Transmission Expansion Advisory Committee

April 9th, 2015

Interregional Planning Update

EIPC non-grant 2014 Analysis

- 2025 summer and winter scenario build
  - Initial SSMLFWG kickoff – February 4
  - April 10 target first build
  - Target complete models late summer
- Ground work for production cost studies
  - March 11 TC discussion
  - April 1 PCTF conference call
  - July 9th TC targeted for recommendation

SERTP

- NC Utility Commission study
  - Implement enhanced Order No. 1000 planning
  - NC operational readiness meeting 3/18/15 Charlotte
  - Commission TC April 27 regarding study
- Order 1000 compliance
  - 60 day extension to late May 2015
  - Discussions coordinating response in progress

MISO-PJM JOA

- PJM/MISO
  - Order No. 1000 Interregional Compliance
    - June 16, 2015
    - IPSAC March-May timeframe
  - “Quick hit” study – M2M congestion 2013-2014
    - PJM and MISO top 38 historical M2M constraints
    - $400 M total congestion
    - Approved upgrades address $270 M
    - 3 flowgates for further study – Michigan Interface
    - 3 potential quick hit upgrades

MISO-PJM JOA / SERC

- MISO-PJM JOA
  - IPSAC review and input April 14, 2015
  - Metric and Process review
  - Interregional Order 1000 Studies – Next Steps

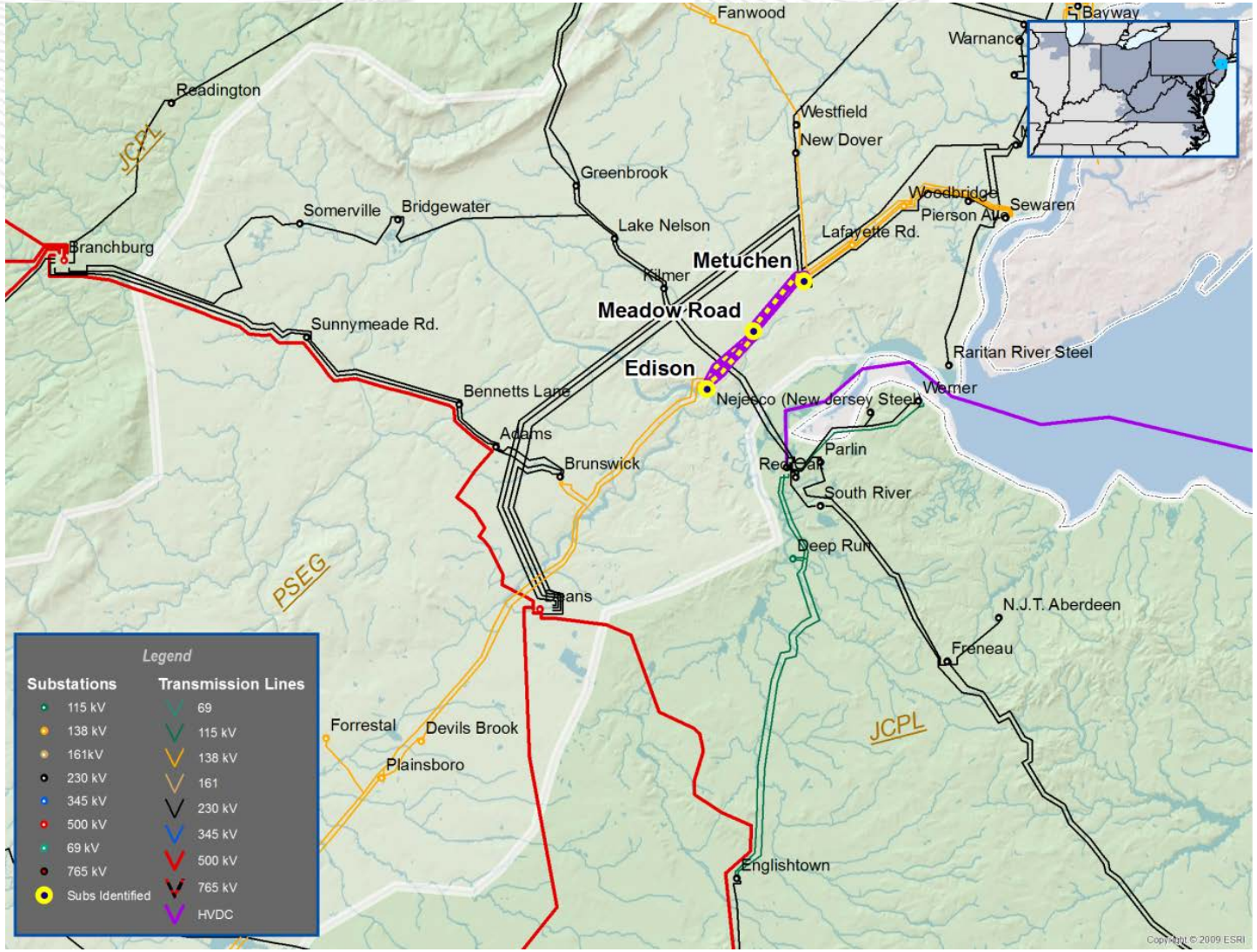
- SERC
  - LTSG and NTSG study scope discussions
  - RTO’s dispatch

Reliability Analysis Update

PSE&G Transmission Zone

- Scope Change For B2218 Upgrade:
- The B2218 (Rebuild 4 miles of overhead line from Edison - Meadow Rd - Metuchen) was identified during a retirement study in 2013. Alternative solution considered.
- New Proposed Solution:

  Convert the two R-1318 and Q-1317 138 kV circuits located on the right-of-way between Edison and Metuchen to one 230kV circuit. Also relocate the S-2219 230 kV circuit to the same tower structures. Relocate the existing Metuchen autotransformer to Edison.
- Previous Cost Estimate: $49.6 M
- Updated Cost Estimate: $48.6
- Required IS Date: 6/1/2015.



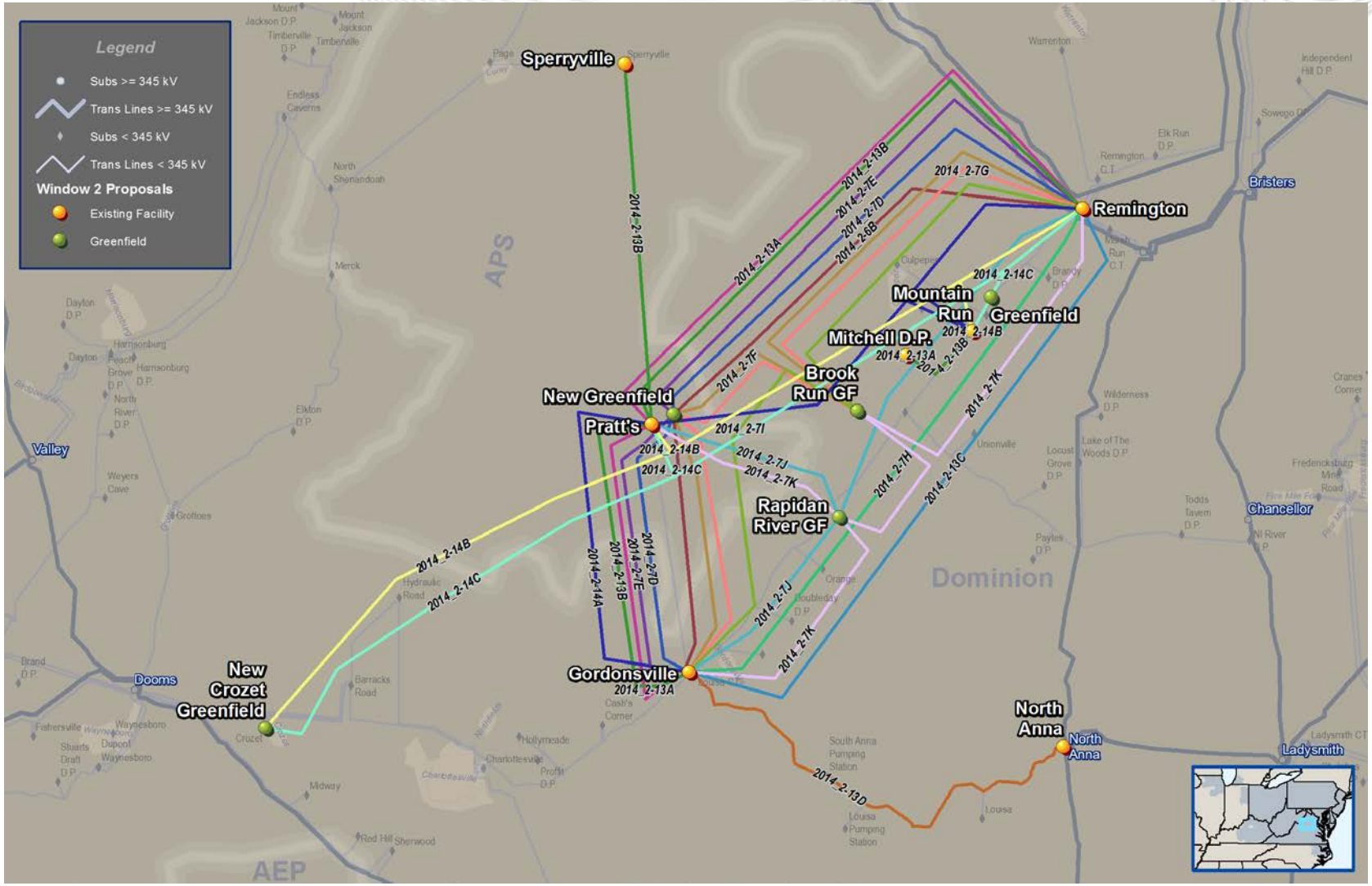
RTEP Proposal Window Update

RTEP Proposal Window Status

	Artificial Island	2013 Market Efficiency	2014 RTEP Proposal Window 1	2014 RTEP Proposal Window 2	2014 RTEP Proposal Window 2 Addendum 1	2014 RTEP Proposal Window 2 Addendum 2	2014/15 RTEP Long Term Proposal Window	2015 RTEP Proposal Window 1
Window Open	4/29/2013	8/12/2013	6/27/2014	10/17/2014	1/20/2015	2/24/2015	10/30/2014	2Q 2015
Window Close	6/28/2013	9/26/2013	7/28/2014	11/17/2014	2/3/2015	3/12/2015	2/27/2015	
Objective	Operational Performance	Market Efficiency	Reliability Criteria - Thermal	Reliability Criteria Thermal and Voltage; Transmission Owner Criteria	N-1-1 Voltage Drop	N-1-1 Voltage Drop	Long Term Reliability Criteria; Long Term TO Criteria; Market Efficiency	Reliability Criteria
Proposals	26	17	106	79	4	10	119	
Entities	7	6	15	14	3	4	22	
Status	Evaluation in Progress	Recommendations Complete	Recommendations Complete	Recommendations Complete	Complete, continued as Addendum 2	Evaluation in Progress	Evaluation in Progress	Anticipated Open in 2Q 2015

Pratts Area Review

All Pratts Proposals



Pratts Area Recommendation

- 2/12/2015 recommendation to PJM TEAC
- Construct 2014_2-13A to resolve the Pratts area violations

Project ID	Upgrade/ Greenfield	Proposing Entity	Cost ($M)	Major Components
2014_2-13A	Greenfield	Dominion/First Energy	149.30	1. Remington – Oneals Road (Pratts) 230 kV line: Construct a new 230 kV transmission line from Dominion's existing Remington substation to FirstEnergy's upgraded Oneals Road (Pratts) 230 kV switching station. Included in this work will be an uprate of one existing 115 kV line segment between Mountain Run and Mitchell for the length of right-of-way it shares with new structures for the new 230 kV line. 2. Gordonsville – Oneals Road (Pratts) 230 kV line: Convert the existing FirstEnergy radial Gordonsville to Pratts 115 kV line to 230 kV and terminate in the new Oneals Road (Pratts) 230 kV switching station creating a new Gordonsville to Oneals Road (Pratts) 230 kV line. 3. Oneals Road (Pratts) substation: Upgrade/expand the existing Pratts substation and install a 230 kV ring bus with a 230/115 kV transformer to connect to the existing Rappahannock Electric Cooperative (REC) Pratts distribution station. 4. Remington substation: Upgrade the 230 kV bus to a ring configuration. 5. Gordonsville substation: Upgrade the 230 kV bus to a breaker-and-a-half configuration.

Pratts Area Recommendation

- Pratts area recommendation by PJM
- March 24, 2015 Letter from Northeast Transmission Development to the PJM TEAC
- Recommendation included consideration of:
  - Performance
  - Cost Effectiveness
    - PJM included consideration of cost commitments
  - Risk
    - The 2014_2-13A recommendation has the fewest miles of new Right of Way (ROW) and utilizes locally owned stations

Pratts Area Recommendation

- Additional stakeholder feedback received from ITC and Northeast Transmission Development (NTD)

- Letters posted with today's TEAC material

- Feedback on PJM's consideration of:
    - Cost commitment
    - Project combinations
    - New ROW assumptions
    - Risk assumptions

Next Steps - Pratts Area

- Further evaluate feedback from stakeholders
- Review with TEAC
- Solicit PJM Board approval following subsequent TEAC review

2014/15 RTEP Long Term Proposal Window

2014/15 RTEP Long Term Proposal Window – Project Submissions

- 22 Proposing entities
  - PJM Transmission Owners
  - PJM Non incumbent Entitles

- 119 Proposals

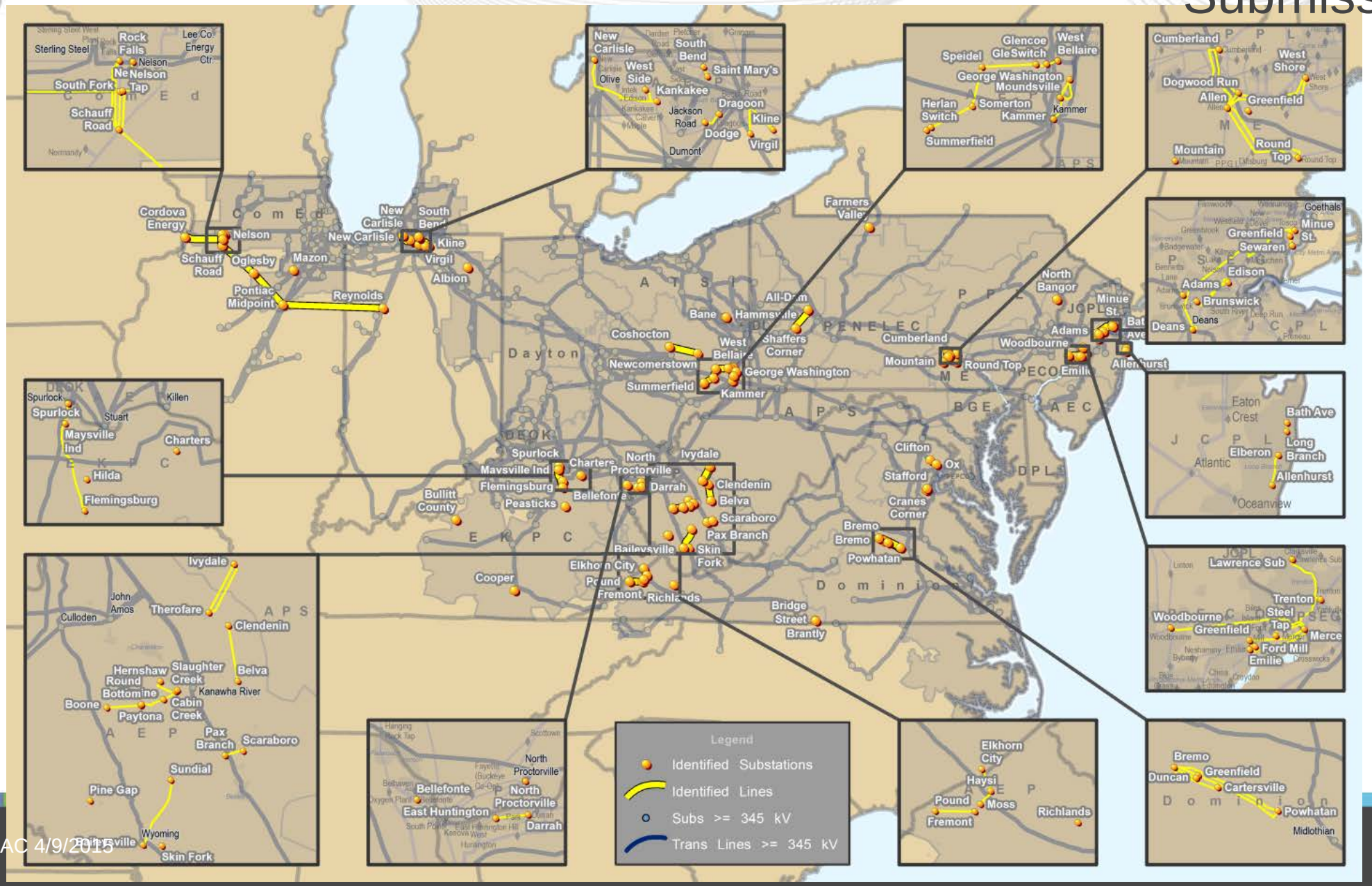
- 22 target TO Zones (Including multi-zone combinations)

- Detailed list and descriptions are posted with the March 2015 TEAC meeting materials

2014/15 RTEP Long Term Proposal Window – Project Submissions

- 26 Reliability Criteria Proposals
  - 15 Transmission Owner Upgrades
    - Cost range of $0.3M to $62.48M
  - 11 Greenfield Projects
    - Cost range of $17.6M to $100.7M
- 93 Market Efficiency Proposals
  - 34 Transmission Owner Upgrades
    - Cost range of $0.1M to $81.16M
  - 58 Greenfield Projects
    - Cost range of $9.2M to $432.5M

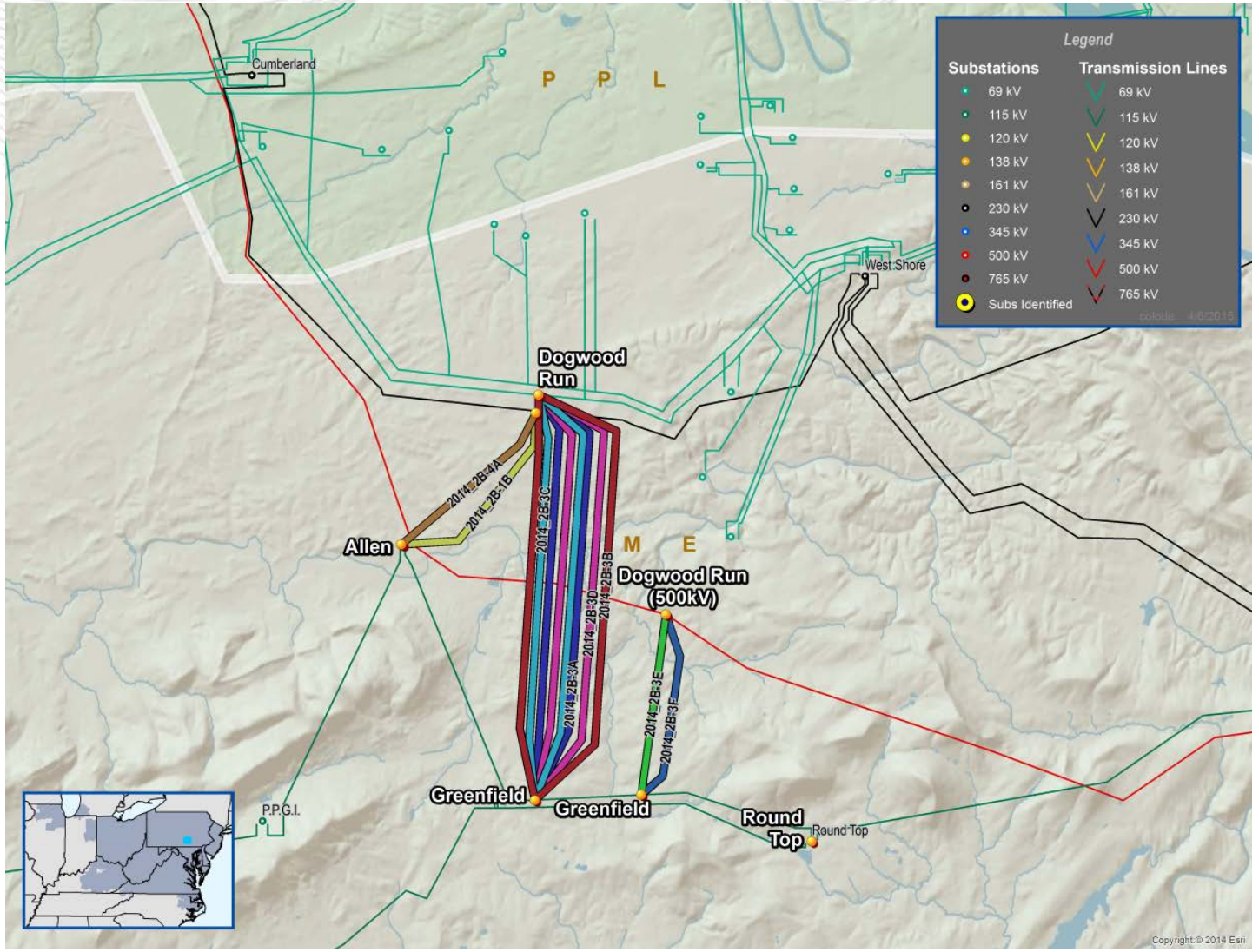
2014/15 RTEP Long Term Proposal Window – Project Submissions



2014 RTEP Proposal Window 2 Addendum 2

2014 RTEP Proposal Window 2 Addendum 2 – Project Submissions

- 4 Proposing entities
- 10 Proposals
  - 9 Greenfield
    - Cost Range $10.55M - $25.5M
  - 1 TO Upgrade
    - Cost: $0.96M
- 1 target TO Zone - Meted
- Detailed list and descriptions are posted with today's meeting materials



2014 RTEP Proposal Window 2 Addendum 2 – Project Submissions

Project ID	Upgrade/ Greenfield	Proposing Entity	Cost ($M)	Target Zone	kV Level	Analysis Type	Major Components
2014_2B-1A	Greenfield	Transource	16.13	Meted	230	N-1-1 Voltage Drop	Build a new 230/115 kV Station. Install 2-230 kV breakers, 2-115 kV breakers, and a 230/115 kV transformer.
2014_2B-1B	Greenfield	Transource	10.55	Meted	115	N-1-1 Voltage Drop	Allen - Williams Grove (PPL's Cumberland-West Shore 230/69kV Station S0859) 115kV project will build a new 115kV single ckt line from METED's Allen Station to Williams Grove station. Williams Grove station will incorporate a new 230/115kV transformer (300 MVA) and install a 115kV breaker as part of the proposed project. We assume that PPL will still cut in the 2-69kV lines between Cumberland and West Shore as well as build 69kV lines to West Carlisle and Carlisle Barack Stations. Allen Station will have to be expanded to incorporate the new 115kV line including 2-115kV breakers.
2014_2B-2A	Upgrade	First Energy	0.96	Meted	115	N-1-1 Voltage Drop	Install a 28.8 MVAR 115 kV capacitor at the Mountain substation. Capacitor should be switched on prior to the second contingency.
2014_2B-3A	Greenfield	Northeast Transmission Development	13.80	Meted	69	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/69 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation
2014_2B-3B	Greenfield	Northeast Transmission Development	17.10	Meted	69	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/69 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation with 60 MVAR Fast Switched Shunt.
2014_2B-3C	Greenfield	Northeast Transmission Development	16.30	Meted	230	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/230 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation
2014_2B-3D	Greenfield	Northeast Transmission Development	21.20	Meted	230	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/230 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation with 90 MVAR Fast Switched Shunt.
2014_2B-3E	Greenfield	Northeast Transmission Development	20.30	Meted	500	N-1-1 Voltage Drop	Build 500/115 kV Substation (Dogwood Run) Interconnecting Juniata-Three Mile Island 500 kV Line to Allen-Roundtop 115 kV Line
2014_2B-3F	Greenfield	Northeast Transmission Development	25.50	Meted	500	N-1-1 Voltage Drop	Build 500/115 kV Substation (Dogwood Run) Interconnecting Juniata-Three Mile Island 500 kV Line to Allen-Roundtop 115 kV Line with 2.5-mile 115 kV Line to a new 115/69 kV substation adjacent to the PPL S0859 230/69 kV substation.
2014_2B-4A	Greenfield	PPL/FE	11.94	Meted	230	N-1-1 Voltage Drop	Expand the existing Allen substation, and connect via new ~2.6 Mile 115kV transmission to PPL's Williams Grove Substation, with transformation to 230kV at Williams Grove Substation

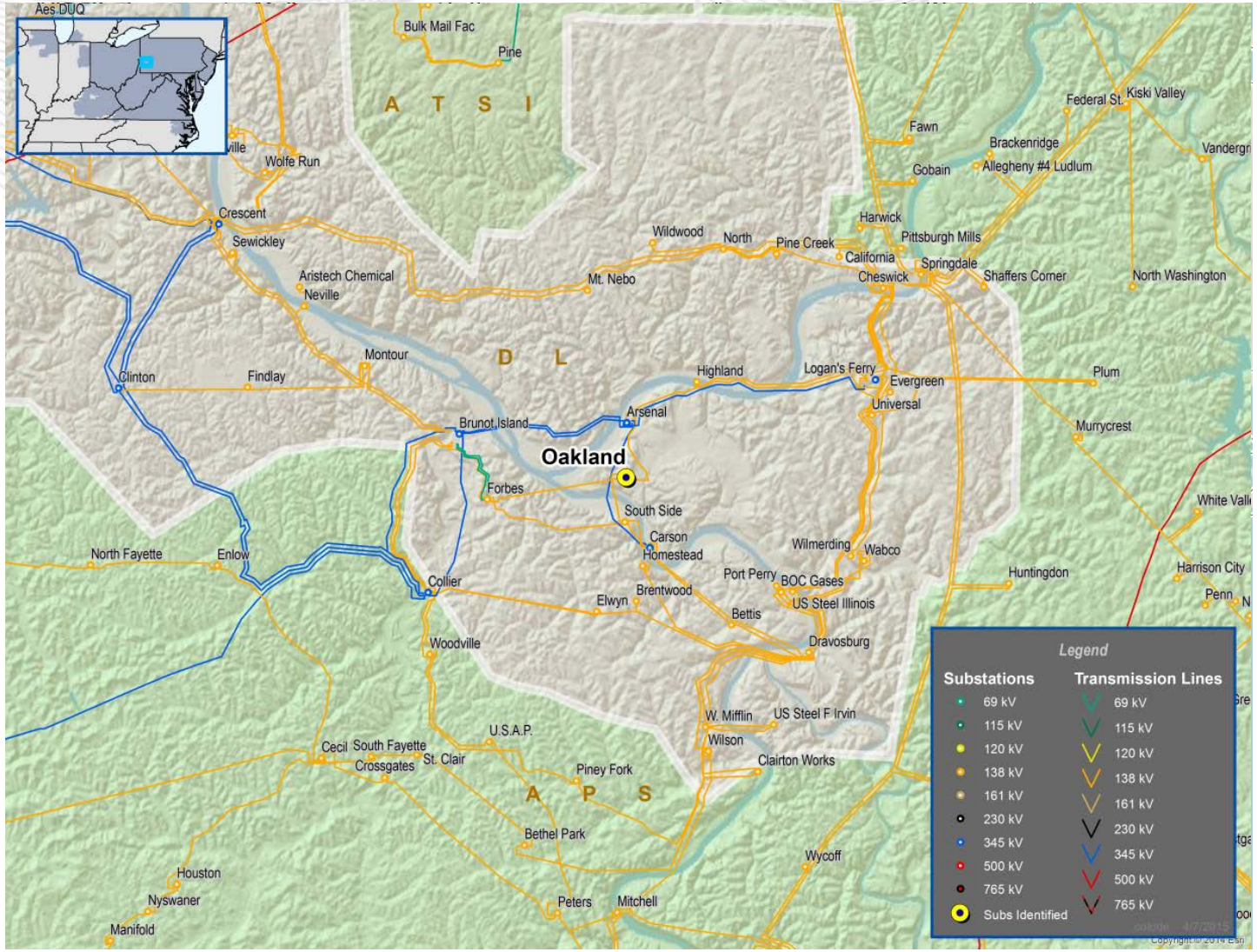
2014 RTEP Proposal Window 2 Addendum 2 – Project Submissions

- Next steps
  - Continuing analytical performance evaluation of the project submissions

Short Circuit Upgrades

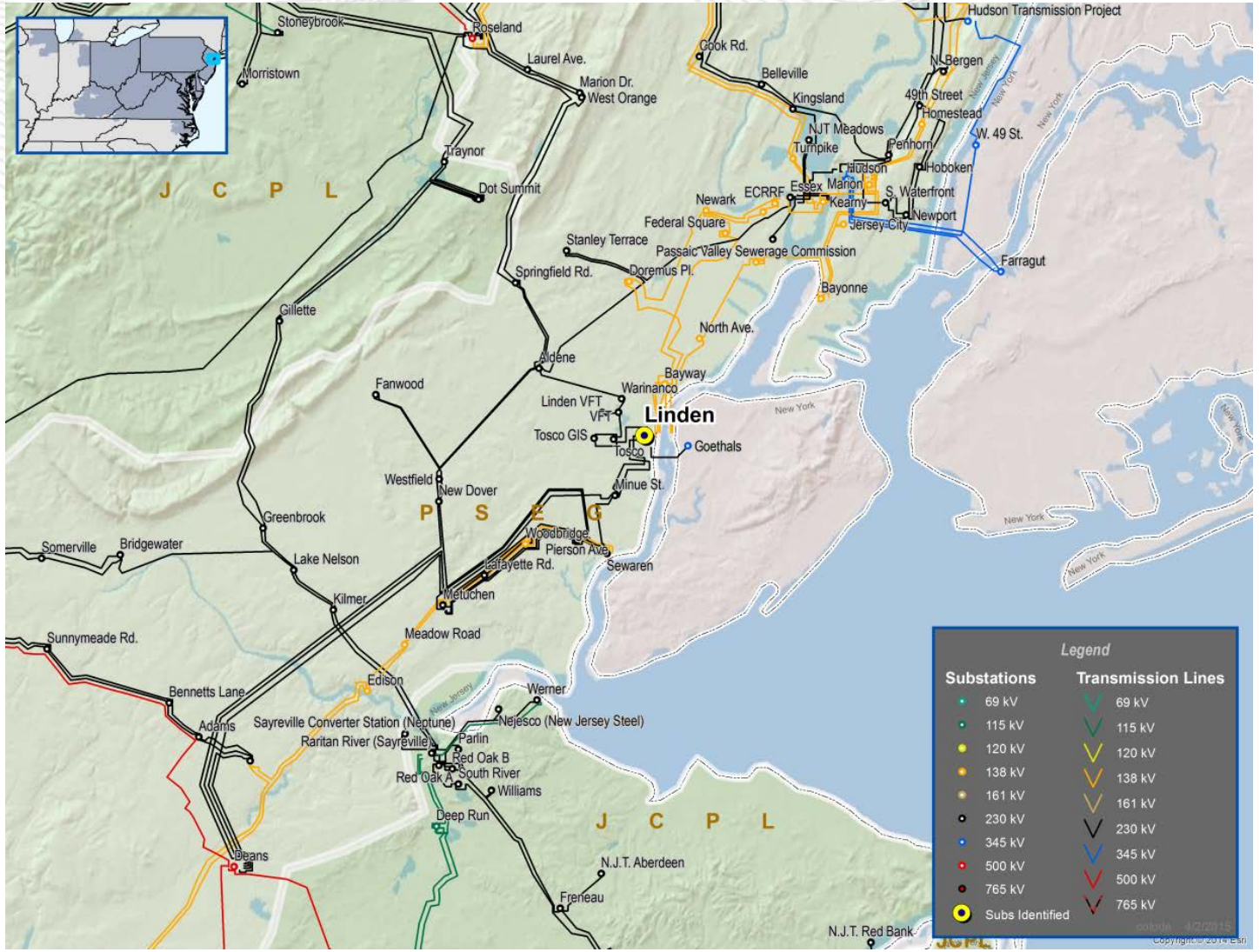
DUQ Transmission Area

- The Oakland 138kV ‘Z-101 Arsenal’ breaker is overstressed
- Proposed Solution: Replace the Oakland 138kV ‘Z-101 Arsenal’ breaker (b2632)
- Estimated Project Cost: $330 K
- Required In Service Date: 6/1/2019



PSE&G Transmission Area

- The Linden 230kV GSU breakers are overstressed
- Proposed Solution: Replace the four Linden 230 kV GSU breakers with 80kA breakers (b2631)
- Estimated Project Cost: $4.5 M
- Required In Service Date: 6/1/2018



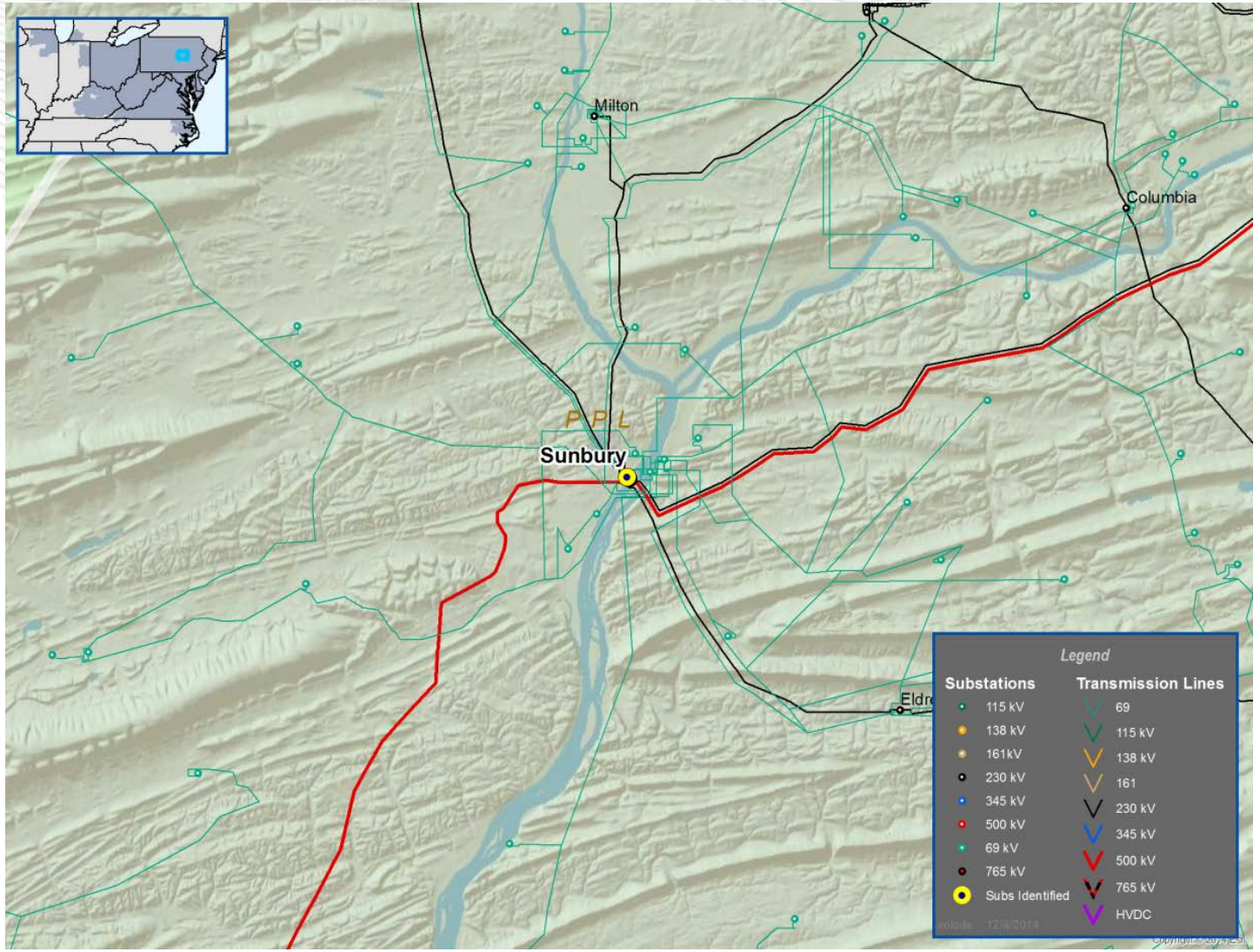
Supplemental Projects

PPL Transmission Zone

- Supplemental Upgrade:
- To improve operational performance in the area
- Proposed Solution:
  - Install new 500-230 kV Transformer at Sunbury. (S0932)
- Estimated Project Cost:

  $ 10 M
- Projected IS Date:

  12/31/2017



PPL Transmission Zone

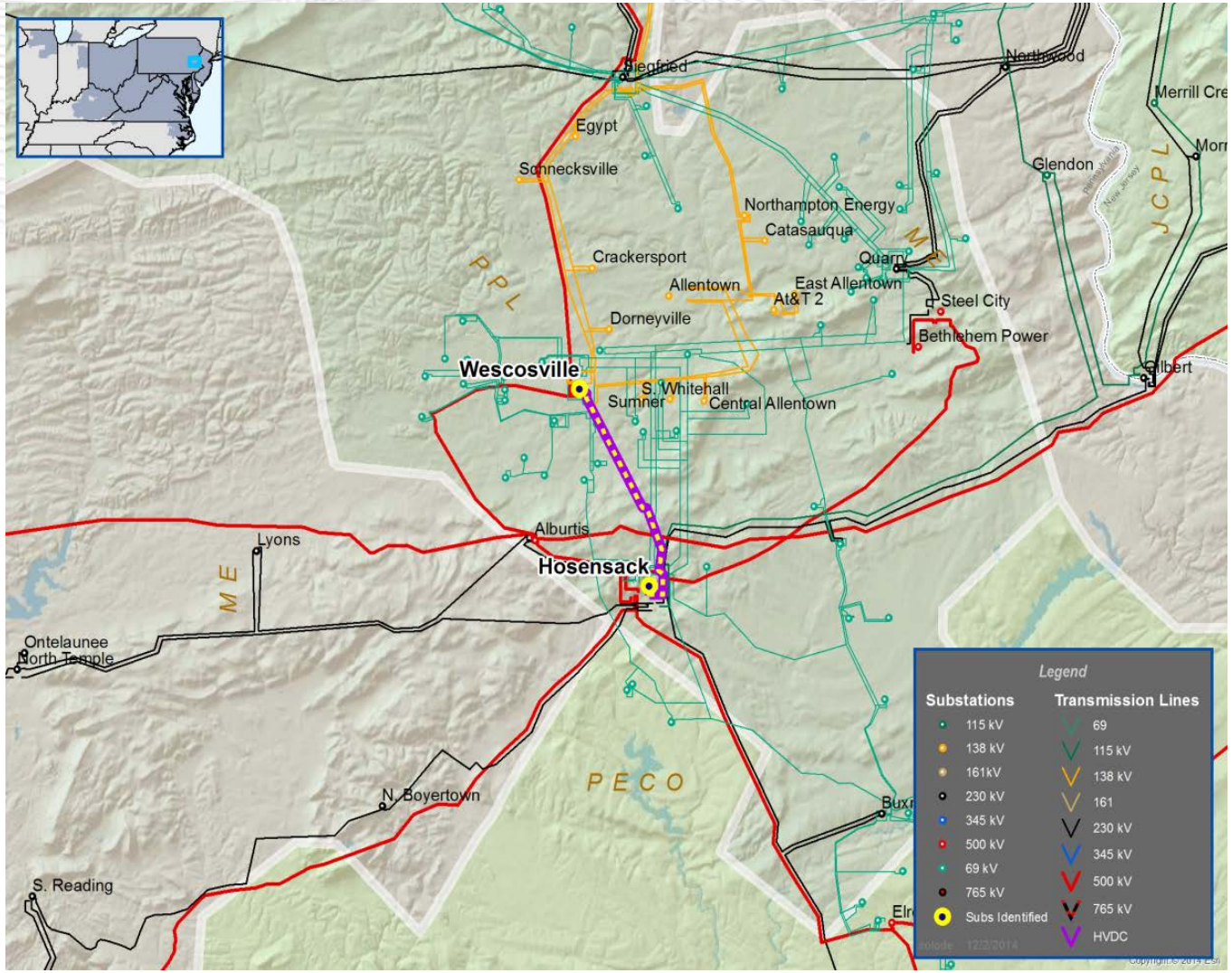
- S0864 Supplemental Upgrade Scope Change:
- Old Scope:

  Rebuild approximately 10 miles of the Hosensack-Wescosville 230 kV line to 500 kV and upgrade Wescosville 500-138 kV Substation.

  New Scope:
  - Build approximately 6 miles 500 kV 2nd circuit on the existing Alburtis – Breinigsville.
  - Reconfigure the Wescosville 500 kV station to double breaker arrangement.
  - Install a new Wescosville 230/138 kV transformer.
- Estimated Project Cost:

  $ 58.4 M
- Projected IS Date:

  12/31/2017



2015 RTEP Scenario Studies

2015 RTEP Scenario and Sensitivity Studies

- Section 111(d) of the Clean Air Act
  - Develop and run Market Efficiency Scenarios
  - Reliability modeling
  - Reliability Criteria Violation identification
  - Transmission Overlay Development

- Analysis of critical Winter conditions – Gas/Electric interaction
  - Develop and document planning analysis procedures to assess risk associated with gas / electric interdependencies
  - Development of gas contingencies

EPA 111(d) Study

111(d) At-Risk Scenario Study – Assumptions

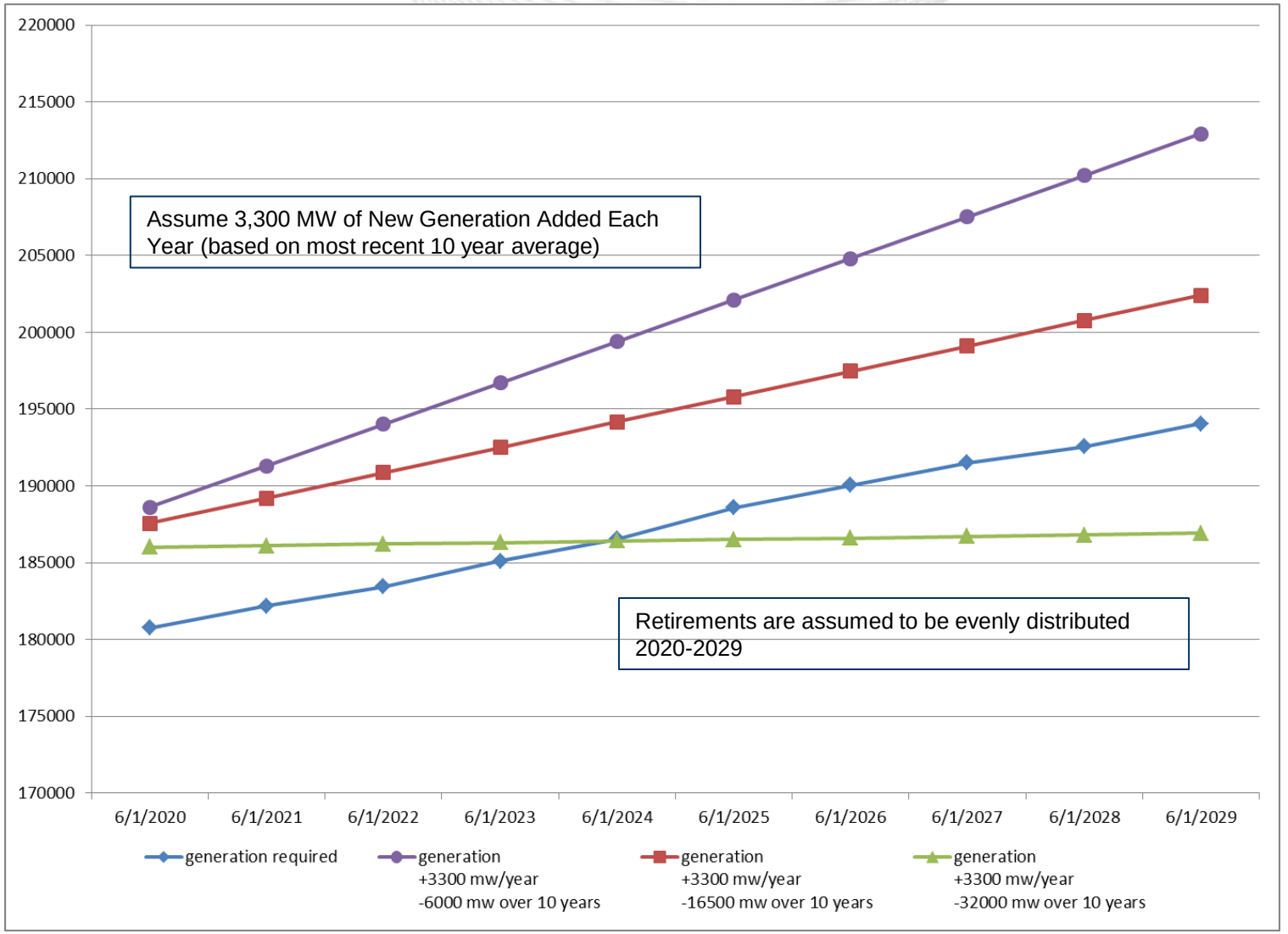
- Three at-risk studies: 6GW, 16GW and 32GW
- Base case: 2022 Summer Peak
- FSA generation will likely need to be turned on to satisfy load and interchange
- Reliability tests:
  - Generation Deliverability
  - Load Deliverability of select areas based on location of at-risk generation
- Monitor all PJM monitored facilities (includes all BES - 100 kV facilities and above)
- Use conductor ratings

111(d) At-Risk Scenario Study – Scenarios

- Three at-risk scenario studies: 6 GW, 16 GW and 32 GW
  - The 16 GW and 32 GW scenarios will require replacement generation to meet load and interchange
    - Add generation based on existing queue
    - Include western HVDC merchant transmission as resources up to firm injection capability
    - Replacement scenario: Replace at-risk generation with new gas-fired generation at the existing at-risk brownfield sites near existing gas infrastructure
    - Replacement scenario: Replace at-risk generation with new energy efficiency, wind generation consistent with EPA assumptions

Possible 2020 – 2029 Generation Reserve Picture

as a function of at-risk retirement scenarios



6,000 MW Retirement Scenario available generation

16,500 MW Retirement Scenario available generation

Generation Requirement (load – DR)*IRM

32,000 MW Requirement Scenario available generation

- Next Steps
  - Identify critical load deliverability areas to run based on the at-risk generation profile in each zone
  - Calculate CETO values for the critical zones
  - Run Load Deliverability and calculate CETL values
  - Evaluate the case using the Generator Deliverability and Common Mode Outage test procedures

Winter Peak Study Update

2014 RTEP PJM Winter Peak Study

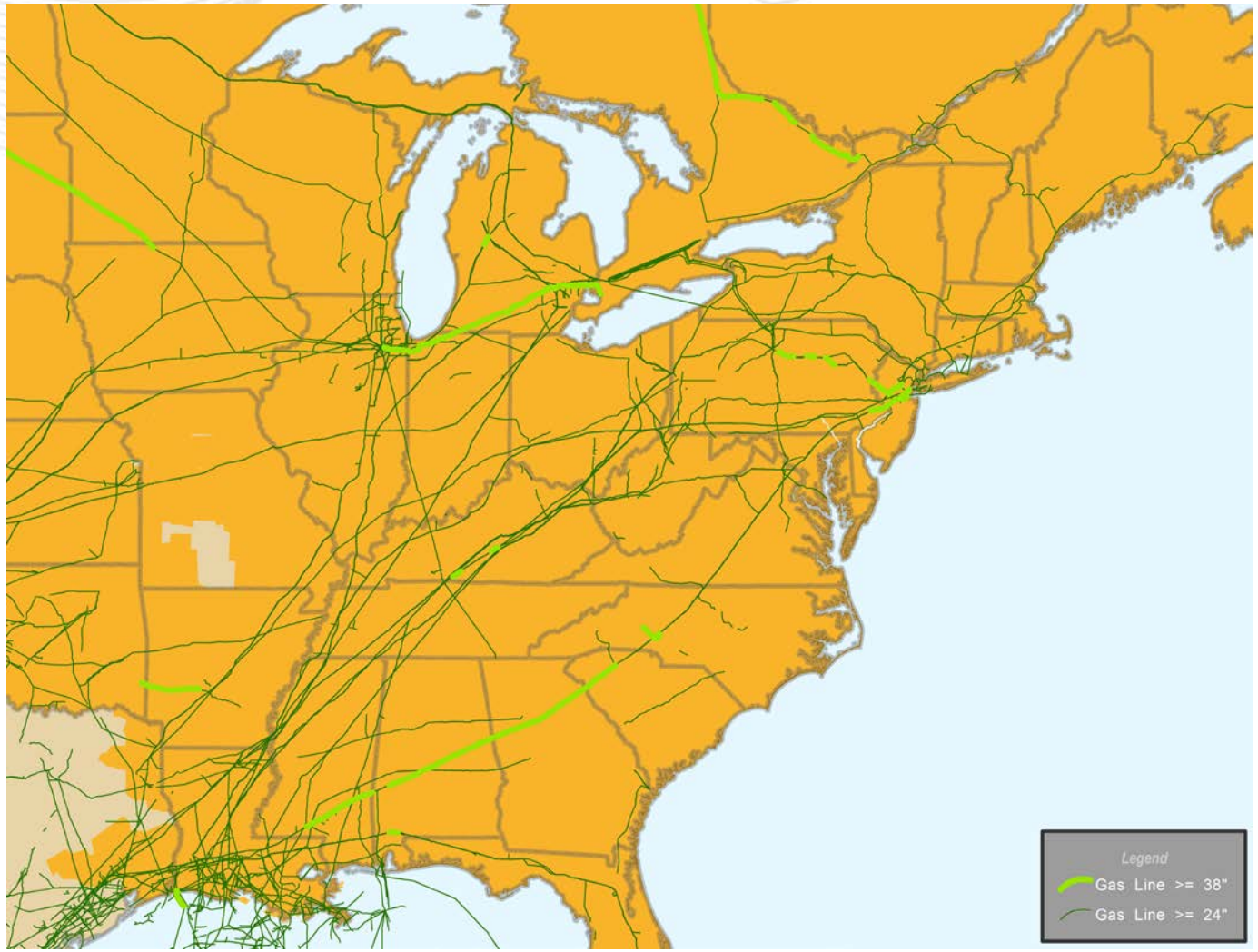
- 2014 RTEP Winter Study Overview (Last year's study)
  - Coordinated a 2019 winter case with the PJM TOs
  - Evaluated the case using the PJM Generator Deliverability and Common Mode Outage test procedures
    - The results were compared to other 2014 RTEP reliability criteria tests for overlap and shared with the TEAC
  - Also evaluated several Locational Deliverability Areas (LDAs) with high gas concentration in the load deliverability test
  - Final 2014 RTEP result: Few overloads on the local TO systems remained
  - Next Steps

2015 RTEP PJM Winter Peak Study

- Next steps for the 2015 RTEP (This year's study)
- Last Year's Study - Year 2019
- Transmission Owner Feedback and Benchmarking
  - TO Feedback: The load profile in parts of the case may need an update to meet the winter profile
- Refine the load profile
  - Check the local load models in the case and update as necessary
  - Next steps:
    - Request the updated load profile updates from TOs
    - Apply the updated load profile to 2020 winter study
    - Re-run the study with an updated load profile

Gas Infrastructure Overview

- Gas Pipeline Network
- Inter-state, Intra-state and local distribution companies
  - Local Distribution Companies (LDC)
  - Non-firm nature of LDC
  - Nearly all gas-fired generators served by an LDC in PJM and NYISO lack firm transportation rights
- Supply Points
- Compressor Stations
- Dual Fuel generation assumptions
  - Timeline to switch to alternate fuel can be significant
- Failure mode assumption of gas generation due to shortage or compressor failure
  - Gas interruption and failure of corresponding generation will occur within minutes



Gas Contingency Evaluation

- In last year's winter load deliverability study, several scenarios of gas plant outages were assumed in each of three base cases.
  - Contingency analysis was run in addition to the base generation outages
- This year, a thorough set of gas pipeline contingencies that result in 1000 MW or more of generation loss will be studied.
  - Temperature Threshold
    - At a pre-determined temperature threshold, assume that non-firm customers (i.e. non-heating demand) will be interrupted.
  - Pipeline outages or compressor failure
    - Identified multiple locations on the pipelines serving PJM's footprint, utilizing the Gas Electric Coordination Team's ArcGIS mapping system, where outages would affect 1000 MW or more.
      - Approximately 26 contingencies have been identified

Winter Peak Study Next Steps

- Complete development of the necessary models, CETO values and contingency definitions

- Begin development of a winter procedure or criteria

Artificial Island Update

Summary of Actions Taken

- Completed Siemens SSR Screening Study and follow up assessment by Exponent®

- Additional technical analysis
  - Optical Ground Wire (OPGW) and Generator GSU Tap Settings
  - Margin Testing

Continued TCSC Study and Analysis

- Siemens Power Technologies International (Siemens PTI) was contracted to perform an Sub Synchronous Resonance screening study of the Dominion 1A proposal
- Siemens SSR Screening Study
  - Available Data
    - Mass moment of inertia and torsional modes
  - Assumptions
    - Approximate two-mass modeling approach
    - Critical conditions (including system configuration and critical faults)
  - Analysis
    - PSCAD simulation and frequency scan
  - Result
    - Negative damping at the Artificial Island for several resonant frequencies

Continued TCSC Study and Analysis

- Exponent® was contracted to validate the Siemens PTI study
- Exponent's preliminary report summary:
  - Determined Siemens SSR study is inconclusive based on the study assumptions
  - Concerned with a practical safety margin to avoid resonance due to the 90% post contingency TCSC compensation level
    - Identifies that 70-80% compensation is highest in general industry practice
  - Additional study work is needed and should consider simulations in a real time digital power system simulation such as RTDS

Artificial Island Timeline

- Identify recommended solution alternative at a Tuesday, April 28, 2015 Artificial Island TEAC

- Recommendation to PJM Board Reliability Committee on Tuesday, May 19, 2015

RTEP Next Steps

Questions?

Email: RTEP@pjm.com

Revision History

- Revision History
  - Original version distributed to the PJM TEAC 4/8/2015
  - 4/9/2015
    - Slide 30, updated the supplemental s0862 to s0864.
  - 4/13
    - Slide 26, Oakland map was updated
  - 4/14
    - Slide 10,18,19, 22 and 23 – Window Tracking information updated