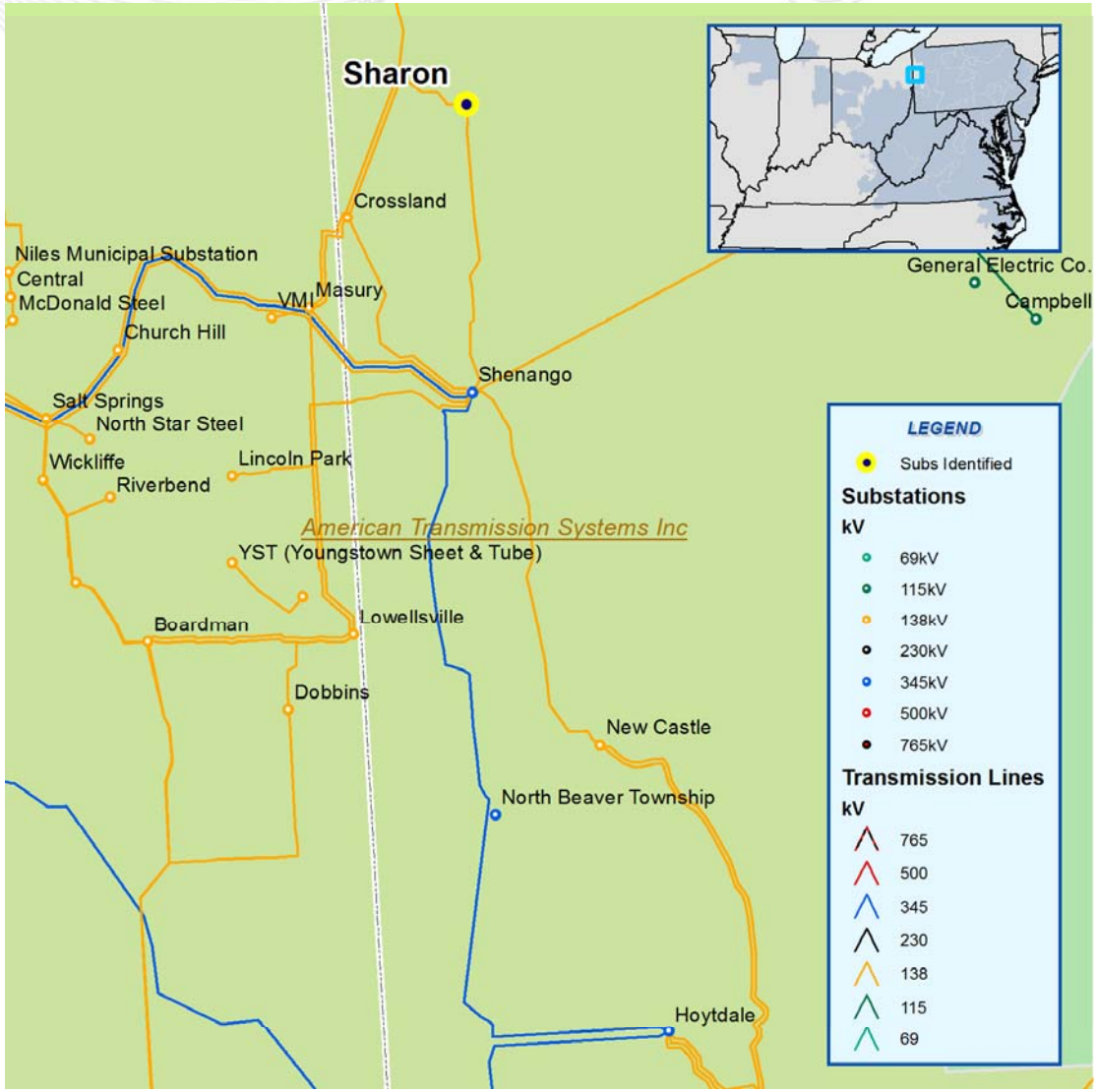
ATSI Transmission Zone

- N-1-1 Voltage violation
- Low Voltage magnitude and Voltage drop at Airpark, Clark, East Spring, and London 138kV buses for various contingency combinations
- Proposed Solution: Install a 25 MVAR cap bank at Airpark 138kV substation (b1341)
- Estimated Project Cost: $1.5 M
- Expected IS Date: 6/1/2015



ATSI Transmission Zone

- N-1-1 Voltage violation
- Low voltage magnitude at Maysville, Sharon, Sharpsville, Winner 138kV buses for the loss of the Hoytdale – Shenango 345kV line and the Highland - Shenango 345kV line
- Proposed Solution: Install a 50 MVAR cap bank at Sharon 138kV substation (b1342)
- Estimated Project Cost: $1.32 M
- Expected IS Date: 6/1/2015



RTEP Baseline Analysis Next Steps

- 2014 Retool Studies

- Finalize 2015
  - N-1-1 Voltage Analysis
  - Mid-Atlantic local issues
    - Verify potential solutions to reliability issues in southern PSEG
  - PJM West
    - Verify potential solutions in AEP and ComED
  - Dominion
    - Verify potential solutions in Dominion

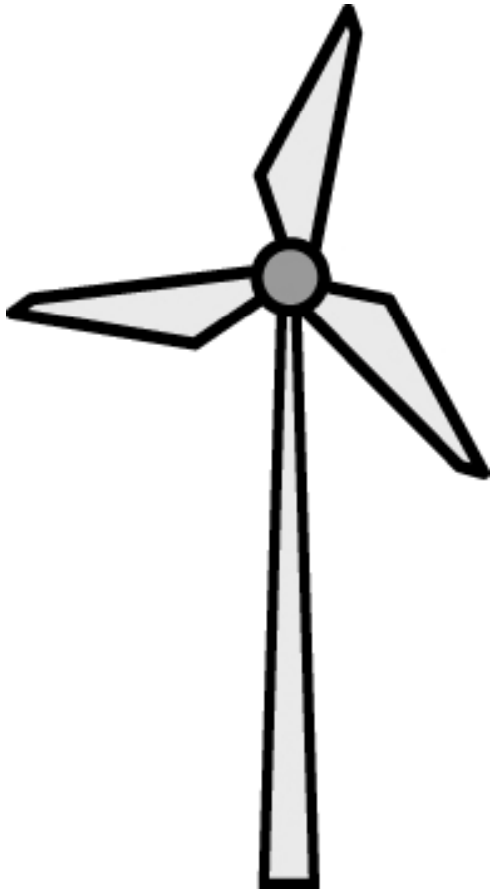
Off-Shore Wind Conceptual Study
Initial Results

Conceptual Offshore Wind Study Scope

- Evaluate the reliability and market efficiency impact of offshore wind
  - Reliability - Generator deliverability analysis
  - Market Efficiency - Promod production cost simulation

Conceptual Study Approach

- Identify injection points to be studied where the offshore wind will interconnect with the existing transmission system.
- Perform reliability screening of single contingencies to identify potential constrained facilities.
- Utilize production cost simulation tools to evaluate the impact of the offshore wind

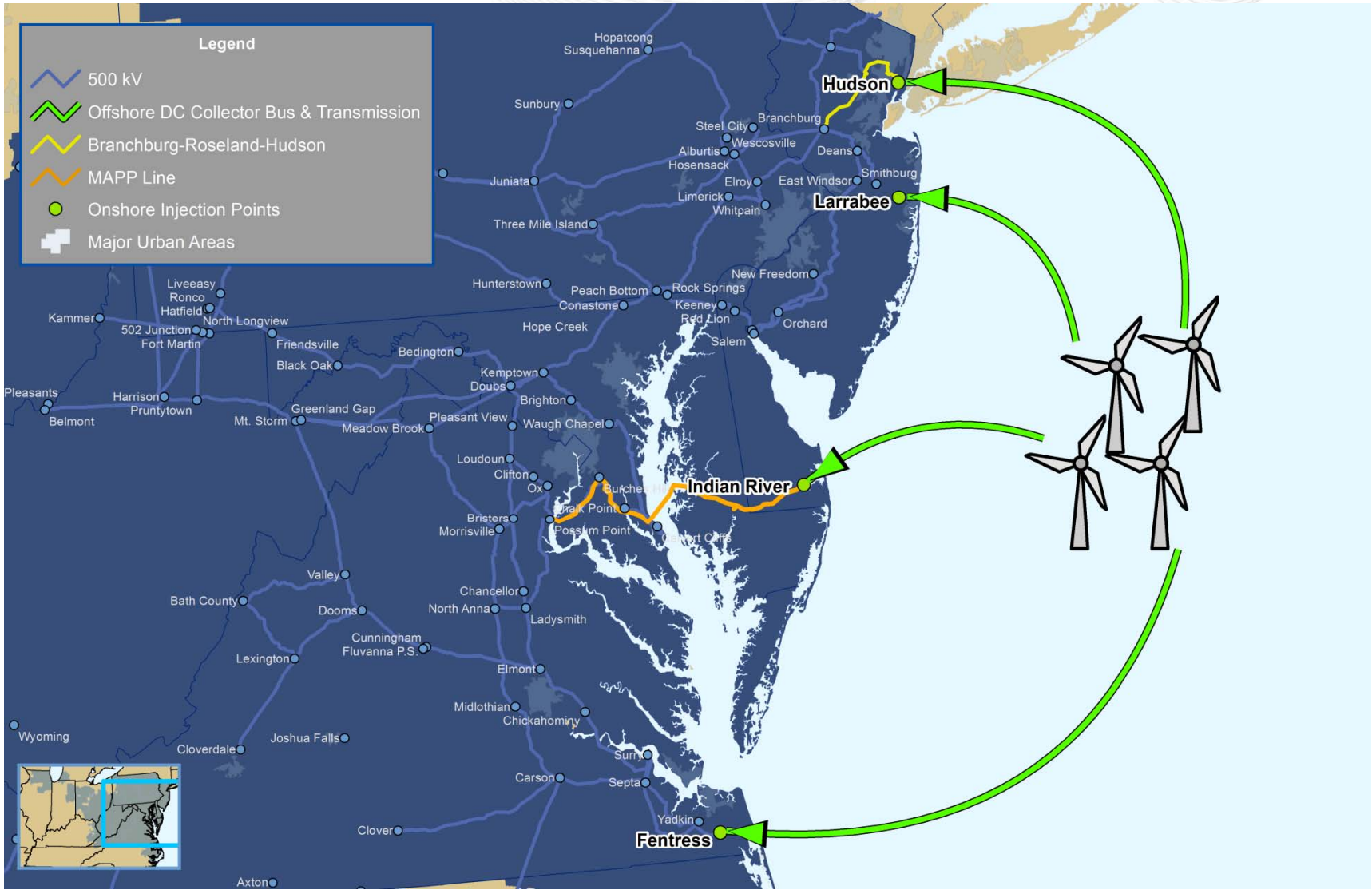


- Topology
  - Backbone Projects In-service
    - TRAIL
    - Carson - Suffolk
    - Susquehanna – Roseland
    - PATH
    - MAPP
  - Branchburg – Roseland – Hudson not included
  - Branchburg – Roseland – Hudson 230kV alternative upgrades not included

Initial Input Assumptions

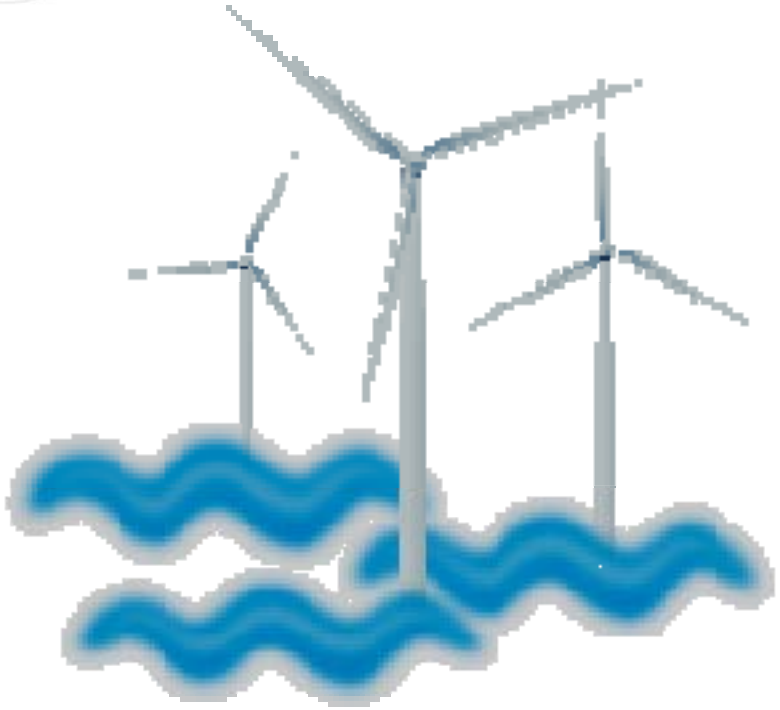
- 2010 RTEP assumptions
  - Fuel prices per the May 27, 2009 TEAC
  - Load and energy forecast per the PJM 2010 Load Forecast Report
- Wind Profile
  - Use DOE offshore data developed for the EWITS

Injection Points



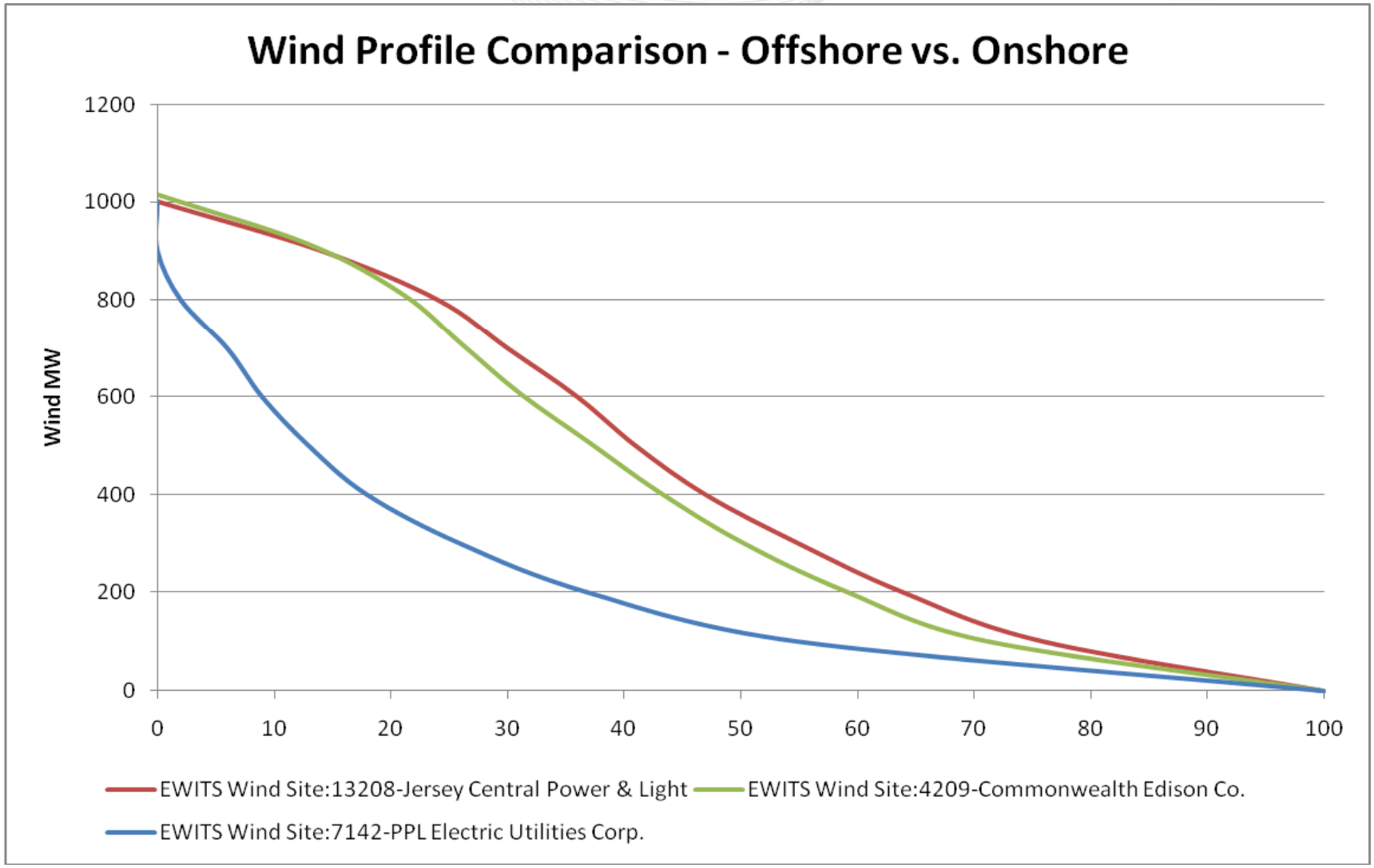
Scenarios Tested

- Four scenarios tested
  - No wind (base system)
  - 10 GW
  - 20 GW
  - 30 GW

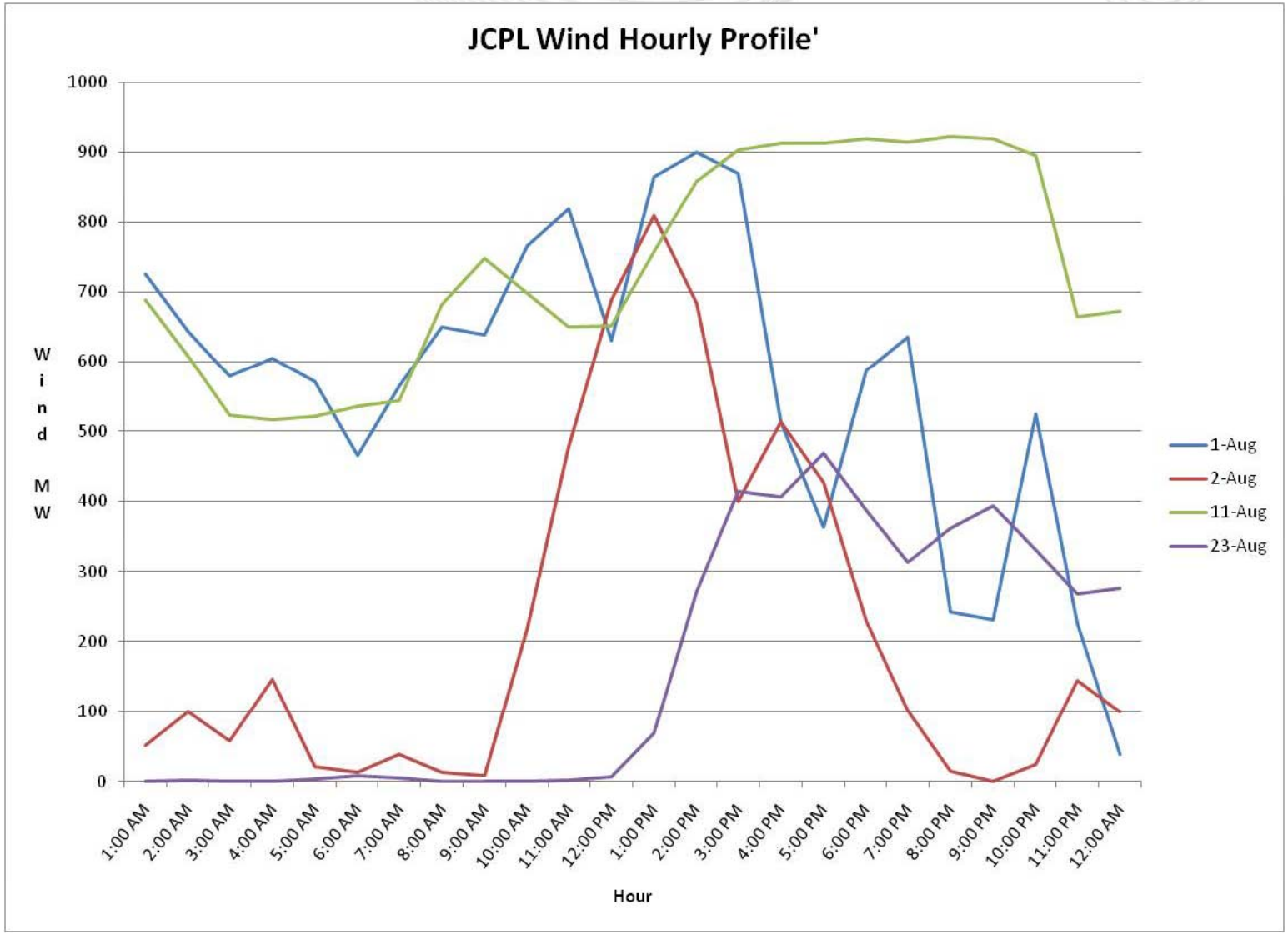


- Assumed four independent injection points

Wind Profile



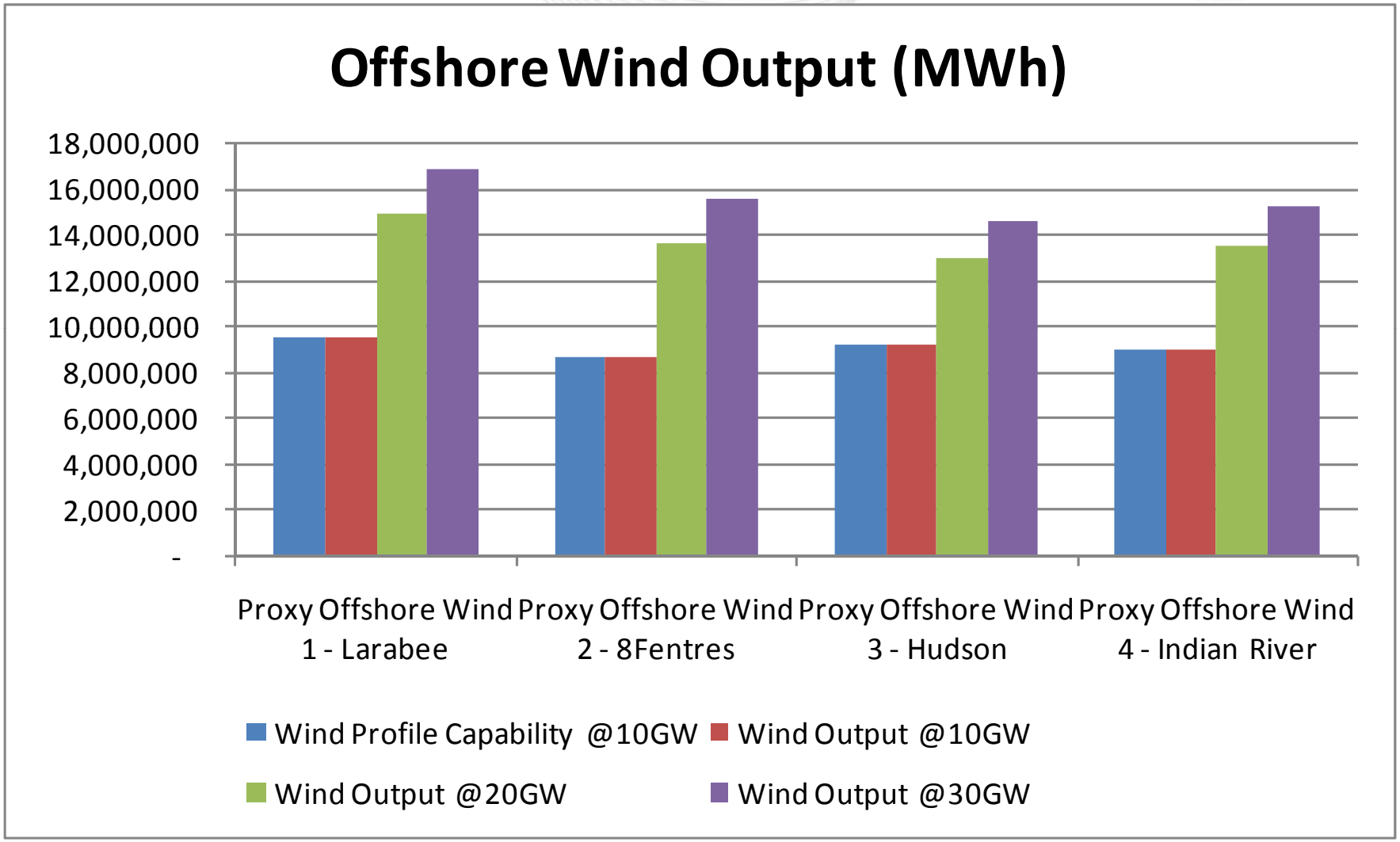
Wind Hourly Profile



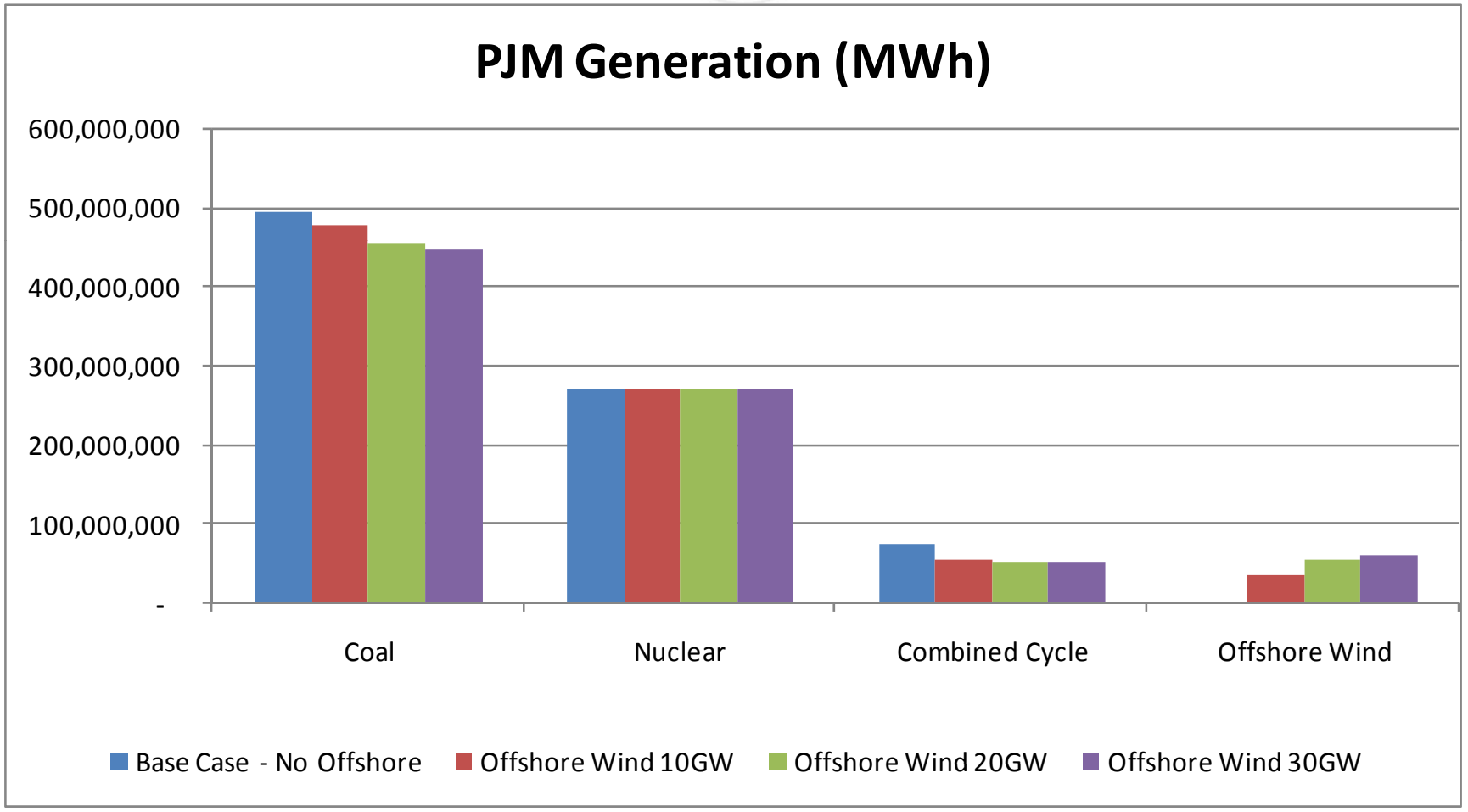
Capacity Factor

EWITS Code	EWITS Wind Site:13208	EWITS Wind Site:7142	EWITS Wind Site:4209
	Offshore Wind	Onshore Wind	Onshore Wind
Area	Jersey Central Power & Light	PPL Electric Utilities Corp.	Commonwealth Edison Co.
Installed Capacity (MW)	1,000	100	1,014
Max Annual (MW)	927	87	945
Average Annual (MW)	432	21	400
Energy Total Annual (MW)	3,799,028	184,630	3,511,423
Capacity Factor (MW)	43%	21%	39%
Capacity Credit (MW)	46%	9%	37%
Max August 4:00pm -5:00pm	921	27	945
Max June 4:00pm -5:00pm	922	50	937

Disclaimer: Capacity projections based on the EWITS data may be higher than average historical PJM data due to better technology and greater heights of wind turbines. Also, these projections are based on a single year. Long term performance may be different.


Offshore Wind Output (MWh)
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
-
Proxy Offshore Wind 1 - Larabee
Proxy Offshore Wind 2 - 8Fentres
Proxy Offshore Wind 3 - Hudson
Proxy Offshore Wind 4 - Indian River
Wind Profile Capability @10GW
Wind Output @10GW
Wind Output @20GW
Wind Output @30GW

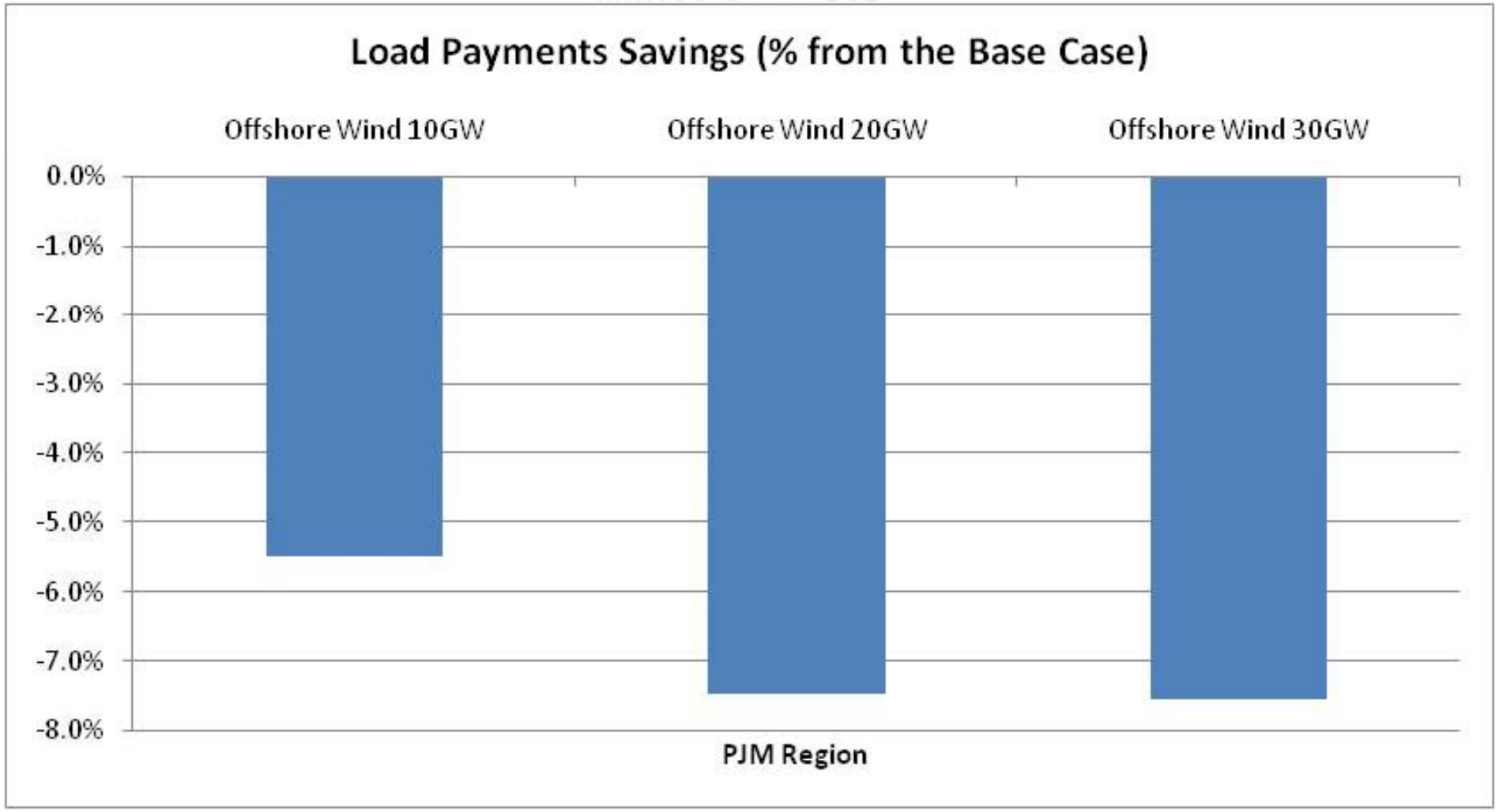
Generation Differences



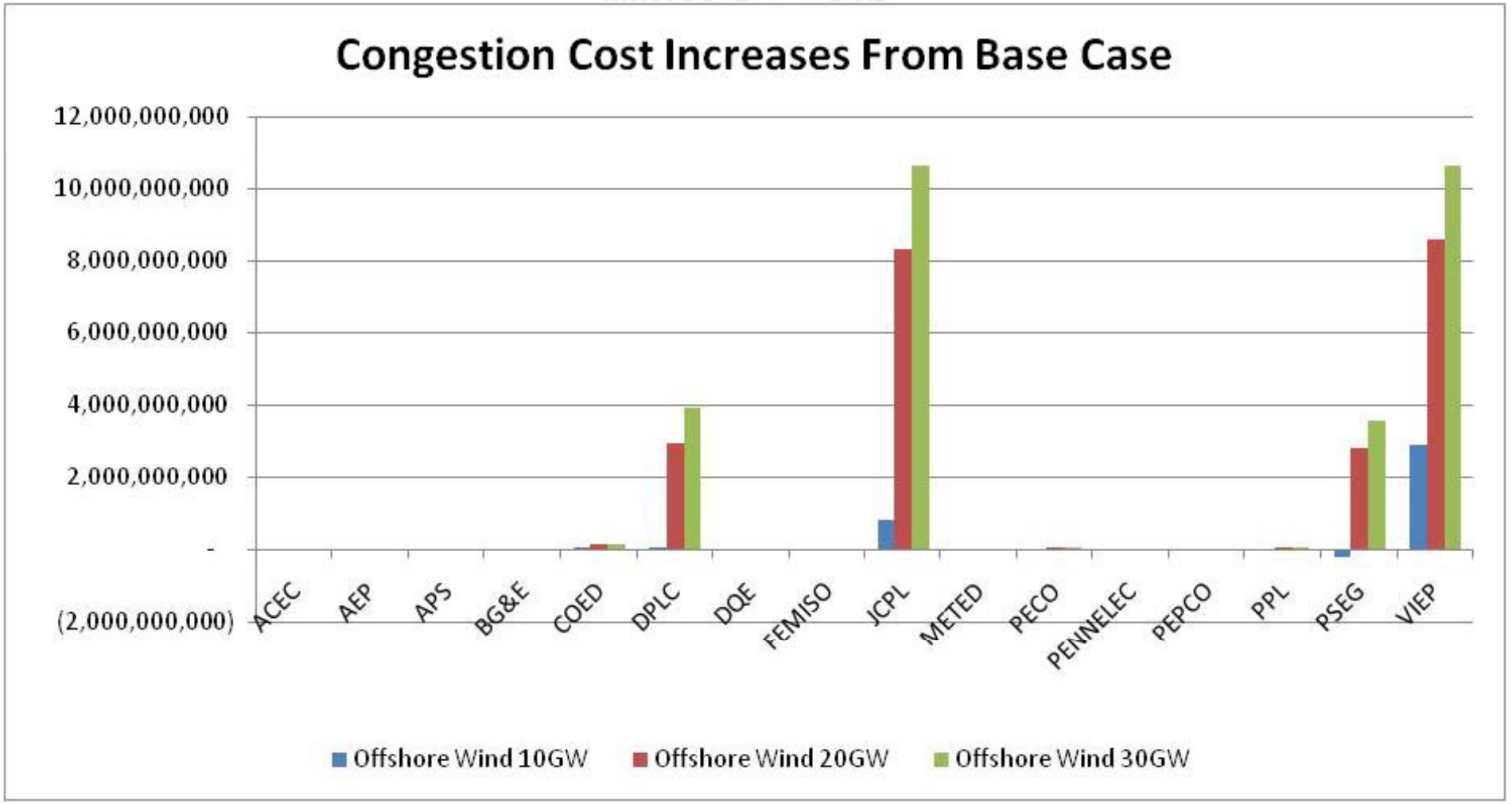
Generation Summary

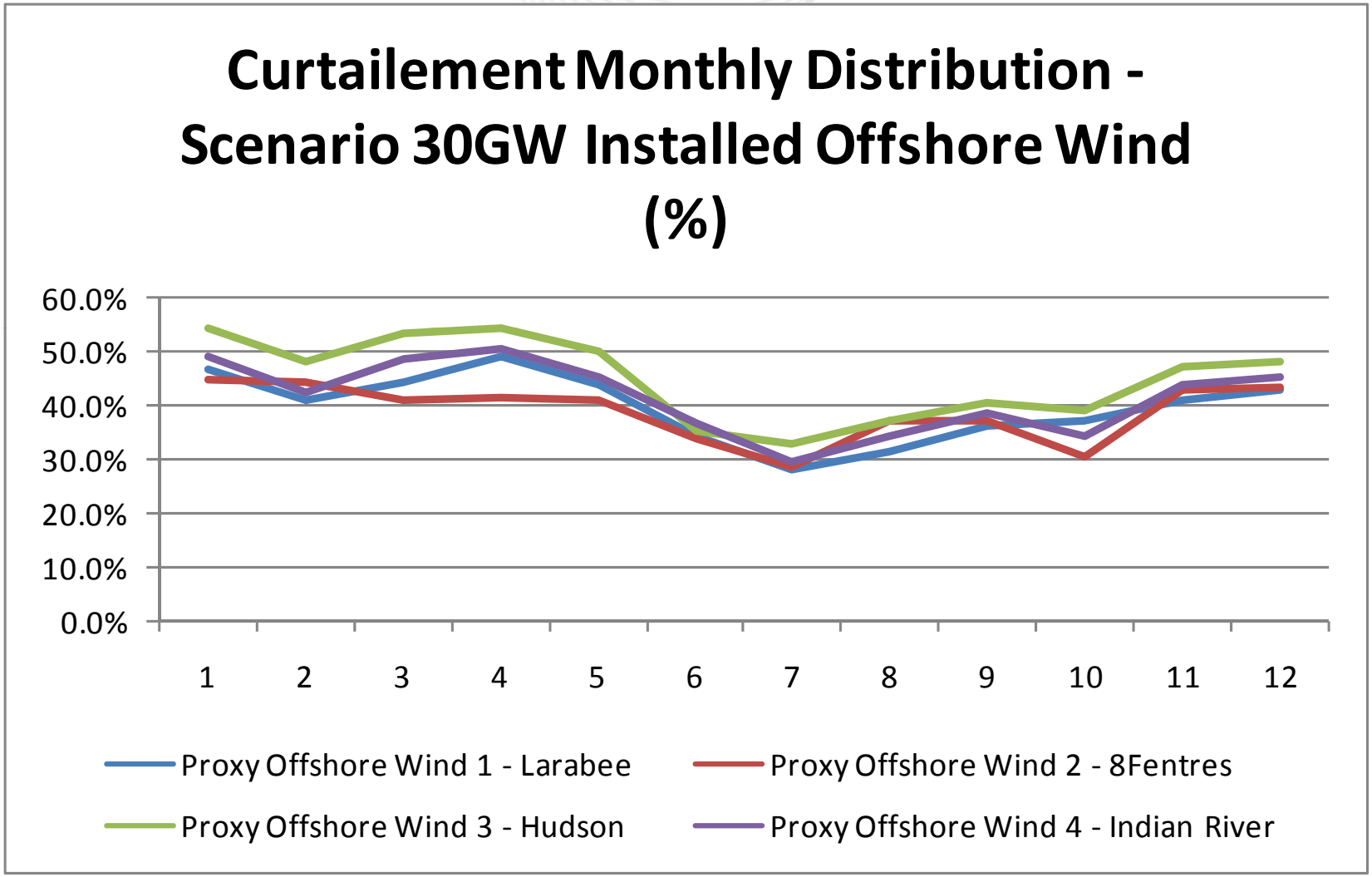
Total Generation Change (%)			
Generation (MW)	Coal	Nuclear	Combined Cycle
Offshore Wind 10GW - Base Case	-3.7%	0.0%	-25.1%
Offshore Wind 20GW - Base Case	-7.9%	0.0%	-27.7%
Offshore Wind 30GW - Base Case	-9.5%	0.0%	-29.7%

Load Payments Savings



Congestion Cost




Curtailement Monthly Distribution - Scenario 30GW Installed Offshore Wind (%)
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
1
2
3
4
5
6
7
8
9
10
11
12
Proxy Offshore Wind 1 - Larabee
Proxy Offshore Wind 2 - 8Fentres
Proxy Offshore Wind 3 - Hudson
Proxy Offshore Wind 4 - Indian River

Offshore Wind Conceptual Study Next Steps

- Further evaluate constrained facilities and potential upgrades
- Offshore grid to accommodate transfers between injection areas
- Additional reliability analysis
  - Validate monitored flowgates used in production cost simulations
  - NERC TPL-003
- Update topology in northern New Jersey

Email RTEP@pjm.com with any comments

Next Steps

Review Issues Tracking