Transmission Expansion Advisory Committee

November 5, 2012
Issues Tracking
• Open Issues
  – None

• New Issues
2012 RTEP Scenario Analysis
2012 RTEP Scenario Analysis – High Load Forecast
PJM RTO – High Load Forecast

PJM RTO
Summer Peak Forecast

Baseline
High Economics
% Difference

Historical Load:
- Baseline: 135,000 to 185,000
- High Economics: 135,000 to 185,000

Future Load Forecast:
- Baseline: Projected to increase from 135,000 to 185,000 by 2022
- High Economics: Projected to increase from 135,000 to 185,000 by 2022

% Difference:
- Baseline: 0.0% to 4.0%
- High Economics: 0.0% to 4.0%

Future Load Forecast by Year:
- 2012: 135,000
- 2013: 140,000
- 2014: 145,000
- 2015: 150,000
- 2016: 155,000
- 2017: 160,000
- 2018: 165,000
- 2019: 170,000
- 2020: 175,000
- 2021: 180,000
- 2022: 185,000

% Difference Forecast:
- 2012: 0.0%
- 2013: 0.5%
- 2014: 1.0%
- 2015: 1.5%
- 2016: 2.0%
- 2017: 2.5%
- 2018: 3.0%
- 2019: 3.5%
- 2020: 4.0%
PJM West – High Load Forecast

PJM West
Summer Peak Forecast
### High Load Growth Scenario – CETO

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High Load Growth Scenario – Summary

• The economic high growth scenario forecast shows small increase on the load forecast over the next 10 years

• Impact to analytical study results is minimal
  – Baseline contingency analysis, generator deliverability, common mode outage analysis, and load deliverability

• CETO changes due to the high load growth is not significant given that the RTEP analysis of 2017 load deliverability did not identify any issues
• No significant new transmission projects or changes to existing projects are required by the high load growth scenario
2012 RTEP Scenario Analysis - At Risk Generation
• At-Risk MW in addition to known Deactivation Notifications

• Approximately 7,000 MW
• Purpose
  – Identify potential regional and local reliability concerns

• Overall Assumptions
  – 2017 RTEP Base Case
  – 2012 PJM Load Forecast Report
    • Include Demand Response (DR) and Energy Efficiency (EE)

• At-risk generation
  – Announced retirements
  – Coal Plant Size and Age
  – State agency feedback
  – Media publication
  – Other at-risk
At-Risk Generation

• Assumptions
  – Same as 2012 RTEP base except “at-risk” generation
  – Total 6362 MW plus Oyster Creek (614 MW) “at-risk” generation

• Analysis
  – Reliability Analysis monitored 230 kV and above facilities
    • Generator Deliverability (50/50 load level)
      – Thermal
    • Common Mode Outage test (50/50 load level)
      – Thermal
    • Load Deliverability (90/10 load level)
      – MAAC (Thermal and voltage)
      – EMAAC (Thermal and voltage)
• Results
  – PJM Mid-Atlantic Thermal Overloads
    • 4 - 500/230 kV transformers
    • >20 - 230 kV circuits
  – PJM South Thermal Overloads
    • 1 – 500/230 kV transformer
    • 6 – 230 kV circuits
  – PJM West Thermal Overloads
    • 4 – 345 kV circuits
  – EMAAC Voltage
    • Potential voltage violations for several contingencies
2012 RTEP - Renewable Portfolio Standards Scenarios
Renewable Portfolio Standards

• Overall Assumptions
  – Model the latest Renewable Portfolio Standards (RPS) state targets
    • Assume production from renewable wind
    • Update target PJM installed renewable MW requirements
    • Update installed reserve calculation

  – 2012 PJM Load Forecast Report
    • 15 Year Load Forecast
    • Include Demand Response (DR) and Energy Efficiency (EE)

  – Incorporate findings from 2011 RTEP RPS scenario studies
RPS – Scenario #1

• Assumptions
  – Assume RPS supply from PJM resources
  – 7 GW Offshore
  – Study year: 2027

• Analysis
  – Reliability Analysis
    • Generator Deliverability (50/50 load level)
    • Common Mode Outage test (50/50 load level)
  – Market Efficiency Analysis
    • Security Constrained Optimal Power Flow (SCOPF)
    • Production cost simulation using PROMOD

• Result
  – Thermally overloaded facilities
  – Congestion $‘s
  – Develop transmission overlay
Scenario #1 Reliability Constraints
• Assumptions
  – **Low GW Offshore**
  – Otherwise, same as RPS – Scenario #1 but with a low GW offshore assumption
  – The remainder of the state target RPS will be sourced from inland PJM resources
Scenario #2 Reliability Constraints
• Assumptions
  – **RPS Source from Neighboring Entities**
  – Otherwise, same as RPS – Scenario #2 (low MW offshore)
  – The remainder of the state target RPS will be sourced from inland PJM resources

• Neighboring Entities
  – Assume 40% of the PJM RPS supplied from renewable wind in the Midwest ISO (MISO)
    • Assume DC injection points from MISO to PJM
    • Injection points to PJM to be determined
Scenario #3 Reliability Constraints

Legend
- Trans Lines >= 500 kV
- Subs >= 500 kV
- Trans Lines = 345 kV
- Subs = 345 kV
- Generator Deliverability Constraints Scenario 3
- SCOPF Constraints Scenario 3
• Initial Overlay

• Developed by considering load flow analysis, SCOPF analysis, and market efficiency analysis
Preliminary RPS Transmission Overlay (Under Development)
High Voltage in PJM Operations Analysis Update
• Determined potential reactor locations
  – from historical PI data and high voltage alarm data

• Modeled and simulated reactors in several operational cases to determine the potential magnitude that is necessary to control high voltage

• Also simulated high voltage conditions and reactors in a planning case to determine system needs beyond the operational cases
Locations noted in the 5 Cases from PJM Operations
Progress Update

• Provided PJM Operations with a list of potential reactor locations and magnitude for review

• Next Steps
  – Provide TOs with a list of potential reactor locations and magnitude for review
  – Coordinate PJM Operations and PJM TO input
  – Develop recommendation
Generation Deactivation Notification (Retirements) Update
Generation Deactivation Notifications

- **Yorktown 2**
  - Dominion Transmission Zone
  - 165 MW
  - Notification received 10/11/2012
  - Anticipated deactivation date 12/31/2014
  - Reliability analysis underway

- **Schuylkill Unit 1**
  - PECO Transmission Zone
  - 166 MW
  - Notification received 10/31/2012
  - Anticipated deactivation date 2/1/2013
  - Reliability analysis underway

- **Schuylkill Diesel**
  - PECO Transmission Zone
  - 3 MW
  - Notification received 10/31/2012
  - Anticipated deactivation date 2/1/2013
  - Reliability analysis underway

- **Riverside 6**
  - BGE Transmission Zone
  - 118 MW
  - Notification received 10/31/2012
  - Anticipated deactivation date 6/1/2014
  - Reliability analysis underway
Ohio Area Deactivation Upgrade Alternative Analysis
- No Alternative – Just PJM Board Approved Upgrades
  - Marysville – South Amherst 765 kV
    - Also includes 2-5 miles of 345 kV from South Amherst – Beaver 345 kV
  - Trivalley – South Amherst 765 kV
    - Trivalley will intersect Kammer – Vassell 765 kV near Conesville 345 kV
    - Also includes 2-5 miles of 345 kV from South Amherst – Beaver 345 kV
  - Conesville – Beaver 345 kV
  - Conesville – Harmon 345 kV
  - Beaver Valley - Leroy Center 345kV + Mansfield – Leroy Center 345kV line
• Complete:
  – Voltage Stability
  – Baseline Contingency Analysis, Generator Deliverability, Common Mode Outage Analysis, N-1-1 Thermal analysis completed
  – Multiple criteria violations identified in the base case

• In-progress:
  – N-1-1 Voltage
Future Considerations

- Cleveland area voltage stability margin
- Scenario Analysis
- Load growth
- Generation interconnection analysis
- Other Criteria
  - Transient voltage recovery criteria
  - Light load reliability criteria analysis
Next Steps

• Resolve 2017 base case violations

• Voltage stability sensitivity analysis
Reliability Analysis Update
DEOK Transmission Zone

- **Project Replacement** -- Increased reliability and operational flexibility at a lower cost.

- **New Projects:**
  - Convert Summerside 138 kV substation to a ring bus, tap the Oakley-Beckjord 138 kV line and extend into Summerside. $5.44M (B2164)
  - Install 0.5% reactor in the Red Bank-Oakley 138 kV line. $0.643M (B2167)
  - Convert Tobasco 138 kV substation to a ring bus. $1.87 M (B2177)
  - Move the 138 kv Cornell line tap from the Dimmick-Socialville line section to the Port Union-Summerside line. $0.442M (B2178)
  - Expected IS Date: 6/1/2014

- **Cancel Projects:**
  - B1707.1: Add a 138/69 kV transformer at Newtown substation - $8M
  - B1707.2: Add a new 69 kV line Newtown - Mt. Washington
  - B1707.3: Add a new 69 kV line Newtown - Bershire
  - B1707.4: Reconfigure the 69 kV loop
  - B1574: Reconductor 6 miles of the Port Union - Dimmick 138 kV circuit and the Dimmick - Cornell Tap 138 kV circuit with 954 ACSR conductor - $1.85M
  - Expected IS Date: 6/1/2014
• The Waneeta 230 kV breakers 015, 035, 875 and 895 are overstressed

• Proposed Solution: Replace Waneeta 230 kV breakers 015, 035, 875 and 895 with 63kA rated breakers (B2130 -2133).

• Estimated Project Cost: $281 K per breaker

• Expected IS Date: 06/01/2017
• The Plymouth Meeting 230 kV breaker 115 is overstressed
• Proposed Solution: Replace Plymouth Meeting 230 kV breaker 115 with 63kA rated breaker (B2134).
• Estimated Project Cost: $289 K
• Expected IS Date: 06/01/2017
Proposed 2011 RTEP Upgrades presented at Previous TEAC meetings
Baseline upgrade solutions in this presentation (with the exception of EKPC) will be proposed to the PJM Board in December 2012 for approval and inclusion in the RTEP.

Network upgrade solutions (associated with interconnection projects) that are included with today’s posted TEAC materials (11/5/2011) will be Proposed to the PJM Board in December 2012 for approval and inclusion in the RTEP.

EKPC mitigation plans will continue to be reviewed with the TEAC and will be presented to the PJM Board for approval following the planned June 1, 2013 EKPC integration.
• Generation Deliverability:
• The Corson – Tuckahoe 69 kV circuit is overloaded for tower contingency loss of the BL England – Scull – Mill 138 kV circuits #1 and #2.
• Proposed Solution:
  Re-build 5.3 miles of the Corson – Tuckahoe 69 kV circuit (B2157).
• Estimated Project Cost: $4,505 M
• Expected IS Date: 6/1/2017
• **Project Cancellation**

  • B1811.1 and B1811.2 need to be canceled. They are not needed with the project B2017.

  • B1811.1: Perform a sag study of 4 miles of the Waterford - Muskingum line  IS Date: 6/1/2016 (Cancel)

  • B1811.2: Rebuild 0.1 miles of Waterford - Muskingum 345 kV with 1590 ACSR IS Date: 6/1/2016 (Cancel)

  • B2017: Reconductor or rebuild Sporn - Waterford - Muskingum River 345 kV line IS Date: 6/1/2015
AEP Transmission Zone

- AEP Criteria Violation

- Loss of either the Merrimac 138 kV Tap, 138/69 kV Merrimac Transformer or North Blacksburg 138/69 kV transformer causes an overload of the South Christiansburg-Cambria 69 kV line section

- Build a new 138 kV line from Falling Branch to Merrimac and add a 138/69 kV transformer at Merrimac Station (B2135)

- Estimated Project Cost: $25M

- Expected IS date: 06/01/2015
• Project Scope Change – B1502

• Old Scope: Reconductor the Conesville East – Conesville Prep Plant Tap 138 kV section of the Conesville – Ohio Central 138KV line

• Old Estimated Project Cost: $2M

• New Scope: Perform a sag study of the Prep Plant Tap - Conesville East 138 kV

• Estimated Project Cost: $0.006M

• Expected IS date: 06/01/2013
• Duplicated projects: B1870 and B2052

• Cancel B2052

• B1870: Replace the Ohio Central transformer #1 345/138/12 kV 450 MVA for a 345/138/34.5 kV 675 MVA transformer

• Previous Estimated Project Cost: $8M
• Updated Estimated Project Cost: $10M

• Expected IS date: Advance from 6/1/2015 to 12/31/2013
The George Washington 138 kV breaker 'A' is overstressed

Proposed Solution: Replace George Washington 138 kV breaker 'A' with 63kA rated breaker (b2069)

Estimated Project Cost: $800 K

Expected IS Date: 06/01/2013
• The Tanner Creek 345 kV breakers ‘P’, ‘P2’, and ‘Q1’ are overstressed
• Proposed Solution: Replace Tanner Creek 345 kV breakers with 63kA rated breakers (b2084 - b2086)
• Estimated Project Cost: $1.3 M per breaker
• Expected IS Date: 06/01/2013
• The George Washington 138 kV breaker 'B' is overstressed
• Proposed Solution: Replace George Washington 138 kV breaker 'B' with 63kA rated breaker (b2092)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
AEP Transmission Zone

- The Harrison 138 kV breaker '6C' is overstressed
- Proposed Solution: Replace Harrison 138 kV breaker '6C' with 63kA rated breaker (b2070)
- Estimated Project Cost: $800 K
- Expected IS Date: 06/01/2013
• The Lincoln 138 kV breaker 'L' is overstressed
• Proposed Solution: Replace Lincoln 138 kV breaker 'L' with 63kA rated breaker (b2071)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
The Natrium Plant 138 kV breaker 'I' is overstressed

Proposed Solution: Replace Natrium Plant 138 kV breaker 'I' with 63kA rated breaker (b2072)

Estimated Project Cost: $800 K

Expected IS Date: 06/01/2013
- The Natrium Plant 138 kV breaker 'K' is overstressed
- Proposed Solution: Replace Natrium Plant 138 kV breaker 'K' with 63kA rated breaker (b2083)
- Estimated Project Cost: $800 K
- Expected IS Date: 06/01/2013
The Darrah 138 kV breaker 'B' is overstressed

Proposed Solution: Replace Darrah 138 kV breaker 'B' with 63kA rated breaker (b2073)

Estimated Project Cost: $800 K

Expected IS Date: 06/01/2013
• AEP Criteria Violation

• Loss of either the Merrimac 138 kV Tap, 138/69 kV Merrimac Transformer or North Blacksburg 138/69 kV transformer causes an overload of the South Christiansburg-Cambria 69 kV line section

• Build a new 138 kV line from Falling Branch to Merrimac and add a 138/69 kV transformer at Merrimac Station (B2135)

• Estimated Project Cost: $25M

• Expected IS date: 06/01/2015
AEP Transmission Zone

- Project Scope Change – B1502

- Old Scope: Reconductor the Conesville East – Conesville Prep Plant Tap 138 kV section of the Conesville – Ohio Central 138KV line

- Old Estimated Project Cost: $2M

- New Scope: Perform a sag study of the Prep Plant Tap - Conesville East 138 kV

- Estimated Project Cost: $0.006M

- Expected IS date: 06/01/2013
• Duplicated projects: B1870 and B2052

• Cancel B2052

• B1870: Replace the Ohio Central transformer #1 345/138/12 kV 450 MVA for a 345/138/34.5 kV 675 MVA transformer

• Previous Estimated Project Cost: $8M
• Updated Estimated Project Cost: $10M

• Expected IS date: Advance from 6/1/2015 to 12/31/2013
• The Harrison 138 kV breaker '6C' is overstressed
• Proposed Solution: Replace Harrison 138 kV breaker '6C' with 63kA rated breaker (b2070)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
• The Lincoln 138 kV breaker 'L' is overstressed
• Proposed Solution: Replace Lincoln 138 kV breaker 'L' with 63kA rated breaker (b2071)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
• The Natrium Plant 138 kV breaker 'I' is overstressed
• Proposed Solution: Replace Natrium Plant 138 kV breaker 'I' with 63kA rated breaker (b2072)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
- The Darrah 138 kV breaker 'B' is overstressed
- Proposed Solution: Replace Darrah 138 kV breaker 'B' with 63kA rated breaker (b2073)
- Estimated Project Cost: $800 K
- Expected IS Date: 06/01/2013
• The Wyoming 138 kV breakers 'G', 'G1', 'G2', 'H', 'H1', 'H2', 'J', 'J1', and 'J2' are overstressed

• Proposed Solution: Replace Wyoming 138 kV breakers with 80kA rated breakers (b2074-b2082)

• Estimated Project Cost: $1 M per breaker

• Expected IS Date: 06/01/2013
The Tanner Creek 345 kV breakers 'P', 'P2', and 'Q1' are overstressed.

Proposed Solution: Replace Tanner Creek 345 kV breakers with 63kA rated breakers (b2084-b2086).

Estimated Project Cost: $1.3 M per breaker.

Expected IS Date: 06/01/2013.
The Wyoming 138 kV breakers 'G', 'G1', 'G2', 'H', 'H1', 'H2', 'J', 'J1', and 'J2' are overstressed.

Proposed Solution: Replace Wyoming 138 kV breakers with 80kA rated breakers (b2074-b2082).

Estimated Project Cost: $1M per breaker.

Expected IS Date: 06/01/2013.
• The Tanner Creek 345 kV breakers 'P', 'P2', and 'Q1' are overstressed

• Proposed Solution: Replace Tanner Creek 345 kV breakers with 63kA rated breakers (b2084-b2086)

• Estimated Project Cost: $1.3 M per breaker

• Expected IS Date: 06/01/2013
• The South Bend 138 kV breaker 'T' is overstressed
• Proposed Solution: Replace South Bend 138 kV breaker 'T' with 63kA rated breaker (b2087)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
The Tidd 138 kV breakers 'L' and 'M2' are overstressed

Proposed Solution: Replace Tidd 138 kV breakers with 63kA rated breakers (b2088 & b2089)

Estimated Project Cost: $800 K per breaker

Expected IS Date: 06/01/2013
The McKinley 138 kV breaker 'A' is overstressed.

Proposed Solution:
Replace McKinley 138 kV breaker 'A' with 40kA rated breaker (b2090).

Estimated Project Cost: $800 K

Expected IS Date: 06/01/2013
The West Lima 138 kV breaker 'M' is overstressed

Proposed Solution:
Replace West Lima 138 kV breaker 'M' with 63kA rated breaker (b2091)

Estimated Project Cost:
$800 K

Expected IS Date:
06/01/2013
• The Turner 138 kV breaker 'W' is overstressed
• Proposed Solution: Replace Turner 138 kV breaker 'W' with 63kA rated breaker (b2093)
• Estimated Project Cost: $800 K
• Expected IS Date: 06/01/2013
• The Kammer 138 kV breaker ‘E’ is overstressed
• Significant Driver: Add two additional 345/138kV Kammer (b1864.1)
• Proposed Solution: Replace Kammer 138 kV breaker ‘E’ (b1864.3)
• Estimated Project Cost: $1 M
• Expected IS Date: 06/1/2016
AEP Transmission Zone

- Significant Driver: Add 345/138 transformer at Sporn, Kanawah River & Muskingum River stations (b2021)
- Proposed Solution: Replace Muskingum 138 kV breakers (b2021.2-b2021.7)
- Estimated Project Cost: $700 K per breaker
- Expected IS Date: 06/1/2015
The Sporn 138 kV breakers D1', D2', F', F2', G', G2', and N1' are overstressed.

**Significant Driver:** Add 345/138 transformer at Sporn, Kanawah River & Muskingum River stations (b2021)

**Proposed Solution:** Replace Sporn 138 kV breakers (b2021.8-b2021.14)

**Estimated Project Cost:** $1 M per breaker

**Expected IS Date:** 06/1/2015
The Kanawha River 138 kV breakers ‘M’, and ‘L’ are overstressed

Significant Driver: Add 345/138 transformer at Sporn, Kanawha River & Muskingum River stations (b2021)

Proposed Solution: Replace Kanawha 138 kV breakers (b2021.15 & b2021.1)

Estimated Project Cost: $700 K per breaker

Expected IS Date: 06/1/2015
AEP Transmission Zone

- Generator Deliverability Violation

- U4-038 Tap – Grant 138kV line is overload for the Rose Hill – Linwood-South Elwood – Mullin 138kV line with stuck breaker at ROSEHI 138kV bus or the Linwood –South Elwood – Mullin 138kV line with stuck breaker at the SELWOO 138kV bus

- Add a fourth circuit breaker to the station being built for the U4-038 project, tentatively called Conelley station. Rebuild the U4-038 - Grant Tap line as a double circuit tower line to eliminate the hard tap on the line and create separate circuits between U4-038 - Fisher Body and U4-038 - Deer Creek. (B2160)

- Estimated Cost: $15M

- Required IS Date: 06/01/2017
AEP Transmission Zone

• Common Mode Violation

• Timer Switch– Tillman 138kV line, T131 TAP – Allen 138kV line, and Tillman – Allen 138kV line are overload for various category C contingencies

• Rebuilding approximately 20 miles of the Allen – S073 double circuit 138 kV line (with one circuit from Allen - Tillman - Timber Switch - S073 and the other circuit from Allen - T-131 - S073) utilizing 1033 ACSR (B2161)

• Estimated Cost: $60M

• Required IS Date: 06/01/2017
• Common Mode Violation

• The Belpre - Degussa 138 kV line is overload for the tower outage of the Edgelawn – Belmont 138kV line and the Edgelawn – Trissler 138kV line

• Perform a sag study to improve the emergency rating of the Belpre - Deguss 138 kV line (B2162)

• Estimated Cost: $0.01M

• Required IS Date: 06/01/2017
• Common Mode Violation

• The Desoto - Jay 138 kV line is overload for the tower outage of the Desoto – Keystone 345kV line, the Desoto – Sorenson 345kV line #2 and the Desoto – Tanner 345kV line

• Replace breaker and wavetrap at Jay 138 kV station (B2163)

• Estimated Cost: $0.3 M

• Required IS Date: 06/01/2017
• The Wylie Ridge 345 kV breakers 'WK-1' through 'WK-6' are overstressed
• Proposed Solution: Replace Wylie Ridge 345 kV breakers with 63kA rated breakers (b2106-b2110, b2112)
• Estimated Project Cost: $808 K per breaker
• Expected IS Date: 06/01/2017
The Wylie Ridge 138 kV breaker 'WK-7' is overstressed

Proposed Solution: Replace Wylie Ridge 138 kV breaker with 63kA rated breaker (b2111)

Estimated Project Cost: $250 K

Expected IS Date: 06/01/2017
• N-1-1 Thermal Violation

• The Feagan’s Mill–Stonewall 138kV line is overloaded for the loss of the Double Toll Gate – Old Chapel 138kV line and the loss of the Bedington – Sheperdstown 138kV line

• Replace 800A wave trap at Stonewall with a 1200 A wave trap. (B2165)

• Estimated Cost: $0.07M

• Required IS Date: 6/1/2016
• **N-1-1 Thermal Violation**

• The Millville – Sleepy Hollow 138kV line is overloaded for various pairs of contingencies

• Reconduct the Millville – Sleepy Hollow 138kV 4.25 miles of 556 ACSR with 795 ACSR, upgrade line risers at Sleepy Hollow, and change 1200 A CT tap at Millville to 800. (B2166)

• Estimated Cost: $2.7M

• Required IS Date: 6/1/2016
• N-1-1 Thermal Violation

• Voltage drop violations at Craigsville, Crupperneck, Enon Tap, Gilboa, Grassy Falls, Jones Branch, Nettie, Powell Mountain and Summersville 138kV buses for various contingency pairs

• For Grassy Falls 138kV Capacitor bank adjust turn-on voltage to 1.0pu with a high limit of 1.04pu, For Crupperneck and Powell Mountain 138kV Capacitor Banks adjust turn-on voltage to 1.01pu with a high limit of 1.035pu. (B2168)

• Estimated Cost: $0.0M

• Required IS Date: 6/1/2016
• Project Cancellation

• Cancel B1942: Change the CT ratio at Millville to improve the Millville – Old Chapel 138 kV line ratings

• Estimated Cost: $0.05M

• Advance B1835 from 06/01/2016 to 06/01/2015

• B1835: Reconductor 14.3 miles of 556 ACSR with 795 ACSR from Old Chapel to Millville 138 kV and upgrade line risers at Old Chapel 138 kV and Millville 138 kV and replace 1200 A wave trap at Millville 138 kV
• FE Criteria Violation

• Low voltage and voltage drop violations at Kiesters 138kV for the loss of Krendale – Kiesters line

• **McDowell Substation** - Add a new 138 kV line exit - $1.8 M (B2124.1)
  **Campbell Substation** - Construct a 138 kV ring bus and install a 138/69 kV autotransformer - $5.4 M (B2124.2)
  **Kiesters Substation** - Add new 138 kV line exit and Install a 138/25 kV transformer - $3.5 M (B2124.3)
  **McDowell – Campbell 138 kV** - Construct approximately 5.5 miles of 138 kV line - $5.2 M (B2124.4)
  **Campbell – Kiesters 138 kV** - Convert approximately 7.5 miles of 69 kV to 138 kV - $3.9 M (B2124.5)

• Total Estimated Project Cost is: $19.8M

• Expected IS date: 06/01/2016
• The Weirton 138 kV breaker ‘2&5 XFMR’ is overstressed
• Proposed Solution: Revise the reclosing of Weirton 138 kV breaker ‘2&5 XFMR’ (b2096)
• Expected IS Date: 06/01/2016
• Common Mode Violation

• The Yukon – Smithton 138KV line is overloaded for the loss of the tower lines: the Yukon – Charleroi 138kV line and Yukon – Westraver 138kV line; or the loss of the tower lines: the Yukon – Charleroi 138kV line and Charleroi – Westraver 138kV line

• Replace/Raise structures on the Yukon-Smithton 138 kV line section to eliminate clearance de-rate. (New line rating will be 293 /332 MVA ) (B2169)

• Estimated Cost: $0.06

• Required IS Date: 6/1/2017
• Common Mode Violation

• The Smithton – Shepler Hill Jct 138KV line is overloaded for the loss of the tower lines: the Yukon – Charleroi 138kV line and Yukon – Westraver 138kV line; or the loss of the tower lines: the Yukon – Charleroi 138kV line and Charleroi – Westraver 138kV line

• Replace/Raise structures on the Smithton-Shepler Hill Jct 138 kV line section to eliminate clearance de-rate. (New line rating will be 296 /354 MVA) (B2170)

• Estimated Cost: $0.116

• Required IS Date: 6/1/2017
• Common Mode Violation

• The Parson – William 138KV line is overloaded for the Albright tie breaker failure

• Replace/Raise structures on the Parsons-William 138 kV line section to eliminate clearance de-rate. (New line rating will be 152/179 MVA ) (B2171)

• Estimated Cost: TBD

• Required IS Date: 6/1/2017
• **Common Mode Violation**

• The Parson – Loughs Lane 138KV line is overloaded for the Albright tie breaker failure

• Replace/Raise structures on the Parsons - Loughs Lane 138 kV line section to eliminate clearance de-rate. (New line rating will be 152/179 MVA ) (B2172)

• Estimated Cost: TBD

• Required IS Date: 6/1/2017
• Basecase Analysis Violation

• Voltage drop violation at Dale Summit, Milesburg, and Shingletown 230KV buses for various contingencies

• Install a 75 MVAR 230 kV capacitor at Shingletown Substation.(B2173)

• Estimated Cost: $0.19M

• Required IS Date: 6/1/2017
• The Weirton 138 kV breaker "Wylie Ridge 210" and "Wylie Ridge 216" are overloaded
• Proposed Solution: Replace Weirton 138 kV breakers (b2142 & b2143)
• Estimated Cost: TBD
• Expected IS Date: 06/01/2017
• Project Cancellation

• Cancel B0560: Install a 250 MVAR capacitor at Kemptown 500 kV

• Cost Estimate: $4M

• With the cancellation of the PATH Project, this substation, and the associated capacitor bank, will not be constructed.
• Project Cancellation
• Cancel B0560: Install a 250 MVAR capacitor at Kemptown 500 kV
• Cost Estimate: $4M
• With the cancellation of the PATH Project, this substation, and the associated capacitor bank, will not be constructed.
- Basecase Analysis Violation
- Voltage drop violation at Dale Summit, Milesburg, and Shingletown 230KV buses for various contingencies
- Install a 75 MVAR 230 kV capacitor at Shingletown Substation. (B2156)
- Cost Estimate: $0.19M
- Required IS Date: 6/1/2017
• The Weirton 138 kV breakers "SToronto 226", "No.6 Xfmr", and "Tidd224" are overstressed

• Proposed Solution: Replace Weirton 138 kV breakers with 63kA rated breakers (b2095, b2113, & b1408)

• Estimated Project Cost: $800 K per breaker

• Expected IS Date: 06/01/2013
• The Ridgeley 138 kV breakers '#2 XFMR OCB', 'WC 4', and '#1 XFMR OCB' are overstressed

• Proposed Solution: Replace Ridgeley 138 kV breakers with 40kA breakers (b2097, b2100, b2101)

• Estimated Project Cost: $800 K per breaker

• Expected IS Date: 06/01/2013
• The Ridgeley 138 kV breakers ‘AR3’ and ‘AC1’ are overstressed
• Proposed Solution: Revise the reclosing of the Ridgeley 138kV breakers (b2098 & b2099)
• Expected IS Date: 06/01/2013
• The Armstrong 138 kV breakers 'GARETTRJCT', 'BURMA', 'KITTANNING', and 'KISSINGERJCT' are overstressed

• Proposed Solution: Replace Armstrong 138 kV breakers with 40kA breakers (b2102-b2105)

• Estimated Project Cost: $900 K per breaker

• Expected IS Date: 06/01/2013
- The Armstrong 138 kV breaker 'Bus-Tie' is overstressed
- Proposed Solution: Replace Armstrong 138 kV breaker 'Bus-Tie' (Status On-Hold pending retirement) (b2114)
- Estimated Project Cost: TBD
- Expected IS Date: 06/01/2013
• Overdutied 138kV breakers at Cabot
• Proposed Solution: Revise the reclosing of Cabot 138 kV breaker 'C9-KISKI VLY' (b1409)
• Estimated Project Cost: $10 K
• Expected IS Date: 06/01/2016
• The Evergreen 138 kV breakers ‘2801-B-16’, ‘2801-B-20’, ‘2801-B-21’, ‘2801-B-21’, ‘2801-B-65’, and ‘2801-B-6’ are overstressed
• Significant Driver: Build a new 345/138 kV Substation at Niles (b1934)
• Proposed Solution: Revise reclosing of Evergreen breakers (b1934.22-b1934.26)
• Expected IS Date: 06/1/2015
• The Allen Junction 138 kV breakers 'MECS/TR1:3', 'MIDWAYMECS', and 'MIDWAY/MECS', and 'MIDWAY/TR1' are overstressed

• Significant Driver: Install a 2nd 345/138 kV transformer at the Allen Junction station (b1921)

• Proposed Solution: Replace Allen Junction 345 kV breakers with 40kA breakers (b1921.1-b1921.3)

• Estimated Project Cost: $350 K per breaker

• Expected IS Date: 06/01/2014
• The Bluebell 138 kV breaker '301-B-15' is overstressed
• Significant Driver: Create a new Harmon 345/138/69 kV substation by looping in the Star – South Canton 345 kV line (b1925)
• Proposed Solution: Replace Bluebell 138 kV breaker '301-B-15' with 40kA breaker (b1925.1)
• Estimated Project Cost: $180 K
• Expected IS Date: 06/01/2015
• The Longview 138 kV breakers '651-B-219' and '651-B-32' are overstressed

• Significant Driver: Build a new Harmon – Brookside + Harmon - Longview 138 kV line (b1926)

• Proposed Solution: Replace Longview 138 kV breakers with 40kA breakers (b1926.1-b1926.2)

• Estimated Project Cost: $180 K per breaker

• Expected IS Date: 06/01/2015
• The Evergreen 138 kV breaker '2801-B-20' is overstressed
• Significant Driver: Build a new 345/138 kV Substation at Niles
• Proposed Solution: Revise the reclosing of Evergreen 138 kV breaker '2801-B-20' (b1934.23)
• Estimated Cost: $0.03M
• Expected IS Date: 06/01/2015
• The Avon Lake 138 kV breaker '2045-B-5', '2045-B-6', '2045-B-7', and '2045-B-8' are overstressed

• Proposed Solution: Replace Avon Lake 138 kV breakers (b2152-b2155)

• Estimated Cost: TBD

• Expected IS Date: TBD
• The Bluebell 138 kV breakers ‘301-B-11,’ ‘301-B-9,’ ‘301-B-187,’ ‘301-B-206,’ and ‘301-B-10’ are overstressed.

• Proposed Solution: Replace Bluebell 138 kV breakers ‘301-B-11,’ ‘301-B-9,’ ‘301-B-187,’ ‘301-B-206,’ and ‘301-B-10’ (b2059-b2063)

• Estimated Project Cost: $180 K per breaker

• Expected IS Date: 06/1/2013
• The Knox 138 kV breaker \(307\text{-B-10}'\) is overstressed
• Proposed Solution: Replace Knox 138 kV breakers 307-B-10' (b2064)
• Estimated Project Cost: $0.18 M
• Expected IS Date: 06/1/2013
The Niles 138 kV breaker '170-B-10' is overstressed

Significant Driver: Build a new 345/138 kV Substation at Niles (b1934)

Proposed Solution: Replace Niles 138 kV breaker '170-B-10' with 63kA breaker (b1934.10)

Estimated Project Cost: $230 K

Expected IS Date: 06/01/2015
• The Salt Springs 138 kV breakers '105-B-2', '105-B-40', '105-B-42', '105-B-45', '105-B-56', '105-B-58', '105-B-170', '105-B-192', and 'Bay' are overstressed

• Significant Driver: Build a new 345/138 kV Substation at Niles (b1934)

• Proposed Solution: Replace Salt Springs 138 kV breakers with 63kA breakers (b1934.11-b1934.19)

• Estimated Project Cost: $230 K per breaker

• Expected IS Date: 06/01/2015
• The Wickliffe 138 kV breaker '144-B-103' is overstressed
• Significant Driver: Build a new 345/138 kV Substation at Niles (b1934)
• Proposed Solution: Replace Wickliffe 138 kV breaker '144-B-103' with 40kA breaker (b1934.20)
• Estimated Project Cost: $180 K
• Expected IS Date: 06/01/2015
The Evergreen 138 kV breaker '802-B-93' is overstressed

Significant Driver: Build a new 345/138 kV Substation at Niles (b1934)

Proposed Solution: Revise the reclosing of Evergreen 138 kV breaker '802-B-93' (b1934.21)

Estimated Project Cost: $30 K

Expected IS Date: 06/01/2015
• The Niles 138 kV breakers '170-B-11', '170-B-19', '170-B-20', '170-B-9', '170-B-97', '170-B-16', and '170-B-19' are overstressed

• Significant Driver: Build a new 345/138 kV Substation at Niles (b1934)

• Proposed Solution: Replace Niles 138 kV breakers with 63kA breakers (b1934.3-b1934.9)

• Estimated Project Cost: $230 K per breaker

• Expected IS Date: 06/01/2015
• The Brookside 138 kV breakers '701-B-128', '701-B-135', '701-B-206', '701-B-28', '701-B-3', '701-B-30', '701-B-31', '701-B-36', '701-B-40', and '701-B-7' are overstressed.

• Significant Driver: ATSI-AEP 138 kV Substation (Brubaker) on near territory border + 138 kV from new substation to Longview approx. 8 miles (b1935)

• Proposed Solution: Revise the reclosing of Brookside 138 kV breakers (b1935.1-b1935.10)

• Estimated Project Cost: $30 K per breaker

• Expected IS Date: 06/01/2015
ComEd Transmission Zone

- Project Change

- Delay the Expected IS Date for B0693 & B0694 from 06/01/2013 to 06/01/2014 due to issues with acquiring the necessary land.
  - B0693: Add 115.2 MVAR capacitor at Crawford 138 kV "Blue"
  - B0694: Add 115.2 MVAR capacitor at Crawford 138 kV "Red"

- Advance the Expected IS Date for B0738 & B0739 from 06/01/2014 to 06/01/2013
  - B0738: Add 115.2 MVAR capacitor at Burnham 138 kV "Red"
  - B0739: Add 115.2 MVAR capacitor at Burnham 138 kV "Blue"
ComEd Transmission Zone

- Light Load Violation
- Dixon – McGir 138kV Red line (L10714) is overloaded for the loss of the Haumesser Road - W. DE Kalb-Glidden 138KV line (L11323)
- Reconductor 25 miles of 138 kV line 10714 from Dixon to McGirr Road and replace line traps on each end. B(2119)
- Estimated Project Cost: $30.4M
- Expected IS date: 12/31/2016
• Light Load Violation

• The Haumesser Road - W. Dekalb - Glidden - Waterman 138kV Blue line (L11323) is overloaded in base case

• Reconductor 8.9 miles of 138 kV line 11323 from Waterman to Glidden
• Replace CB 3-4 at Glidden
• Reconductor two spans of conductor between Haumesser Road and Waterman also on line 11323. (B2128)

• Estimated Project Cost: $12.5M
• Expected IS date: 12/31/16
ComEd Transmission Zone

- Convert Supplemental project to a baseline project due to the deactivation of Fisk and Crawford, failure of ComEd dynamic voltage recovery criteria

- Convert supplemental upgrade S0395 to baseline upgrade B2127
  - B2127 - Install two 300 MVAR SVCs on the 138kV red and blue buses at Prospect Heights substation

- Estimated Project Cost: $75M

- Expected IS date: 06/01/2014
DAYTON Transmission Zone

- Basecase Analysis Violation

- Voltage Drop Violation at Stuart 138KV bus for the loss of the Stuart – Hillcrest 138KV line with the stuck breaker at the Stuart 138kV bus or the loss of the Stuart – Clinton 345kV line with the stuck breaker at the Stuart 345kV bus

- Change the tap setting on the Stuart 345/138kV transformer from 1.00pu to 1.025pu (B2176)

- Estimated Cost: $0.0M

- Required IS Date: 6/1/2017
**DEOK Transmission Zone**

- The Fairfield 138 kV breakers ‘860’ and ‘872’ are overstressed
- Significant Driver: Create a ring at Fairfield 138 kV substation (b1726)
- Proposed Solution: Replace Fairfield 138 kV breakers (b1726.3 & b1726.4)
- Estimated Project Cost: $320 K per breaker
- Expected IS Date: 06/01/2016
• The Terminal 138 kV breakers ‘903’ and ‘910’ are overstressed
• Proposed Solution: Replace Terminal 138 kV breakers with 63kA breaker (b2067 & b2068)
• Estimated Project Cost: $320 K per breaker
• Expected IS Date: 06/01/2016
• The Terminal 138 kV breaker ‘908’ is overstressed

• Proposed Solution: Revise the reclosing of Terminal 138kV breaker ‘908’ (b2094)

• Expected IS Date: 06/01/2016
**DLCO Transmission Zone**

- **Generator Deliverability/ Common Mode Violation**
  - The Mitchell – Elrama 138kV line is overloaded for the loss of the Keystone – South Bend 500kV line; The Dravosburg – West Mifflin 138kV line is overloaded for the tower outage of the Dravosburg – West Mifflin 138kV line #2 and the Elrama – Dravosburg 138kV line
  - Convert the Wilson 69kV substation to 138kV
  - Extend the Elrama-Mitchell 138kV circuit to Wilson substation by converting the 69kV lines between Elrama and Wilson to 138kV
  - Convert the 69kV lines between Dravosburg and Wilson to 138kV and create a new Dravosburg-Wilson 138kV circuit.
  - Combine the Bethel Park-Elrama and Elrama-West Mifflin 138kV circuits and loop through the Wilson 138kV substation creating a Bethel Park-Wilson 138kV circuit and a West Mifflin-Wilson 138kV circuit.
  - Combine the Piney Fork-Elrama and Elrama-Clairton 138kV circuits to create a Piney Fork-Clairton 138kV circuit.
  - Bifurcate the Dravosburg-West Mifflin 138kV circuit utilizing the conductors of the Elrama-Dravosburg 69kV circuit.
  - Retire the Elrama 138/69kV substation and the Elrama-Dravosburg 138kV circuit.
  - (B2174)

- Estimated Cost: $16.4M
- Expected IS Date: 6/1/2015
• Basecase Analysis Violation

• High voltage violation at Brunot Island, Carson, Arsenal, and Logan’s Ferry 345kV buses for the tower outage of the Crescent – Brunot Island 345kV line and the Brunot Island – Collier 345kV line

• Perform a High Voltage Study to determine the optimal configuration of the shunt reactors or another reactive compensation solution (B2175)

• Estimated Cost: $0.05M

• Expect IS Date: 3/1/2013
• Northern Virginia

• Operational Performance:
  – Dominion Virginia Power continues to experience high voltage on the 230kV transmission system in Northern Virginia during periods of light system load.
  – Light load studies identified the need for three additional shunt reactor banks.

• Proposed Solution:
  – Install four additional 230kV 100MVAR variable shunt reactor banks at Clifton Substation, Gallows Road Substation, Garrisonville, and Virginia Hills Substations.

• Total Estimated Cost:
  $24 M

• Expected In-Service Date:
  Fall 2013
• Eastern Virginia

• Operational Performance:
  – Dominion Virginia Power continues to experience high voltage on the 230kV transmission system in Eastern Virginia during periods of light system load.
  – Light load studies identified the need for two additional shunt reactor banks.

• Proposed Solution:
  – Install two additional 230kV 100MVAR variable shunt reactor banks at Churchland and Shawboro Substations

• Total Estimated Cost: $12 M

• Expected In-Service Date: Spring 2014
• **Project Scope/Cost Change**

  - **Reason:** B2174 changes the line configuration, the segment of the new line needs to be reconducted
  
  - **B1985 Old Scope:** Upgrade the Duquesne portion of the Elrama – Mitchell 138 kV line
  
  - **B1985 New Scope:** Reconductor a portion of the Mitchell-Wilson 138kV line

  - **Old Estimated Cost:** $3.1M

  - **New Estimated Cost:** $4.4M

  - **Expected IS Date:** 4/16/2015
Dominion Transmission Zone

- Existing PJM project (b1503)

- Original proposal:
  - Feed a new 230kV Waxpool Substation by 11/2013 with a new 230kV underground line of approximately 1.6 miles from NIVO to Waxpool Substation
  - Install a four-breaker 230kV ring bus at Waxpool
  - Install a new 230kV overhead line of approx. 2.1 miles from Waxpool to Shellhorn.

- Additional Violation:
  - For the N-1 loss of Line #2095 between Brambleton and Shellhorn Substations, Line #227 (Brambleton - Beaumeade) loads to 97% in 2014.
  - By 2016, Line #227 loads to 117% for the same contingency scenario.
Dominion Transmission Zone

- Existing PJM project (b1503) continued from previous slide.
- Proposed solutions given additional criteria violation.

- Proposed Solution:
  - Loop Line #2095 in and out of Waxpool approximately 1.5 miles.
  - Construct a new 230kV line from Brambleton to BECO Substation of approximately 11 miles with approximately 10 miles utilizing the vacant side of existing Line #2095 structures.
  - The new Brambleton - BECO line will relieve Line #2095 of Shellhorn Substation load and Greenway TX’s #2&3 load.
  - Estimated Project Cost: $39.7M
  - Expected In-Service Date: 6/1/2014
Regions with thermal issues

- **Project b1504**
- Dominion Criteria violation radial load greater than 100 MW
  - Summer 2013 loading on Line #134 (Bull Run to Harrison DP) exceed 120 MW
- NERC Category B violation:
  - Outage of NOVEC CKT 923
  - NOVEC will transfers part or all of ckt 923 load to ckt 912 via normally open tie switch. DVP’s Line #134 would overload to 135 % of its STE Rating.

- Proposed solution: Rebuild 0.5 miles of Line #134 (Bull Run to Harrison DP) and #163 (Bull Run to Cannon Branch 115 kV) for a higher capacity. Install a 115 kV line switch between Line #134 and Line #163 at Harrison DP to be operated normally open.

- Estimated cost $3 M
- Projected IS Date: 5/31/2013
Dominion Transmission Zone

Dominion Criteria Violation

• **Project b1505**
  - Dominion Distribution has requested a new 230 kV delivery by 2013 to serve forecasted system conditions associated with the MetroRail extension into Loudoun County and also increased loading due to continued datacenter development. Initial load is 30 MW in 2013 growing to 60 MW by 2015.
  - The initial installation will include looping Line 2095 approximately 200 feet in-and-out of the station and installing two 230 kV breakers to avoid having 300 MVA exposed to a single contingency event, Line stuck breaker failure L2095 (227T2095). The loss of 300 MVA would exceed Dominion and PJM criteria
• Estimated Project Cost $3.0 M
• Projected IS Date: May 2013
NERC Category A Violation

- **Project b1506**
- Problem: Block load additions at NOVEC's Gainesville DP is increasing load by 120-140 MW over the next several years. By summer 2012, the transformer feeding their DP will be above its emergency rating (269.1 MVA) under normal conditions.

  - Proposed Solution:
    - At Gainesville Substation, create two 115 kV straight-buses with a normally open tie-breaker
    - Upgrade Line 124 (radial from Loudoun) to a minimum continuous rating of 500 MVA and network it into the 115 kV bus feeding NOVEC's DP at Gainesville
    - Install two additional 230 kV breakers in the ring at Gainesville (may require substation expansion) to accommodate conversion of NOVEC's Gainesville to Wheeler line
    - Convert NOVEC's Gainesville-Wheeler line from 115 kV to 230 kV (will require replacement of three transformers total at Atlantic and Wheeler Substations)

- Estimated Project Cost $20.0 M*
- Projected IS Date: May 2013

*Note: After conversion to 230kV there will be several radial 230kV lines approaching 100 MW; DVP is evaluating options that will be presented at a later TEAC*
• **Project: b1729 Scope/Cost Change**

• Uprate Garner to Lancaster section of Line #65

• VDOT Bridge work to be competed December 2012.

• Original Estimated Project Cost: $5.8 M

• Revised Project cost $13.2 M
  – Addition of mats and access roads
  – Additional permitting costs
  – Additional forestry costs
  – Additional material and installation costs

• Projected IS Date: 5/31/2013.
Dominion Transmission Zone

- **Project:** b1058 scope/cost change

- **Problem:** An outage of both Suffolk 230-115 kV transformers (N-1-1) overloads the remaining 115 kV facilities in this area to over 100% and results in voltages in this area less than 90% of nominal.

- **Recommended Solution:** The initial plan was to add a third 230-115 kV transformer.
  - Upon review, it was determined that both of the 115 kV main bus and transfer bus would need to be upgrade and re-arrange for the installation of the third transformer.
  - Recommended scope change is to convert Suffolk 115 kV Straight Bus to a Ring Bus for the three 230-115 kV transformers and three 115 kV lines.

- **Original Estimated Project Cost:** $6 M

- **Revised Estimated Project Cost:** $23M.

- **Projected IS Date:** 05/31/2014
Dominion Transmission Zone

- **Project: b1729 Scope/Cost Change**
- **Problem:** In summer 2015, for any tower line outages of line #27 and line #67 between Greenwich and Davis Corner 115 kV, the total load loss due to this event is more than 300 MW.
- **Problem:** Currently, for the loss of both line #27 and line #67 at Greenwich due to any tower line outages between Greenwich and Davis Corner, line #27 cannot pick up all of the loads on line #67 (about 163 MVA in summer 2013)
- **Approved Solution** – Add 4 breaker ring bus at Burton 115kV substation and construct a 115kV line approximately 3.5 miles from Oakwood substation to Burton substation (b1729).

- Original Estimated Project Cost: $13.3 M
- New Estimated Project Cost: $36.75 M
- Continued next slide
• **Scope Change Drivers**
  - R/Way Reclamation work - $3.7 M
  - FAA height restriction at Norfolk International Airport requiring UG 0.7 miles - $16 M
  - Corten Tower replacement - $3.1 M

• **Alternate Solution**: Rebuild about 12.7 miles of line #27 between Virginia Beach to Burton.
  - Estimated Project Cost: $50+M

• Recommendation continue with existing project which also supports new Little Creek Substation Project

• Projected IS Date: 12/31/2015
• Problem: **Operational Performance**

• Line #2124 Auto-sectionalizing Scheme

• Problem: Lockout of Line #2124 Hopewell – Prince George 230 kV causes an outage of Prince George Electric Cooperative’s Brickhouse DP.

• Proposed Solution: Install a transmission line sectionalizing scheme at Prince George Substation to automatically open the 230kV switch at Prince George for Line #2124 (Hopewell to Prince George 230 kV) lockout and allow Brickhouse DP to be re-energized from the 115kV source. This project adds a motor operator to an existing switch at Prince George and the control scheme.

• Projected IS Date: 5/31/2013

• Estimated cost $150,000
NERC Category C violation

- Outage of Brambleton – Waxpool Tower Line results in 256 MW Load Drop in 2014 growing to 311 MW Load Drop Violation in 2016
- Proposal:
  - Install 230kV 4-breaker ring at Enterprise 230 kV to isolate load from transmission system when substation initially built.
  - Estimated Cost is approximately $3.9M
  - Projected IS Date: 5/31/2014
• Problem: **Operation Performance**

• Line #266 Autosectionalizing Scheme

• Problem: A lockout of Line #266 (Clifton – Glen Carlyn) results in an outage of Keene Mill TX#2 (11,478 customers), Gallows Road TX#1 (5,557 customers), and Falls Church TX#4 (14,824 customers), for a total of 31,859 customers.

• Proposed Solution: Install a transmission line sectionalizing scheme at Keene Mill Substation to automatically open a 230kV switch during the 20" and 80" reclose interval of the Line #266 breakers at Clifton and Glen Carlyn Substations. Depending on the location of the fault, either 11,478 customers or 20,381 customers will be restored. This project adds a motor operator to an existing switch and a control scheme at Keene Mill Substation.

• Estimated cost $ 150,000

• Projected IS Date: 5/31/2014
Problem: Operational Performance

Problem: Line #229 Edgecombe NUG – Everetts 230 kV is a 45 mile long line with 10 operations (4 sustained) in the last 5 years. Line #229 feeds two autotransformers at Tarboro each feeding radial 115kV load with multiple delivery points.

Proposed Solution: Install a 230kV breaker at Tarboro to split Line #229: 17 miles Tarboro – Edgecombe and 28 miles Tarboro-Everetts. Each 230 kV line will feed one autotransformer at Tarboro. Install circuit switchers on both autotransformers at Tarboro to prevent a 230 kV line operation for a transformer fault. Install sectionalizing schemes to restore service to either autotransformer at Tarboro for the loss of its associated 230kV line (Tarboro – Edgecombe or Tarboro – Everetts).

Estimated cost $2.5 M

Projected IS Date: 12/31/2014
**Region with thermal issues**

- Approved RTEP Project #b1792 – **Target Date change from June 2016 to June 2014**
- **NERC Category B & C Violations**
- Studied with drought conditions: (Kerr Dam, Gaston and Roanoke Rapids generation off line)
- Analyzed with new customer load projections
- Problem: The 2014 summer case indicates the following deficiencies:
  - An N-1 outage of Line #556 (Clover – Carson) overloads Line #33 (Halifax – Chase City) by 19%
  - An N-1 outage of Line #127 (Halifax – Buggs Island) overloads Line #33 (Halifax – Chase City) by 7%.
  - An N-1 outage of Line #238 (Clubhouse-Carson) overloads Line #33 (Halifax – Chase City) by 1%
  - An N-1 outage of Line #36 (Buggs Island – Chase City) overloads Line #33 (Halifax – Chase City) by 2%
  - An N-1-1 outage of Line #556 (Clover – Carson) and Line #127 (Halifax–Buggs Island) overloads by 29%
  - An N-1-1 outage of Line #556(Clover – Carson) and Line #36 (Chase City—Buggs Island) overloads by 18%
  - An N-1-1 outage of Line #36 (Chase City – Buggs Island) and Line #193 (Buggs Island – Kerr Dam) overloads Line #33 (Halifax – Chase City) by 19%
  - An N-1-1 outage of the Clubhouse 230-115kV transformer and Line #127 (Buggs Island – Halifax) overloads Line #33 (Halifax—Chase City) by 7%

- Projected IS Date: 5/31/2014
Voltage issues

Approved RTEP Project #b1321 – Proposed scope change in project solution.

NERC Category B and C Violations

A. NERC Category B. The N-1 loss of the 198 line section Chancellor to Ni River 115 kV, with load on the 198 line restored, results in low voltage at several locations on the 198 line in the summer 2014 base case.

B. NERC Category C3. The N-1-1 loss of the 198 line Section (Ni River to Chancellor) and the loss of 11 line section (Gordonsville to Somerset) results in low voltage at several locations on the 198 line and 2 line in the summer 2012 base case.

C. NERC Category C3. The N-1-1 loss of the 198 line Section (Ni River to Chancellor) and the loss of 70 line section (Brandy to Remington) results in low voltage on the 70, 2 and 198 lines in the summer 2012 base case.

D. NERC Category C3. The N-1-1 loss of both 500-115kV transformers at Chancellor results in low voltage at several locations on the 198 line in the summer 2013 base case.

- Note: Operating procedures will be implemented to alleviate the N-1-1 violations for the years 2012 through 2013. A long term solution will be necessary for 2014 and beyond to resolve the Category B event.
Long Term Solutions Considered:

<table>
<thead>
<tr>
<th>Solutions Considered:</th>
<th>Estimated Cost</th>
<th>ROW</th>
<th>Does solution solve Deficiencies?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve power factor at LSE delivery points</td>
<td>-</td>
<td>-</td>
<td>No No No No</td>
</tr>
<tr>
<td>Build a new 500-115kV substation at Gold Dale Junction (Spotsylvania Substation) with one 500-115kV, 336 MVA transformer bank. Install 500kV ring bus and 115kV breaker and a half bus at this location.</td>
<td>$33M</td>
<td>Land</td>
<td>Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Build a new 25 mile 230kV line North Anna to Oak Green and install a 224MVA 230-115kV transformer at Oak Green.</td>
<td>$64 M</td>
<td>11 mi of additional ROW</td>
<td>Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Build a new 20 mile 230kV line Remington to Oak Green and install a 224MVA 230-115kV transformer at Oak Green.</td>
<td>$56 M</td>
<td>20 mi of additional ROW</td>
<td>Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Convert the 11 Line, the 198 Line, the 2 Line, and the 70 Line to 230kV.</td>
<td>$200 M</td>
<td>-</td>
<td>Yes Yes Yes Yes</td>
</tr>
</tbody>
</table>

**Revised Recommended Solution:**
Build a new 500-115kV substation at Gold Dale Junction (Spotsylvania Substation) with one 500-115kV, 336 MVA transformer bank. Install a 500kV ring bus and a 115kV breaker and a half bus at this location.

**Target Date:** 5/31/2014
Region with thermal issues

NERC Category B Violation

Problem: The 2017 summer base case indicates the following deficiency

- An outage of Line #69 breaker at Locks overloads Line #69 segment Reams DP to Purdy by 3% after 69T148 is closed and the load is fed from Clubhouse. The overload is created when Center Star DP (SEC) is converted from 34.5kV to 115kV and transferred to Reams DP in 2017.

Proposed Solution:

- Uprate Line #69 segment Reams DP to Purdy (19 miles) from 41 MVA to 162 MVA by replacing 5 structures and re-sagging the line from 50C to 75C.

Estimated cost $0.4 M

Projected IS Date: 5/31/2017
NERC Category  C Violation

Problem: The 2017 summer RTEP case indicates the following deficiency
  • An N-1-1 outage of Line # 54 Carolina – Earleys and the Earleys 230-115kV transformer overloads Line #108 Boykins – Tunis by 17.8%.

Proposed Solution:
  • Install a 2nd 230-115kV transformer at Earleys connected to the existing 115kV and 230kV ring busses. Add a 115 kV breaker and 230kV breaker to the ring busses.

Estimated cost $ 8.0 M

Projected IS Date: 5/31/2017
Region with thermal issues

Region with voltage issues

• **NERC Category B Violations**

• Problem: The 2017 RTEP indicates the following voltage deficiency:
  
  o An outage of the 47 Line b/t Fredericksburg and Slabtown causes low voltage at Slabtown - below 0.93pu (No Four Rivers 115 kV Gen)

• Problem: The 2019 Basecase indicates the following thermal deficiency:
  
  o An outage of Line #2090 b/t Ladysmith CT and Mine Rd overloads Line #47 b/t Four Rivers and Kings Dominion - over 94.0% (No Possum Pt. #5 Gen)

• **Potential Solutions** –
  
  1. Convert Line #47 between Fredericksburg and Ladysmith CT Tap to 230 kV. Install a substation at Ladysmith CT Tap with a 230kV ring bus and a 230-115 kV Tx to keep Line #47 between Four Rivers and Ladysmith CT at 115 kV.
  
  2. Rebuild Line #47 between Four Rivers and Kings Dominion (1.9 mi) to a higher capacity 115kV line to solve thermal deficiency. REC to improve power factor at North Doswell and Slabtown to 0.973 to solve voltage deficiency. This is a short term fix to the voltage issue – the conversion of Slabtown is anticipated in the 2020 timeframe to provide further improvement.

• **Projected IS Date 5/31/2017 (voltage), *5/31/2019 (thermal).**

*Thermal deficiency could accelerate with generation interconnects and retirements.*
Dominion Transmission Zone

Proposed Solution:
Rebuild Line #47 between Four Rivers and Kings Dominion to a higher capacity 115kV line. REC to improve power factor at North Doswell and Slabtown to 0.973.

Target Date:
5/31/2017 (Voltage) – 5/31/2019 (Thermal)

Notes:
1) Target date of Line #47 rebuild in the Proposed Solution to solve thermal deficiency could accelerate due to generation interconnects and retirements.
• NERC Category C Violation
• Problem:
  • Before Summer 2018, a tower-line outage involving the Brambleton-Greenway 230 kV structures (Lines #2095 and #2137) will drop over 300 MW of load at Greenway and Shellhorn Substations.
• Proposed Solution:
  • Install 4 - 230kV breakers at Shellhorn 230 kV to isolate load.
• Estimated Project Cost: $2.0 M
• Proposed IS Date: 12/31/2017
• Common Mode Violation:
• Proposed Solution:
  At Deep Run, install 115 kV line breakers on the B2 and C3 115 kV lines (B2147).
• Estimated Project Cost:
  $ 10.7 M
• Expected IS Date:
  6/1/2015
• **N-1-1 Voltage Violation:**
  Voltage drop violation and potential loss of more than 300 MW load in the Atlantic 230 kV area for the loss of the Atlantic – Ocean View 230 kV circuits ‘X2024‘ & ‘Y2025‘.

• **Proposed Solution:**
  - Build a new 230 kV circuit from Larrabee to Oceanview (B2015).

• **Estimated Project Cost:**
  $78.333 M

• **Expected IS Date:**
  6/1/2016
MedEd Transmission Zone

- FE Planning Criteria Violation:
  - Potential low voltage in the Yoe vicinity for line fault stuck breaker contingency loss of the Yorkana 115 kV bus.

- Proposed Solution:
  Install a 115 kV 28.8 MVAR capacitor at Pleasureville substation (B2148).

- Estimated Project Cost: $1.2 M

- Expected IS Date: 6/1/2013
FE Planning Criteria Violation

The Smith St. – York Inc 115 kV circuit is overloaded for line fault stuck breaker contingency loss of the Yorkana 115 kV bus.

Proposed Solution:
- York Inc. substation: upgrade substation riser on the Smith St.
- York Inc. 115 kV line (B2149).

Estimated Project Cost: $0.04 M

Expected IS Date: 6/1/2013
MedEd Transmission Zone

- FE Planning Criteria Violation:
  - The York Heaven 115 kV bus is overloaded for N-1-1 contingency loss of Middletown Jct. – York Heaven (978) and Smith St. – York Inc (967) 115 kV circuits.

- Proposed Solution:

- Estimated Project Cost:
  - $0.06 M

- Expected IS Date:
  - 6/1/2013
• Generation Deliverability:
• The Richmond 230/69 kV transformer # 7 is overloaded for the stuck breaker contingency loss of the Richmond – Waneeta and Richmond – Holmesburg – Eddington 230 kV circuits.
• Proposed Solution:
  - Replace two sections of conductor inside Richmond substation (B2145).
• Estimated Project Cost: $ 0.025 M
• Expected IS Date: 6/1/2017
• Generation Deliverability:
  • The Emilie 230/138 kV transformer # 8 is overloaded for several contingencies
• Proposed Solution:
  - Install a third 230/138 kV transformer at Emilie (B2140).
• Estimated Project Cost: $ 8.0 M
• Expected IS Date: 6/1/2017
• Common Mode Outage Test
• The Morgantown – V3-017 230 kV 3086 circuit is overloaded for the tower outage of the Oak Grove to V3_017 3066 & 23068 circuits.
• Proposed Solution:
  - Reconductor the Morgantown – V3-017 230 kV 3086 circuit and replace terminal equipments at Morgantown (B2136).
• Estimated Project Cost: $ 11.4 M
• Expected IS Date: 6/1/2017
• Common Mode Outage Test
• The Morgantown – Talbert 230 kV ‘2085‘ circuit is overloaded for the tower outage of the Oak Grove to V3_017 ‘2066‘ & ‘23068‘ circuits.
• Proposed Solution:
  - Reconductor the Morgantown – Talbert 230 kV ‘2085‘ circuit and replace terminal equipments at Morgantown (B2137).
• Estimated Project Cost: $18.4 M
• Expected IS Date: 6/1/2017
PEPCO Transmission Zone

- Common Mode Outage Test
- The Hawkins Gate – V3-017 230 kV ‘23084’ circuit is overloaded for the tower outage of the Oak Grove to V3_017 ‘23066’ & ‘23068’ circuits.

- Proposed Solution:
  - Replace terminal equipments at Hawkins 230 kV substation (B2138).
- Estimated Project Cost: $ .066 M
- Expected IS Date: 6/1/2017
• N-1-1 Thermal Analysis:
• The Geneva – Wayne 115 kV is overloaded for N-1-1 contingency loss of Erie West – Wayne and Erie West – Ashtabula 345 kV circuits.
• Proposed Solution:
  - Reconductor bus at Wayne 115 kV station (B2016).
• Estimated Project Cost: $0.025 M
• Expected IS Date: 6/1/2013
• PPL EU Reliability Principles and Practices:

• Voltage violation in the West Carlisle 69 kV vicinity pre and post contingency, fault on the Juniata - Cumberland 230 kV circuit and failure of the Cumberland (Cumberland – Juniata) breaker.

• Proposed Solution: Install 10.8 MVAR capacitor at West Carlisle 69/12 kV substation (B2158).

• Estimated Project Cost: $0.840 M

• Expected IS Date: 5/31/2015
The following PPL baseline numbers are changed:

<table>
<thead>
<tr>
<th>Old #</th>
<th>New #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>b1215</td>
<td>b1813.1</td>
<td>Reconduct and rebuild 16 miles of Peckville-Varden 69 kV line and 4 miles of Blooming Grove-Honesdale 69 kV line</td>
</tr>
<tr>
<td>b1524</td>
<td>b1813.2</td>
<td>Build a new Pocono 230/69 kV substation</td>
</tr>
<tr>
<td>b1524.1</td>
<td>b1813.3</td>
<td>Build approximately 14 miles new 230 kV South Pocono – North Pocono line</td>
</tr>
<tr>
<td>b1524.2</td>
<td>b1813.4</td>
<td>Install MOLSABs at Mt. Pocono substation</td>
</tr>
<tr>
<td>b1525</td>
<td>b1813.5</td>
<td>Build new West Pocono 230/69 kV Substation</td>
</tr>
<tr>
<td>b1525.1</td>
<td>b1813.6</td>
<td>Build approximately 14 miles new 230 kV Jenkins-West Pocono 230 kV Line</td>
</tr>
<tr>
<td>b1525.2</td>
<td>b1813.7</td>
<td>Install Jenkins 3E 230 kV circuit breaker</td>
</tr>
<tr>
<td>b1761</td>
<td>b1813.8</td>
<td>Build a new Paupack - North 230 kV line (Approximately 21 miles)</td>
</tr>
<tr>
<td>b1762</td>
<td>b1813.9</td>
<td>Replace 3.7 miles of the existing 230 kV Blooming Grove - Peckville line by building 8.4 miles of new 230 kV circuit onto the Lackawanna - Hopatcong tower-line</td>
</tr>
<tr>
<td>b1763</td>
<td>b1813.10</td>
<td>Re-terminate the Peckville - Jackson and the Peckville - Varden 69 kV lines from Peckville into Lackawanna</td>
</tr>
<tr>
<td>b1764</td>
<td>b1813.11</td>
<td>Build a new 230-69 kV substations (Paupack)</td>
</tr>
</tbody>
</table>
• Originally recommended at 10/11/2012 TEAC meeting
• Construct HVDC back to Back facility at Hudson:
  – Construct back to back HVDC converter station at Hudson
  – Remove the PARs at Farragut
    • Ultimately determined by Con Ed
  – Modify/coordinate protection relay schemes at Hudson and Farragut
• Estimated Project Cost: $300 M
• Expected In-service date: 6/1/2015
B-3402 & C-3403 would remain AC facilities

Back-to-back convertor stations

New

Hudson 230kV

Farragut 345kV

Remove PARs (Con Ed will determine)
PSE&G Transmission Zone

- PSEG Reliability Criteria:
  - Voltage violations in the Hinchmans and Jackson Rd. vicinity for the loss of Cedar Grove – Jackson Rd. and Hinchmans – Hawthorne 230 kV circuits

- Proposed Solution:
  - Construct Jackson Rd. 69 kV substation and loop the Cedar Grove - Hinchmans Ave in to Jackson Rd, and construct Hawthorne 69 kV substation and build 69 kV circuit from Hinchmans Ave – Hawthorne – Fair Lawn (B02151).

- Estimated Project Cost:
  - $105 M

- Expected IS Date:
  - 6/1/2016
• Generation Deliverability/Baseline:

• Voltage magnitude and drop violations in the Brunswick vicinity for several contingencies and the Ridge Rd. – Dow Jones – Sand Hill 69 kV circuit is overloaded for several contingencies.

• Proposed Solution:
- Re-configure the Brunswick 230 kV and 69 kV substations (B2146).

• Estimated Project Cost:
$ 47.0 M

• Expected IS Date:
6/1/2017
• Generation Deliverability/N-1-1 Thermal:

  • The Linden – North Ave. 138 kV circuit is overloaded for a line fault stuck breaker contingency loss of the Bayway – Doremus 138 kV, Bayway 138/26 kV bank #2 and Bayway 138 kV bus 1-3. Several 138 kV circuits in the Linden vicinity overloaded for N-1-1 contingencies.

  • Proposed Solution:
    - Reconfigure the Linden, Bayway, North Ave. and Passaic Valley S.C. 138 kV substations. Construct and loop new 138 kV circuit to new airport station (B2159).

  • Estimated Project Cost: $ 250 M

  • Expected IS Date: 6/1/2017
• Generation Deliverability
• The Mickleton – Deptford 230 kV circuit is overloaded for multiple contingencies.
• Proposed Solution:
  - Reconductor the Mickleton – Gloucester 230 kV parallel circuits with double bundle conductor (B2139).
• Estimated Project Cost: $10 M
• Expected IS Date: 6/1/2017
- PJM has identified breakers in PSEG territory that are close to or exceeding 80 kA as of the 2016 planning year
  - Kearny
  - NJT Meadow
  - Essex
• Cancelled upgrade: Advance n0666.5, n0666.3, and n0666.10 (Replace Hudson 230kV breakers ‘1HB’, ‘2HA’, and ‘2HB’ with 80kA breakers) (b1750-b1752)
• Reason for cancellation: Fault current levels decrease as a result of the Hudson Unit 1 retirement
Supplemental Projects
ComEd Transmission Zone

- **Supplemental Project**
  - Install a new 345 kV GIS bus, install two new 345/138 kV autotransformers, and completely rebuild the 138 kV bus at Station 16 Waukegan. 345 kV lines 2218 & 2219, Zion to Northbrook, will be cut into the new 345 kV ring bus at Waukegan. The Zion to Waukegan lines will retain the numbers 2218 & 2219, while the Waukegan – Northbrook lines will be numbered 1625 & 1626. (S0494)

- Estimate Cost: $154M

- Expected IS Date: 6/1/2015
• PSE&G local area reliability
• Improves reliability and transformer availability during contingency/failure.
• Proposed Solution:
  - Purchase 230/138 kV spare Auto - transformers (S0496).

• Estimated Project Cost: $9 M
• Expected IS Date: 6/1/2014
• Hudson transmission project (O66) is building a new under ground 230 kV circuit from Athenia to Bergen (n1035) with a low rating conductor (2500 kmcil). To replace the circuit once built for potential future overloads would cost approximately $80 M. The circuit is can be built with higher conductor rating (3500 kmcil), with additional initial cost of $7 M.
• Build the Athenia – Bergen 230 kV with higher rating conductor (S0497).
• Estimated Project Cost: $ 7 M
• Expected IS Date: 6/1/2015
Interconnection Queue Network Upgrades Update
Next Steps
RTEP Next Steps

• Scenario Analysis
• Ohio Area analysis
• High voltage evaluation
• RTEP reliability analysis
  – Finalize N-1-1

• December PJM Board Approval
  – Forward any comments to RTEP@pjm.com

• 2013 RTEP Assumptions
Questions?

Email: RTEP@pjm.com