



PJM Sub Regional RTEP Committee Meeting

January 22, 2016

David Gladey, Manager – Transmission Planning
Lisa Krizenoskas – Supervising Engineer
Mark Safi – Supervising Engineer



PPL Electric Utilities

Supplemental Projects: PPL EU Philosophy

Supplement Projects do not address violations due to following:

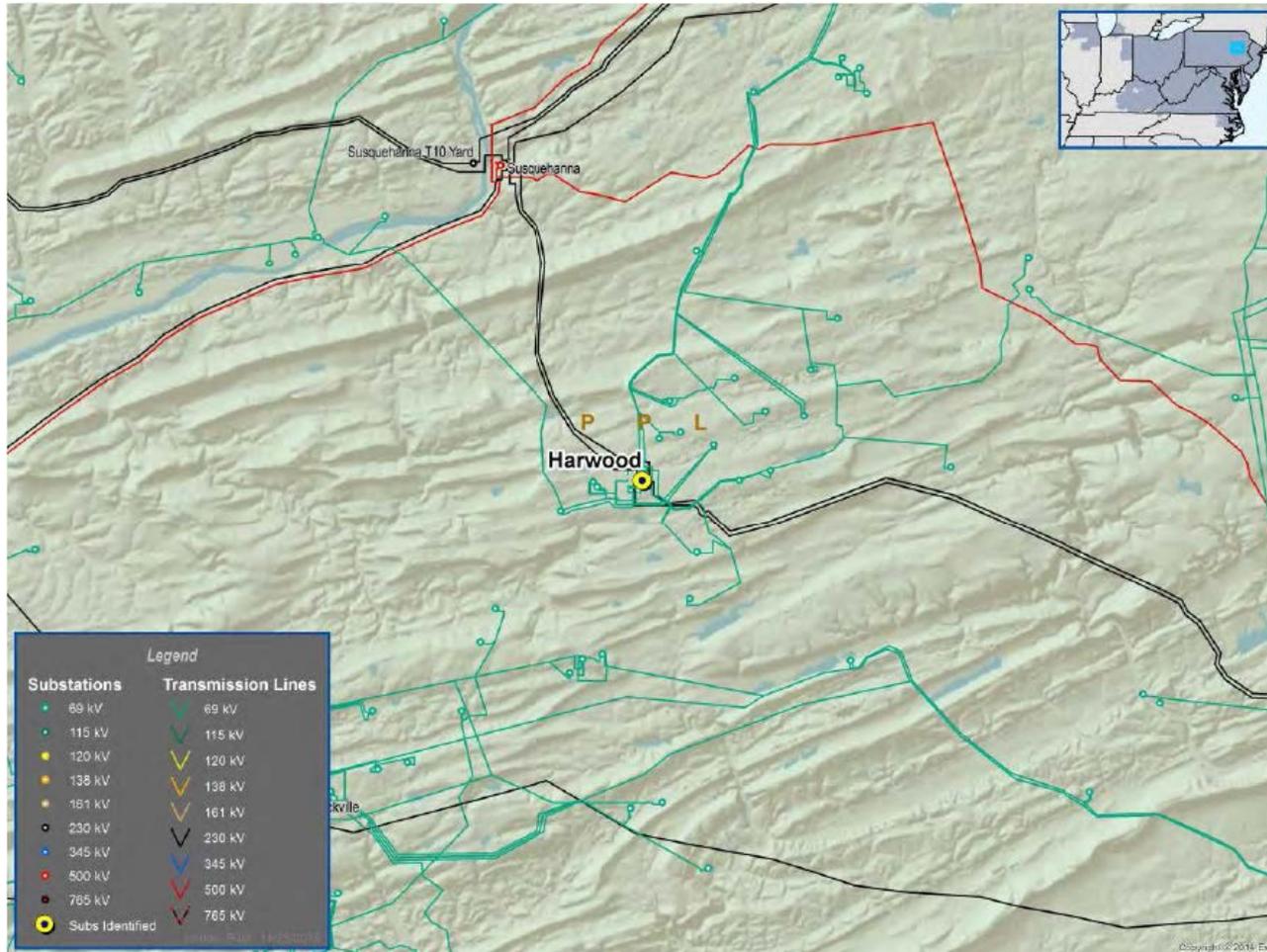
- PPL EU reliability Criteria
- PJM reliability Criteria
- NERC TPL standards

Supplement Projects address following needs:

- Upgrade poor performing aged assets to current standards
- Improvement in SAIDI/CAIDI/MAIFI by reducing line exposure and customer counts
- Upgrade old substations to current standards and install new Physical Security measures
- Install Optical Ground Wire (OPGW) to provide communication path
- To install smart devices to more accurately locate faults and reduce customer restoration time



Harwood 230 kV Yard Upgrades and 69 kV Yard Line Reterminations



PPL Electric Utilities

Harwood 230 kV Yard Upgrades

- **Problem Statement:**

- The current Harwood 230kV configure is not configured to the PPL EU internal design standards. This unreliable configuration includes line tap transformer, line connected to one bus, and line connected to bus without a circuit breaker.
- Substation Security does not meet current PPL EU internal design standards.
- Several existing gang operated disconnects are 1970's vintage HK Porter switches, which PPL has historically had maintenance issues with. These GODs repeatedly have fallen out of adjustment and failed to operate properly, even after overhaul.

- **Proposed Solution:**

- Install additional circuit breakers to re-configure to standard breaker-and-half configuration to enhance reliability, provide operational and maintenance flexibility.
- Install substation security to met current PPL EU internal design standards.
- Replace four 230kV GODs with MODs. Retrofit of these switches with motor operators is infeasible due to the maintenance issues and vintage of the switch.

- **Alternative:**

- No alternatives were considered because of the nature of the work. The work is required in the existing substation.

- **Estimated Project Cost:** \$ 3.6 M

- **Scheduled IS Date:** 12/31/2020

- **Project Status:** Project Development and Engineering



Harwood 69 kV Yard Line Reterminations

Problem Statement:

- Existing Harwood-Berwick 69 kV breaker in the old Harwood 69 kV yard is vintage type and in need of replacement.
- Old Harwood 69 kV yard consists of obsolete equipment in a non-standard, unreliable configuration.

Proposed Solution:

- Instead of upgrading the old 69 kV yard with new equipment, re-terminate the Harwood-Berwick 69 kV line shall be re-terminated into the new/more reliably configured 69kV yard (existing newer standard yard next to old yard).
- Re-termination of Harwood-Berwick 69 kV line will shorten the line by a few spans.
- Three other 69 kV lines will be reterminated into the new 69 kV yard as well which will eliminate line crossings.
- Eliminating line crossings provides operational and maintenance flexibility.

Proposed Solution:

- No alternatives were considered because of the nature of the work. The work is required in the existing substation.

Estimated Cost: \$8.1 M

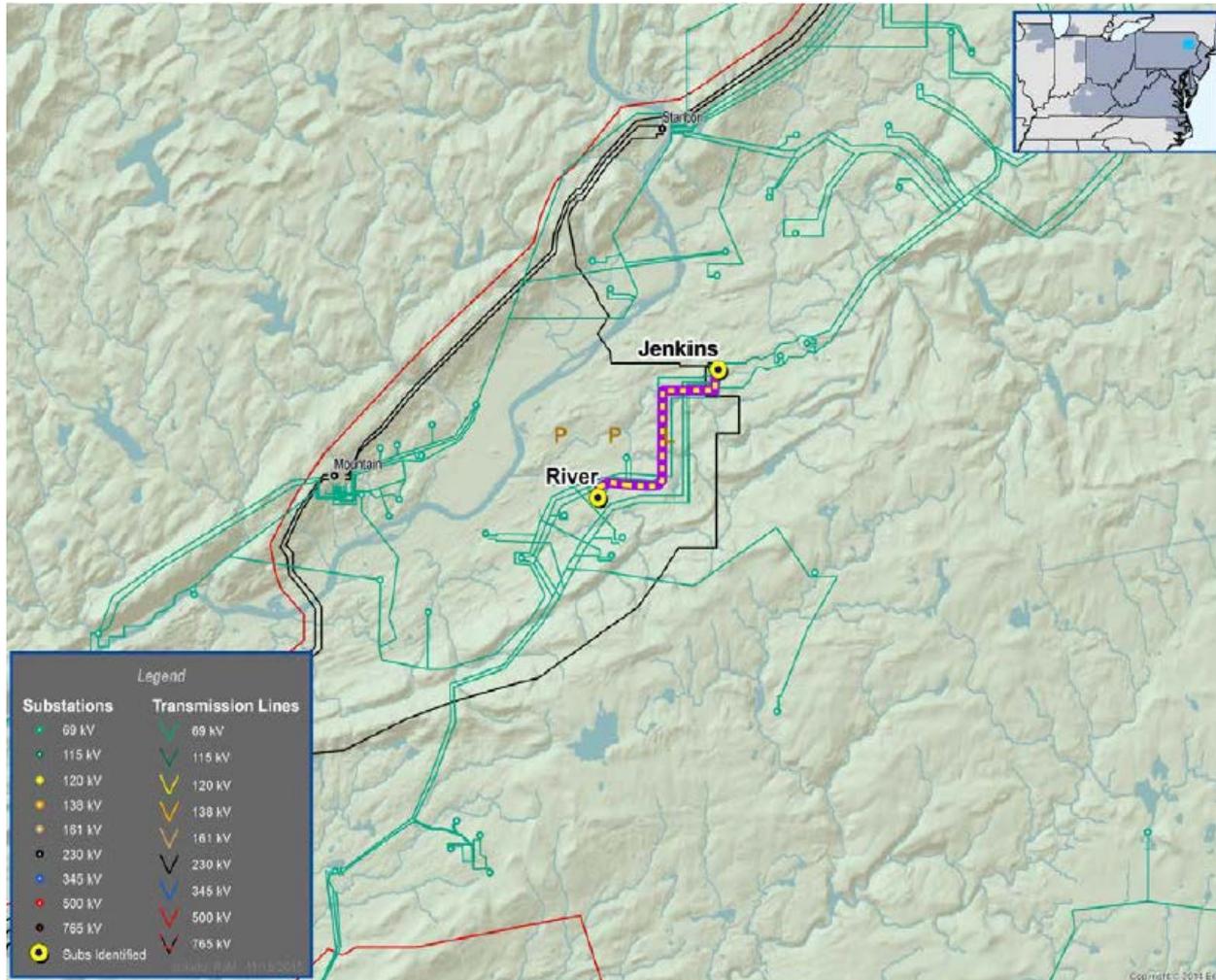
Scheduled IS Date: 12/2020

Project Status: Project Development



PPL Electric Utilities

Jenkins-River 1 & 2 69 kV Line Rebuild (3.5 mi)



PPL Electric Utilities

Jenkins-River 1 & 2 69 kV Line Rebuild (3.5 mi)

Problem Statement:

- The majority of the transmission structures on this double circuit line are in excess of 60-70 years old.
- The replacement of all remaining wood transmission structures on this line is critical due to their age and history of poor performance. They also do not meet modern performance design requirements.
- The existing lattice steel towers are experiencing structure corrosion, hardware deterioration.
- Sections of the conductor on this circuit have reached an age where environmental factors are contributing to deterioration.
- This line requires a fiber optic communication path for the network, which requires the installation of OPGW and new or reinforced structures to support the additional structural loading.

Proposed Solution:

- Replace all wood structures and evaluate all lattice steel towers for condition and determine if replacement is justified.
- Install new overhead Optical Ground Wire (OPGW) for new fiber communication path.
- Replace all insulators and hardware to ensure sufficient insulation levels are achieved for this voltage level.
- Replace all transmission switches with motor operated switches for increased operability and improved sectionalizing capability.

Alternatives:

- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substations. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

Estimated Cost: \$4.2 M

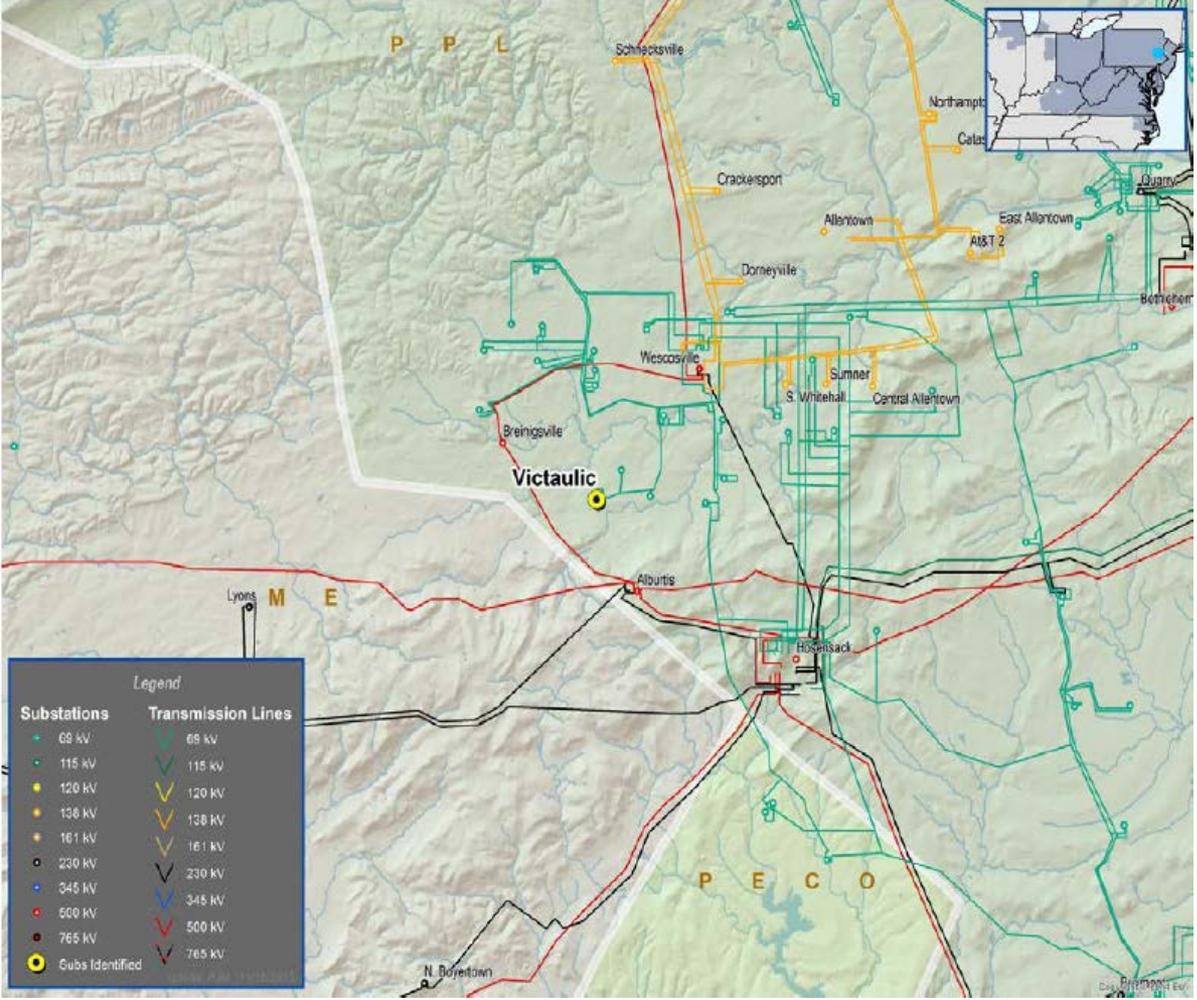
Scheduled IS Date: 12/31/2020

Project Status: Project Development and Engineering



PPL Electric Utilities

Add 2nd 69 kV Circuit to Victaulic Tap (1.2 mi)



Add 2nd 69 kV Circuit to Victaulic Tap (1.2 mi)

- **Problem Statement:**

- Schoeneck Substation needs to add a 2nd 69-12 kV transformer to serve growing load.
- Shoeneck Substation has 2-12 kV circuits and is expanding to 4-12 kV circuits.
- Distribution Planning requires an additional 69-12 kV transformer to accommodate the additional load served by these new distribution lines.
- Transmission planning development guideline recommends no more than 30 MW on single circuit tap.

- **Proposed Solution:**

- Install second 69 kV circuit for 1.2 mile on the existing Victaulic Tap to Schoeneck 69-12 kV Substation

- **Alternative:**

- Adding the second circuit to the existing tap line is the best possible solution which has the least environmental impact from a ROW perspective. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed.

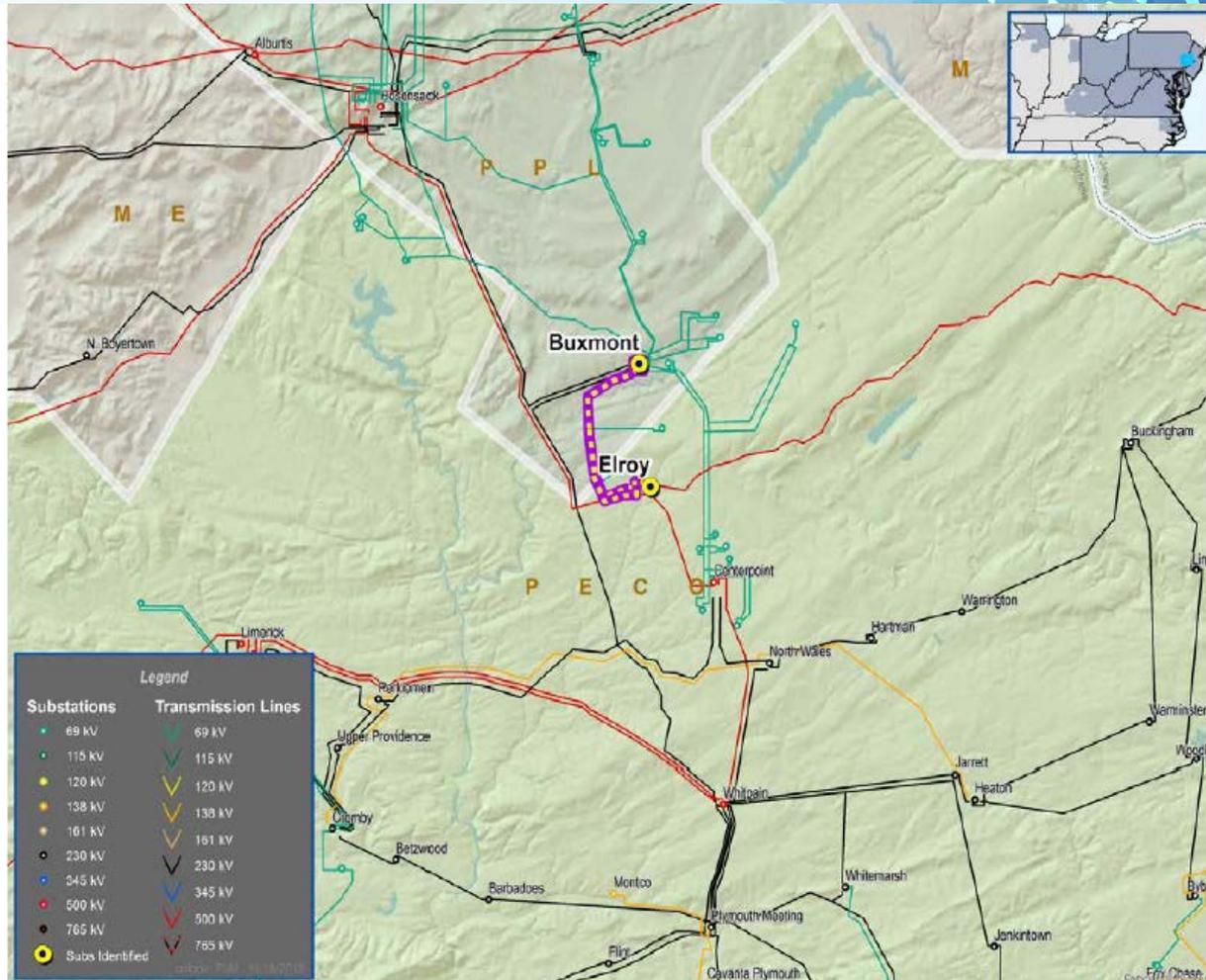
- **Estimated Cost: \$1.1 M**

- **Scheduled IS Date: 11/2016**

- **Project Status: Engineering**



Buxmont Area 230 kV substation and 69kV Line Upgrades



Buxmont 230-69 kV Substation Upgrade Project

- **Problem Statement:**
 - Transformer 2 has been identified to be nearing or at end of life. It is 43 years old and has a history of unplanned maintenance. To maintain system reliability, it should be replaced.
 - Five Circuit Breakers been identified to be nearing or at end of life. Four are 40+ year old Oil Circuit Breakers, while the fifth is an SF6 breaker with a history of leaking SF6 gas. Analysis shows replacement of leaking SF6 breakers to be a more cost effective and reliable solution than trying to repair/overhaul. Oil breakers are part of a long-standing initiative to remove from the system due to environmental concerns. To maintain system reliability and reduce potential environmental issues, these breakers should be replaced.
 - Existing Cap Bank has a history of blown fuses and continues to have increasing failures, requiring extensive repairs and unplanned maintenance. Based on the increasing failure rate and operational age (1970's vintage), as well as an expected life study, existing Cap Bank and Vacuum Switch have reached their end of reliable life and should be replaced.
 - Transformer monitors are not present on either existing transformer and should be installed to maintain high reliability and reduce O&M costs.
- **Proposed Solution:**
 - Replace Transformer 2
 - Replace five Circuit Breakers as stated above
 - Replace Cap Bank and Vacuum Switch
 - Install Transformer Monitors
- **Alternative:**
 - No alternatives were considered because of the nature of the work. The work is required in the existing substation.
- **Estimated Cost:** \$5.1 M
- **Scheduled IS Date:** 12/2018
- **Project Status:** Project Development and Engineering



Buxmont Area 69kV Line Upgrades

Buxmont-Elroy 1&2 and Elroy-Hatfield 1&2

Problem Statement:

- Structures installed in the 1960's.
- Some wood poles are Cellon class and at risk of material and structural failure.
- Some wood structures with 4 Bell insulators on Steel arms creating poor insulation levels and poor lightning performance.
- Line requires a newly installed fiber optic communication network path.

Proposed Solution:

- Rebuild Buxmont-Elroy 1&2 (6.0 mi) and Elroy-Hatfield 1&2 (0.25 mi) for Double Circuit to current PPL EU internal design standards.
- Install new overhead Optical Ground Wire (OPGW) for new fiber communication path.
- Replace all transmission switches with motor operated switches for increased operability and improved sectionalizing capability.

Alternatives:

- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substations. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

Estimated Cost: \$13.3 M

Scheduled IS Date: 12/31/2018

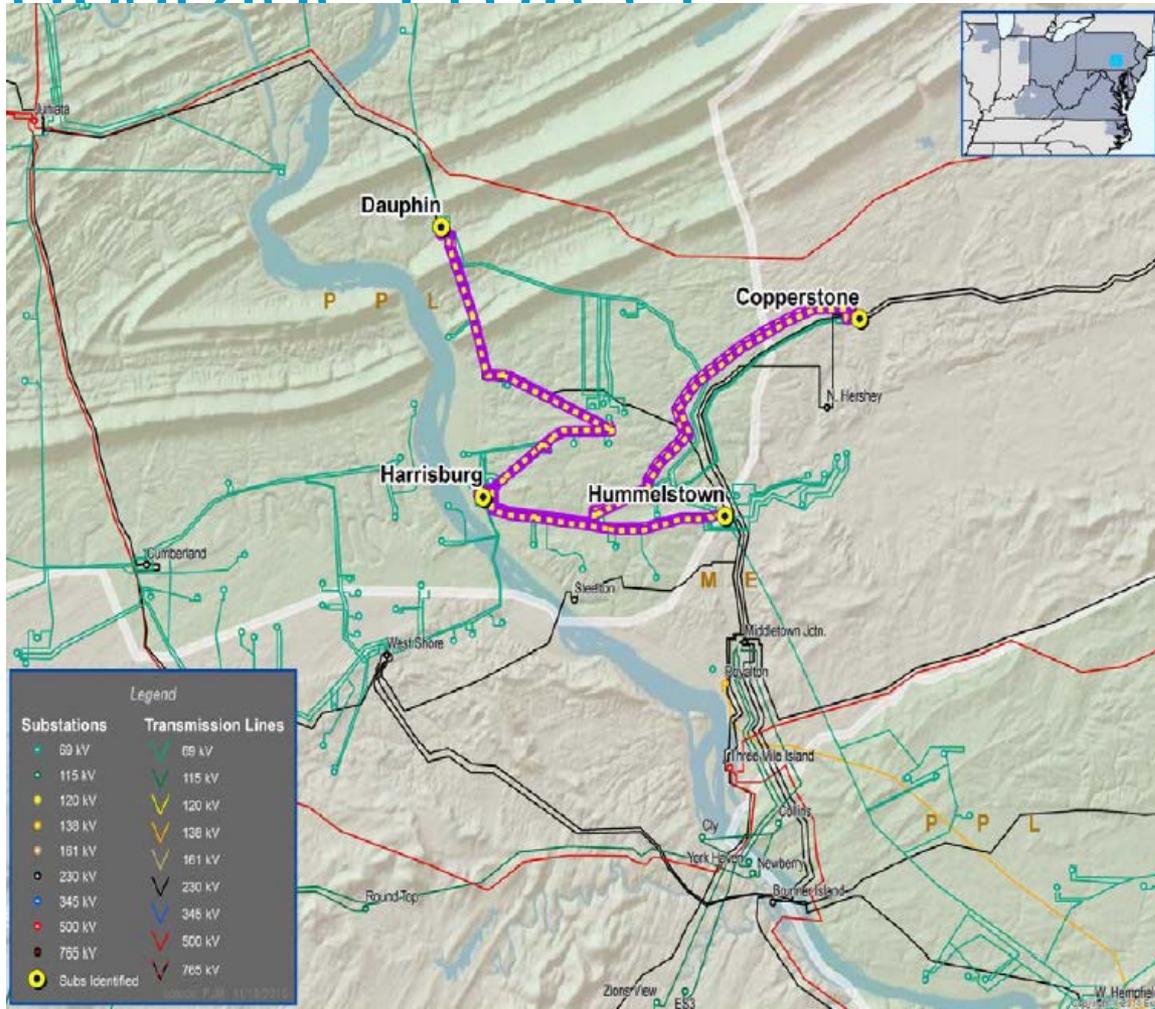
Project Status: Project Development



PPL Electric Utilities

Hummelstown-Copperstone- Harrisburg

Relay Upgrade Project

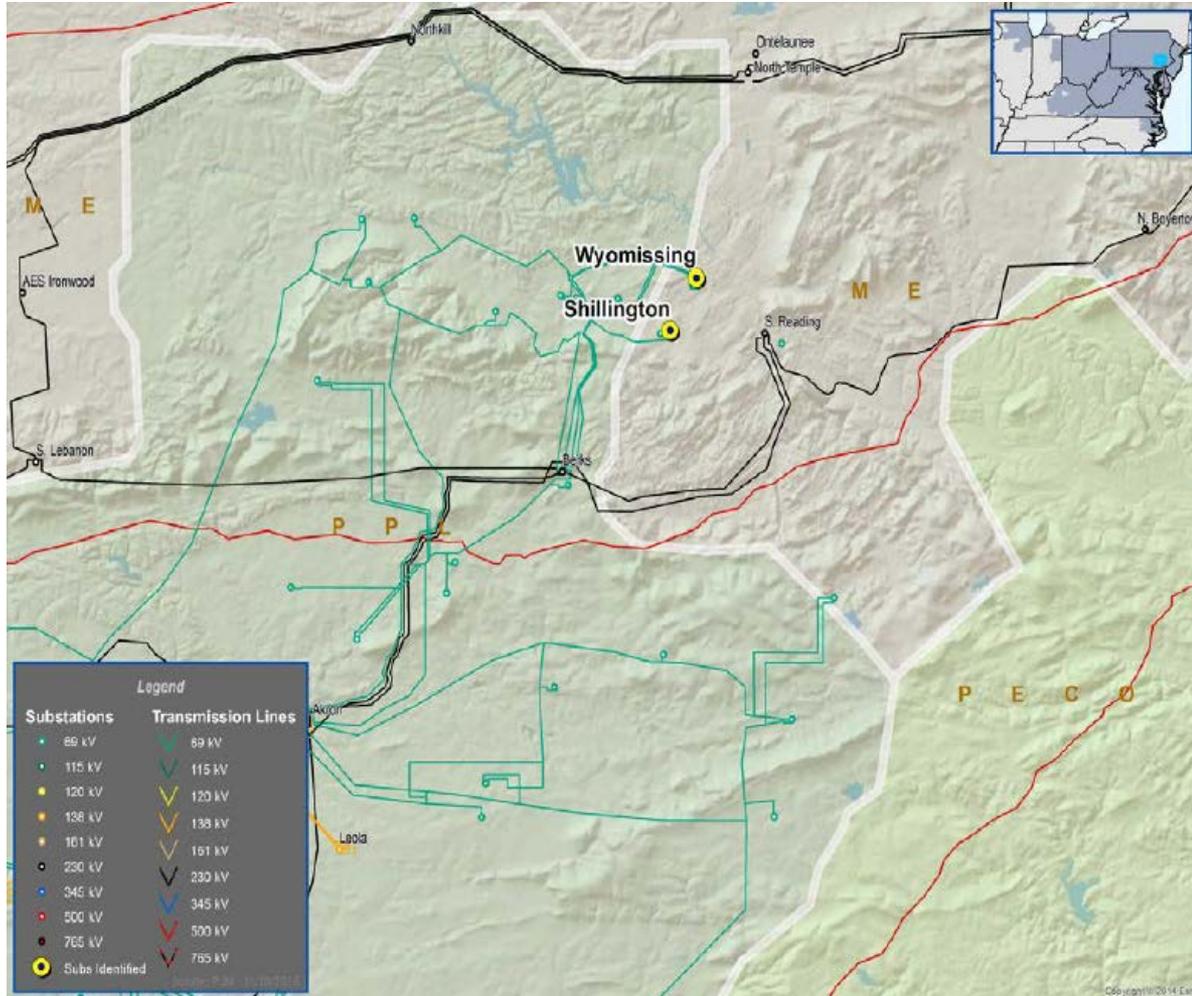


Hummelstown-Copperstone-Harrisburg Relay Upgrade Project

- Problem Statement:
 - Copperstone and Dauphin 230-69 kV Substations currently only have two 230 kV sources. For an N-1-1 condition or for a maintenance outage followed by an N-1 condition, all load can be lost at these substations.
 - Operating 69 kV line in network in the area will prevent loss of load under this scenario.
 - In order to operate the lines in network, relaying will need to be upgraded at the regional substations.
- Proposed Solution:
 - Remove the primary and backup relaying and install new primary and backup relaying at Copperstone, Harrisburg and Hummelstown 230-69 kV substations on the following 69 kV lines:
 - Hummelstown-Harrisburg 1 & 2 69 kV lines
 - Copperstone-Harrisburg 1 & 2 69 kV lines
 - Dauphin-Harrisburg 1 & 2 69 kV lines
 - Create new relay settings for network line application between these substations.
 - Install communication for SCADA to allow remote access to change protective settings groups and report the active settings group to TMS.
- Alternative:
 - No alternatives were considered because of the nature of the work. The work is required in the existing substation.
- Estimated Cost: \$1.62 M
- Scheduled IS Date: 11/1/2016
- Project Status: Project Development



New 69 kV Double Circuit Tap To Shillington (2 mi)



New 69 kV Double Circuit Tap To Shillington (2 mi)

- Problem Statement:

- The Shillington 69/12kV Substation is supplied by two 69kV feeders- one sourced from PPL EU's Berks Substation and the other sourced from MetEd's Adamstown Substation.
- The line sourced from PPL EU's Berks substation includes portions which are leased from MetEd.
- The line sourced from MetEd's Adamstown Substation is owned and operated by MetEd.
- PPL and MetEd 69kV systems have phase angle differences and therefore Shillington Substation is equipped with non-standard 'zig-zag' transformers which allows the distribution load to be served by either feeder without a phase angle conflict.
- PPL desires to serve the Shillington Substation from feeders that are both owned and maintained by PPL.
- PPL also desires to eliminate the non-standard zig-zag transformers altogether to reduce O&M costs and enhance reliability.

- Proposed Solution:

- Tap the new Lauschtown-Wyomissing #1 & #2 D/C 69kV lines and extend ~2 miles to Shillington Sub over new ROW.
- Install motorized switches outside of Shillington Sub to achieve auto-throwover on loss of one or the other feeder.

- Alternate Solution:

- Purchase the one feeder from MetEd that connects Berks to Shillington to eliminate lease payments, thus allowing PPL to maintain the line. This alternate solution does not address the zig-zag transformer need as the second feeder to Shillington, owned by MetEd and having phase angle issues, would still be required.

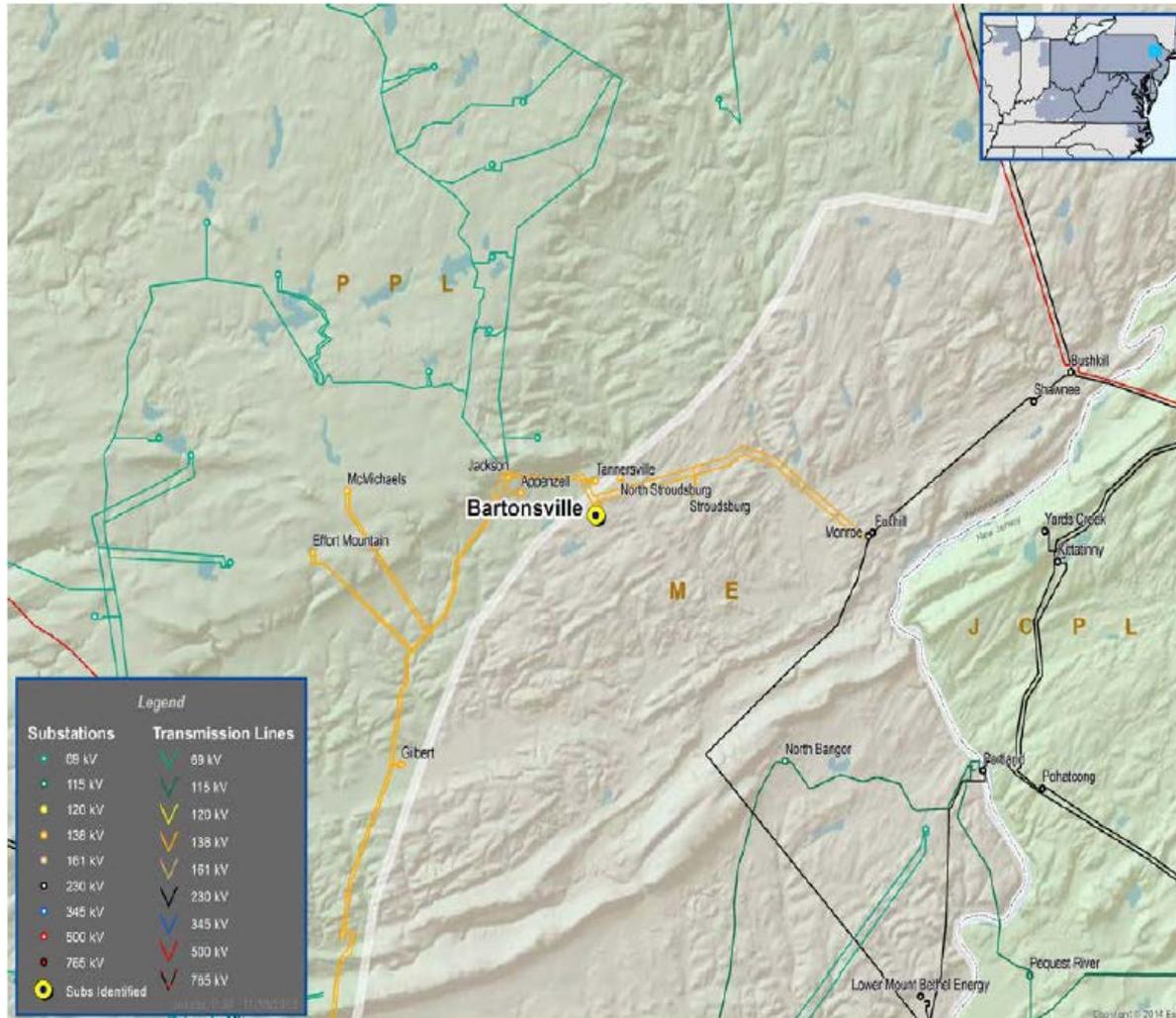
- Estimated Cost: \$4.9M

- Scheduled IS Date: 5/2019

- Project Status: Project Development



Bartonsville Tap 69kV Line Rebuild



Bartonsville Tap 69kV Line Rebuild

Problem Statement:

- Most structures are 30+ year old Cellon Wood Poles at immediate risk of material and structural failure.
- Line requires a newly installed fiber optic communication network path.
- The Bartonsville 69-12 kV Substation has weak ties on the 12 kV distribution side to neighboring substations. Rebuilding to double circuit will enhance reliability to the customers served from this substation for loss of one transmission circuit.

Proposed Solution:

- Rebuild Bartonsville 69kV Tap (3.2 mi) for Double Circuit to meet current design criteria and provide two-line supply to Bartonsville Substation.
- Install new overhead Optical Ground Wire (OPGW) for new fiber communication path.
- Existing Steel monopole structures to be evaluated and reused where possible.
- Existing conductor meets ampacity requirements and will be evaluated and reused if possible.
- Replace all transmission switches with motor operated switches for increased operability and improved sectionalizing capability.

Alternative:

- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substation. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

Estimated Cost: \$5.3 M

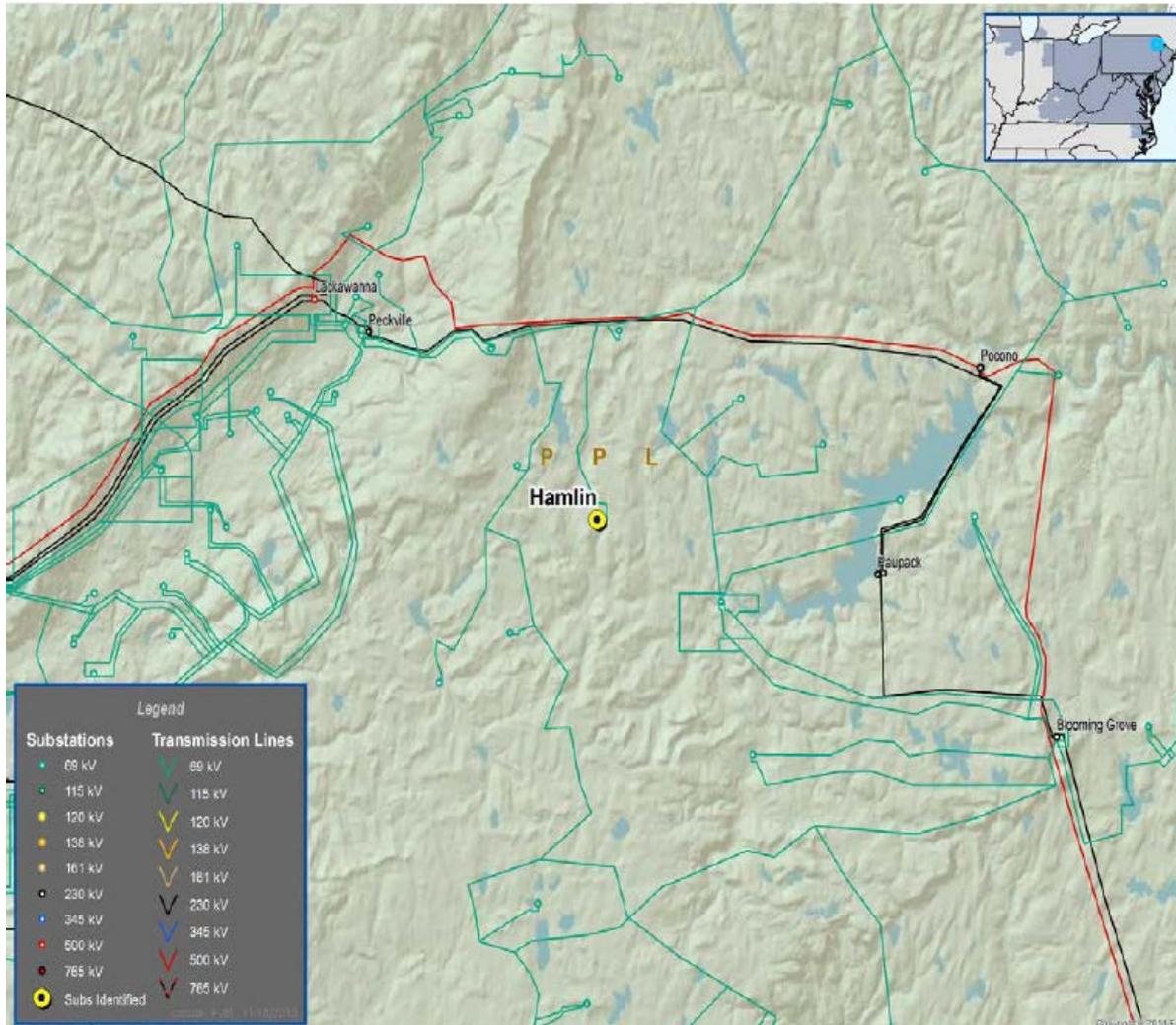
Scheduled IS Date: 5/31/2019

Project Status: Project Development



PPL Electric Utilities

Hamlin Tap 69kV Line Rebuild



Hamlin Tap 69kV Line Rebuild

Problem Statement:

- Most structures are 30+ year old Cellon Wood Poles at immediate risk of material and structural failure.
- Line requires a newly installed fiber optic communication network path.

Proposed Solution:

- Rebuild Hamlin 69kV Tap (6.6 mi) for Single Circuit to meet current design criteria.
- Design for Future Double Circuit to accommodate future substation conversions.
- Install new overhead Optical Ground Wire (OPGW) for new fiber communication path.
- Existing conductor meets ampacity requirements and will be evaluated and reused if possible.
- Replace all transmission switches with motor operated switches for increased operability and improved sectionalizing capability.

Alternative:

- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substation. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

Estimated Cost: \$14.5 M

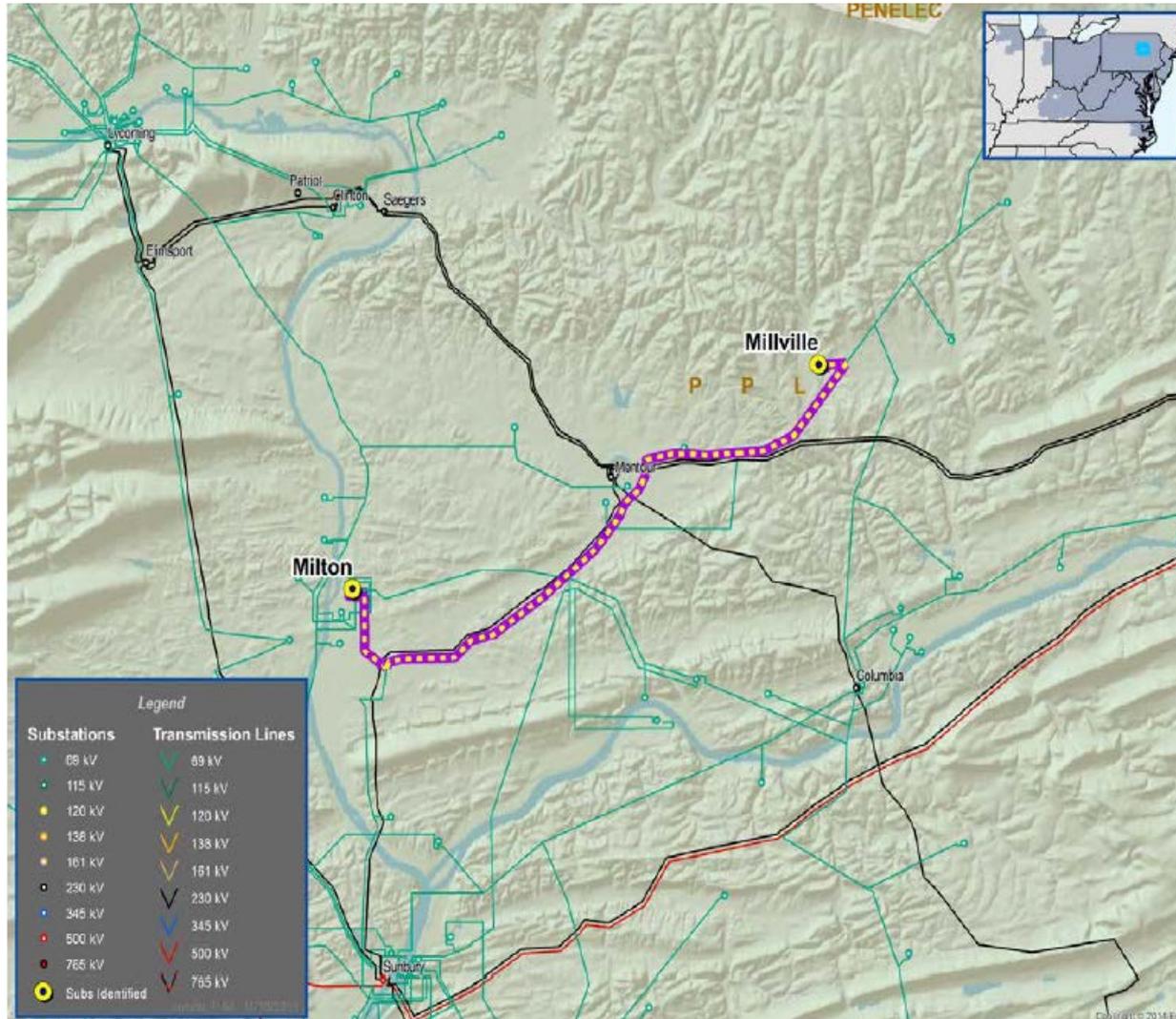
Scheduled IS Date: 12/31/2019

Project Status: Project Development



PPL Electric Utilities

Rebuild Milton-Millville 69 kV Line (9.8 mi)



Rebuild Milton-Millville 69 kV Line (9.8 mi)

• Problem Statement:

- The majority of the transmission structures on this line section are over 40 years old and are predominately Cellon-treated wood poles.
- The replacement of all Cellon-treated wood transmission structures on this line is critical since these assets are at significant risk of failure due to the accelerated deterioration of the wood.
- This line also requires a fiber optic communication path for the network, which requires the installation of OPGW and new or reinforced structures to support the additional structural loading.
- Finally, this line does not meet current PPL EU internal design standards.

• Proposed Solution:

- The proposed solution will be to replace all wood transmission structures and conductor on this section of the line.
- It is to be built to current single-circuit operation, future double-circuit for future substation conversions.
- All existing transmission switches will be replaced with motor operated switches for increased operability and timely response to outage events.

• Alternative:

- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substations. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

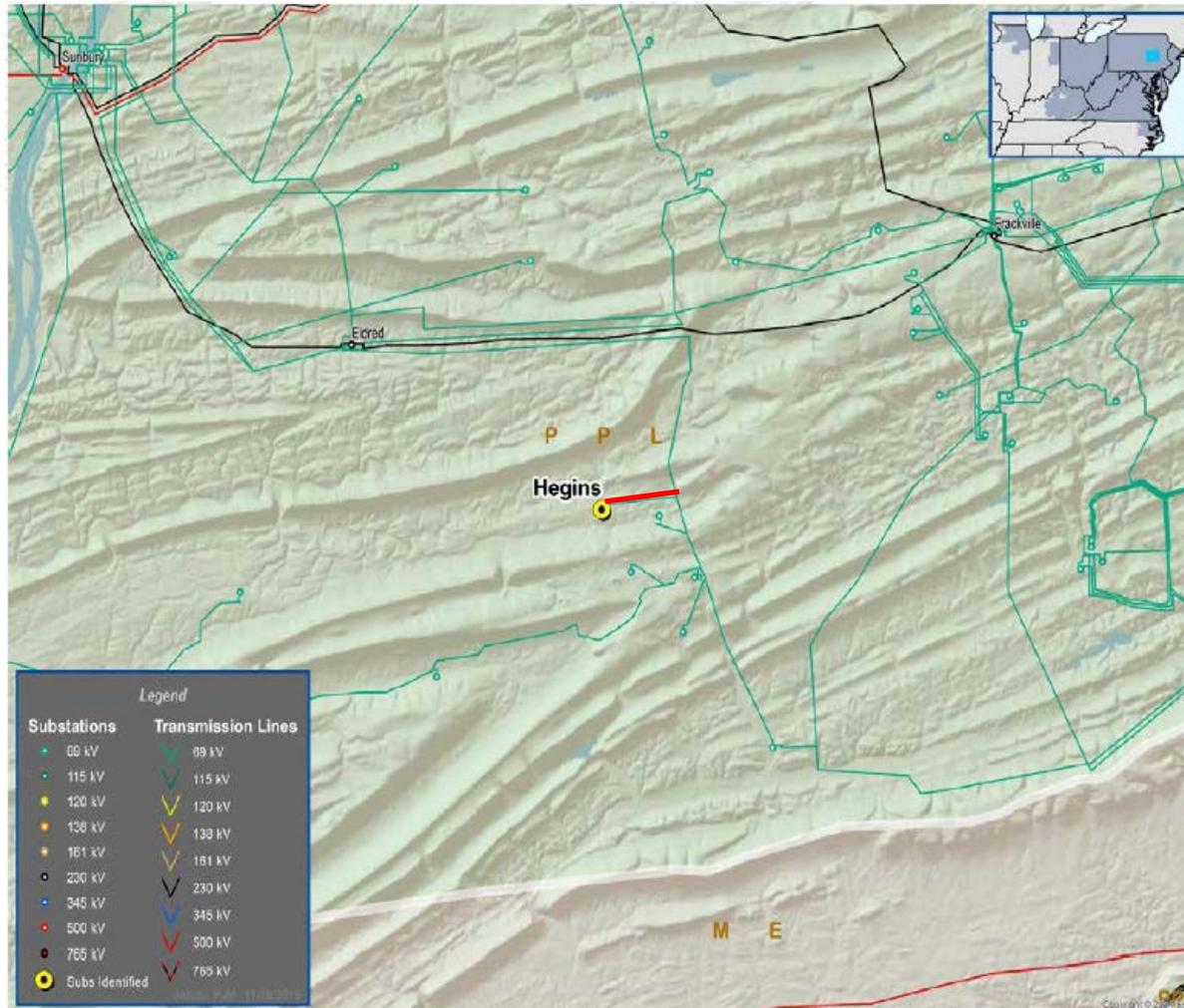
• Estimated Cost: \$17M

• Scheduled IS Date: 1/2021

• Project Status: Project Development



Rebuild Hegins 69 kV Tap (3.2 mi)



Rebuild Hegins 69 kV Tap (3.2 mi)

Problem Statement:

- Most structures are 30+ year old Wood Poles.
- Line does not meet current PPL EU internal design standards.
- Line requires a newly installed fiber optic communication network path.
- Hegins 69-12 kV Distribution Substation to be converted to “Twin A” design and requires a two-line supply.

Proposed Solution:

- Rebuild Hegins 69kV Tap (3.2 mi) for Double Circuit to meet current design criteria and provide two-line supply to Hegins Substation.
- Install new overhead Optical Ground Wire (OPGW) for new fiber communication path.
- Replace all transmission switches with motor operated switches for increased operability and improved sectionalizing capability.

Alternatives:

- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substation. One alternate solution would be to build a new double circuit 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

Estimated Cost: \$4.5 M

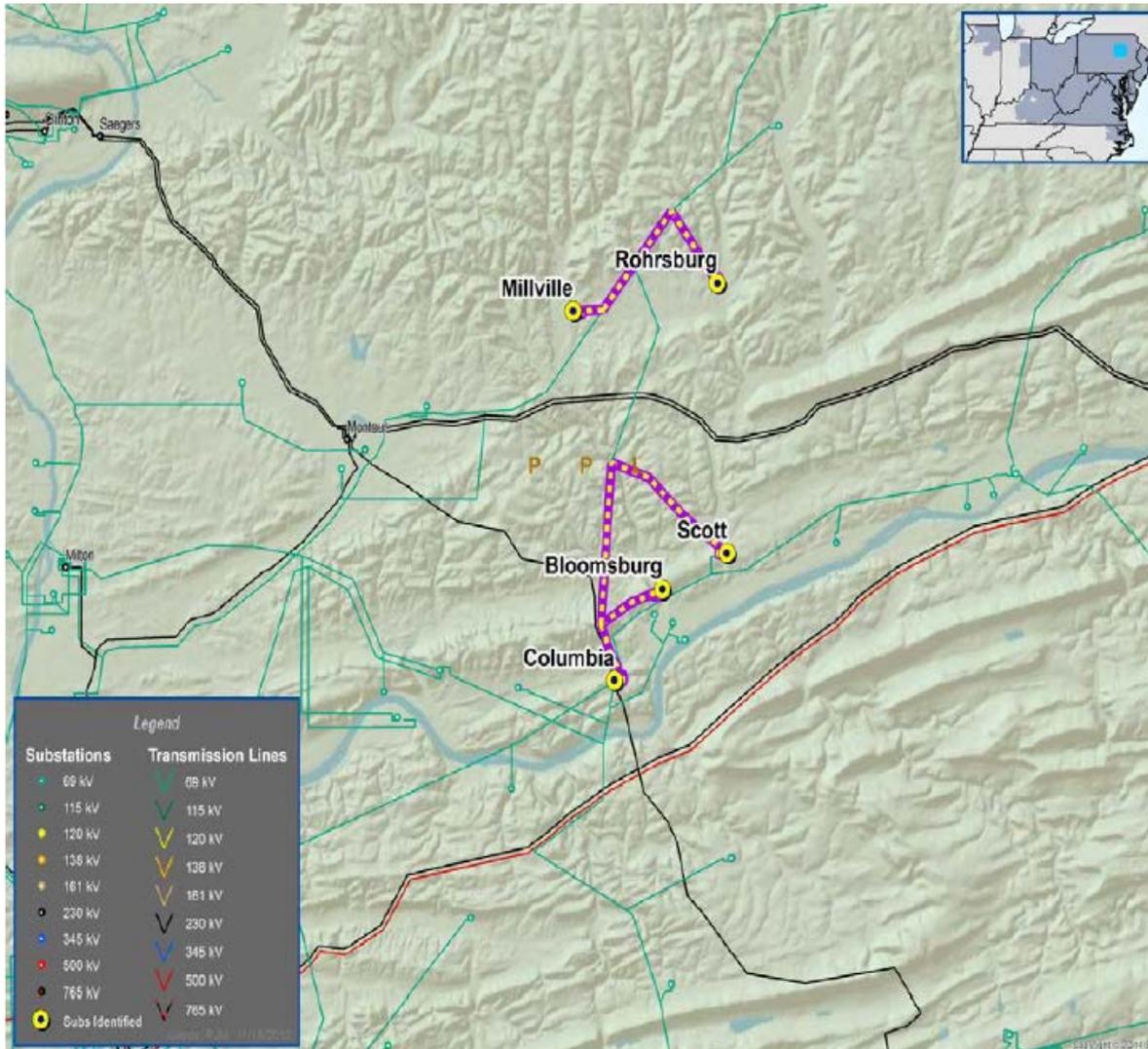
Scheduled IS Date: 4/30/2017

Project Status: Project Development



PPL Electric Utilities

Columbia-Scott-Millville 69 kV Line Enhancement Project



Columbia-Scott-Millville 69 kV Line Enhancement Project

- **Problem Statement:**

- The majority of the transmission structures on these line sections are 40+ year old wood structures .
- Additionally there are large sections of these lines that are predominately Cellon-treated wood poles which are at significant risk of failure due to the accelerated deterioration of the wood.
- These lines also require a fiber optic communication path for the network, necessitating the installation of OPGW and new or reinforced structures to support the additional structural loading.
- These line sections do not meet current PPL EU internal design standards.

- **Proposed Solution:**

- The proposed solution will be to replace all wood transmission structures and conductor on the line sections identified below.
- The lines are to be built to current single-circuit operation, future double-circuit for future substation conversions.
- All existing transmission switches will be replaced with motor operated switches for increased operability and timely response to outage events.

Rebuild the existing Columbia-Scot 69 kV line from Columbia sub to Bloomsburg sub to single circuit (Approximately 2.5 Miles)

- Projected in service date: Feb-2017
- Estimated Cost: \$5.8 M

Rebuild the existing Columbia-Scot 69 kV line from Bloomsburg sub to Scott sub to double circuit (Approximately 3.3 Miles)

- Projected in service date: Dec-2017
- Estimated Cost: \$7.6 M

Rebuild the existing Rohrsburg-Millville 69 kV tap (Approximately 5.9 Miles)

- Projected in service date: May-2019
- Estimated Cost: \$10.6 M



Columbia-Scott-Millville 69 kV Line Enhancement Project (cont.)

Alternative:

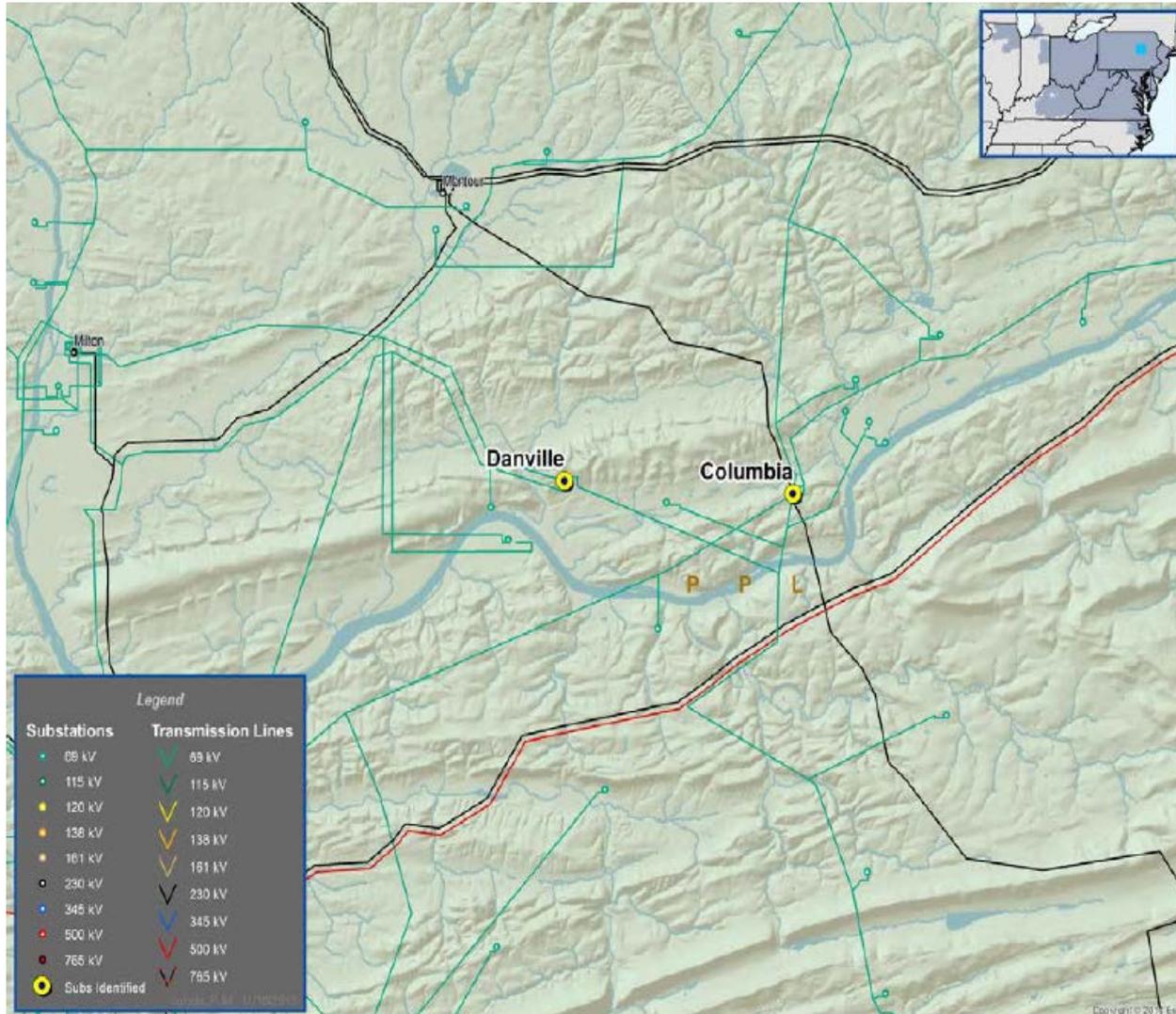
- Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substations. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.

Project Status: Project Development and Construction



PPL Electric Utilities

Danville Area Reliability Project



PPL Electric Utilities

Danville Area Reliability Project

- Problem Statement:

- A Special Protection Scheme at the Danville switchyard must have a long term resolution for removal according to PJM criteria.
- The addition of new lines from Columbia and reconfiguration of Danville will allow the decommissioning of the Special Protection System.
- To support the additional lines needed the Columbia 69kV substation must be expanded.
- Danville substations also contains 1960 vintage oil circuit breakers which have high maintenance costs and pose environmental concerns.
- Undesirable 69 kV networked lines between Columbia, Danville, Sunbury and Milton Substations.

- Proposed Solution:

- The Columbia Substation will have two additional breakers added to provide termination points for the new lines required to allow the removal of the Danville SPS.
 - Projected in service date: April-2018
 - Estimated Cost: \$0.7 M
- Danville Substation will be reconfigured to a 69-12 kV distribution substation. The Milton 69 kV line will be removed which will allow for the retirement of the oil circuit breakers and the SPS scheme.
 - Projected in service date: June-2020
 - Estimated Cost: \$1 M

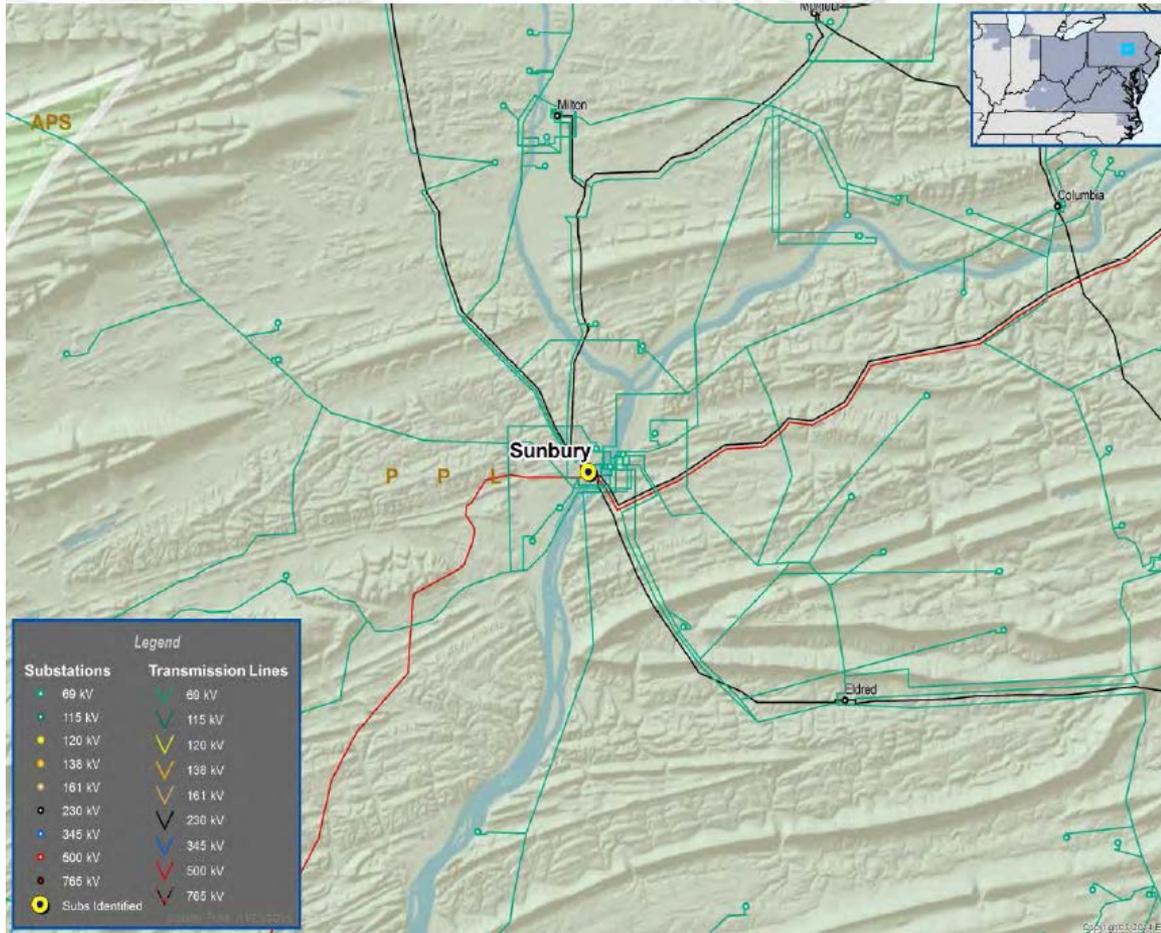
- Alternative:

- One alternative considered was to rebuild existing single circuit lines in place but we would not be able to eliminate the network ties without the double circuit upgrades. The preferred solution will allow us to operate the transmission lines radially and will also allow for the elimination of a few transmission lines which will minimize maintenance costs.

- Project Status: Project Development



Sunbury 230 kV and 69 kV work



Sunbury 230 kV GIS Substation

- **Problem Statement:**
 - The current Sunbury 230kV configure is a non-standard, unreliable configuration that includes 2 line tap transformers and transmission lines with single breaker connections.
 - Two new additional transformers to be installed by 2018 will require additional bays for termination.
 - The busses are also single 1590 conductor that will require a complete rebuild due to increased fault duty with new transformers.
 - Two 69kV CBs are 1970 Oil Breakers which have high maintenance costs and pose environmental concerns.
 - Several existing 1980's Siemens SP-72.5 CBs have had continuing problems with SF6 leaks. Analysis was completed and shows that replacement is a better option than repair for leaking SF6 CBs due to the low success rate of repairs.
 - Several existing HK Porter and Westinghouse disconnect switches have had historic maintenance issues. They typically fall out of adjustment and fail to operate properly, even after overhaul. Retrofit of these switches with motor operators is infeasible due to the maintenance issues and vintage of the switch.
 - Several existing sets of 1960's CCVTs have a known history of sudden catastrophic failure should be replaced due to safety and reliability concerns.
- **Proposed Solution:**
 - Construct a new 230 kV GIS yard at Sunbury Substation in a standard breaker-and-half configuration to enhance reliability and provide operational and maintenance flexibility.
 - Construction of a new yard will ensure adequate bay positions to manage the planned equipment terminations.
 - Construction of a new GIS will allow operational flexibility to continue with operation of the existing 230kV yard until the new yard is complete.
- **Alternate Solution:**
 - Rebuild the existing 230kV switchyard in place. This will require a lengthy outage of 230kV lines, busses and will likely require relocation of the T24 500-230kV transformer because there is no room to expand to breaker and a half configuration in the current yard layout. The operational risk is too high for a rebuild in place as it compromises system integrity.
- **Estimated Cost:** \$ 25 M
- **Scheduled IS Date:** 4/30/2018
- **Project Status:** Project Development



Sunbury 69 kV Yard Upgrades

- Problem Statement:

- The Sunbury 69kV Yard #1 and Yard #2 contain several oil circuit breakers that have high maintenance costs and pose environmental concerns.
- To support PPL EU's planned reliability improvements, new lines will be required to be terminated into the substation for projects that will be rebuilding lines from single circuit to double circuit.
- Additionally, work is needed to separate Corona Generation's infrastructure from PPL EU equipment.

- Proposed Solution:

- The proposed solution will remove any remaining oil circuit breakers and will relocate lines to a configuration to eliminate line crossing for improvement in reliability of the substation in Yard # 1.
- The proposed solution will add 4 additional bays to Sunbury Yard #2 to accommodate lines being rebuilt from single circuit to double circuit.
- In addition, any remaining oil circuit breakers in Yard #2 will be replaced.

69kv Yard #1 Expansion and Upgrade at Sunbury Substation

- Projected in service date: April-2018
- Estimated Cost: \$1.7 M

69kv Yard #2 Expansion and Upgrade at Sunbury Substation

- Projected in service date: June-2018
- Estimated Cost: \$1.9 M

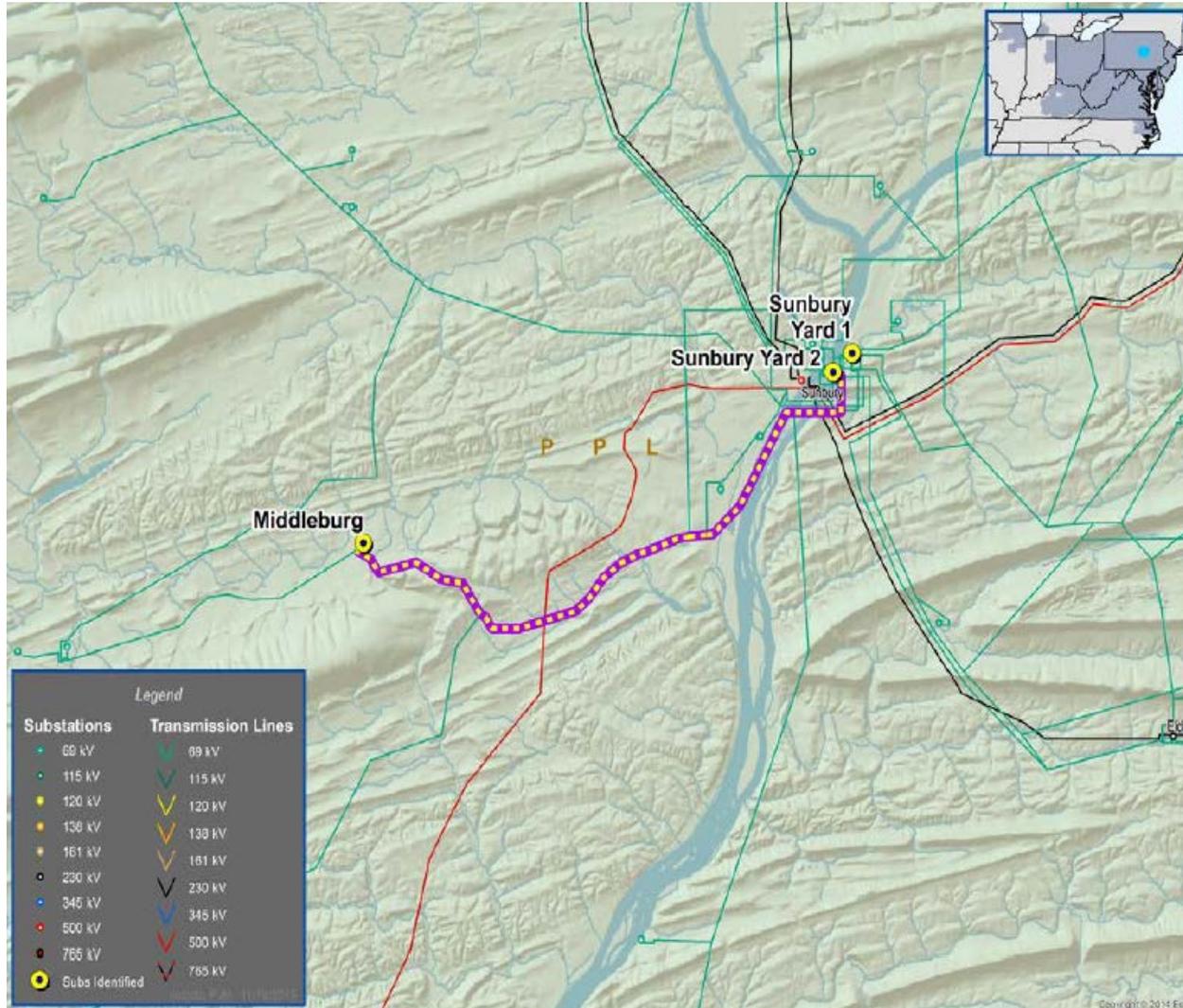
- Alternative:

- No alternatives were considered because of the nature of the work. The work is required in the existing substation.

- Project Status: Project Development



Sunbury-Middleburg 69 kV Line Rebuild (23.7 mi)

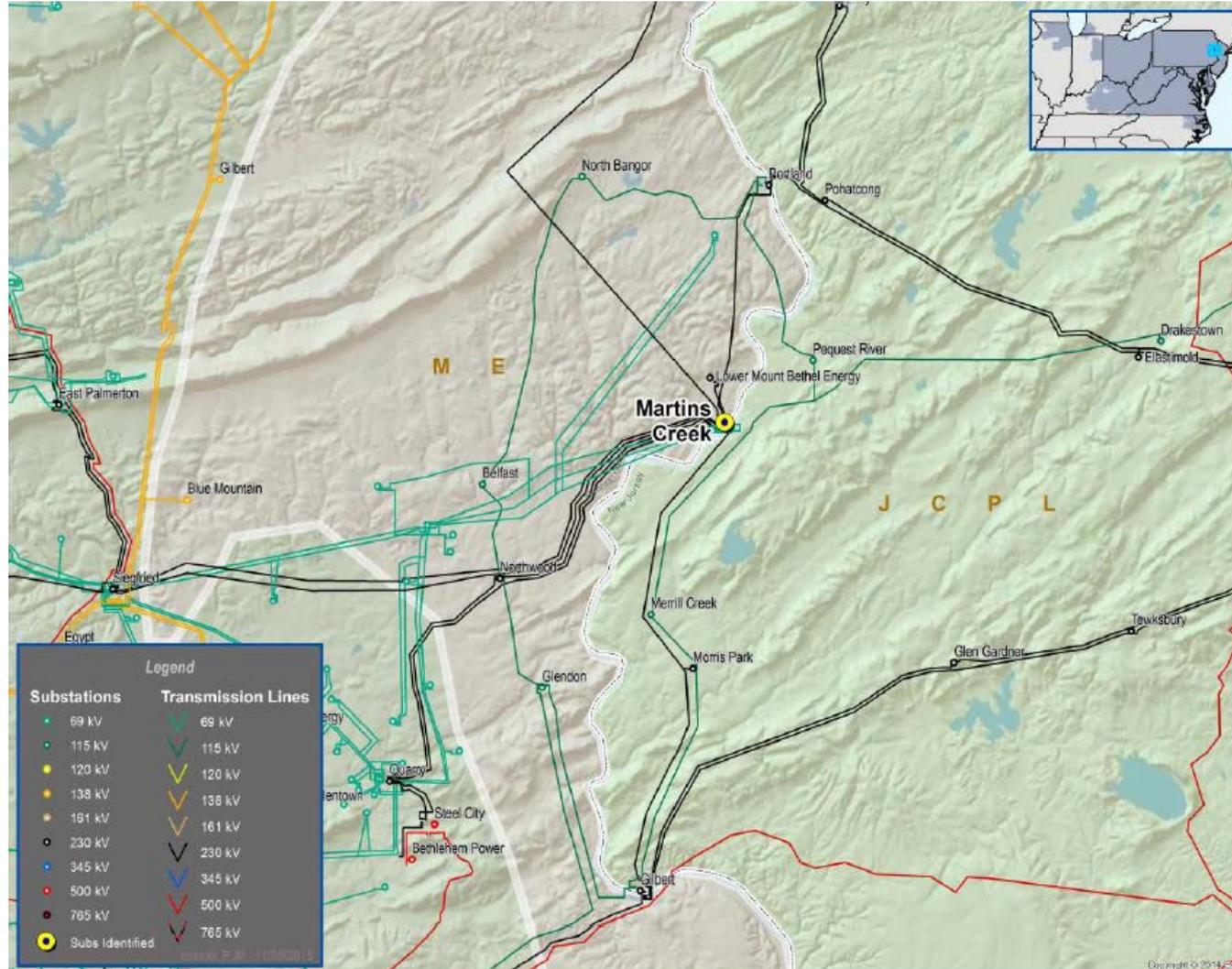


Sunbury-Middleburg 69 kV Line Rebuild (23.7 mi)

- Problem Statement:
 - The majority of the transmission structures on this line section are 40+ year old wood structures and need to be replaced to address the significant reliability risk due to material failure.
 - These lines also require a fiber optic communication path for the network, necessitating the installation of OPGW and new or reinforced structures to support the additional structural loading.
 - These line sections do not meet current PPL EU internal design standards.
- Proposed Solution:
 - The proposed solution will be to replace all wood transmission structures and conductor on the line.
 - It is to be built for double-circuit operation for improved reliability and performance on this line for PPL and customer substations.
 - All existing transmission switches will be replaced with motor operated switches for increased operability and timely response to outage events.
- Alternative:
 - Rebuilding the line is the best possible solution which has the least environmental impact from a ROW perspective in order to serve the existing distribution substations. One alternate solution would be to build a new 69 kV line which would require new ROW and be more costly and take longer to implement. Therefore this alternative was dismissed. The current solution will utilize existing assets where possible in order to reduce project costs while achieving required performance and reliability improvements.
- Estimated Cost: \$38.9 M
- Scheduled IS Date: 3/2022
- Project Status: Project Development



Upgrade Martins Creek 230-69 kV Substation



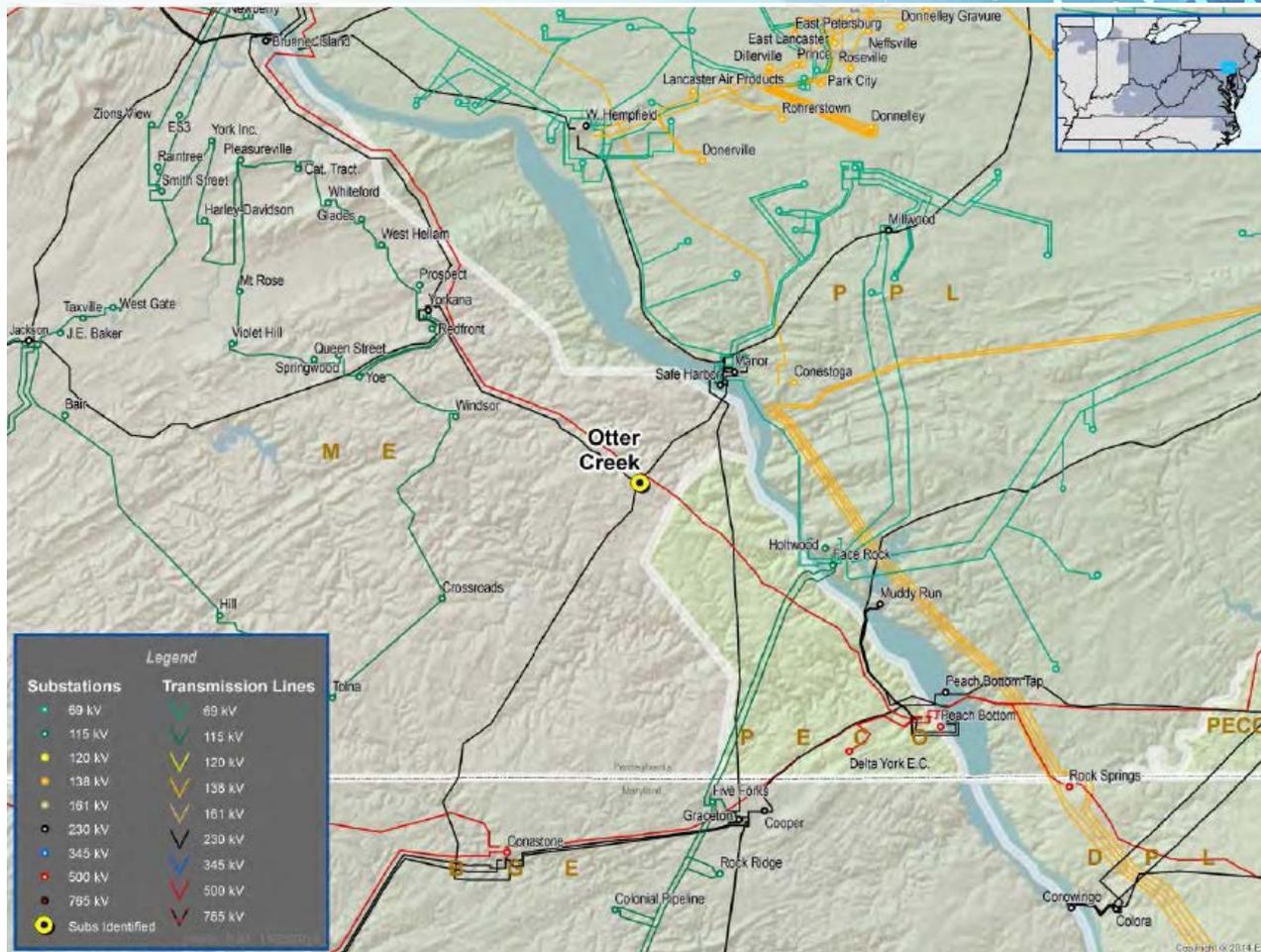
PPL Electric Utilities

Upgrade Martins Creek 230-69 kV Substation

- **Problem Statement:**
 - Martins Creek 230-69 kV Substation is of abnormal configuration and is not up to current PPL EU internal design standards.
 - Three Circuit Breakers been identified as deteriorating infrastructure in the Martins Creek 69kV Yard. These are 33+ year-old Oil Breakers. Oil CBs are part of a long-standing initiative to remove from the system due to environmental concerns. To maintain system reliability and reduce potential environmental issues, these breakers should be replaced.
 - Brown Cap & Pin Insulators (1960's vintage) are present throughout the 69kV Yard. NEETRAC analysis revealed these insulators no longer meet their given ratings, and should be replaced to maintain system reliability.
 - Due to the decommissioning of the dated Nazareth Switchyard and the conversion of Martins Creek–Cherry Hill 1&2 69kV lines from network to radial, Martins Creek requires the installation of a second 230-69kV transformer.
 - Control Cubicle is needed at Martins Creek 69kV to upgrade all relays to current PPL EU internal design standards. Relay upgrades will allow for more reliable relay operation, maintenance cost reductions, as well as improved operational data.
 - Substation Security does not meet current PPL EU internal design standards. Currently there is increased vulnerability to foreign interference, and a threat to system reliability.
- **Proposed Solution:**
 - Construct new 69kV Yard to meet needs outlined above.
 - Decommission existing 69kV yard.
- **Alternate Solution:**
 - Rebuilding the existing 230-69 kV substation in place. This will require a lengthy outage of 69 kV lines and busses . The operational risk is too high for a rebuild in place as it compromises system integrity.
- **Estimated Cost:** \$35 M
- **Scheduled IS Date:** May-2023
- **Project Status:** Project Development



Upgrade Otter Creek 230 kV Yard

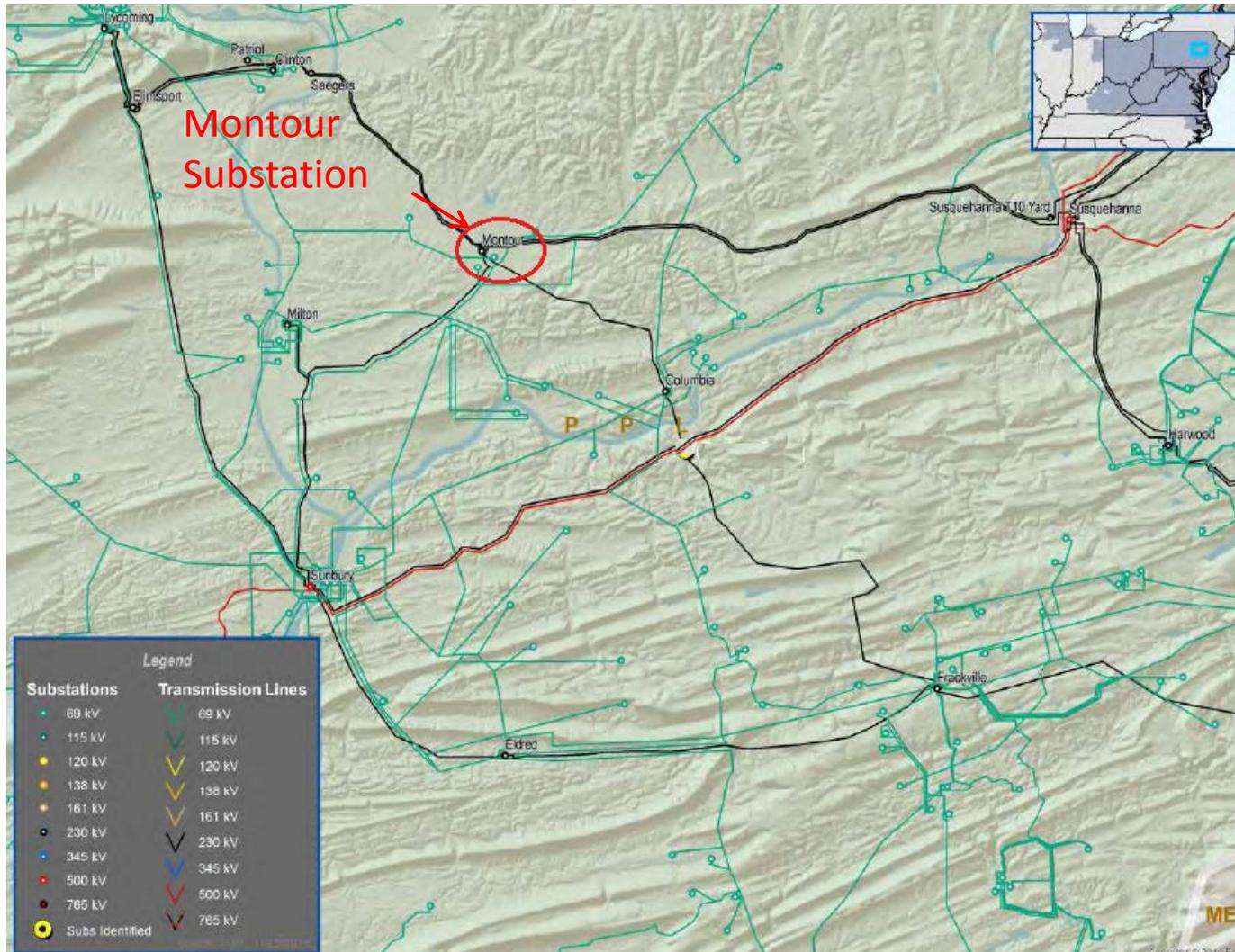


Upgrade Otter Creek 230 kV Yard

- **Problem Statement:**
 - Otter Creek 230 kV Switchyard is of abnormal configuration and is not up to current PPL EU internal design standards.
- **Proposed Solution:**
 - Expand the yard from a three breaker ring bus configuration to a breaker-and-a-half layout with three bays configured as double bus double breaker initially.
 - Upgrade the security fence to the current PPL EU internal design standards.
- **Alternative considered:**
 - Upgrading the existing substation to the current PPL EU internal design standard is the best cost effective solution and can be achieved with minimal outage risk. The other more costly alternative would be to build a brand new substation and retire the existing substation. This less desirable alternative was dismissed.
- **Estimated Cost: \$10.7 M**
- **Scheduled IS Date: 12/31/2026**
- **Project Status: Project Development**



Montour 230 kV Yard Upgrades



Montour 230 kV Yard Upgrades

- **Problem Statement:**

- PPL EU line and customer currently occupy same bay position.
- In Bay 4, existing Saegers 230kV CCVTs are over 49 years old and are of model type PCA-7. Existing North Bus Phase A CCVT is over 43 years old and is of model type PCA-5. These are both types known to experience high catastrophic failure rates at this age. They should be replaced to reduce this safety (and reliability) risk.
- Substation Security does not meet current PPL EU internal design standards. Currently there is increased vulnerability to foreign interference, and a threat to system reliability.

- **Proposed Solution:**

- Reterminate the MONT-SU10 230kV Line from Bay 1 into Bay 5 and the MONT-SUSQ 230kV Line from Bay 2 into Bay 6.
- Upgrade relaying at Susquehanna 230kV Switchyard and Susquehanna T10 Switchyard.
- Remove two (2) Montour 230kV circuit breakers in Bay 1 and Bay 2.
- Replace CCVTs defined above.
- Install a new control house and upgrade substation security to current PPL EU internal design standards.

- **Alternative:**

- No alternatives were considered because of the nature of the work. The work is required in the existing substation.

- **Estimated Cost:** \$ 6.49 M

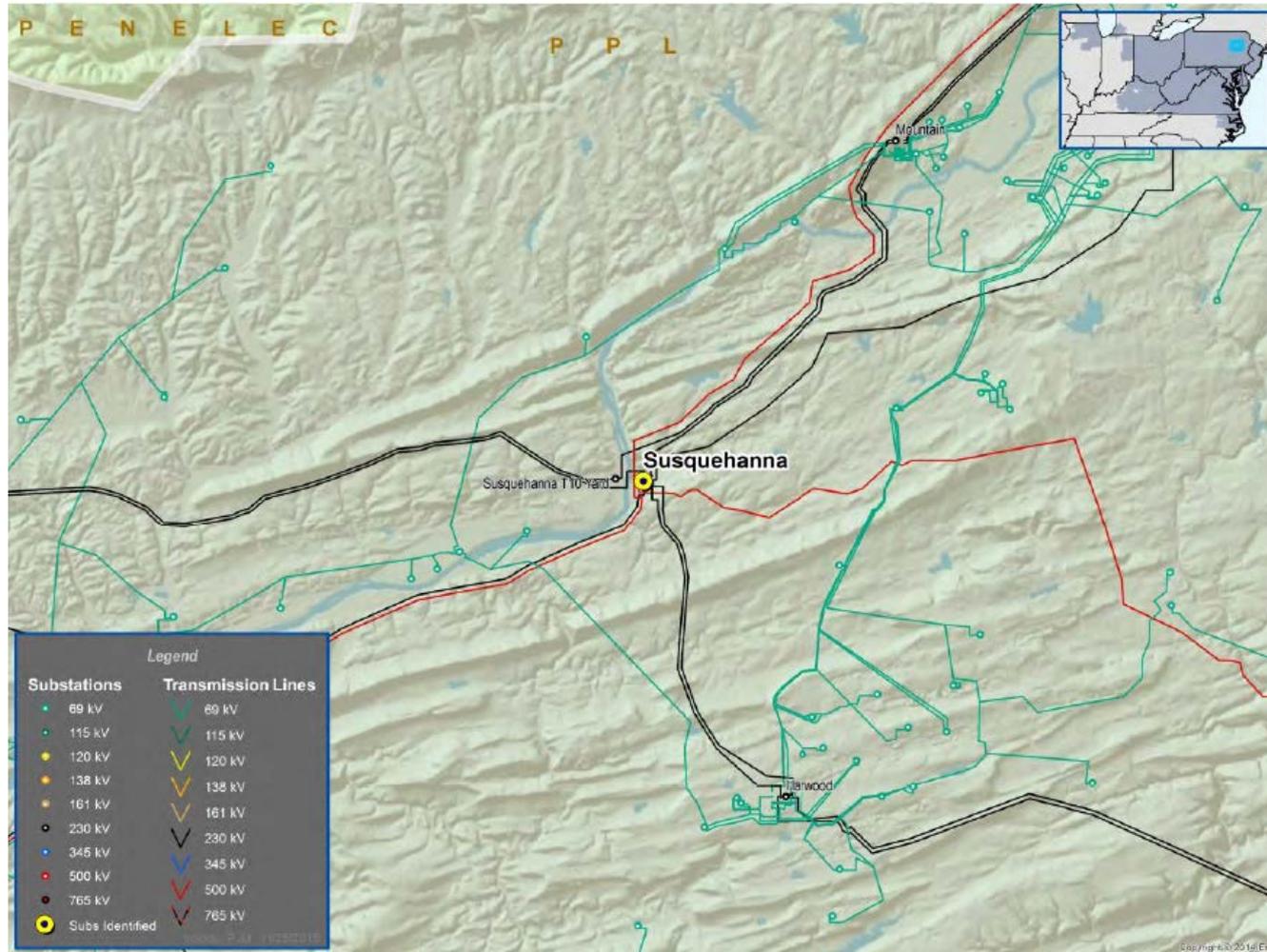
- **Scheduled IS Date:** 12/31/2018

- **Project Status:** Project Development



Susquehanna 500 kV CB Replacements and Triple Circuit SPS

Removal



PPL Electric Utilities

Susquehanna 500 kV CB Replacements

- **Problem Statement:**
 - Analysis shows short and long term reliability of circuit breakers 3N and 3T (27 and 34 years old, respectively) in the Susquehanna 500kV substation is below acceptable levels.
 - In order to maintain system reliability this 500 kV BES Substation which is interconnects a nuclear generation facility to the PPL UE grid, replacement of these CBs is necessary.
- **Proposed Solution:**
 - Replace 3N and 3T Circuit Breakers at Susquehanna 500kV yard
- **Alternative:**
 - No alternatives were considered because of the nature of the work. The work is required in the existing substation.
- **Estimated Cost:** \$2.8 M
- **Scheduled IS Date:** 4/30/2017
- **Project Status:** Project Development

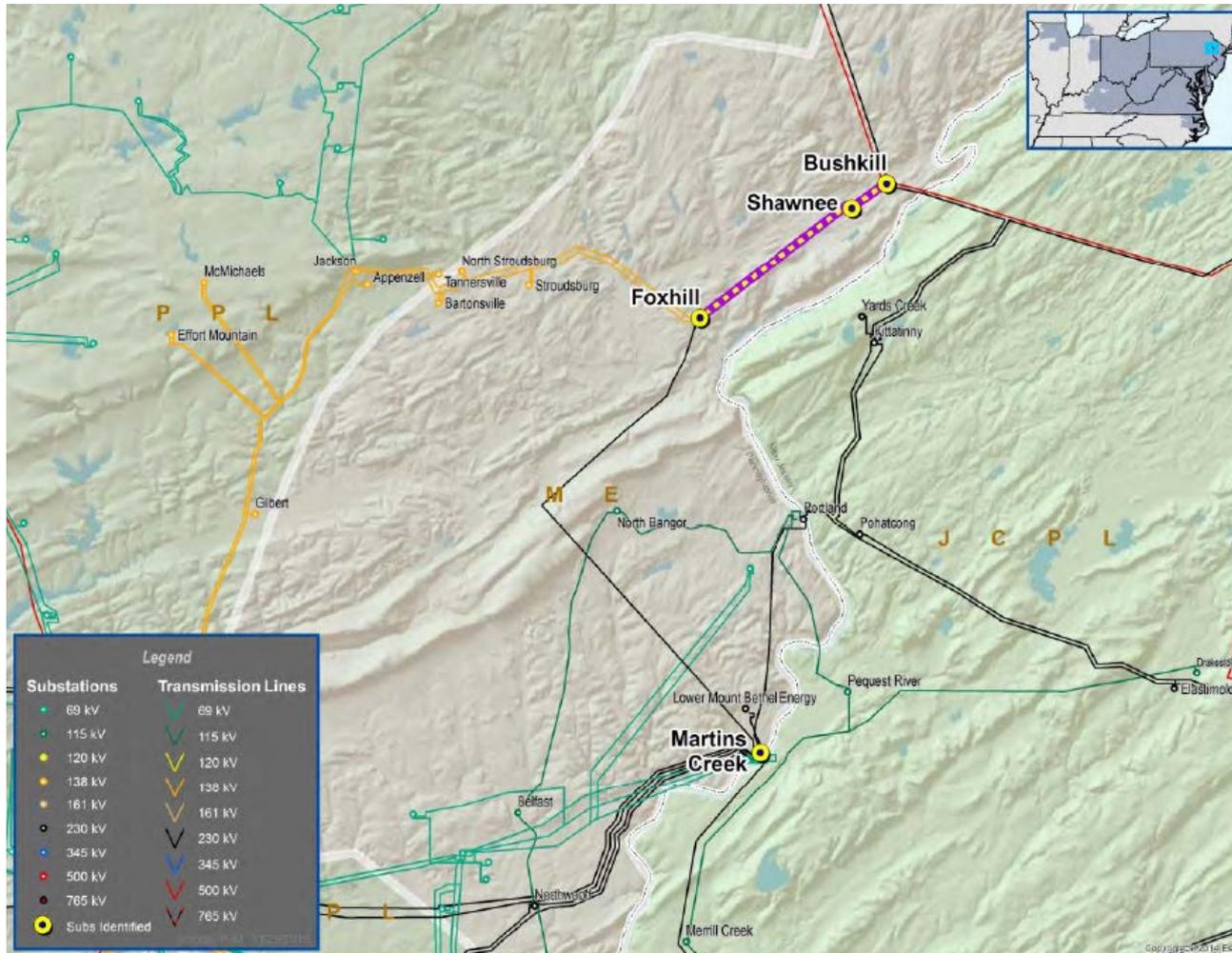


Susquehanna Triple Circuit SPS Removal

- Problem Statement:
 - The Susquehanna triple circuit outage scheme is no longer required with the Susquehanna – Roseland project
- Proposed Solution:
 - Retire and Remove the Susquehanna Triple Circuit Outage Special Protection Scheme
- Alternative:
 - No viable alternatives. Scheme needs to be removed to avoid inadvertent operation.
- Estimated Cost: \$ 0.84 M
- Scheduled IS Date: 4/30/2016
- Project Status: Project Development



Foxhill-Shawnee and Shawnee-Bushkill 230 kV Line Rebuild



Foxhill-Shawnee 230 kV Line Rebuild

- **Problem Statement:**
 - Vintage 1920's 230 kV line.
 - Third party condition assessment was performed to assess condition of line.
 - Foxhill-Shawnee 230 kV line was identified as having structures in poor condition and conductors with internal deterioration, especially at the splice locations.
 - Trending increased maintenance and operating issues giving it a poor health rating.
 - Installation of new conductors and OPGW would also exceed current loading capacity of the transmission structures.
 - Transmission structures need to be replaced to meet modern structure loading and performance requirements.
- **Proposed Solution:**
 - Rebuild the existing Foxhill-Shawnee 230 kV line (Approximately 8.25 Miles) to single circuit, future double circuit design.
 - Install new conductors that meet current PPL EU internal design standards and install dual OPGW for fiber optic communication network requirements.
- **Alternatives:**
 - PPL EU considered rehabilitation instead of replacement. However, due to the extensive rehabilitation needs, the cost benefit analysis proved that a rebuild is more cost effective to reduce the performance risk associated with the line.
- **Estimated Cost: \$ 28.4 M**
- **Scheduled IS Date: 12/31/2020**
- **Project Status: Project Development**

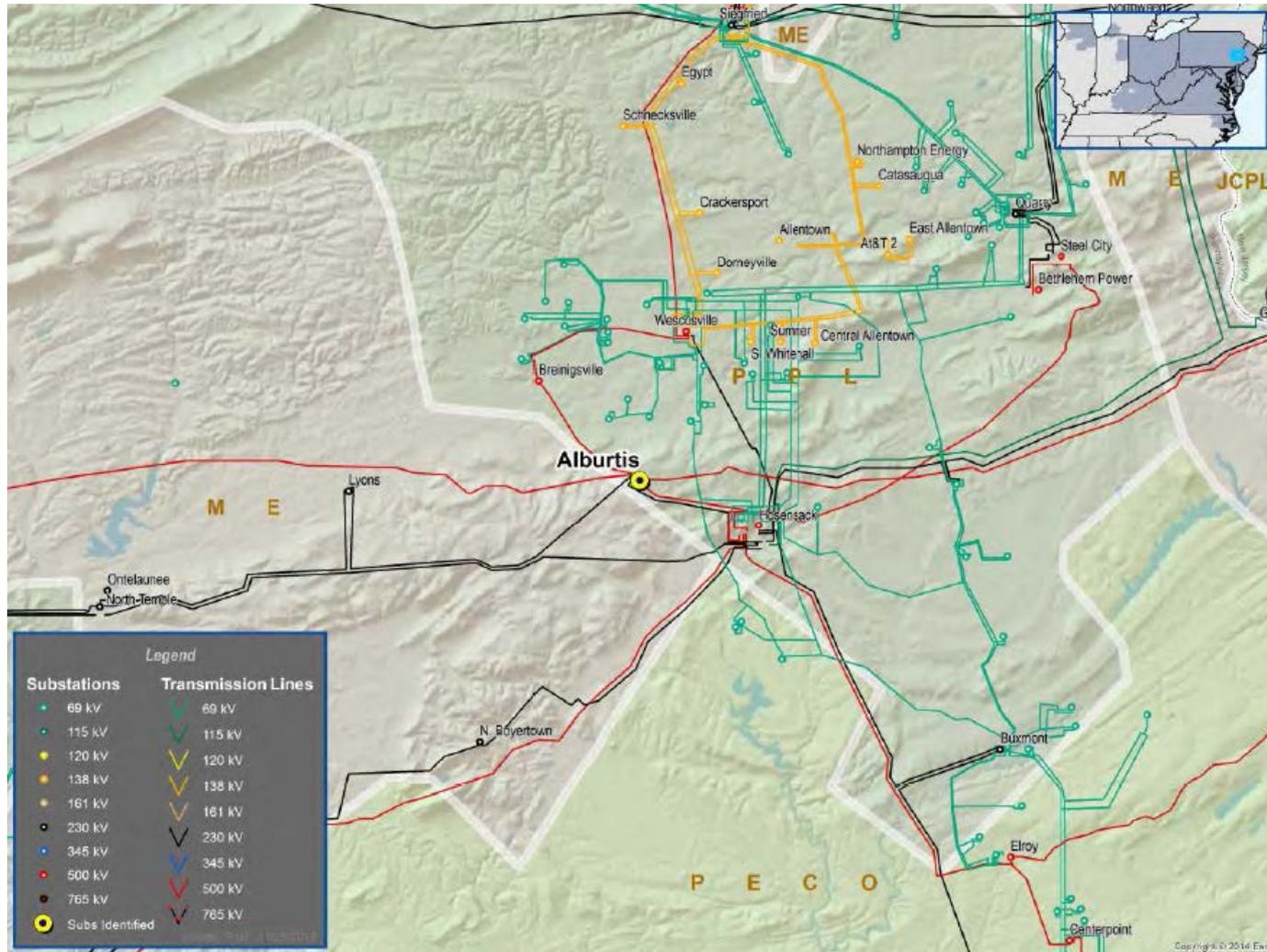


Shawnee-Bushkill 230 kV Line Rebuild (2.2 mi)

- **Problem Statement:**
 - Vintage 1920's 230 kV line.
 - Third party condition assessment was performed to assess condition of line.
 - Shawnee-Bushkill 230 kV line was identified as having structures in poor condition and conductors with internal deterioration, especially at the splice locations.
 - Trending increased maintenance and operating issues giving it a poor health rating.
 - Installation of new conductors and OPGW would also exceed current loading capacity of the transmission structures.
 - Transmission structures need to be replaced to meet modern structure loading and performance requirements.
- **Proposed Solution:**
 - Rebuild the existing Shawnee-Bushkill 230 kV line (Approximately 2.2 Miles) to single circuit, future double circuit design.
 - Install new conductors that meet current PPL EU internal design standards and install dual OPGW for fiber optic communication network requirements.
- **Alternatives:**
 - PPL EU considered rehabilitation instead of replacement. However, due to the extensive rehabilitation needs, the cost benefit analysis proved that a rebuild is more cost effective to reduce the performance risk associated with the line.
- **Estimated Cost:** \$ 6.8 M
- **Scheduled IS Date:** 5/31/2020
- **Project Status:** Project Development



Alburtis 500 kV Switchyard Upgrades

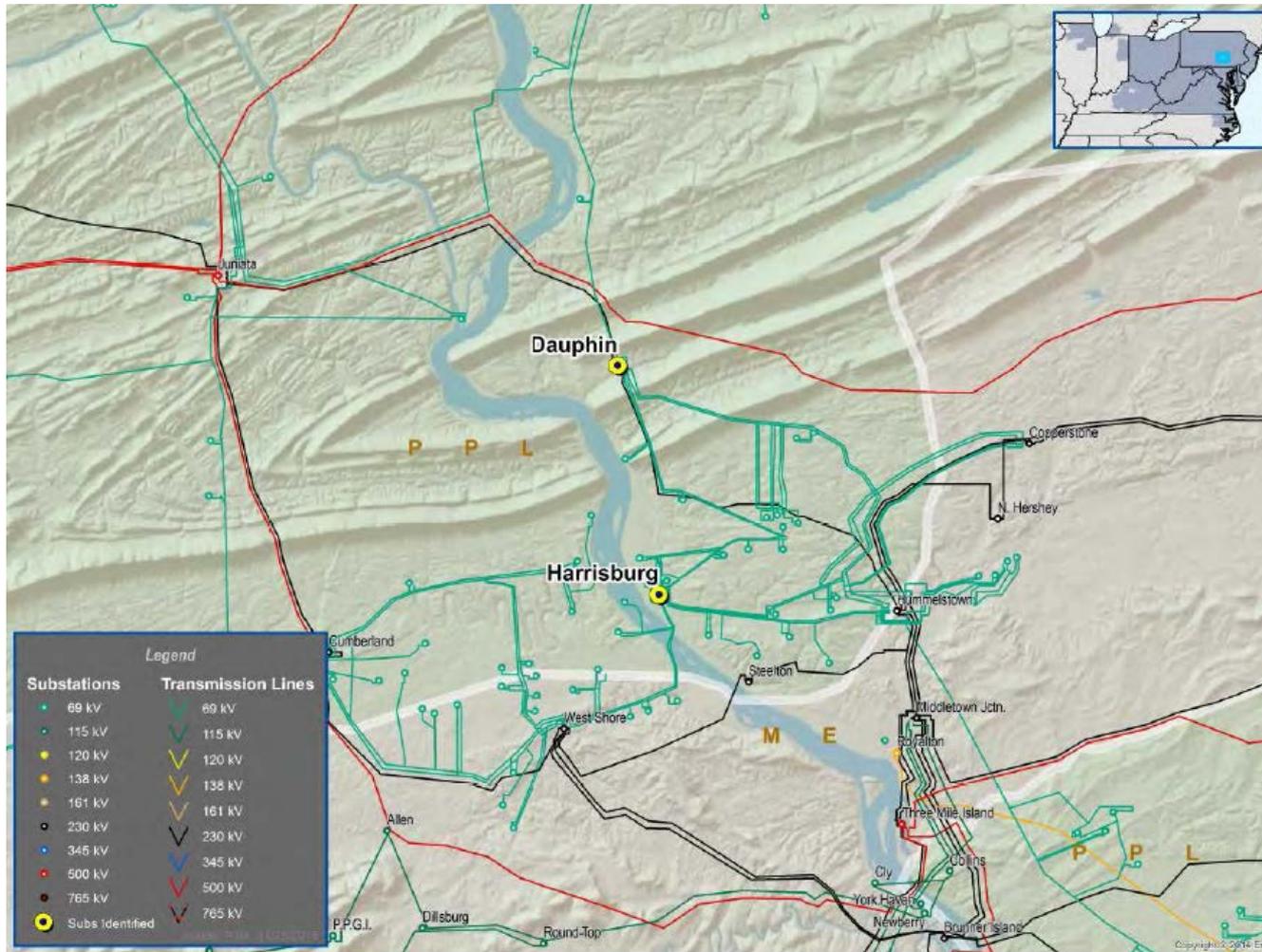


Alburtis 500 kV Switchyard Upgrades

- **Problem Statement:**
 - Security upgrades are needed at this substation based on a security risk evaluation. Based on this evaluation, Alburtis needs increased security measures and barriers at the substation.
 - Control cubicle and relay upgrades are needed at Alburtis as well to allow for relay upgrades which will occur at the remote ends of connected lines.
 - Propellant style high speed ground switches need to be replaced or removed to eliminate the safety and reliability concerns. The elimination of the ground switch will also reduce future maintenance expenses.
 - The replacement of old deteriorated substation equipment is needed for system reliability and maintenance cost improvements.
- **Proposed Solution:**
 - Upgrade to current substation security standards to reduce security risks.
 - Replace control house and relays to accommodate required remote end work
 - Replace failing and outdated equipment, including high speed ground switch, cap bank, and four circuit breakers.
- **Alternative:**
 - No alternatives were considered because of the nature of the work. The work is required in the existing substation.
- **Estimated Project Cost:** \$6.6 M
- **Scheduled IS Date:** 12/31/2017
- **Project Status:** Project Development



Harrisburg 230-69 kV Substation and Connecting Lines

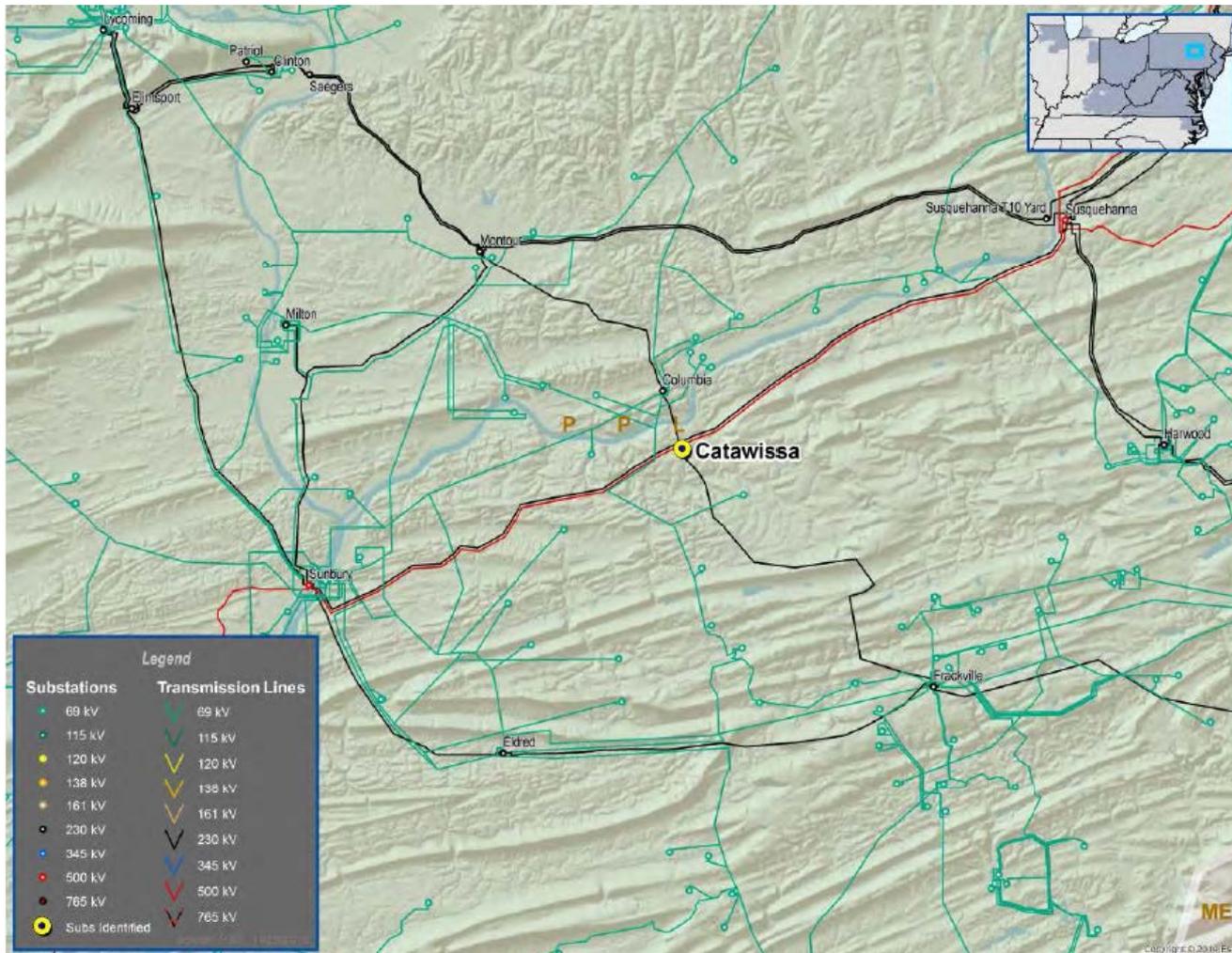


Harrisburg 230-69 kV Substation and Connecting Lines

- **Problem Statement:**
 - Harrisburg 69 kV Switchyard in center city Harrisburg connects to several 230-69 kV regional substations through 69 kV networked lines.
 - These networked lines are long and serve a significant number of customers.
 - PPL objective to eliminate long networked lines to reduce line exposure, reduce number of customers served from each line, and relieve the neighboring regional substations all to improve reliability.
- **Proposed Solution:**
 - Build a new 230-69 kV Substation in downtown Harrisburg to bring a source closer to the load it serves.
 - Involves building a new 230 kV Line (12.8 miles) from Dauphin to new Harrisburg 230-69 kV Substation.
 - Also involves a new 230 kV Line (13.5 miles) from West Shore to new Harrisburg 230-69 kV Substation.
 - The 69kv lines will then be served radially from Harrisburg 230-69 kV Substation, eliminating the long networked lines.
- **Alternative:** The best solution to reduce line exposure is to bring a source more central to the load. The most effective source substation is 230-69 kV. A 138 kV source solution was considered but not developed. With either option, PPL still believes that UG facilities will need to be installed given the location of the Harrisburg substation.
- **Estimated Cost:** \$88 M
- **Scheduled IS Date:** 5/31/2026
- **Project Status:** Project Development



Catawissa 500-230 kV Substation and connecting lines



Catawissa 500-230 kV Substation and connecting lines

- **Problem Statement:**
 - To address instability concerns at Montour for three phase fault on a 230 kV double circuit tower (Montour-Susquehanna T10 and Montour-Susquehanna 230 kV Lines).
- **Proposed Solution:**
 - Build new 500-230 kV Substation and associated transmission work (tap Sunbury - Susquehanna #2 500 kV, Sunbury-Susquehanna #1 230 kV and Columbia - Frackville 230 kV lines).
- **Alternative considered:**
 - The potential alternative to address this problem could be building a approximately 30 miles of new 230 kV line from Montour to Susquehanna substation. This alternative would be more expensive and challenging from siting, permitting and ROW perspective. Additionally, overall the substation option is better than the line option from operational flexibility perspective.
- **Estimated Project Cost:** \$ 95 M
- **Scheduled IS Date:** 12/31/2018
- **Project Status:** Project Development



Additional Detail

Question:

Please explain what an expansion period is and what is the expected age for the end of life of these facilities.

Response:

The term “expansion period” referred in our slides was the time period in the 1970’s when the PPL Transmission system underwent significant growth and construction. In cases where original installation exceeds 40 years we proactively consider asset replacement.



Additional Detail

Question:

Please explain how PPL identifies and prioritizes which facilities to replace.

Response:

PPL takes into consideration a number of general factors when identifying and prioritizing facilities to replace such as age, condition during inspections/maintenance, historic performance, operation and operating experience along with overall meeting our PPL Practices & Principles (P&P) document along with consideration according to criticality of the facility (i.e. number of customers served, redundancy in design, outage availability, customer sensitivity, ability to apply new technologies for security enhancements, etc.).



PPL Electric Utilities

Additional Detail

Question:

Does PPL evaluate its system for reliable operation with the line retired and removed from service?

Response:

Yes, PPL follows its Planning Principles and Practices document for reviewing transmission system operation. This document provides the planning principles such as N-1 analysis and PPL applies this analysis as applicable. Other considerations are also factored into the evaluation such as design requirements, operational flexibility and performance along with meeting the PPL Planning Principles and Practices document.



Additional Detail

Question:

How does PPL decide what specification and capability is required for the replacement facilities?

Response:

PPL has a standards group that is engaged in the industry through technical committees to determine the latest standards that need to be considered in meeting the reliability requirements of the transmission system.

PPL's Standards group determines how our specifications and designs should evolve to meet the reliability needs of our system based on PPL's Reliability Principles and Practices document.

Current industry standards are referenced for the latest design criteria and specifications are set based on those that achieve our planning criteria.



Additional Detail

Question:

Please describe existing facility specifications and latest PPL specifications.

Response:

The existing facilities meet the specification requirements invoked at the time the facility was constructed. Changes to current facilities are required to meet our latest specifications. As stated in the prior question our specifications are based on a number of factors required to meet regulatory, industry and planning principles and practices.



Additional Detail

Question:

What is the issue with line tapped transformers at regional substations?

Response:

PJM Manual 7, section 8.2 refers to “isolation of a faulted transformer tapped to a line” and states that there must be a protective device between a transmission line and the high side of a transformer. In this scenario, a fault on the low-side of the transformer (non-BES element) would affect BES facilities.

Based on the PJM manual requirements, PPL has initiatives to resolve line tapped transformers.



Additional Detail

Question:

What is a regional substation?

Response:

A PPL regional substation is one that has a low-side voltage of 69kV or 138 kV. This substation typically steps voltage down from a Bulk Power level (>200kV) to some sub-transmission level (69kV or 138kV) to deliver power to Distribution level substations or transmission customers.



Additional Detail

Question:

Describe the analysis of maintenance costs used to justify replacement of existing facilities.

Response:

Future maintenance costs are projected based on historical maintenance records, expected life curves, and recommended preventative maintenance cycles. These are used to project potential maintenance savings.

While reduction in maintenance costs are factored into the analysis of replacing existing facilities, these are not the sole consideration. Other factors, like reliability and operational performance, must also be taken into consideration.



Additional Detail

Question:

Please describe the process PPL uses to improve work efficiency and reduce outages.

Response:

Facilities are grouped into “operationally independent zones” where any work within a zone could affect other facilities in that particular zone, but none outside of that zone. All system reinforcement needs or upgrades within that zone are then looked at collectively by a single multi-discipline planning team. A comprehensive project plan is then developed for that zone and then aggregated with the plans for the other zones on the system.

Outage conflicts are then identified and resolved across the system, resulting in a more efficient plan.



Additional Detail

Question:

Please describe the drivers for PPL's relay and control house improvements.

Response:

PPL takes into consideration a number of factors when considering upgrades or replacements of relay and control houses. Some of the drivers for these improvements are:

- Operational & reliability performance of equipment
- Reduction in required operation & maintenance costs associated with maintaining and testing existing relay equipment
- NERC standards for testing requirements
- Improved fault data availability through the use of Microprocessor based relays
- Reduction in human performance errors through standardization of relay designs and control cubicle layout
- Security improvements

