Transmission Expansion Advisory Committee

April 14, 2010

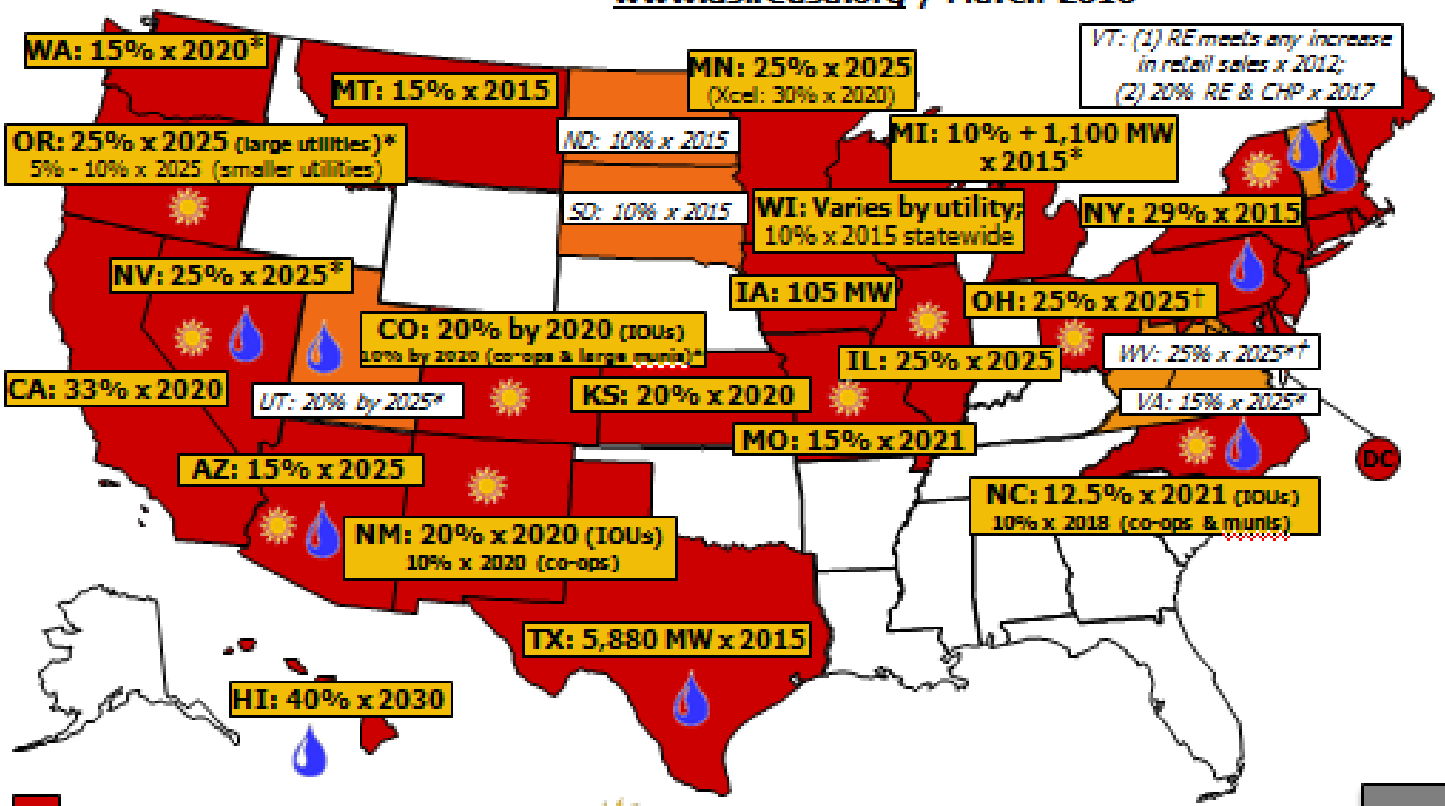
2010 RTEP Sensitivity Analysis Assumptions

Renewable Portfolio Standards

- Renewable portfolio standards by state
  - Typically a target percentage in a future year
- Forecast annual net energy (GWh) by transmission owner zone
  - Table E-1 of PJM Load Forecast Report
- State load allocation by TO zone

Renewable Portfolio Standards

www.dsireusa.org / March 2010



ME: 30% x 2000
New RE: 10% x 2017

NH: 23.8% x 2025

MA: 22.1% x 2020
New RE: 15% x 2020
(+1% annually thereafter)

RI: 16% x 2020

CT: 23% x 2020

PA: 18% x 2021†

NJ: 22.5% x 2021

MD: 20% x 2022

DE: 20% x 2020*

DC: 20% x 2020

State renewable portfolio standard

State renewable portfolio goal

Solar water heating eligible

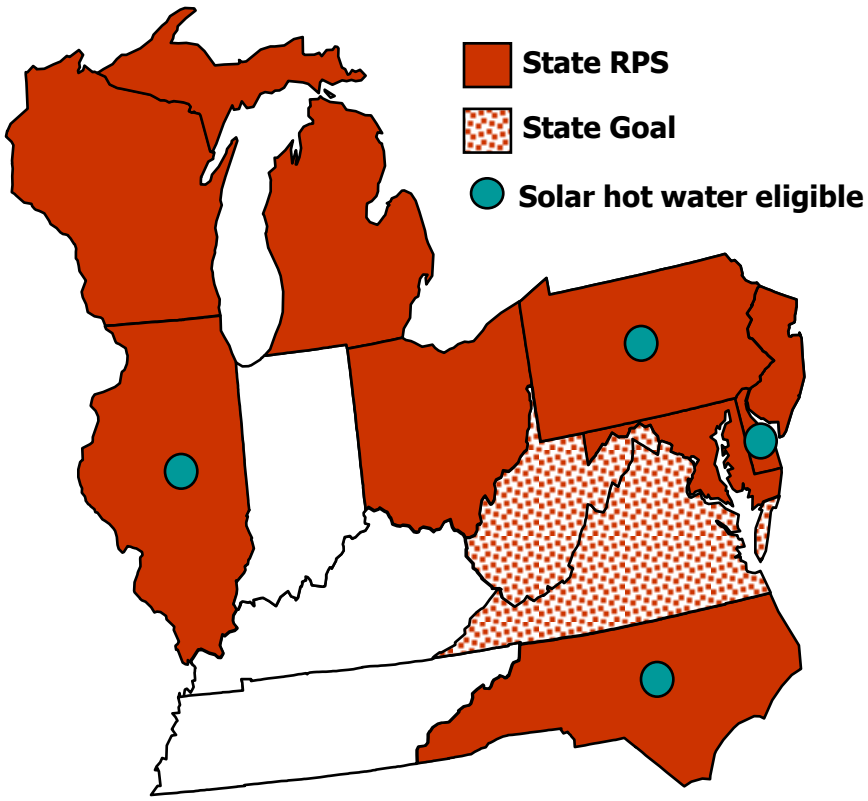
Minimum solar or customer-sited requirement

* Extra credit for solar or customer-sited renewables

† Includes non-renewable alternative resources

29 states + DC have an RPS
(6 states have goals)

State Renewable Portfolio Standards (RPS) require suppliers to utilize wind and other renewable resources to serve an increasing percentage of total demand.

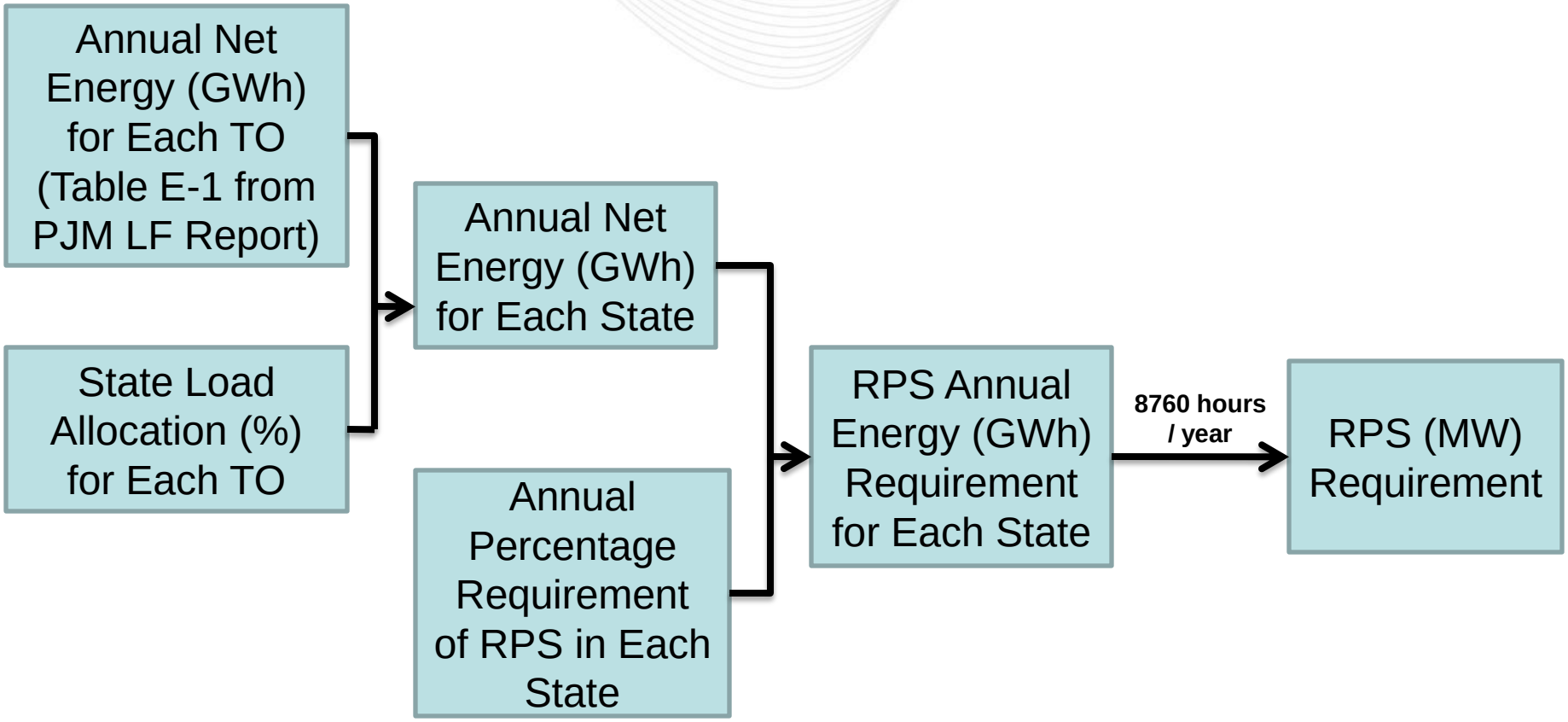


www.dsireusa.org / September 2009

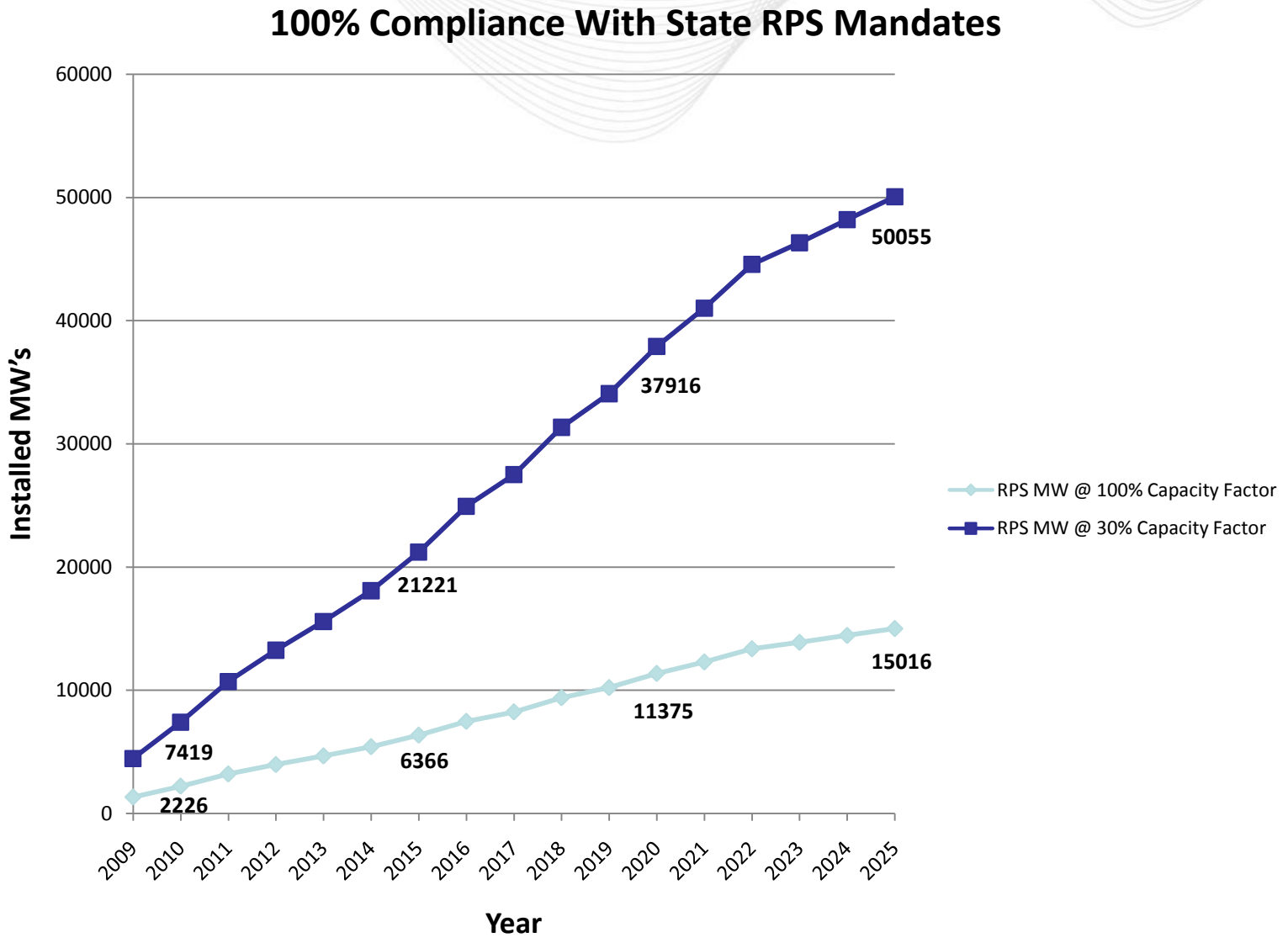
State RPS Targets:

- NJ: 22.5% by 2021
- MD: 20% by 2022
- DE: 20% by 2019
- DC: 20% by 2020
- PA: 18%** by 2020
- IL: 25% by 2025
- OH: 25%** by 2025
- NC: 12.5% by 2021 (IOUs)
  10% by 2018 (co-ops & munis)
- MI: 10% + 1,100 MW by 2015
- VA: 15% by 2025
- WV: 25%** by 2025

RPS Calculation Methodology



PJM RPS Mandates by Year



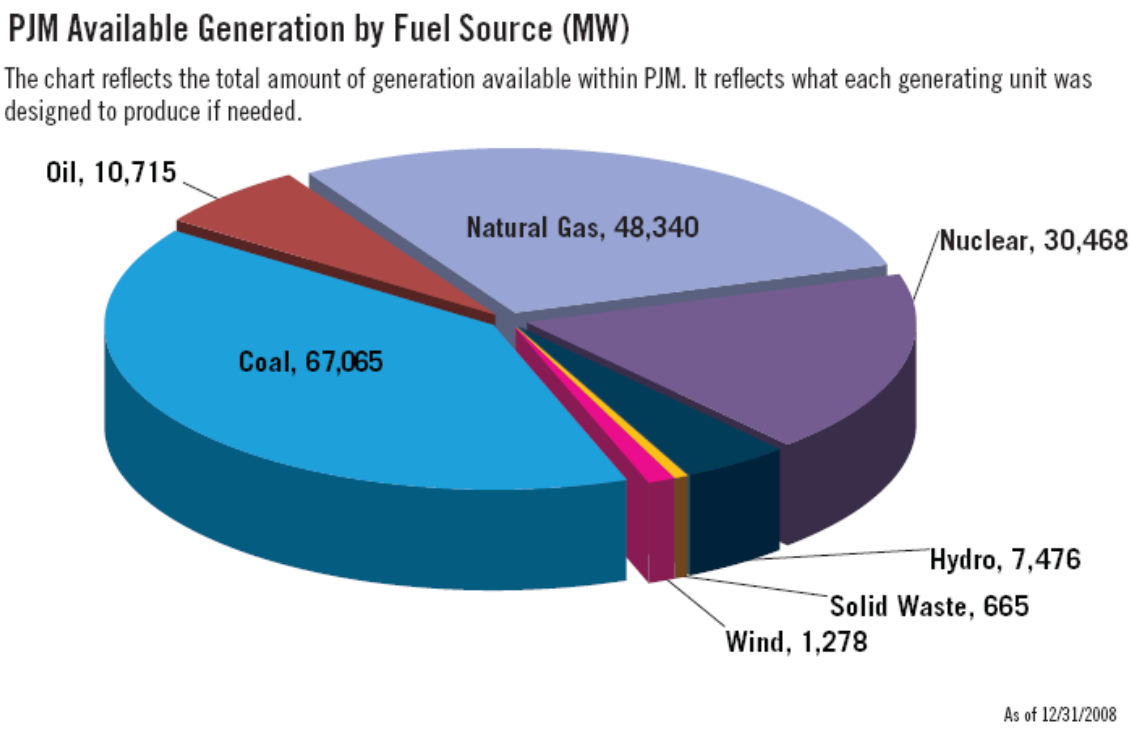
PJM Installed Capacity

Nameplate of Installed PJM Generation (2009)

	MW	Percent
Oil	10715	6%
Coal	67065	40%
Natural Gas	48340	29%
Nuclear	30468	18%
Hydro	7476	5%
Solid Waste	665	0%
Wind	1278	1%
	166007	100%

Nameplate of Renewable PJM Generation (2009)

	MW	Percent
Hydro	7476	5%
Solid Waste	665	0%
Wind	1278	1%
	9419	6%



PJM Renewable Energy Dashboard
http://www.pjm.com/about-pjm/newsroom/renewable-dashboard.aspx

Proposed Generation in PJM

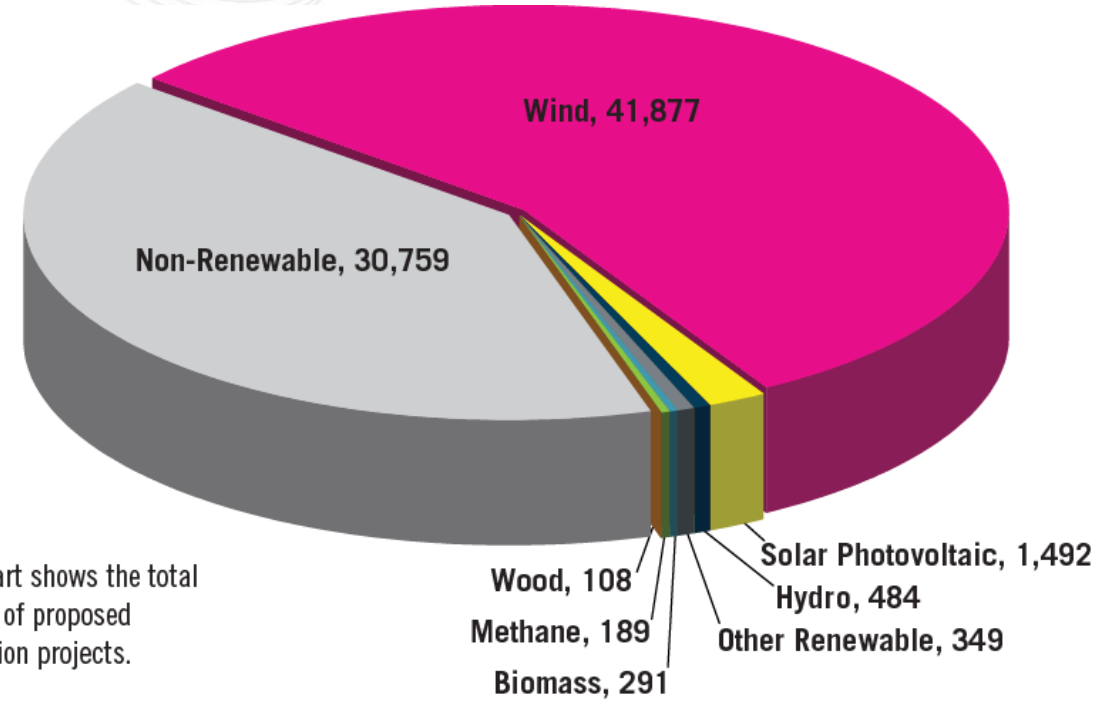
PJM Interconnection Queue

Renewable Requests:

44,790 MW
60% of total requests

Non-Renewable Requests:

30,759 MW
40% of total requests



This chart shows the total amount of proposed generation projects.

Data valid as of March 31, 2010

2009 Energy Production by Fuel Source

Table 3-36 PJM generation (By fuel source (GWh)): Calendar year 2009

		GWh	Percent
Coal		349,818.2	50.5%
Nuclear		249,392.3	36.0%
Gas		67,218.9	9.7%
	Natural Gas	65,848.2	9.5%
	Landfill Gas	1,368.5	0.2%
	Biomass Gas	2.2	0.0%
Hydroelectric		14,123.0	2.0%
Waste		5,664.7	0.8%
	Solid Waste	4,147.0	0.6%
	Miscellaneous	1,517.7	0.2%
Wind		5,489.7	0.8%
Oil		1,568.1	0.2%
	Heavy Oil	1,383.7	0.2%
	Light Oil	162.9	0.0%
	Diesel	14.4	0.0%
	Kerosene	7.1	0.0%
	Jet Oil	0.0	0.0%
Solar		3.5	0.0%
Battery		0.3	0.0%
Total		693,278.7	100.0%

2009 State of the Market Report
http://www.pjm.com/documents/reports/state-of-market-reports.aspx

Capacity Factors for Renewable Generation

Table 3-49 Peak and off-peak seasonal capacity factor, average wind generation, and PJM load, Calendar year 2009

		Winter	Spring	Summer	Fall	Annual
Peak	Capacity Factor	39.0%	31.6%	13.6%	25.0%	27.1%
	Average Wind Generation	810.0	638.7	282.0	592.5	577.5
	Average Load	90,361.8	77,109.7	91,520.8	77,362.0	84,148.4
Off-Peak	Capacity Factor	38.6%	31.8%	18.8%	27.6%	29.1%
	Average Wind Generation	797.6	642.3	388.8	657.9	622.0
	Average Load	78,247.0	63,339.0	70,548.1	62,493.6	68,588.6

2009 State of the Market Report
http://www.pjm.com/documents/reports/state-of-market-reports.aspx

PJM Interconnection Requests by Renewable Fuel Type

Table 2.8: PJM Interconnection Requests by Renewable Fuel Type

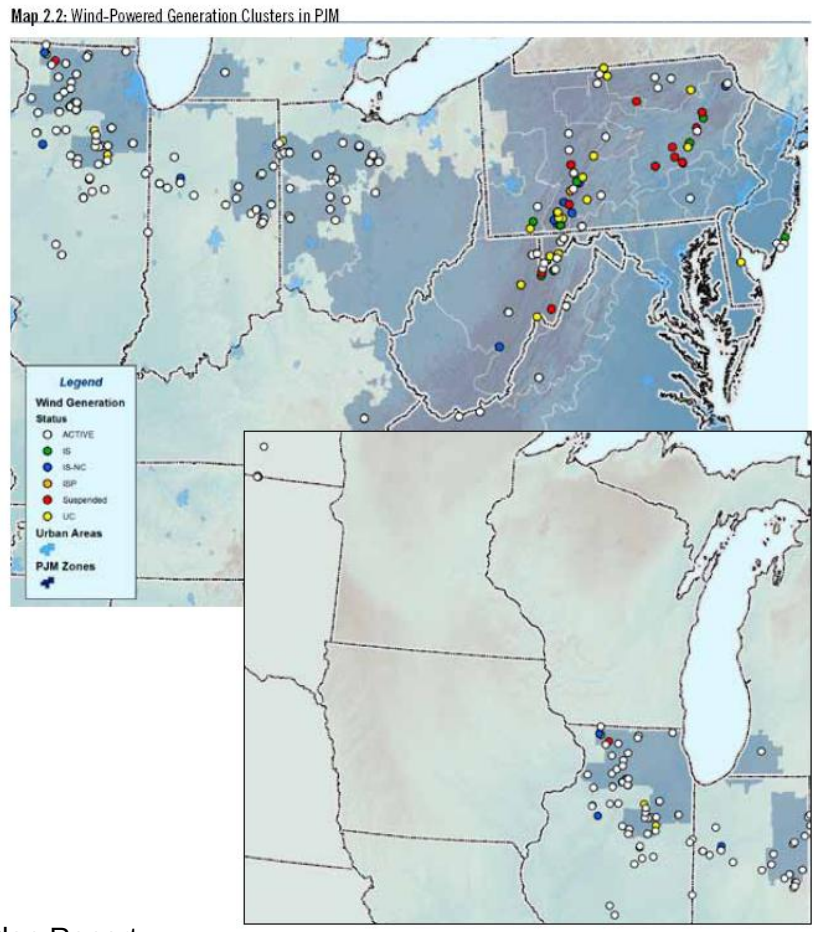
	Active		In Service		Suspended		Under Construction		Withdrawn		Total Sum of MWE	
	MW	# of projects	MW	# of projects	MW	# of projects	MW	# of projects	MW	# of projects	MW	# of projects
Biomass	246	9	124	6	198	3	82	3	56	4	705	25
Hydro	378	14	573	8			172	4	1,706	19	2,829	45
Methane	134	26	230	41	10	1	73	15	237	33	684	116
Solar	710	74	3	1			103	6	57	8	873	89
Wind	38,227	160	2,717	31	1,287	15	2,900	25	16,724	135	61,854	366
Wood	158	2	4	1					50	1	2,124	4
Grand Total	**39,853**	**285**	**3,651**	**88**	**1,495**	**19**	**3,330**	**53**	**18,830**	**200**	**69,069**	**645**

More than 38,000 MW (about 98% of renewable interconnection requests) of active PJM queue requests are wind generation interconnection requests

2009 Regional Transmission Expansion Plan Report
http://www.pjm.com/documents/reports/rtep-report.aspx

Wind-Powered Generation Clusters in PJM

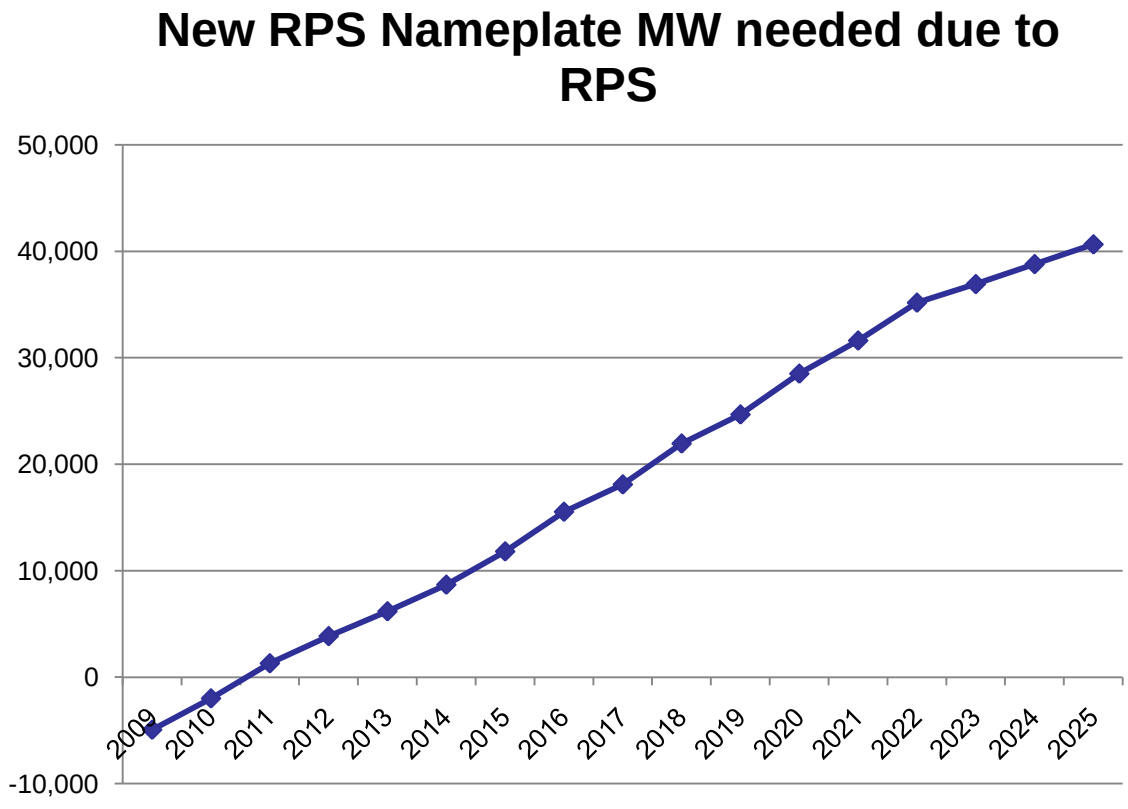
Wind-powered projects have emerged in several clusters across PJM including a cluster off the Atlantic shore of the Delmarva Peninsula

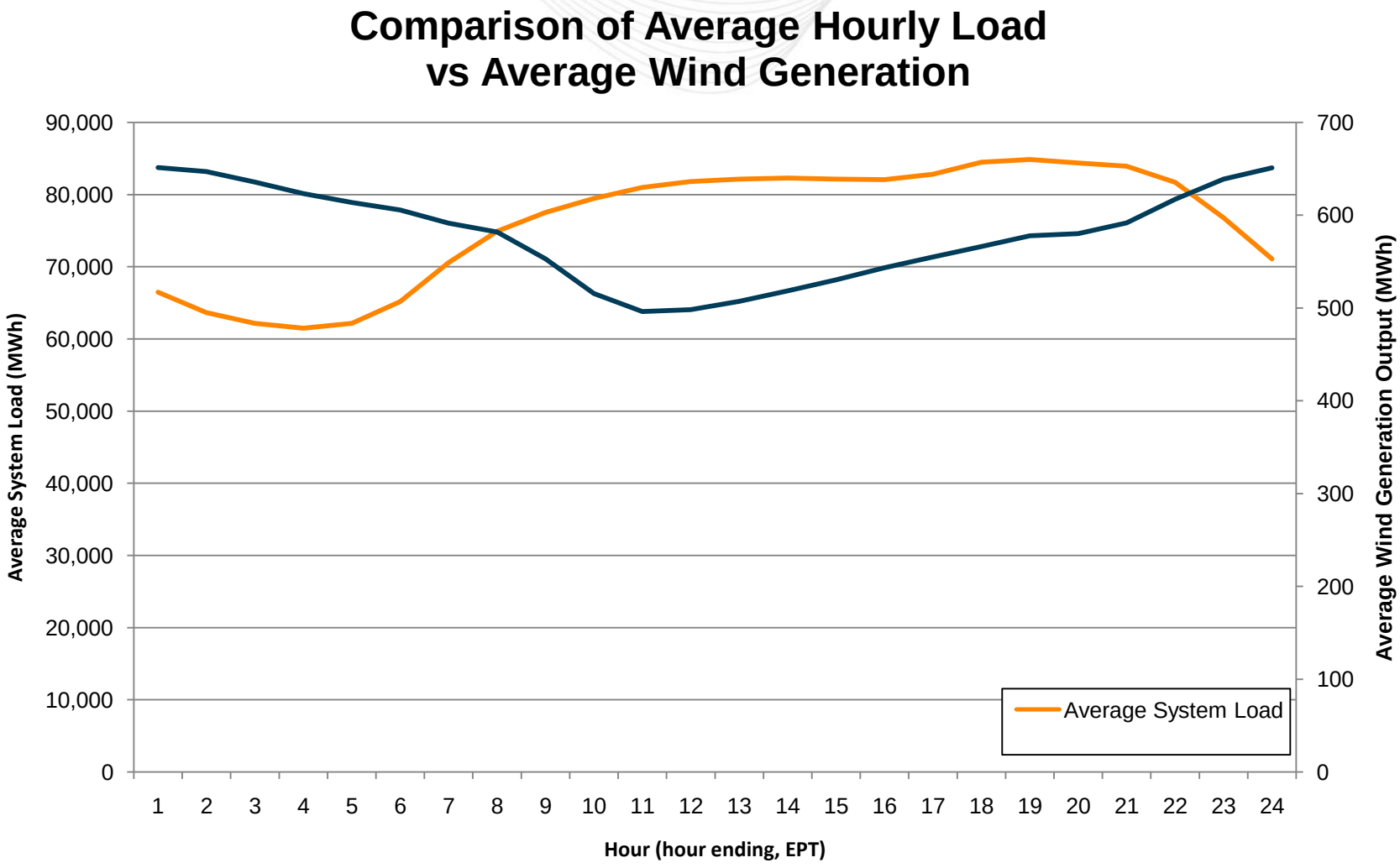


2009 Regional Transmission Expansion Plan Report
http://www.pjm.com/documents/reports/rtep-report.aspx

New Renewable Capacity Required due to RPS

Year	New RPS MW needed assuming a 30% CF for existing and future renewable generation
2009	-4,944
2010	**-2,000**
2011	1,295
2012	3,845
2013	6,175
2014	8,675
2015	**11,802**
2016	15,525
2017	18,093
2018	21,932
2019	24,664
2020	**28,497**
2021	31,602
2022	35,161
2023	36,904
2024	38,779
2025	**40,636**

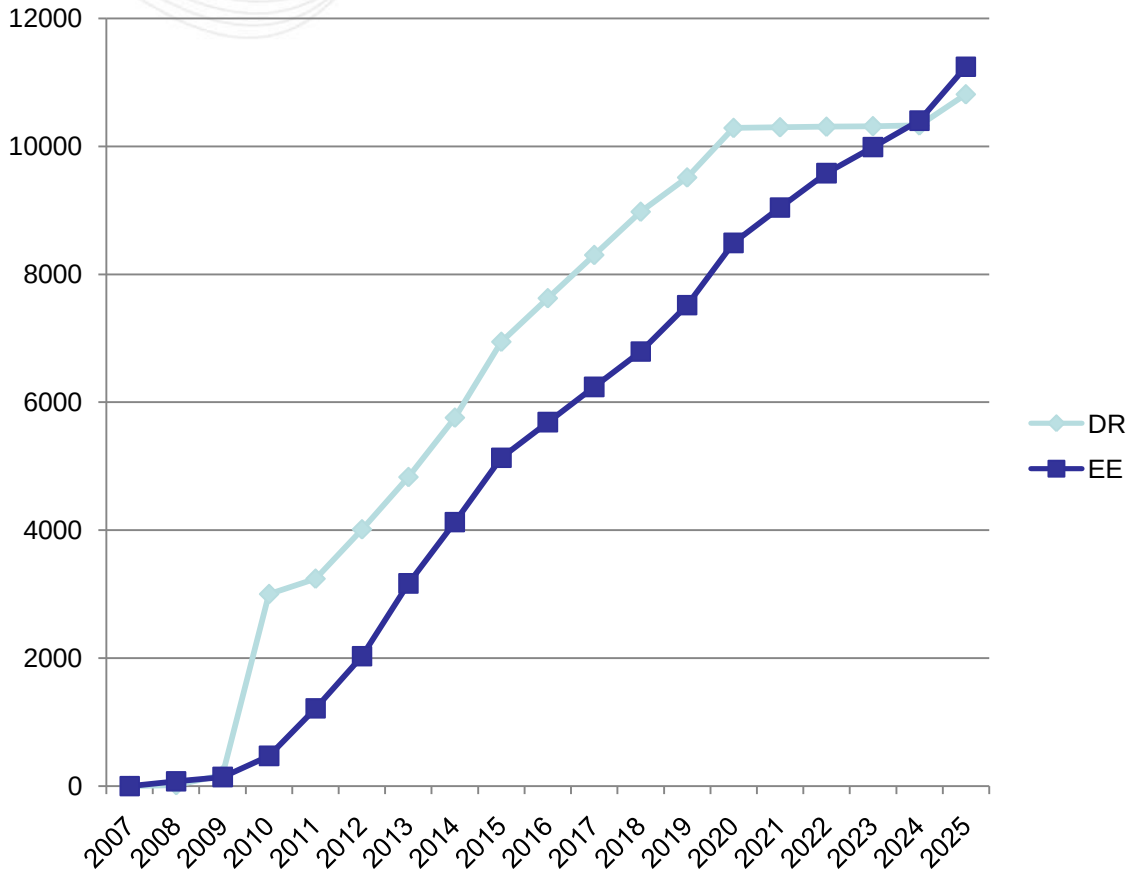



Comparison of Average Hourly Load
vs Average Wind Generation
Average System Load (MWh)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Average Wind Generation Output (MWh)
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour (hour ending, EPT)
Average System Load

Demand Response and Energy Efficiency

PJM DR and EE Mandates (MW) by Year

Year	DR	EE
2007	0	0
2008	14	76
2009	173	141
2010	3001	471
2011	3241	1216
2012	4012	2030
2013	4829	3167
2014	5757	4127
2015	6943	5131
2016	7624	5688
2017	8300	6238
2018	8976	6792
2019	9511	7516
2020	10285	8489
2021	10295	9042
2022	10304	9579
2023	10312	9986
2024	10324	10399
2025	10811	11241



At Risk Generation

- "At Risk" Generation
  - Generation that has not cleared in recent RPM auctions
  - Generation in a carbon constrained world
  - Revenue adequacy at risk generation
    - MMU SOM report identified 11,250 MW of generation
  - Generation that has been in-service for 40 years or more
- Increasing DR, EE, and renewable resources will increase the amount of other capacity resources that do not clear in markets

Analysis Scenarios

- Add renewable generation to meet RPS assuming existing PJM generation remains
- Add renewable generation to meet RPS assuming RPS displaces at-risk generation
- Add renewable generation to meet RPS + DR + EE mandates assuming RPS displaces at-risk generation

Sensitivity Studies – Analytic Approach

- Analysis will focus on EHV facilities
- Each sensitivity will “bias” flows on the EHV as compared to the base system
- Similar implication for reactive analysis
- Studies will focus on long term impact
- Generator Deliverability Test for RPS scenario
- Utilize d-fax to determine the impact of the sensitivity on EHV facilities

Preliminary 2010 RTEP Analysis

- Analysis performed using the latest 2015 Summer RTEP Case

- Modeling Assumptions
  - Three backbone Transmission projects not modeled in the base case
    - PATH
    - MAPP
    - Branchburg – Hudson – Roseland

- Preliminary Load Deliverability Thermal and Voltage Analysis performed on selected LDA's
  - MAAC
  - SWMAAC
  - PEPCO
  - Dominion
  - EMAAC
- Focused on EHV facilities

- Preliminary Thermal Analysis Results for EHV facilities
  - Generation Deliverability and Load Deliverability

From Bus	To Bus	100% Year
Lexington	Dooms	2017
Mt. Storm	T157 Tap	2017
T157 Tap	Doubs	2018
Pruntytown	Mount Storm	2019
Jacks Mountain	Juniata #1	2020
Greenland Gap	Meadow Brook	2022
Bath County	Valley	2022
Jacks Mountain	Juniata #2	2022
Mt. Storm	Greenland Gap	2023
Keystone	Jacks Mountain	2025
Mt. Storm	Meadow Brook	2025
Harrison	Pruntytown	2025

- Preliminary Reactive Analysis Results of 2015
  - Preliminary results show reactive deficiencies in 2015
  - MAAC is voltage limited with multiple contingencies not converging
  - Other areas voltage limited as well but with fewer contingencies causing problems

- These results are preliminary
- Staff still needs to go through the analysis to validate the results
- Additional details will be provided at subsequent meetings

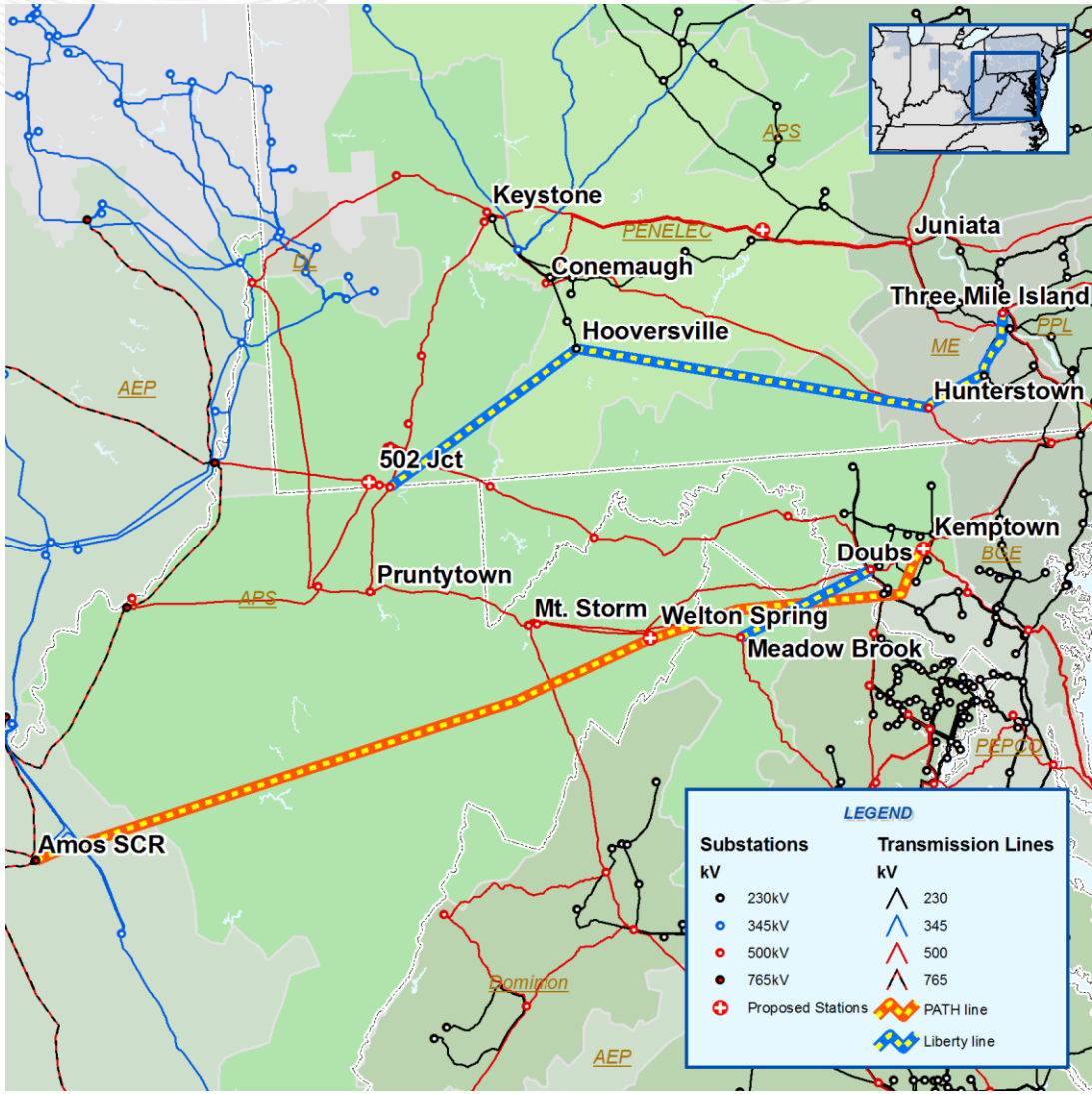
Backbone Alternatives

Backbone Alternatives

- Stakeholders have suggested various alternatives to both the MAPP and PATH projects
- Following slides describe the alternatives suggested
- Initial analytic focus will be on determining the magnitude and timing of violations

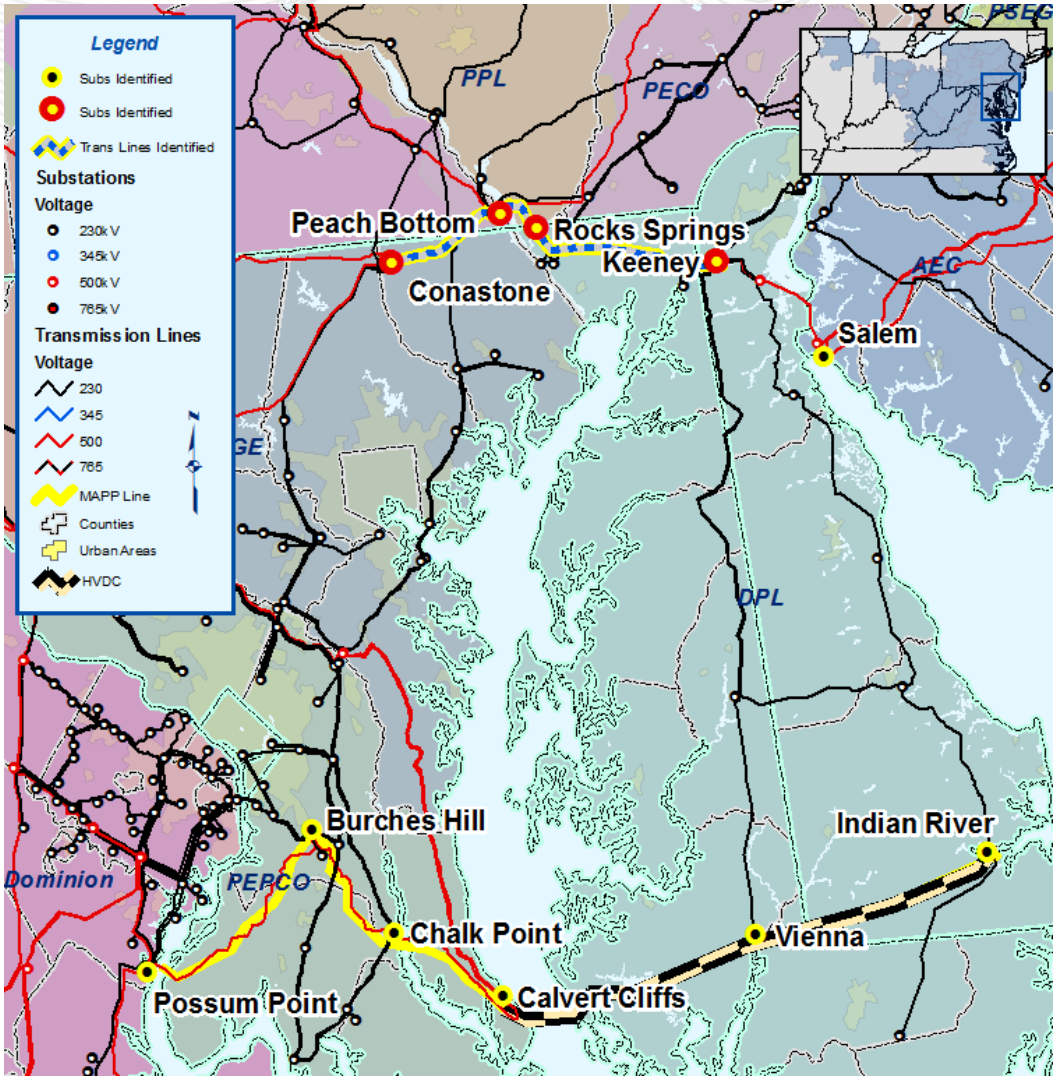
PATH Alternatives

- Original Project Amos – Bedington – Kemptown
- Project later modified to Amos – Welton Spring – Kemptown
- Alternatives evaluated as part of the 2007 RTEP
- Use of HVDC evaluated as part of the 2009 RTEP
- LS Power alternative (Liberty)
- Reconductoring and reactive reinforcement
- 2010 RTEP will evaluate additional alternatives



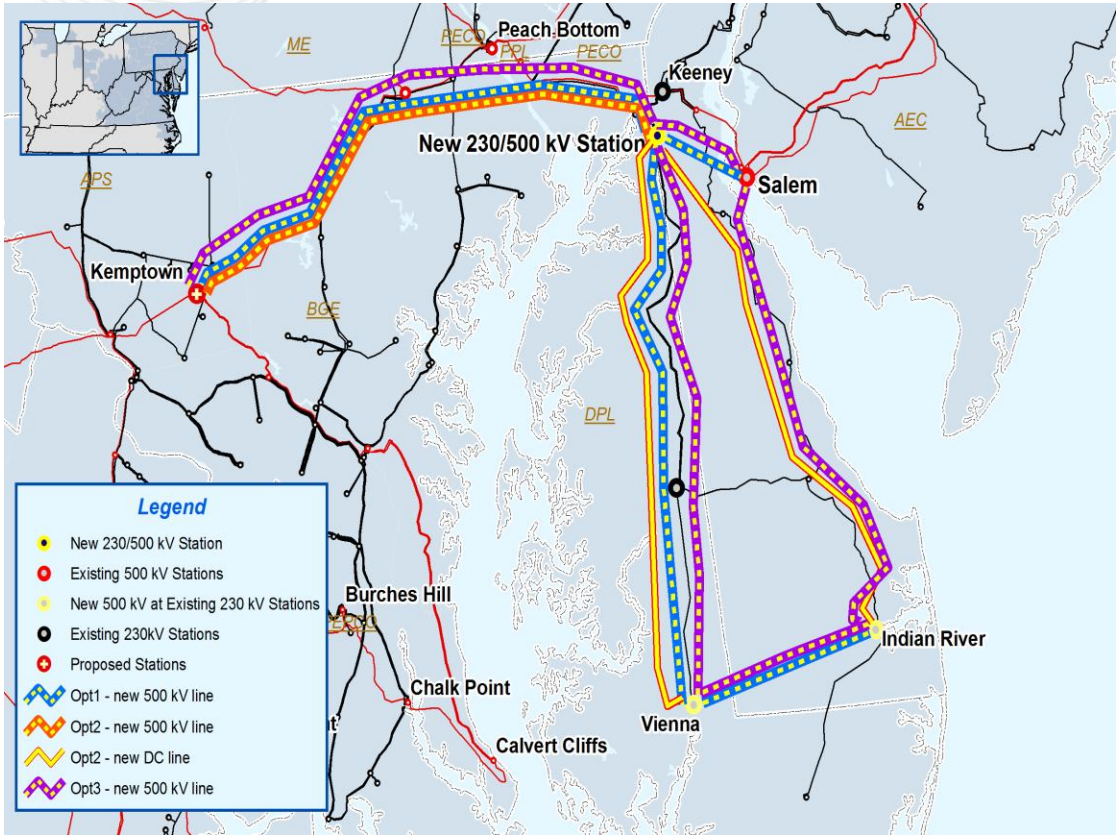
MAPP Alternatives

- Approved MAPP project consists of a Possum Point to Calvert Cliffs 500 kV AC with DC links from Calvert Cliffs to Vienna and Indian River
- As part of the 2008 RTEP PJM evaluated a Conastone – Peach Bottom – Keeney (C-PB-K) 500 kV alternative



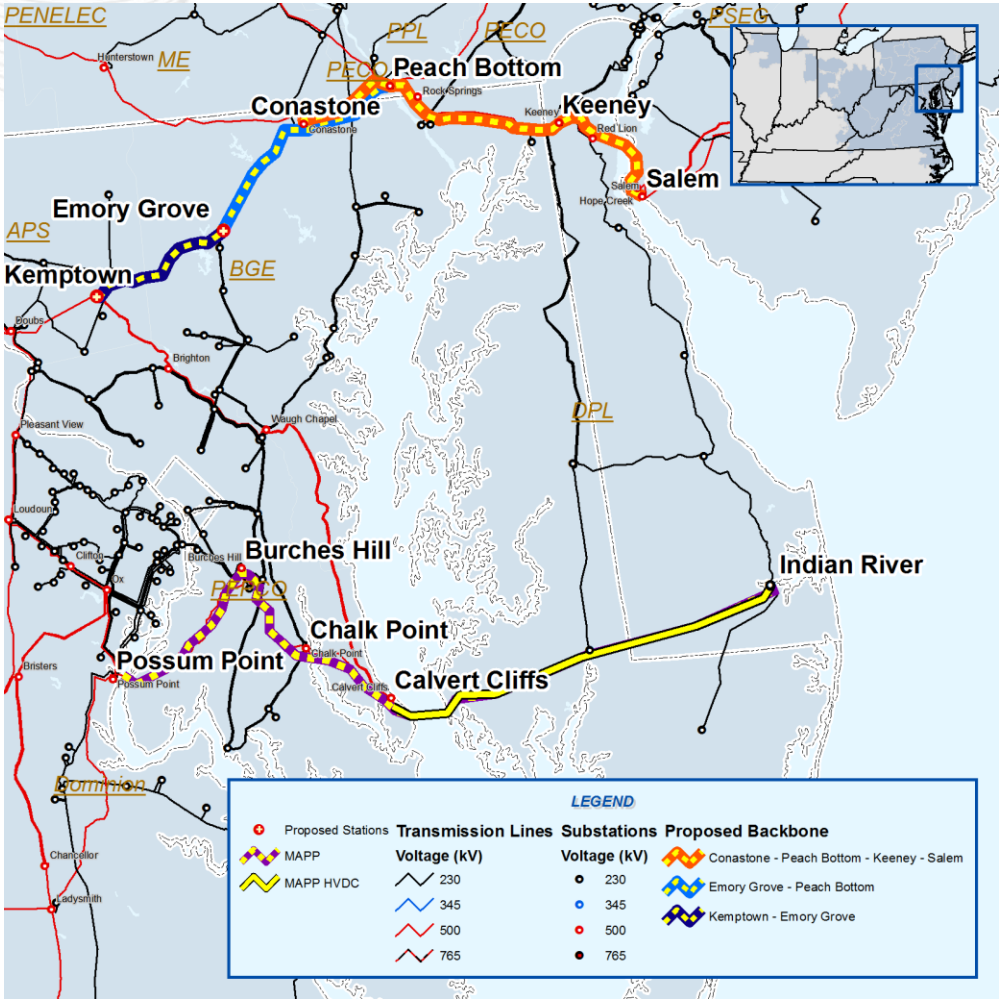
PHI Alternatives

- PHI alternatives developed in response to interveners in the CPCN proceeding
- Request was to develop and evaluate an “apples to apples” alternative
- Alternatives provide a northern route with new transmission down the Delmarva peninsula
- Alternatives include a new “Keeney South” substation to avoid maximum credible disturbance concerns



Recent MAPP Alternatives

- BG&E proposal for a new 500 kV line from Kemptown to Peach Bottom with 500/230 kV substation at Emory Grove (near Northwest)
- Maryland OPC and DNR suggested (C-PB-K) be reevaluated
- PSE&G suggest (C-PB-K) be extended to Salem
- 2010 RTEP will evaluate additional alternatives



Baseline Reliability Update

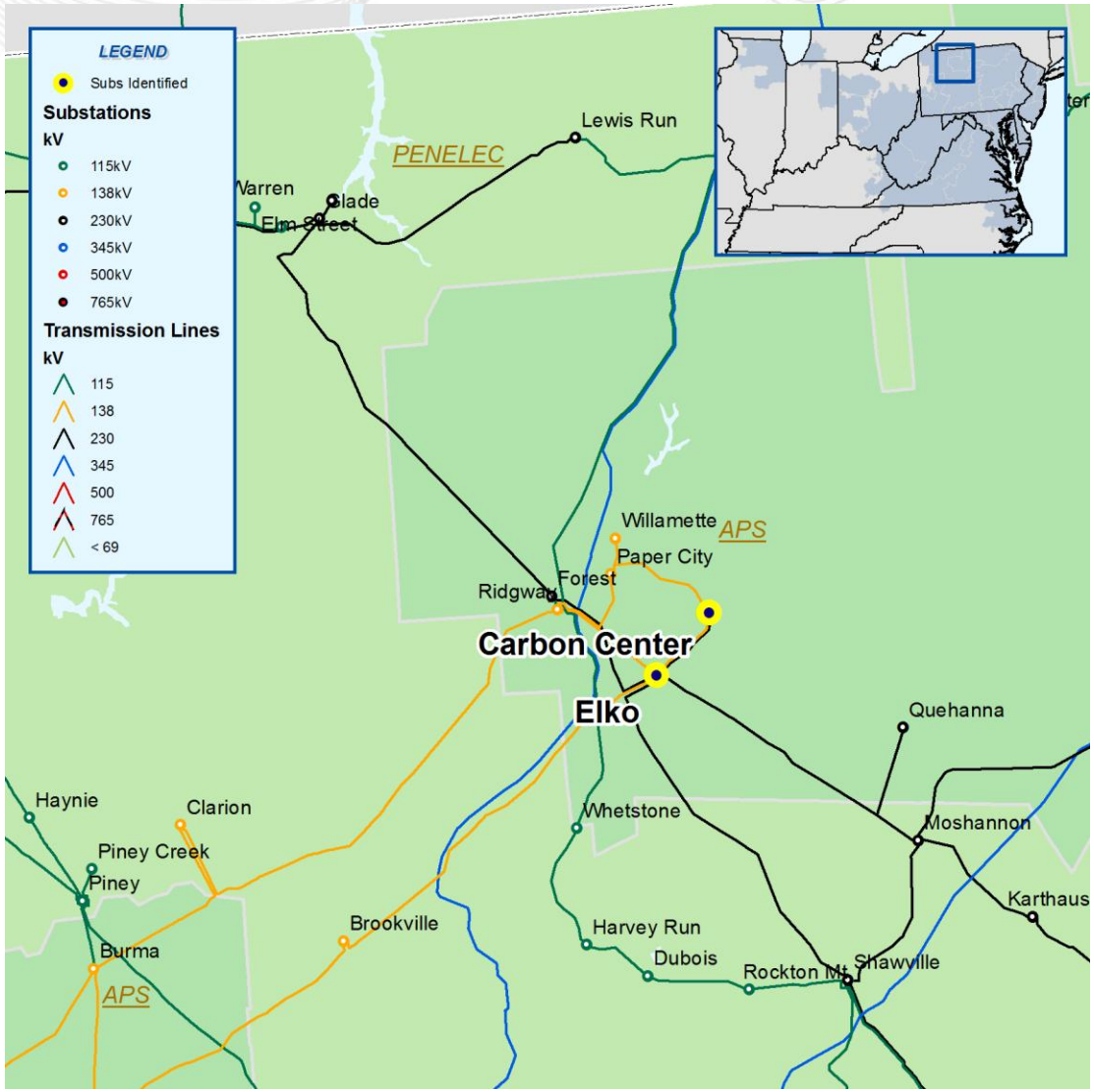
APS Transmission Zone

- Base case voltage study: Voltage collapse for several stuck breaker contingencies at Carbon Center or Elko

- Proposed Solution (b1173):
  - Remove 138 kV from Carbon Center
  - Install 230 kV four breaker ring bus at Carbon Center
  - Convert Carbon Center Jct-Carbon Center from 138 kV to 230 kV
  - Construct Bear Run Substation with 230/138 kV transformer
  - Convert Carbon Center Jct-Bear Run from 138 kV to 230 kV
  - Extend 230 kV bus at Elko
  - Relocate the Elko-Carbon Center Jct. 138 kV line to the 230 kV bus and energize at 230 kV

- Estimated Project Cost: $15M

- Expected IS Date: 6/01/2014



Supplemental Upgrades

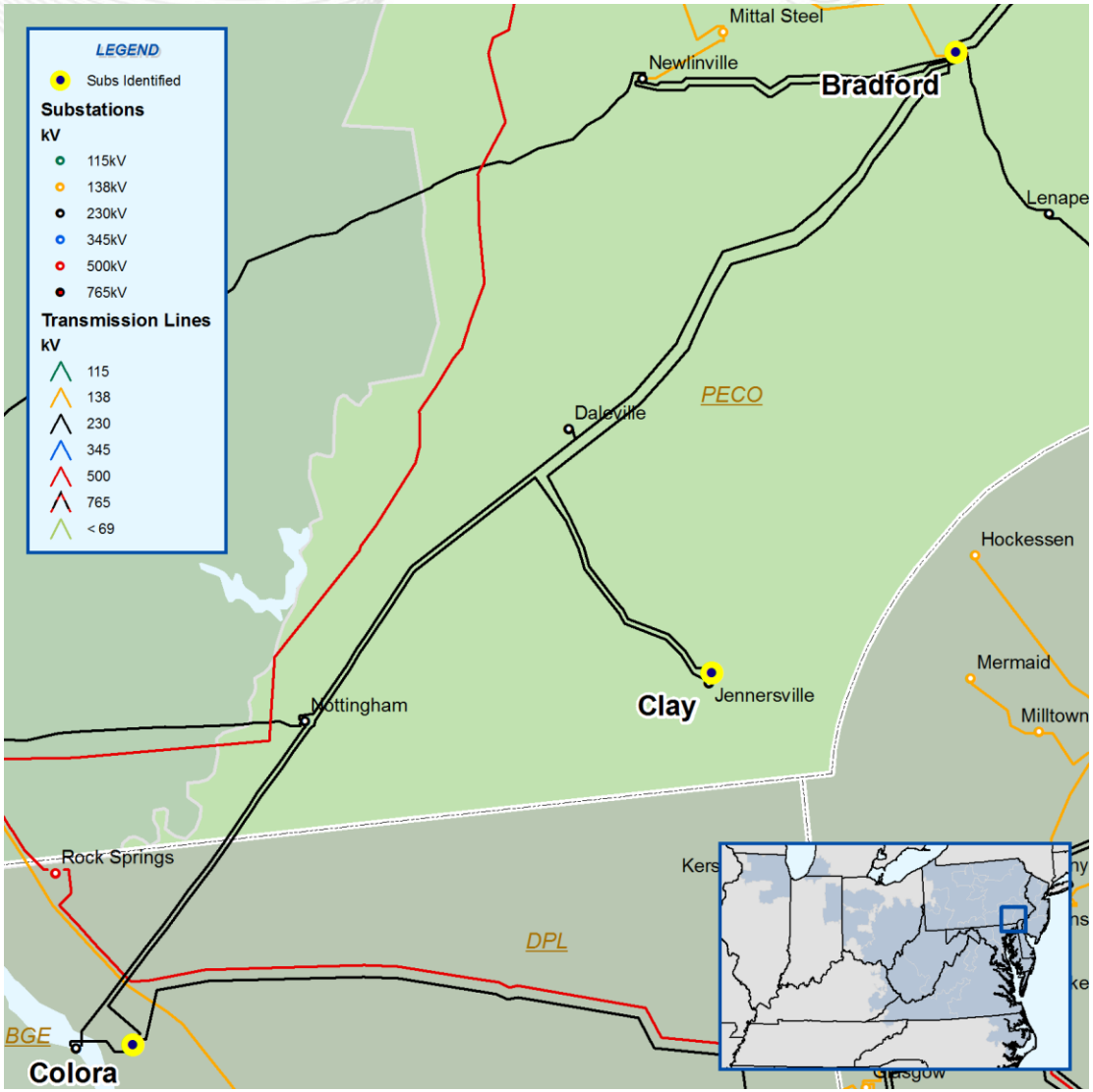
PECO Transmission Zone

- To improve reliability around Clay substation. Clay 230 kV substation is presently supplied by a radial tap from the 220-01 circuit which extends between Bradford and Colora substations.
- Proposed Solution:

  Build a second source to Clay. The new circuit will be parallel to the radial circuit from Clay to the tap point (S0178).
- Estimated Project Cost:

  $21.0 M
- Expected IS Date:

  6/1/2013



- Maryland Case 9149 PJM Testimony Follow-up

- Stakeholder Sensitivity Suggestions
  - American Electric Power
  - Allegheny Power
  - PEPCO Holdings Inc
  - Delmarva Peninsula Planning Association
  - Maryland PSC

Issues Tracking

Issues Tracking

- Track TEAC issues
- Simple offline solution
- Review at each TEAC meeting

Owner	Requestor	Issue Identifier	Issue Title	Issue Description	Issue Status	Stakeholder Body	Date Created
PJM	Stakeholder A	2009-0023	Correction to March 2010 TEAC Presentation	Potential correction needed on slide 8 of the March 2010 TEAC presentation	Evaluation In Progress	TEAC	3/14/2010
PJM	Stakeholder B	2009-0017	Request for Clarification of Result from January 2010 TEAC Presentation	Requested that PJM verify the driver of a reliability upgrade in the January 2010 TEAC presentation	Evaluation In Progress	TEAC	1/15/2010
PJM	Stakeholder C	2009-0048	Request Study Assumptions	Requested for additional information from PJM regarding the study assumptions that were used in the December 2009 TEAC reliability analysis update	Closed	TEAC	12/19/2009

- Continue 2015 Analysis
  - Initial efforts will focus on identifying criteria violations
    - Load deliverability
    - Generation Deliverability
    - Common Mode Violations
    - N-1-1
  - Alternative Evaluations
- Sensitivity Studies
  - Develop / refine analytic methods for sensitivity studies
  - Analysis

Comments or Questions?