Transmission Expansion Advisory Committee

EPA Clean Power Plan Update

July 21, 2015

PJM's Role

PJM has been asked to assess potential impacts of the EPA Clean Power Plan proposal on PJM states

PJM's analysis is directed toward both potential economic and reliability impacts

As an RTO, PJM:

- Maintains neutrality on CO_2 policy
- Acts as an independent source of information on CO_2 policy implications
- Does not forecast market outcomes but rather models outcomes based on specific sets of assumptions

Background

- OPSI requested PJM to study some of the economic impacts of the proposed Clean Power Plan under a variety of scenarios

- PJM supplemented the OPSI request with additional scenarios related to different assumptions regarding natural gas prices, available EE, renewable resources and natural gas resources

Background

- PJM studied the economic impact of 16 different scenarios designed to encompass a range of possible states of the industry heading into CPP compliance
  - Scenarios included mass-based regional compliance scenarios, state-by-state mass-based compliance scenarios and an emission rate based regional compliance scenario

- Outputs from the study included information about generator net energy market revenues and an assessment of generation at risk for retirement

Background

- Varying degrees of “at-risk” resources were identified through these economic analyses

- Results of the economic studies were reviewed at the January 7 TEAC meeting.
  - http://www.pjm.com/~/media/committees-groups/committees/teac/20150107/20150107-pjm-economic-and-reliability-analysis-of-the-epas-cpp.ashx
  - http://www.pjm.com/~/media/committees-groups/committees/teac/20150107/20150107-pjm-economic-analysis-of-generation-retirement-potential.ashx

Reliability Analyses

Reliability Study Objective

To assess the transmission system impact of generation that may be “at-risk” for retirement due to the EPA’s proposed Clean Power Plan

- “At-risk” means that generating resources are anticipated to face varying financial challenges from the proposed rule; it does not mean that resources will necessarily retire.
- Varying degrees of “at-risk” generation must look at how much additional revenue will be needed from the capacity market for the resource to go forward.

At-Risk Reliability Study

- Using the results from the economic analysis, studies were developed of three levels of at-risk generation:
  - 6 GW
  - 16 GW
  - 32 GW

Background

- Transmission system reliability studies were designed to identify broad regional impacts that may require long lead time projects to address.
  - 230 kV and above facilities were monitored.
  - Conductor limits were utilized to identify potential issues
    - Limiting terminal facilities were ignored as these can generally be addressed within a relatively short period of time.
- Reliability studies were done for a single year using various assumptions (i.e. A snapshot).
  - Timing of changes in assumptions will impact reliability needs.

Background

- No attempt was made to try to identify specific local impacts of the retirement of any of the “at-risk” units.

- We know from our experience with the recent MATS related deactivations that there will be local impacts to specific unit deactivations in addition to the broad impacts that we will discuss today.

Background

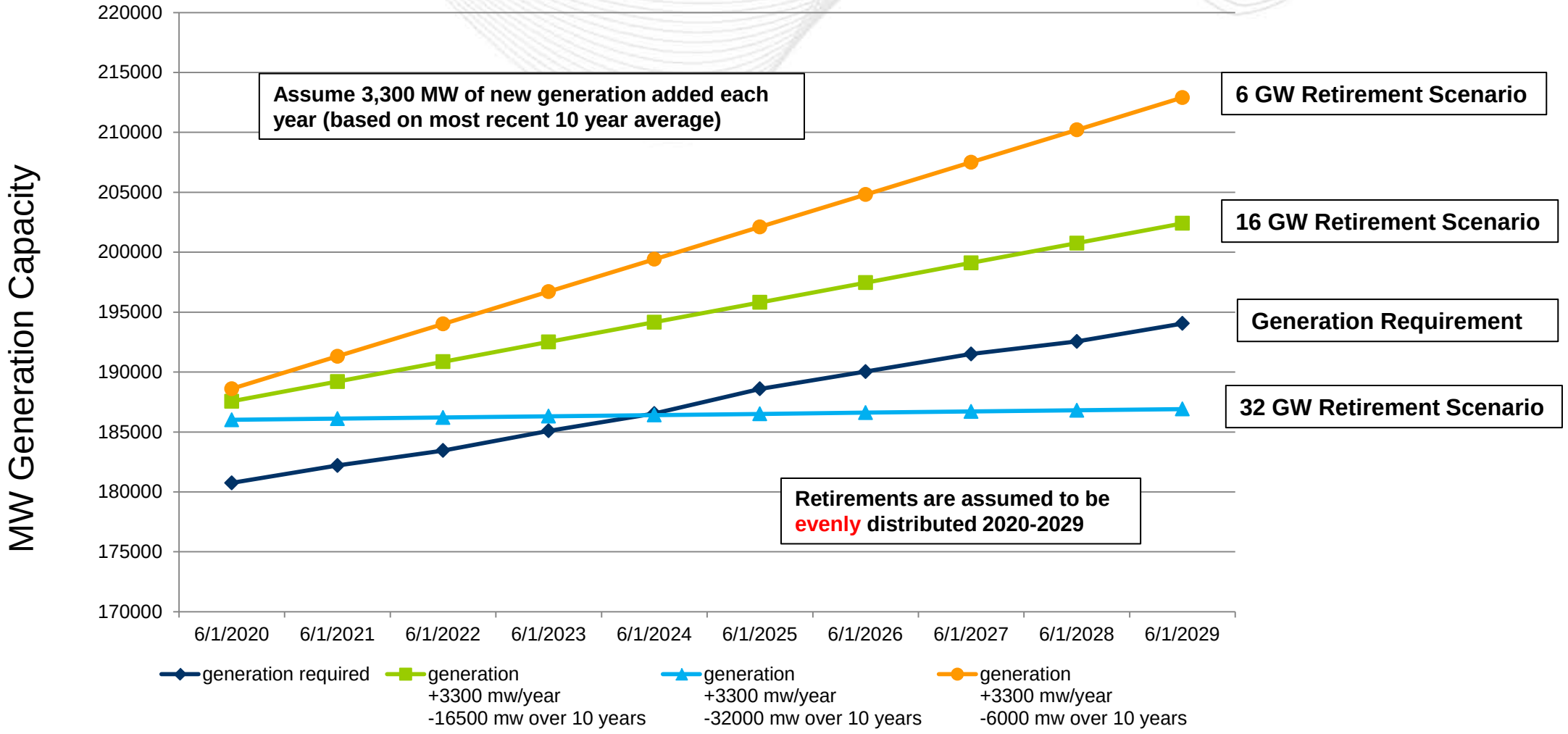
- Results of the reliability analyses are impacted by a number of factors including:
  - Timing of the retirement of “at-risk” generation
  - In-service date of new generation that will be required
  - Location of new resources
  - Type of new resources

- The reliability analysis thus far has focused on resource adequacy, transmission adequacy and potential transmission thermal and voltage violations that could occur under various scenarios.

Overall Resource Adequacy

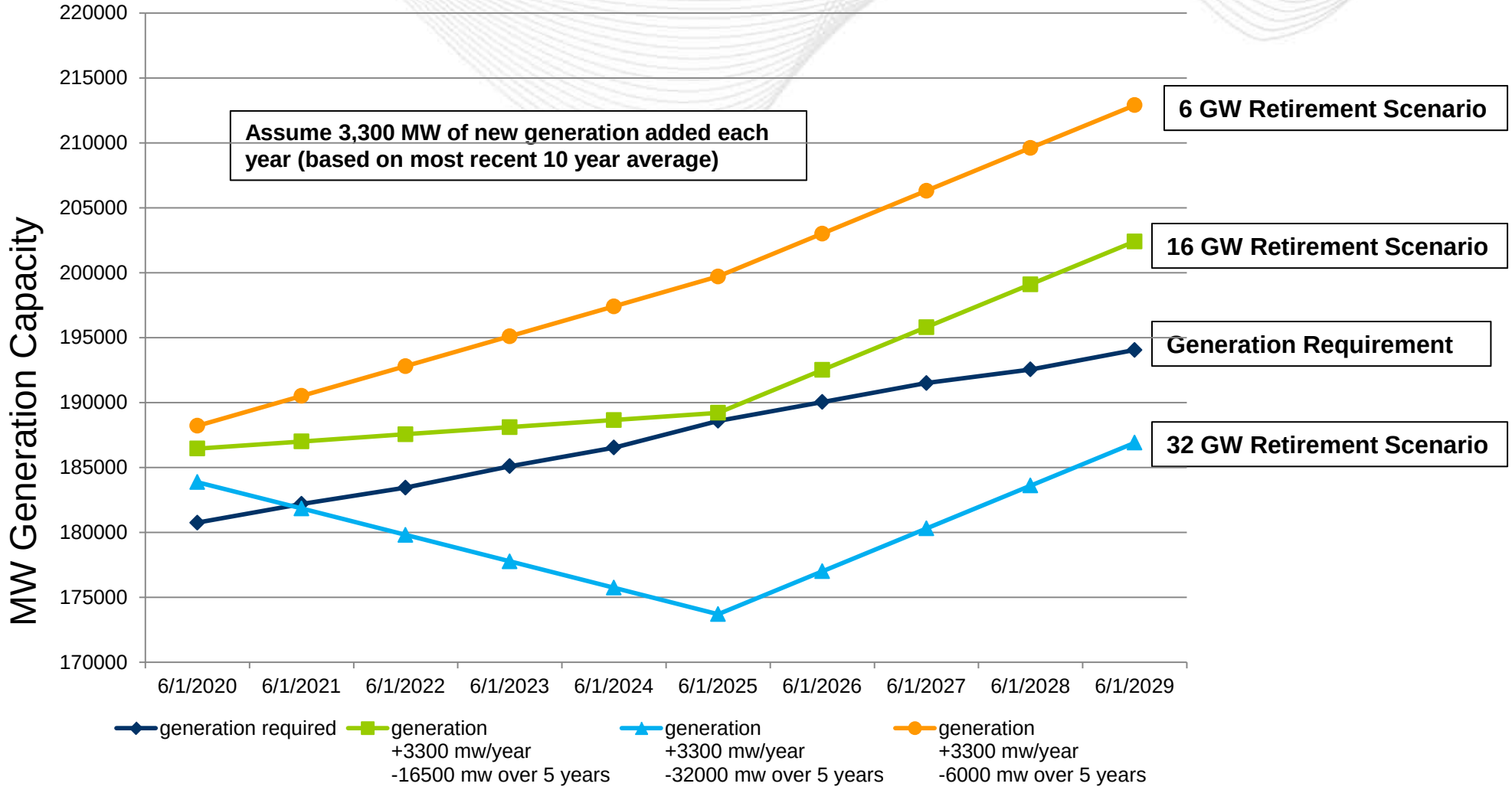
System Requirements vs. Available Resources

(Evenly Distributed Retirements over 10 years)



System Requirements vs. Available Resources

(Evenly Distributed Retirements over first 5 years)



Transmission Adequacy

111(d) At-Risk Scenario Study - Assumptions

- Three at-risk levels: 6 GW, 16 GW and 32 GW
- 2022 Summer Peak case
- 7 scenarios including a low reserve scenario, and three scenarios that meet state Renewable Portfolio Standards (RPS) targets for renewable energy and energy efficiency
  - State standards include annual energy targets for renewable energy such as wind and also Energy Efficiency (EE)

111(d) At-Risk Scenario Study - Assumptions

- FSA generation needed to satisfy load and interchange.
- In addition to the FSA generation, additional generation needed to be added for some of the scenarios.
- Firm injections from queued merchant transmission projects were included in some scenarios.
- For some scenarios, gas generation was added to the model adjacent to at-risk generation locations that were in close proximity to gas pipelines.

CPP Scenario Definitions

- CPP Scenarios
  - Assume replacement by natural gas and reserve margin restored
    - **S1** – 6 GW deactivation scenario
    - **S2** – 16 GW deactivation scenario
    - **S3** – 32 GW deactivation scenario
  - Assume replacement by natural gas and lower reserve margin
    - **S4** – 32 GW deactivation scenario
  - Assume state Renewable Portfolio Standards met
    - **S5** – 16 GW deactivation scenario
    - **S6** – 32 GW deactivation scenario
    - **S7** – 32 GW deactivation scenario + shale gas considerations

CPP At-Risk Scenario Study - Assumptions

Generation Capacity & Load Modeled For Each Scenario

Scenario	S1	S2	S3	S4	S5	S6	S7
At Risk Generation	6 GW	16 GW	32 GW	32 GW	16 GW	32 GW	32 GW
External Generation (MW)	4,802	4,207	7,709	7,709	3,593	7,709	7,709
From 2019 RTEP Case	5,000	5,000	5,000	5,000	5,000	5,000	5,000
At Risk Generation	198	1,407	2,219	2,219	1,407	2,219	2,219
Additional MTX FTIRs	0	0	3,700	3,700	0	3,700	3,700
Additional Gas Generation	0	614	1,228	1,228	0	1,228	1,228
Internal Generation (MW)	183,855	184,449	180,948	175,871	184,080	173,614	173,614
Existing + ISA Generation	184,112	184,112	184,112	184,112	184,112	184,112	184,112
FSA Generation	5,680	12,075	12,075	12,075	12,075	12,075	12,075
At Risk Generation	5,937	14,979	29,871	29,871	14,979	29,871	29,871
Additional Gas Generation	0	3,241	14,632	9,555	0	4,426	4,426*
Additional Renewable Generation	0	0	0	0	2,872	2,872	2,872
Load (MW)	171,217	171,217	171,217	171,217	171,217	171,217	171,217
LM+EE (MW)	13,320	13,320	13,320	13,320	20,654	20,654	20,654
From 2014 Forecast	13,320	13,320	13,320	13,320	13,320	13,320	13,320
Additional EE	0	0	0	0	7,334	7,334	7,334
							0
Reserves	18%	18%	18%	15%	22%	18%	18%

* For Scenario 7 the additional gas generation came from shale gas regions in western Pa. and W.V.

111(d) At-Risk Scenario Studies

- Base case: 2022 summer peak
- Identify potential issues on 230 kV and above facilities
- Reliability tests:
  - Generation Deliverability
  - Common Mode Outage
  - Load Deliverability of select areas based on location of at-risk generation
- Monitor all PJM monitored facilities (includes all Bulk Electric System (BES) - 100 kV facilities and above)
- Conductor ratings were used where available.

111(d) At-Risk Scenario Study – Load Deliverability

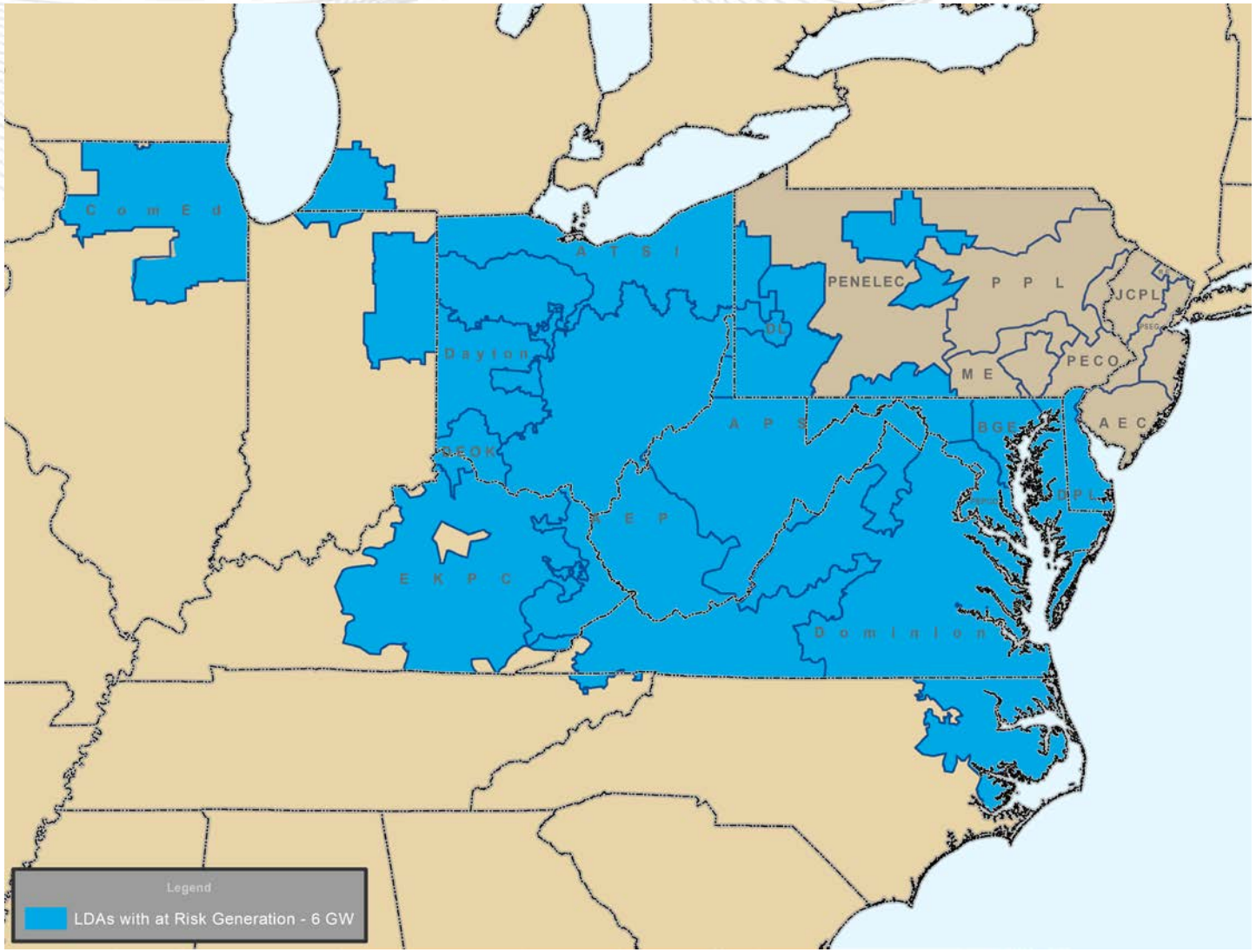
- 17 Locational Deliverability Areas (LDAs) were selected (out of 27 possible) based on the magnitude of at-risk generation in those LDAs

LDAs Examined For Each Scenario

	S1	S2	S3	S4	S5	S6	S7
LDA	6 GW	16 GW	32 GW	32 GW	16 GW	32 GW	32 GW
BGE	x	x	x	x	x	x	x
DPL	x	x	x	x	x	x	x
DPL S	x	x	x	x	x	x	x
DAY	x	x	x	x	x	x	x
DVP	x	x	x	x	x	x	x
AEP	x	x	x	x	x	x	x
EKPC	x	x	x	x	x	x	x
FE		x	x	x	x	x	x
CE		x	x	x	x	x	x
DEOK		x	x	x	x	x	x
SWMAAC	x	x	x	x	x	x	x
PJM W	x	x	x	x	x	x	x
AE			x	x		x	x
PL			x	x		x	x
PENELEC			x	x		x	x
WMAAC			x	x		x	x
MAAC			x	x		x	x

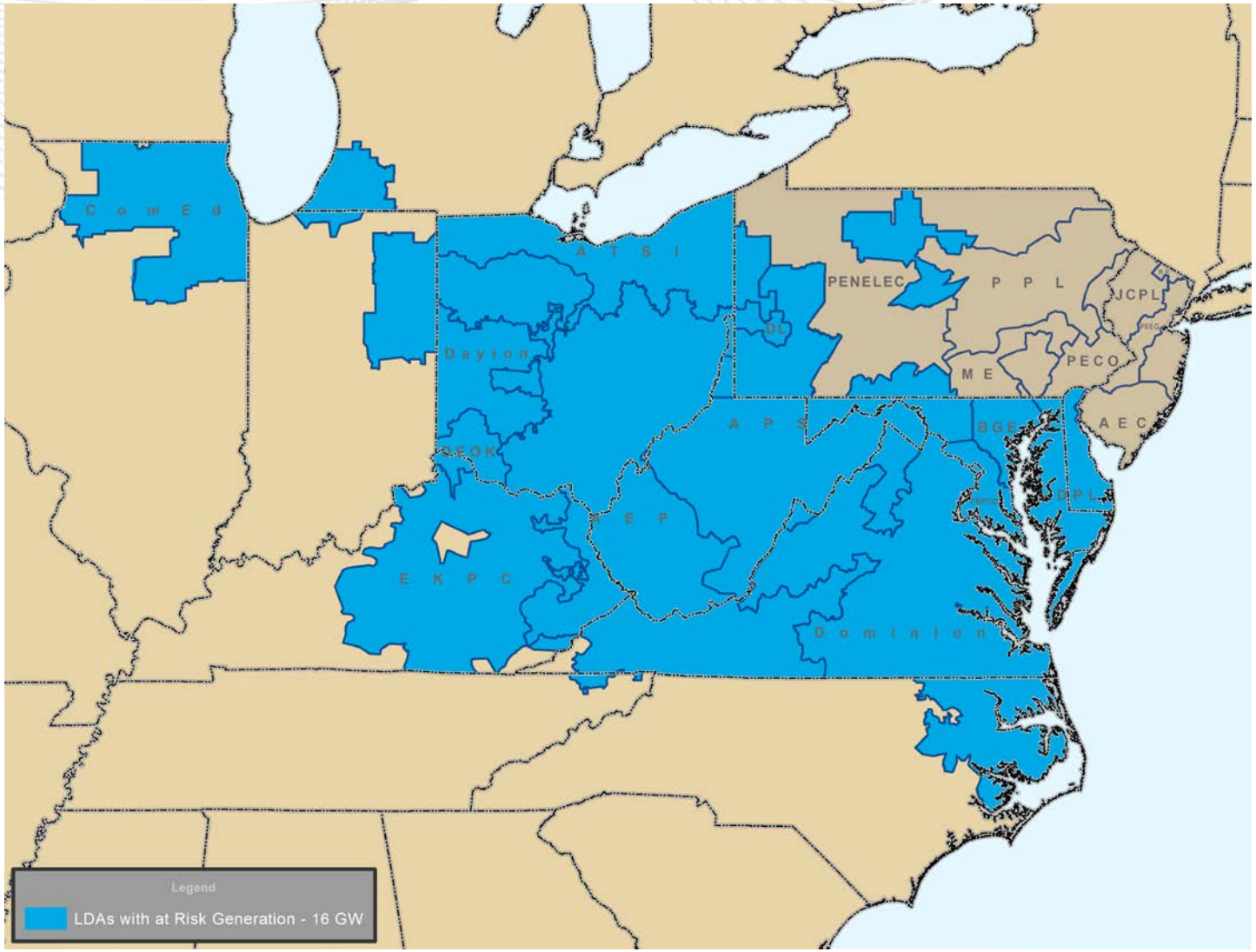
At-Risk LDAs for 6 GW Scenario

At-Risk/LDA	6 GW	16 GW	32GW
AEP	X	X	X
BGE	X	X	X
DAY	X	X	X
DPL	X	X	X
DPL S	X	X	X
DVP	X	X	X
EKPC	X	X	X
CE		X	X
DEOK		X	X
ATSI		X	X
AE			X
PENELEC			X
PL			X
PJM WEST	X	X	X
SWMAAC	X	X	X
WMAAC			X
MAAC			X



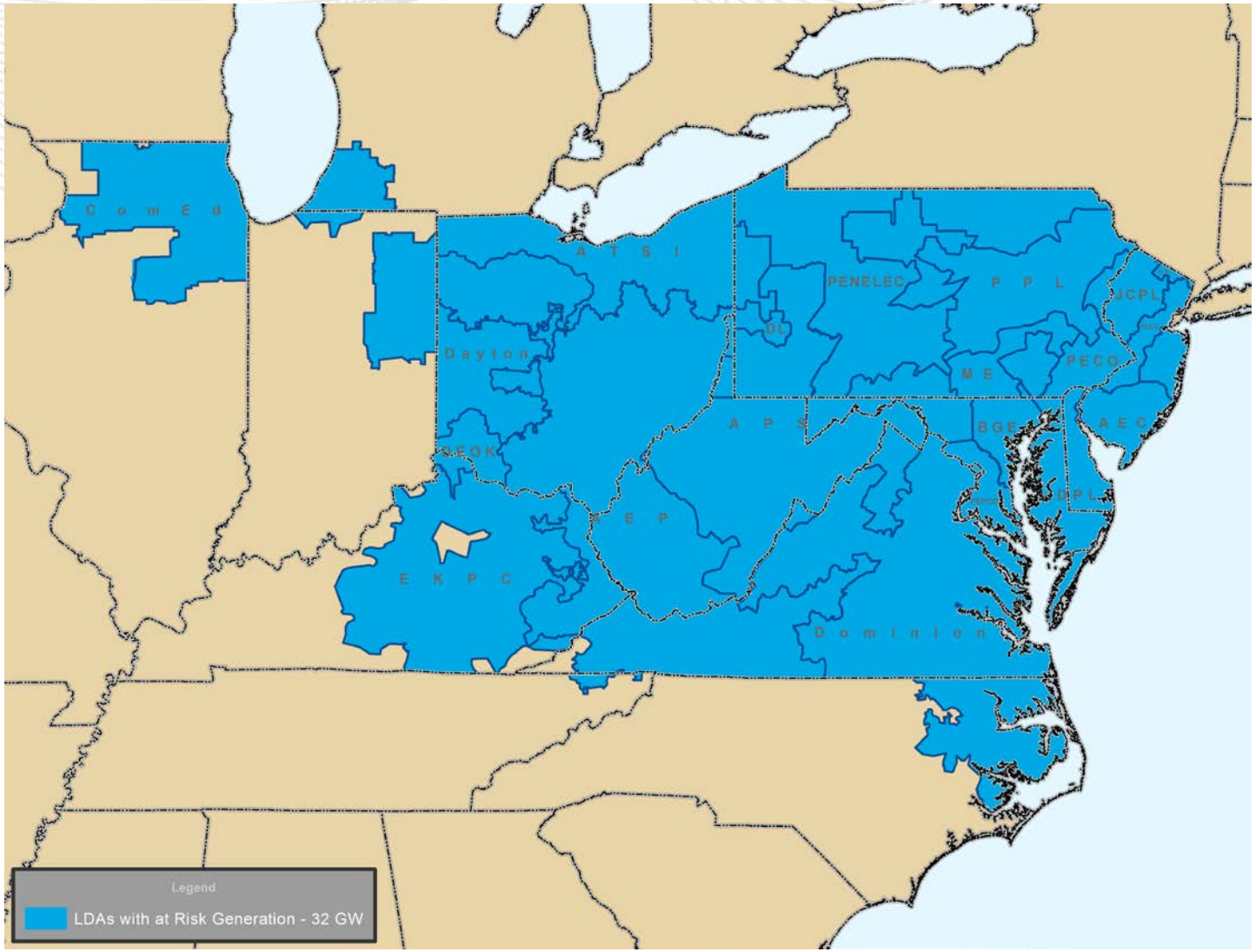
At-Risk LDAs for 16 GW Scenario

At-Risk/LDA	6 GW	16 GW	32GW
AEP	X	X	X
BGE	X	X	X
DAY	X	X	X
DPL	X	X	X
DPL S	X	X	X
DVP	X	X	X
EKPC	X	X	X
CE		X	X
DEOK		X	X
ATSI		X	X
AE			X
PENELEC			X
PL			X
PJM WEST	X	X	X
SWMAAC	X	X	X
WMAAC			X
MAAC			X



At-Risk LDAs for 32 GW Scenario

At-Risk/LDA	6 GW	16 GW	32GW
AEP	X	X	X
BGE	X	X	X
DAY	X	X	X
DPL	X	X	X
DPL S	X	X	X
DVP	X	X	X
EKPC	X	X	X
CE		X	X
DEOK		X	X
ATSI		X	X
AE			X
PENELEC			X
PL			X
PJM WEST	X	X	X
SWMAAC	X	X	X
WMAAC			X
MAAC			X



CPP Transmission Simulation Results

CPP At-Risk Scenario Study – Test Methods & Results

- System-wide Generator Deliverability (for single contingencies) and the Common Mode Outage test (for tower contingencies) and Load Deliverability for a large selection of LDAs completed for all seven at-risk scenarios

- Staff has completed the analysis associated with the scenarios described on the previous slides.
  - 25 potential thermal overloads beyond conductor limits
  - Two areas (BGE & DPL) showing widespread voltage problems

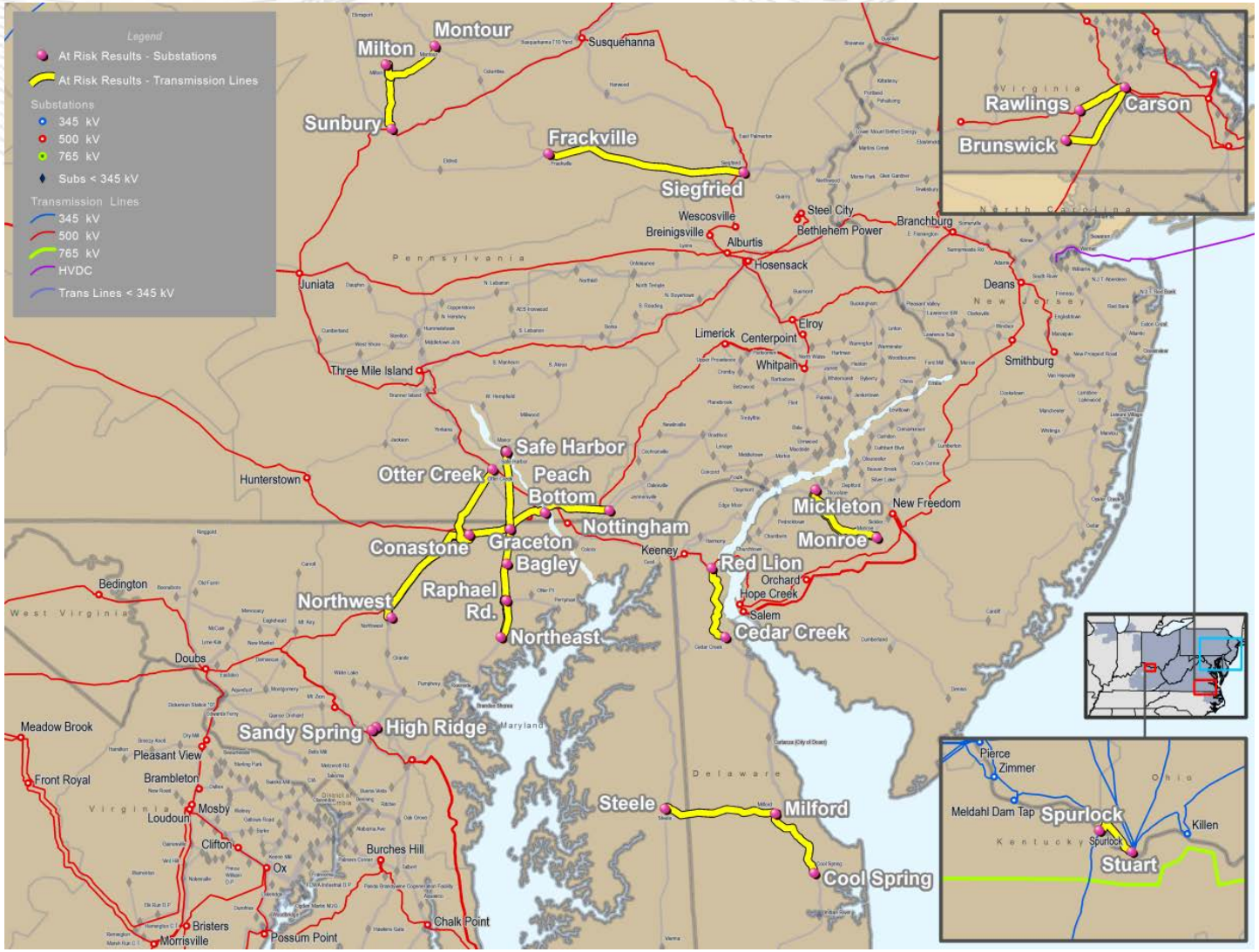
CPP At-Risk Scenario Study - Results

Potential Thermal Violations Beyond Conductor Limit For Each At-Risk Generation Scenario

Transmission Line	Ckt ID	kV Level	Area(s)	S1 (6 GW)	S2 (16 GW)	S3 (32 GW)	S4 (32 GW)	S5 (16 GW)	S6 (32 GW)	S7 (32 GW)
Mickleton - Monroe	1	230	AEC	x			x	x	x	x
Mickleton - Monroe	2	230	AEC	x			x	x	x	x
Bagley - Raphael Road	1	230	BGE							x
Bagley - Raphael Road	2	230	BGE							x
Conastone - Northwest '311'	1	230	BGE					x		x
Conastone - Northwest '326'	1	230	BGE		x	x	x	x	x	x
Graceton - Bagley	1	230	BGE							x
Raphael Road - Northeast '317'	1	230	BGE							x
Raphael Road - Northeast '339'	1	230	BGE							x
Sandy Springs '14' - High Ridge '16'	1	230	BGE				x			
Sandy Springs '34' - High Ridge '16'	1	230	BGE				x			
Stuart - Spurlock	1	345	Dayton/EKPC				x		x	x
Brunswick - Carson	1	500	DOM	x	x	x	x		x	
Rawlings - Carson	1	500	DOM	x	x	x	x		x	
Milford - Cool Springs	1	230	DPL				x			
Red Lion - Cedar Creek	1	230	DPL	x	x		x	x	x	x
Steele - Milford	1	230	DPL	x	x		x	x		
Nottingham - Nottingham Reactor	1	230	PECO						x	x
Nottingham Reactor - Peach Bottom	1	230	PECO						x	
Peach Bottom - Conastone	1	500	PECO/BGE						x	x
Frackville - Siegfried	1	230	PPL	x	x	x		x		
Milton - Sunbury	1	230	PPL					x	x	x
Montour - Milton	1	230	PPL	x	x	x	x	x	x	x
Otter Creek - Conastone	1	230	PPL/BGE							x
Safe Harbor - Graceton	1	230	PPL/BGE					x	x	x

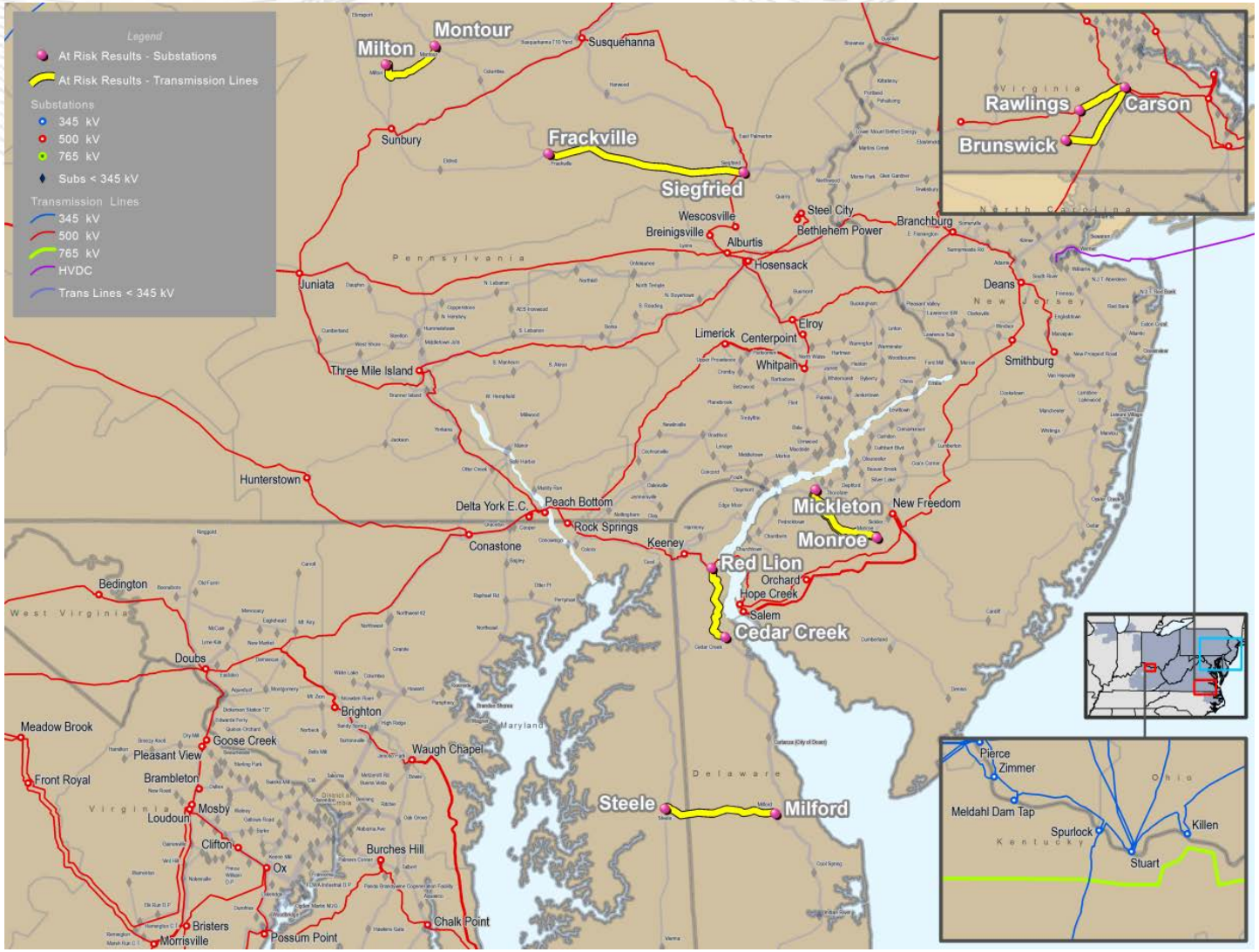
All Scenarios #1 through #7: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Mickleton - Monroe	1	230	AEC
Mickleton - Monroe	2	230	AEC
Bagley - Raphael Road	1	230	BGE
Bagley - Raphael Road	2	230	BGE
Conastone - Northwest '311'	1	230	BGE
Conastone - Northwest '326'	1	230	BGE
Graceton - Bagley	1	230	BGE
Raphael Road - Northeast '317'	1	230	BGE
Raphael Road - Northeast '339'	1	230	BGE
Sandy Springs '14' - High Ridge '16'	1	230	BGE
Sandy Springs '34' - High Ridge '16'	1	230	BGE
Stuart - Spurlock	1	345	Dayton/EKPC
Brunswick - Carson	1	500	DOM
Rawlings - Carson	1	500	DOM
Milford - Cool Springs	1	230	DPL
Red Lion - Cedar Creek	1	230	DPL
Steele - Milford	1	230	DPL
Nottingham - Nottingham Reactor	1	230	PECO
Nottingham Reactor - Peach Bottom	1	230	PECO
Peach Bottom - Conastone	1	500	PECO/BGE
Frackville - Siegfried	1	230	PPL
Milton - Sunbury	1	230	PPL
Montour - Milton	1	230	PPL
Otter Creek - Conastone	1	230	PPL/BGE
Safe Harbor - Graceton	1	230	PPL/BGE



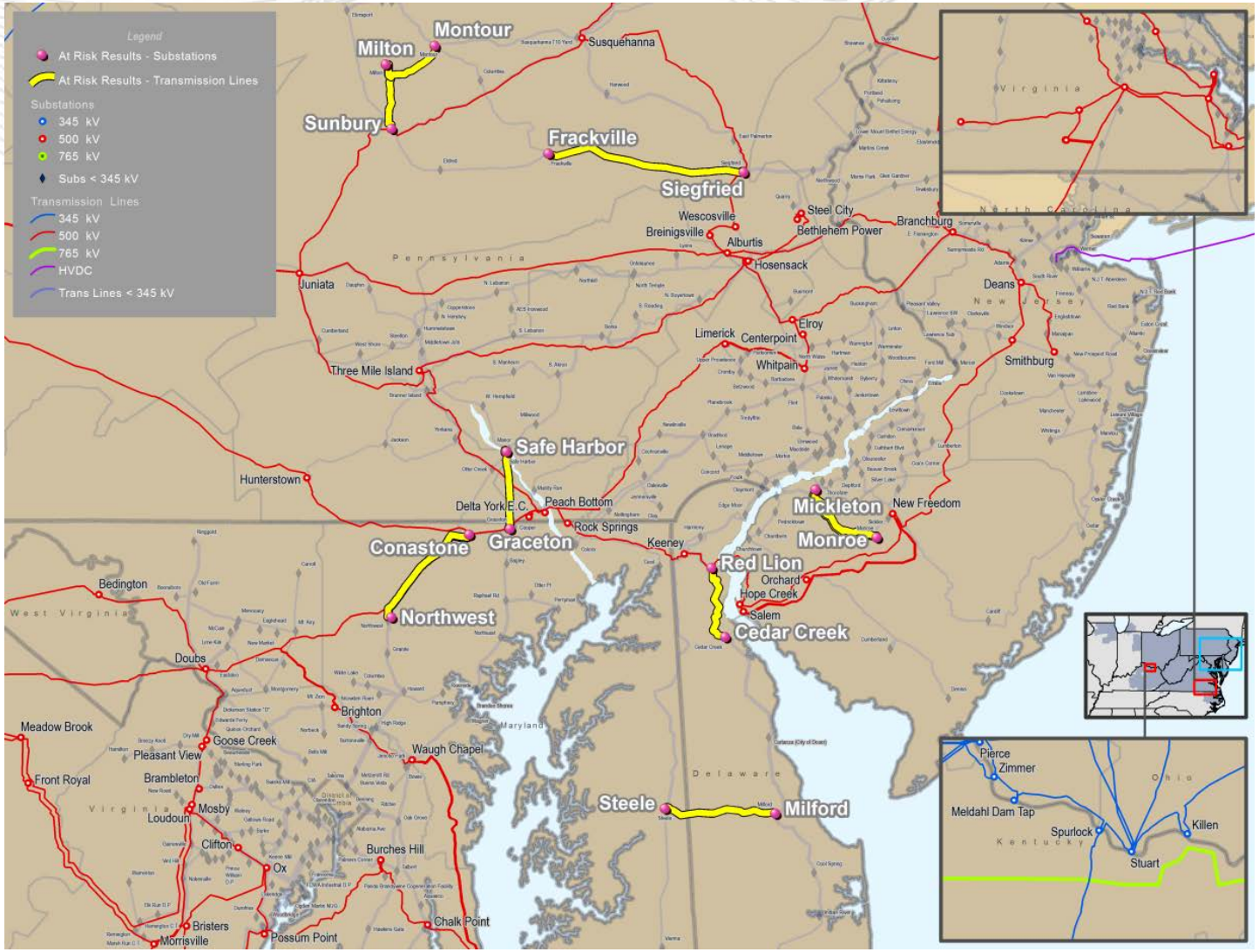
Scenario 1 – 6 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Mickleton - Monroe	1	230	AEC
Mickleton - Monroe	2	230	AEC
Brunswick - Carson	1	500	DOM
Rawlings - Carson	1	500	DOM
Red Lion - Cedar Creek	1	230	DPL
Steele - Milford	1	230	DPL
Frackville - Siegfried	1	230	PPL
Montour - Milton	1	230	PPL



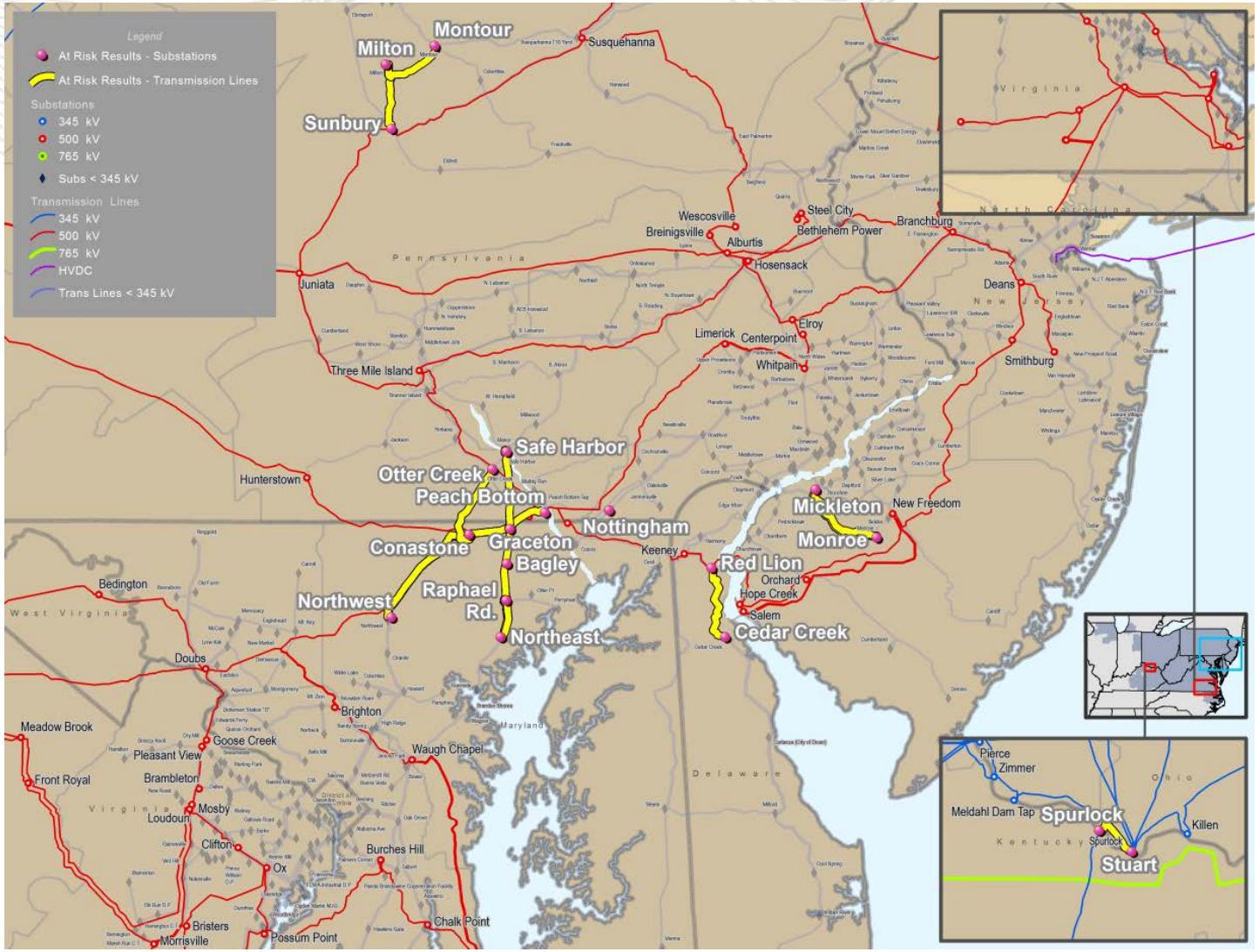
Scenario 2 – 16 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Conastone - Northwest '326'	1	230	BGE
Brunswick - Carson	1	500	DOM
Rawlings - Carson	1	500	DOM
Red Lion - Cedar Creek	1	230	DPL
Steele - Milford	1	230	DPL
Frackville - Siegfried	1	230	PPL
Montour - Milton	1	230	PPL



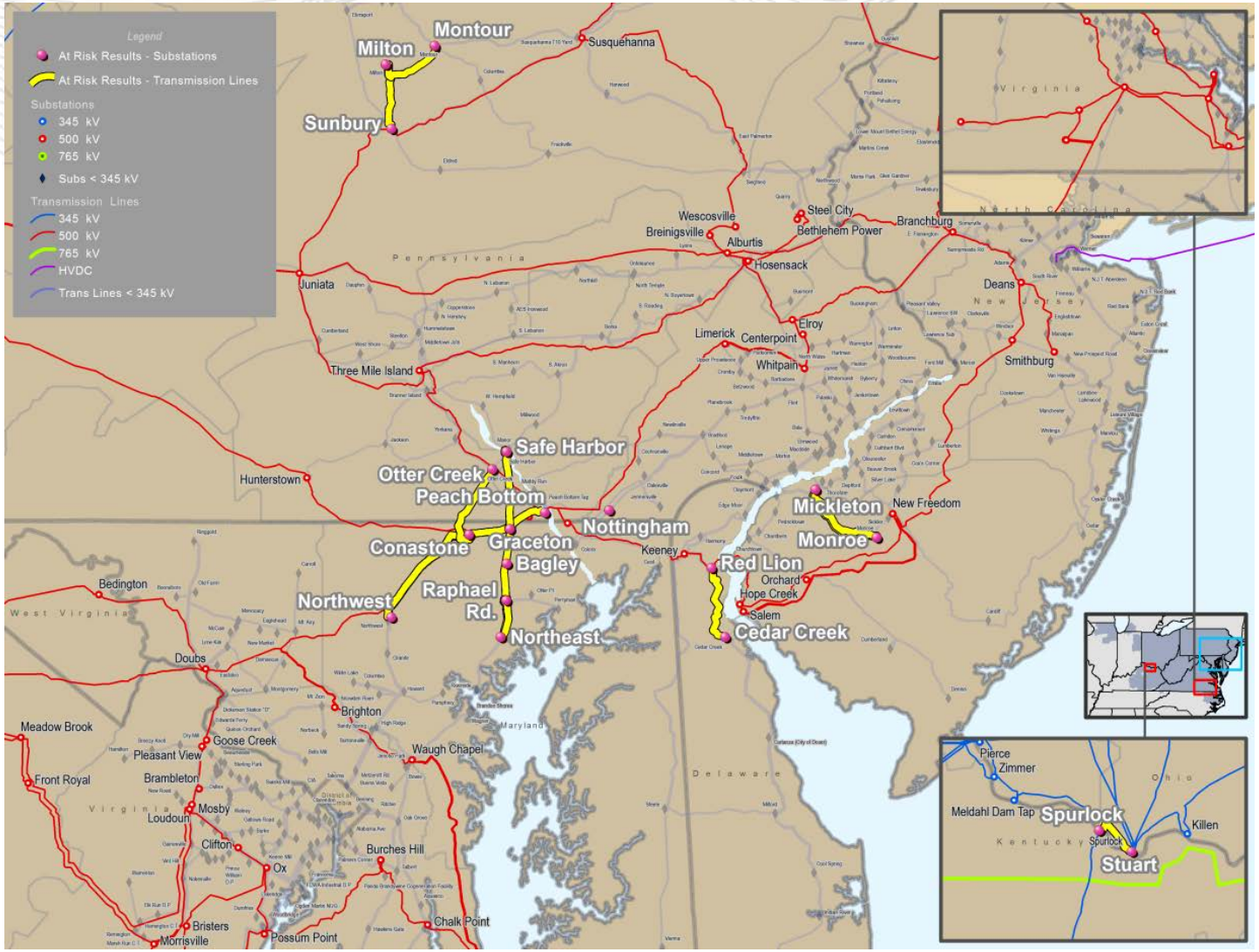
Scenario 3 – 32 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Conastone - Northwest '326'	1	230	BGE
Brunswick - Carson	1	500	DOM
Rawlings - Carson	1	500	DOM
Frackville - Siegfried	1	230	PPL
Montour - Milton	1	230	PPL



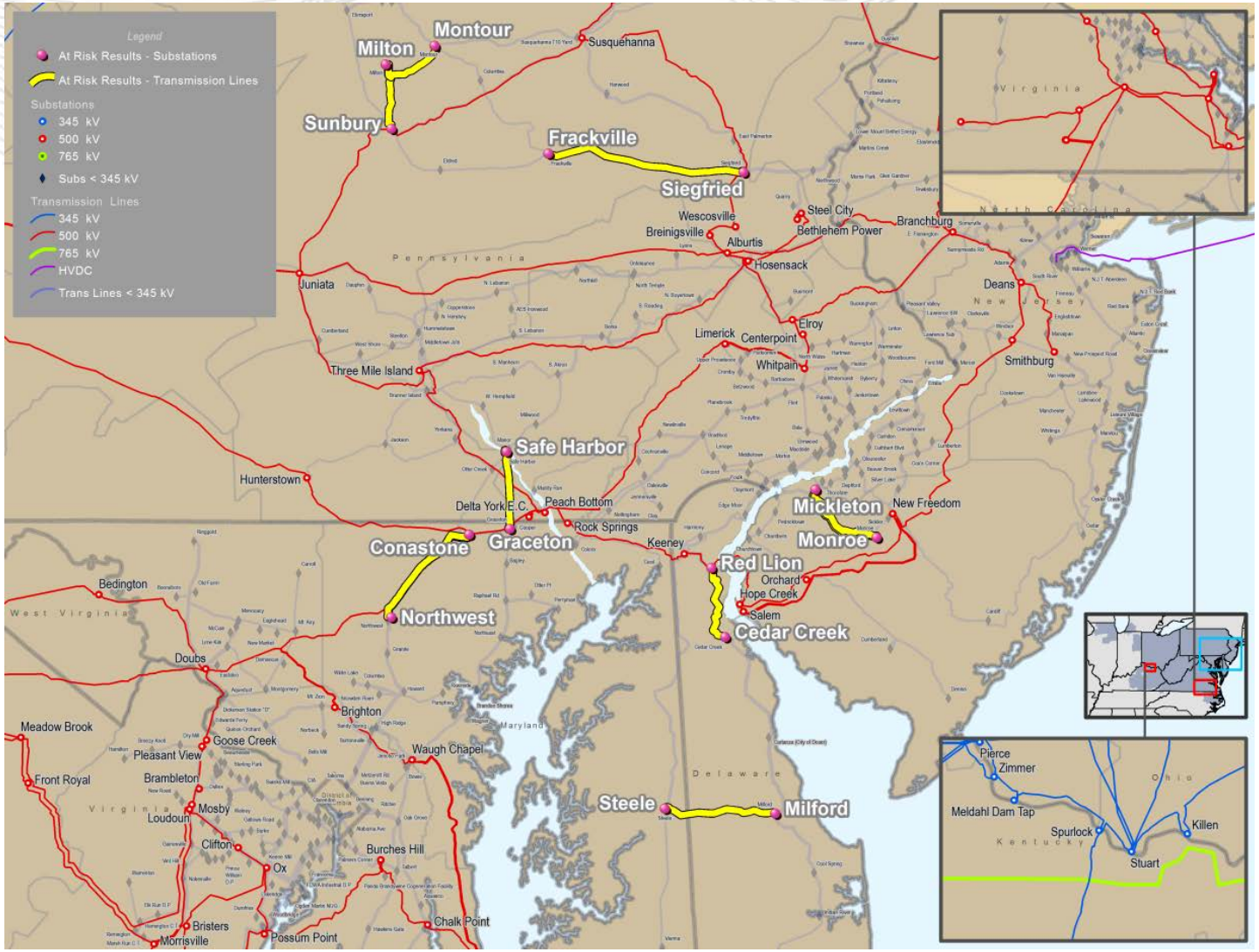
Scenario 4 – 32 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Mickleton - Monroe	1	230	AEC
Mickleton - Monroe	2	230	AEC
Conastone - Northwest '326'	1	230	BGE
Sandy Springs '14' - High Ridge '16'	1	230	BGE
Sandy Springs '34' - High Ridge '16'	1	230	BGE
Stuart - Spurlock	1	345	Dayton/EKPC
Brunswick - Carson	1	500	DOM
Rawlings - Carson	1	500	DOM
Milford - Cool Springs	1	230	DPL
Red Lion - Cedar Creek	1	230	DPL
Steele - Milford	1	230	DPL
Montour - Milton	1	230	PPL



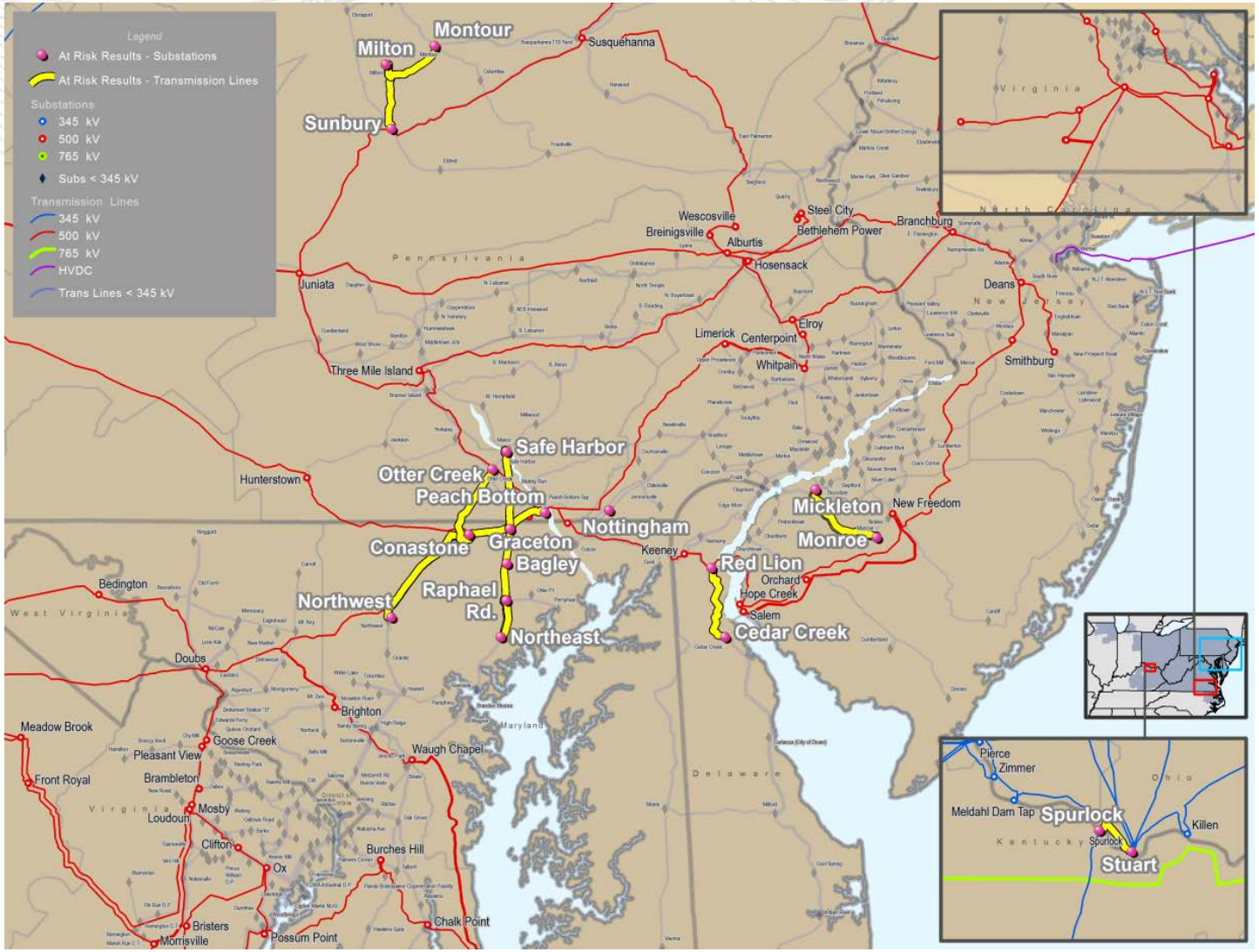
Scenario 5 – 16 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Mickleton - Monroe	1	230	AEC
Mickleton - Monroe	2	230	AEC
Conastone - Northwest '311'	1	230	BGE
Conastone - Northwest '326'	1	230	BGE
Red Lion - Cedar Creek	1	230	DPL
Steele - Milford	1	230	DPL
Frackville - Siegfried	1	230	PPL
Milton - Sunbury	1	230	PPL
Montour - Milton	1	230	PPL
Safe Harbor - Graceton	1	230	PPL/BGE



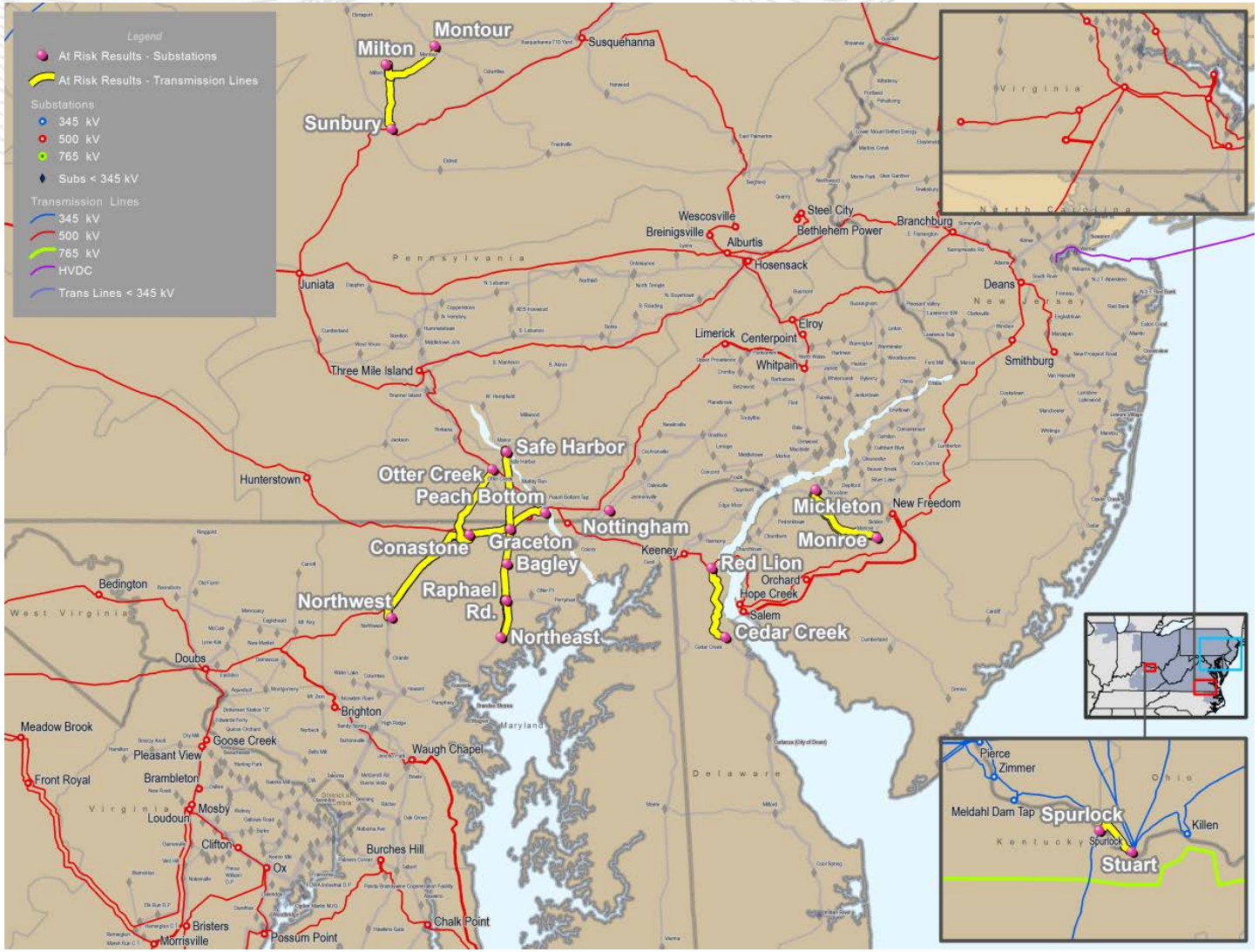
Scenario 6 – 32 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Mickleton - Monroe	1	230	AEC
Mickleton - Monroe	2	230	AEC
Conastone - Northwest '326'	1	230	BGE
Stuart - Spurlock	1	345	Dayton/EKPC
Brunswick - Carson	1	500	DOM
Rawlings - Carson	1	500	DOM
Red Lion - Cedar Creek	1	230	DPL
Nottingham - Nottingham Reactor	1	230	PECO
Nottingham Reactor - Peach Bottom	1	230	PECO
Peach Bottom - Conastone	1	500	PECO/BGE
Milton - Sunbury	1	230	PPL
Montour - Milton	1	230	PPL
Safe Harbor - Graceton	1	230	PPL/BGE



Scenario 7 – 32 GW: Potential Thermal Violations Beyond Conductor Limit

Transmission Line	Ckt ID	kV Level	Tx Zone
Mickleton - Monroe	1	230	AEC
Mickleton - Monroe	2	230	AEC
Bagley - Raphael Road	1	230	BGE
Bagley - Raphael Road	2	230	BGE
Conastone - Northwest '311'	1	230	BGE
Conastone - Northwest '326'	1	230	BGE
Graceton - Bagley	1	230	BGE
Raphael Road - Northeast '317'	1	230	BGE
Raphael Road - Northeast '339'	1	230	BGE
Stuart - Spurlock	1	345	Dayton/EKPC
Red Lion - Cedar Creek	1	230	DPL
Nottingham - Nottingham Reactor	1	230	PECO
Peach Bottom - Conastone	1	500	PECO/BGE
Milton - Sunbury	1	230	PPL
Montour - Milton	1	230	PPL
Otter Creek - Conastone	1	230	PPL/BGE
Safe Harbor - Graceton	1	230	PPL/BGE



Observations

- Studies show a range of potential issues under varying assumptions
- Timing could effect overall impact
- Many of the potential issues are distributed across the RTO
- Corridor into BG&E may require additional review
- Potential issues identified on some facilities for multiple scenarios
  - Can be used to inform RTEP decisions
- Potential solutions and their costs are yet to be studied

- Next Steps

- Questions:
  - RTEP@pjm.com