Overview of Pepco's Electric System District of Columbia

Technical Committee
September 26, 2012

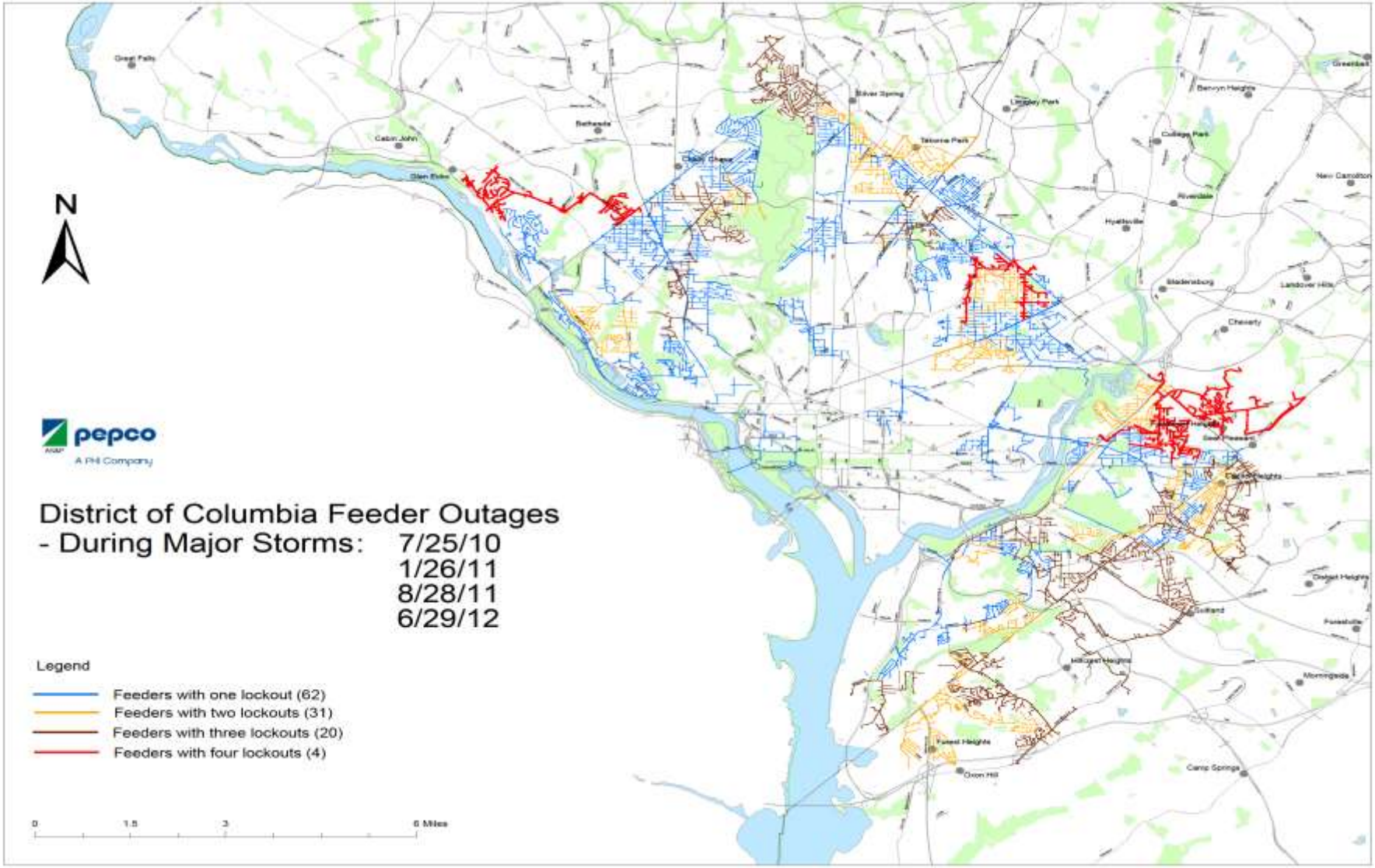
Technical Committee Scope of Work

- Examine generation, transmission and distribution system connectivity with other jurisdictions; and impact on District planning
- Provide details of the current distribution system
- Define steps needed (and process) to move lines underground (how, technically, such undergrounding would occur)
- Examine impact of undergrounding on reliability
- Identify best options for undergrounding coordination with other utilities and DDOT

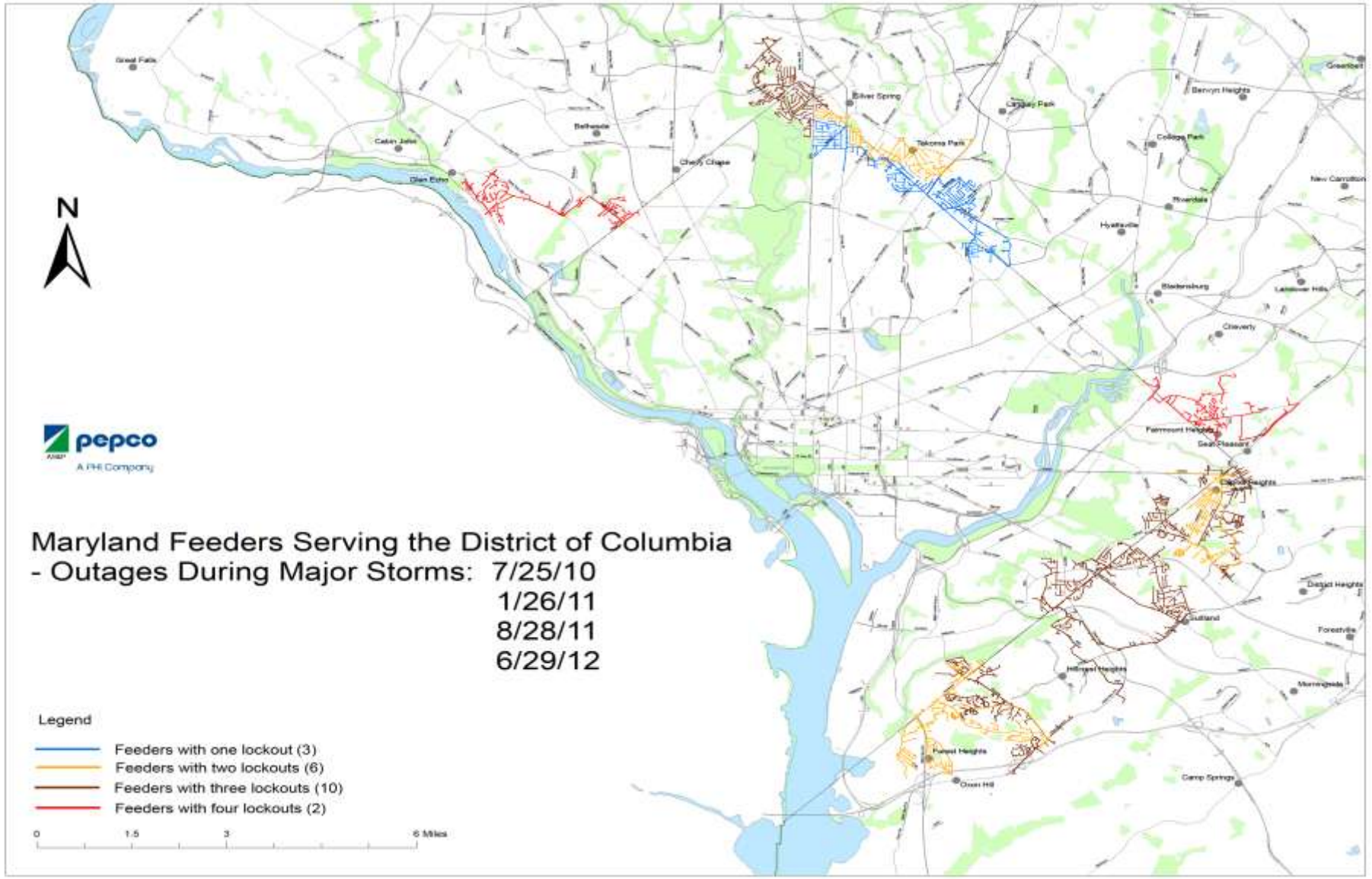
Generation and Transmission

- Generation within the District of Columbia (Benning and Buzzard Point) was retired in May 2012 and Potomac River generation will retire in October 2012
- The District of Columbia is dependent on the transmission system to deliver energy from remote generating plants
- Reliability of the transmission system is high and no customer outages have occurred as a result of any transmission outage
- Pepco's transmission zone must deliver energy for 100% of the District of Columbia peak load and 40% of the State of Maryland
- Nearly all major transmission and substation supply lines within the District of Columbia are already underground
- Due to the existing reliability of the transmission system no additional analysis is needed on undergrounding of substation supply or transmission lines

District of Columbia Feeder Outages During Major Storms



District of Columbia Outages During Major Storms From Maryland Feeders



Underground Initiatives – DC and MD

- After the Derecho, both DC and MD launched task forces to study ways to reduce the duration of outages after a major storm.

- Pepco has undertaken a study to understand alternatives, benefits and costs, and we expect to submit a report to the Commission prior to year end.

- Our current reliability enhancement plan is primarily designed to reduce outages during normal conditions and small storms, but it also provides benefit during major events.

- Significant amounts of the system will need to be placed underground to prevent major storms from causing outages lasting more than 3-4 days.

- The costs to underground Pepco's entire distribution system would cost billions and take years to complete. The challenge is to find the right combination of location and cost to select appropriate portions of the system to underground.

Pepco's UG Study: Purpose, Objectives and Scope

Purpose

1) Produce an analysis and thorough study of the technical feasibility, infrastructure options and reliability implications of undergrounding new or existing overhead electric distribution in Maryland to assist stakeholders in defining a way forward for these types of infrastructure improvements and additions.

Objective

2) Identify high level probable reliability outcomes during major storms from four illustrative types of distribution feeders i.e. majority underground, majority overhead, mixed overhead & underground and feeders serving public welfare and safety agencies and infrastructure (such as hospitals, water and sewage treatment facilities, etc.).

Scope

Background		Examination		Conclusion	
Identify design principles and design implications of Pepco's System Today (History)		Analyze appropriate Undergrounding Options, Costs and Reliability Benefits Estimates		Findings	Summary
Research Comparable Efforts to Pepco System	Include appropriate innovations for Pepco's System of Tomorrow	Investigate Pepco's System Performance In light of major storms	Consider Construction Process	Recommendations	
Discuss the pros and cons	Identify Options for Undergrounding	Discuss Associated Work – Coordination with other Utilities	Challenges, Benefits, Selection Process		

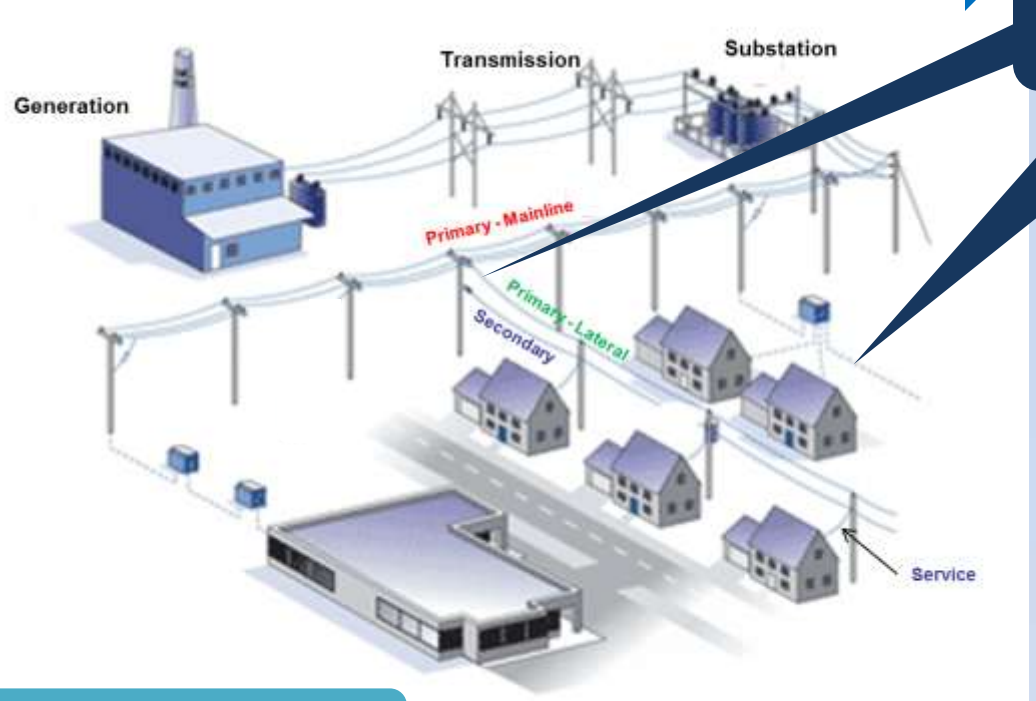
Undergrounding Scenarios Being Considered and Potential Impact on Outages

	Scenario Description	Reduces outages during*		
		Blue Sky	Small Storms	Major Storms
1	Underground mainline primary; retain the current poles, transformers and feed up the poles; retain all lateral overhead primary and all secondary/services.	LOW	MEDIUM	LOW
2	Underground all (mainline and laterals/single phase and three phase) primary; retain the current poles, secondary cables, services and secondary up the poles.	HIGH	HIGH	MEDIUM
3	Underground all primary, secondary and services up to the residence; option of installing new customer meter box.	HIGH	HIGH	HIGH
4	Underground primary taps, secondary and service up to the residence; retain the mainline primary overhead.	LOW	MEDIUM	HIGH
5	Underground sections of the high voltage substation supply lines in accordance with desired future configuration. (Maryland Only)	LOW	LOW	HIGH

*Based on preliminary assumptions.

Undergrounding Model Analysis

Takes outages by:
- Date/time
- Cause
- OH, UG, Network
- Voltage
- Mains. Laterals
- Geography



Length of Primary and Secondary, %OH and UG

+

Feeder Demographics
Commercial, Residential, Rock Digging Areas, %OH and UG

+

Customer and Transformer Counts

=

Look at all outages grouped and analyzed based on weather conditions:

- **Major Event Days**
- **Light Storms**
- **Blue Sky**

Results:

Options identified that projects improvement in reliability and estimates associated costs to underground

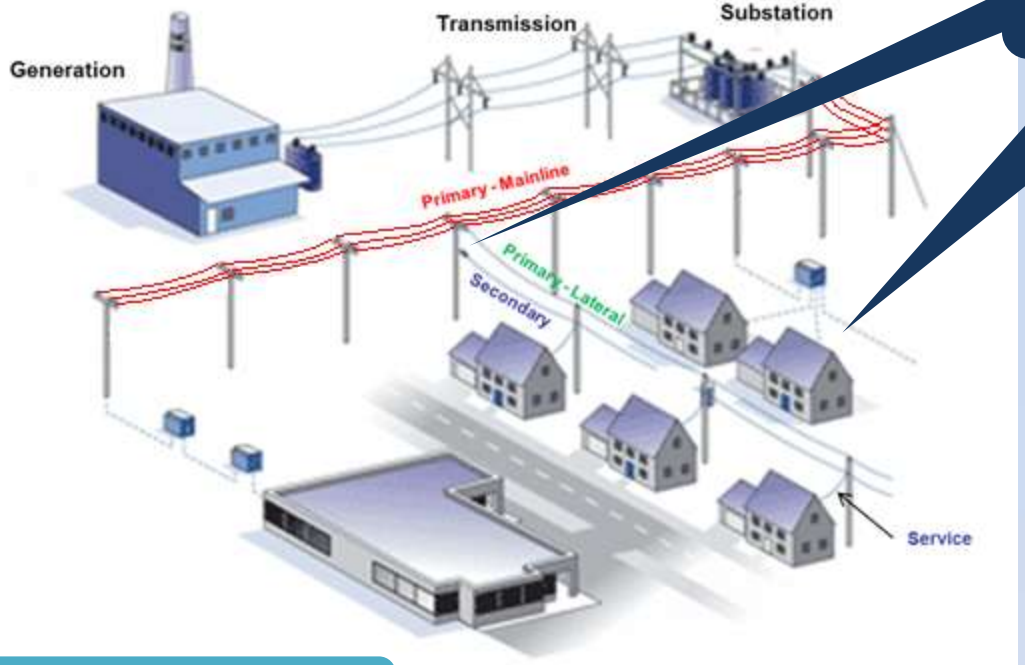
Undergrounding Scenarios Being Considered and Potential Impact on Outages

	Scenario Description	Reduces outages during*		
		Blue Sky	Small Storms	Major Storms
1	Underground mainline primary; retain the current poles, transformers and feed up the poles; retain all lateral overhead primary and all secondary/services.	LOW	MEDIUM	LOW
2	Underground all (mainline and laterals/single phase and three phase) primary; retain the current poles, secondary cables, services and secondary up the poles.	HIGH	HIGH	MEDIUM
3	Underground all primary, secondary and services up to the residence; option of installing new customer meter box.	HIGH	HIGH	HIGH
4	Underground primary taps, secondary and service up to the residence; retain the mainline primary overhead.	LOW	MEDIUM	HIGH
5	Underground sections of the high voltage substation supply lines in accordance with desired future configuration. (Maryland Only)	LOW	LOW	HIGH

*Based on preliminary assumptions.

Undergrounding Model Analysis

Takes outages by:
- Date/time
- Cause
- OH, UG, Network
- Voltage
- Mains. Laterals
- Geography



Length of Primary and Secondary, %OH and UG

+

Feeder Demographics
Commercial, Residential, Rock Digging Areas, %OH and UG

+

Customer and Transformer Counts

=

Look at all outages grouped and analyzed based on weather conditions:

- **Major Event Days**
- **Light Storms**
- **Blue Sky**

Results:

Options identified that projects improvement in reliability and estimates associated costs to underground

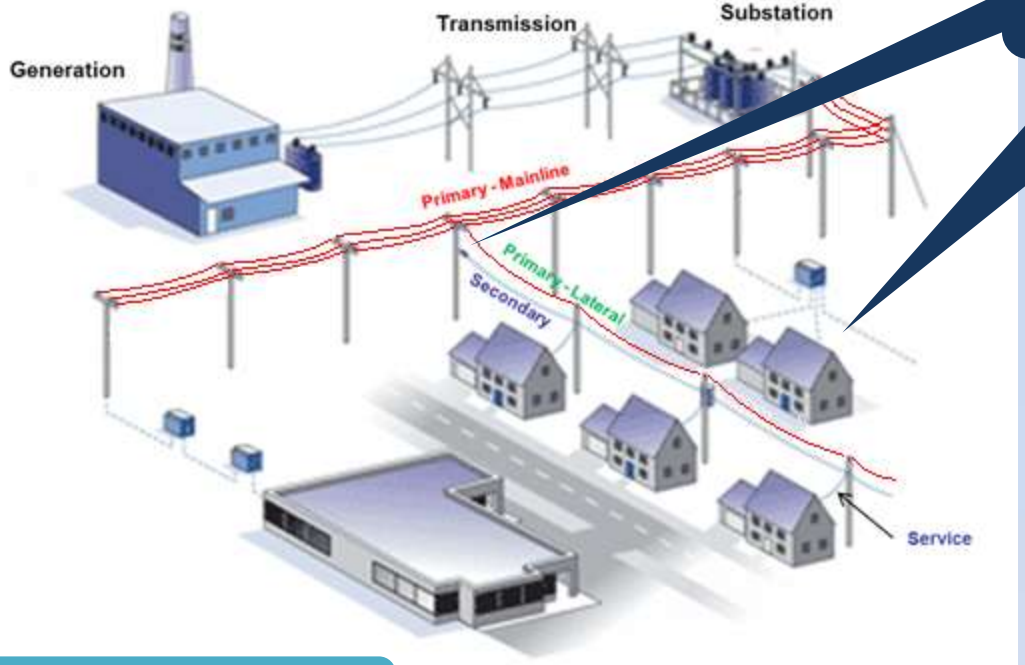
Undergrounding Scenarios Being Considered and Potential Impact on Outages

	Scenario Description	Reduces outages during*		
		Blue Sky	Small Storms	Major Storms
1	Underground mainline primary; retain the current poles, transformers and feed up the poles; retain all lateral overhead primary and all secondary/services.	LOW	MEDIUM	LOW
2	Underground all (mainline and laterals/single phase and three phase) primary; retain the current poles, secondary cables, services and secondary up the poles.	**HIGH**	**HIGH**	**MEDIUM**
3	Underground all primary, secondary and services up to the residence; option of installing new customer meter box.	HIGH	HIGH	HIGH
4	Underground primary taps, secondary and service up to the residence; retain the mainline primary overhead.	LOW	MEDIUM	HIGH
5	Underground sections of the high voltage substation supply lines in accordance with desired future configuration. (Maryland Only)	LOW	LOW	HIGH

*Based on preliminary assumptions.

Undergrounding Model Analysis

Takes outages by:
- Date/time
- Cause
- OH, UG, Network
- Voltage
- Mains. Laterals
- Geography



Length of Primary and Secondary, %OH and UG

+

Feeder Demographics
Commercial, Residential, Rock Digging Areas, %OH and UG

+

Customer and Transformer Counts

=

Look at all outages grouped and analyzed based on weather conditions:

- **Major Event Days**
- **Light Storms**
- **Blue Sky**

Results:

Options identified that projects improvement in reliability and estimates associated costs to underground

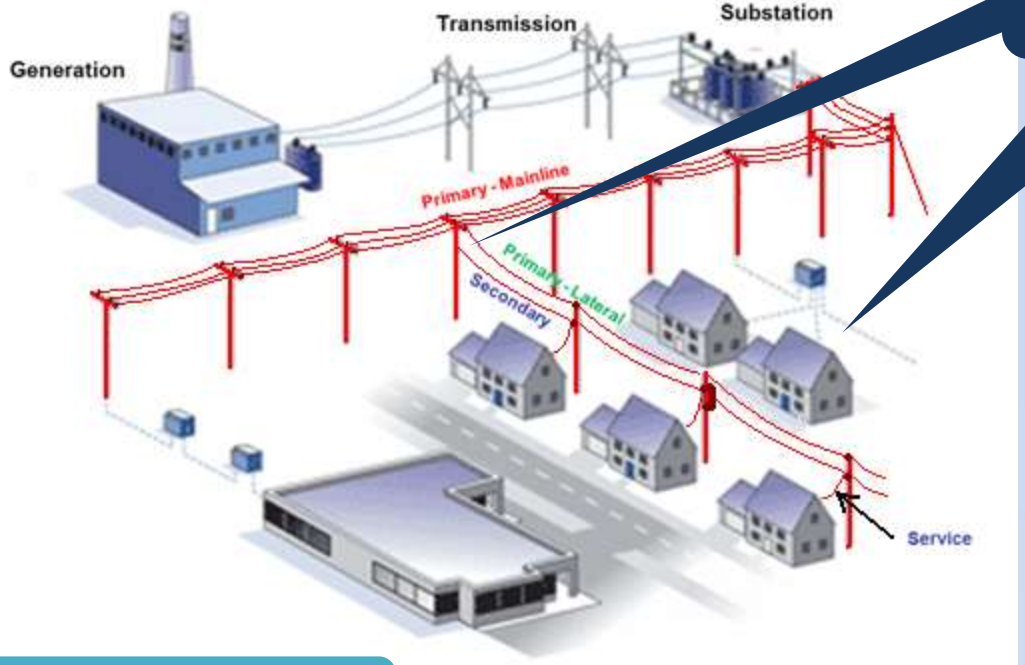
Undergrounding Scenarios Being Considered and Potential Impact on Outages

	Scenario Description	Reduces outages during*		
		Blue Sky	Small Storms	Major Storms
1	Underground mainline primary; retain the current poles, transformers and feed up the poles; retain all lateral overhead primary and all secondary/services.	LOW	MEDIUM	LOW
2	Underground all (mainline and laterals/single phase and three phase) primary; retain the current poles, secondary cables, services and secondary up the poles.	HIGH	HIGH	MEDIUM
3	Underground all primary, secondary and services up to the residence; option of installing new customer meter box.	**HIGH**	**HIGH**	**HIGH**
4	Underground primary taps, secondary and service up to the residence; retain the mainline primary overhead.	LOW	MEDIUM	HIGH
5	Underground sections of the high voltage substation supply lines in accordance with desired future configuration. (Maryland Only)	LOW	LOW	HIGH

*Based on preliminary assumptions.

Undergrounding Model Analysis

Takes outages by:
- Date/time
- Cause
- OH, UG, Network
- Voltage
- Mains. Laterals
- Geography



Length of Primary and Secondary, %OH and UG

+

Feeder Demographics
Commercial, Residential, Rock Digging Areas, %OH and UG

+

Customer and Transformer Counts

=

Look at all outages grouped and analyzed based on weather conditions:

- **Major Event Days**
- **Light Storms**
- **Blue Sky**

Results:

Options identified that projects improvement in reliability and estimates associated costs to underground

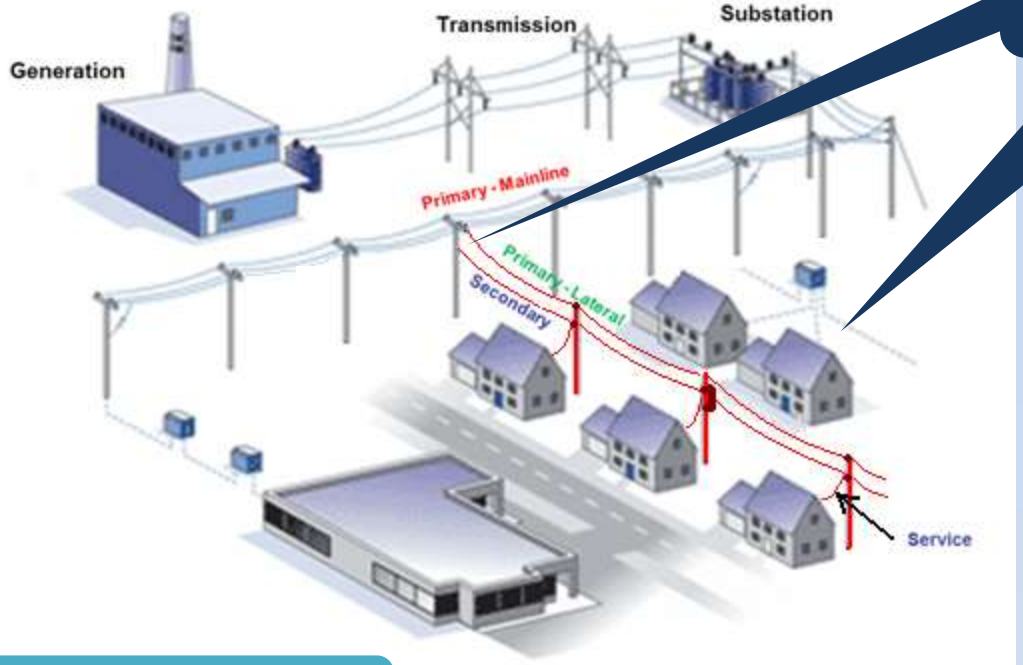
Undergrounding Scenarios Being Considered and Potential Impact on Outages

	Scenario Description	Reduces outages during*		
		Blue Sky	Small Storms	Major Storms
1	Underground mainline primary; retain the current poles, transformers and feed up the poles; retain all lateral overhead primary and all secondary/services.	LOW	MEDIUM	LOW
2	Underground all (mainline and laterals/single phase and three phase) primary; retain the current poles, secondary cables, services and secondary up the poles.	HIGH	HIGH	MEDIUM
3	Underground all primary, secondary and services up to the residence; option of installing new customer meter box.	HIGH	HIGH	HIGH
4	Underground primary taps, secondary and service up to the residence; retain the mainline primary overhead.	**LOW**	**MEDIUM**	**HIGH**
5	Underground sections of the high voltage substation supply lines in accordance with desired future configuration. (Maryland Only)	LOW	LOW	HIGH

*Based on preliminary assumptions.

Undergrounding Model Analysis

Takes outages by:
- Date/time
- Cause
- OH, UG, Network
- Voltage
- Mains. Laterals
- Geography



Length of Primary and Secondary, %OH and UG

+

Feeder Demographics
Commercial, Residential, Rock Digging Areas, %OH and UG

+

Customer and Transformer Counts

=

Look at all outages grouped and analyzed based on weather conditions:

- **Major Event Days**
- **Light Storms**
- **Blue Sky**

Results:

Options identified that projects improvement in reliability and estimates associated costs to underground

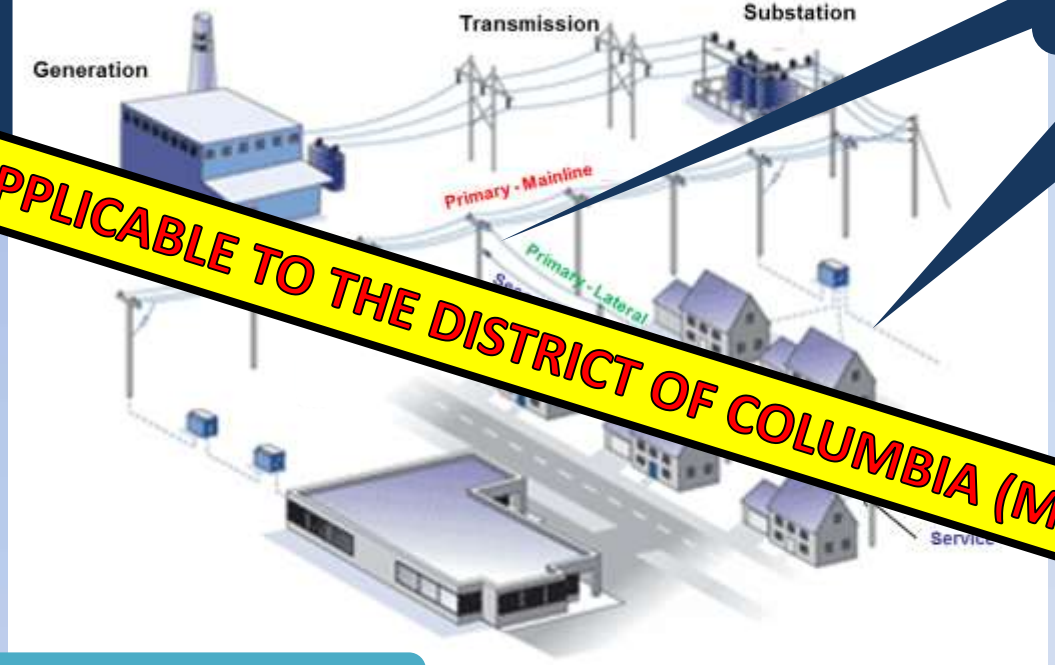
Undergrounding Scenarios Being Considered and Potential Impact on Outages

	Scenario Description	Reduces outages during*		
		Blue Sky	Small Storms	Major Storms
1	Underground mainline primary; retain the current poles, transformers and feed up the poles; retain all lateral overhead primary and all secondary/services.	LOW	MEDIUM	LOW
2	Underground all (mainline and laterals/single phase and three phase) primary; retain the current poles, secondary cables, services and secondary up the poles.	HIGH	HIGH	MEDIUM
3	Underground all primary, secondary and services up to the residence; option of installing new customer meter box.	HIGH	HIGH	HIGH
4	Underground primary taps, secondary and service up to the residence; retain the mainline primary overhead.	LOW	MEDIUM	HIGH
5	Underground sections of the high voltage substation supply lines in accordance with desired future configuration. (Maryland Only)	**LOW**	**LOW**	**HIGH**

*Based on preliminary assumptions.

Undergrounding Model Analysis

Takes outages by:
- Date/time
- Cause
- OH, UG, Network
- Volta
- Mai
- Ge



NOT APPLICABLE TO THE DISTRICT OF COLUMBIA (MD ONLY)

Length of Primary and Secondary, %OH and UG

+

Feeder Demographics
Commercial, Residential, Rock Digging Areas, %OH and UG

+

Customer and ner Counts

=

Look at all outages grouped and analyzed based on weather conditions:

Major Event Days

Light Storms

Blue Sky

Results:

Options identified that projects improvement in reliability and estimates associated costs to underground

Model Data Sources

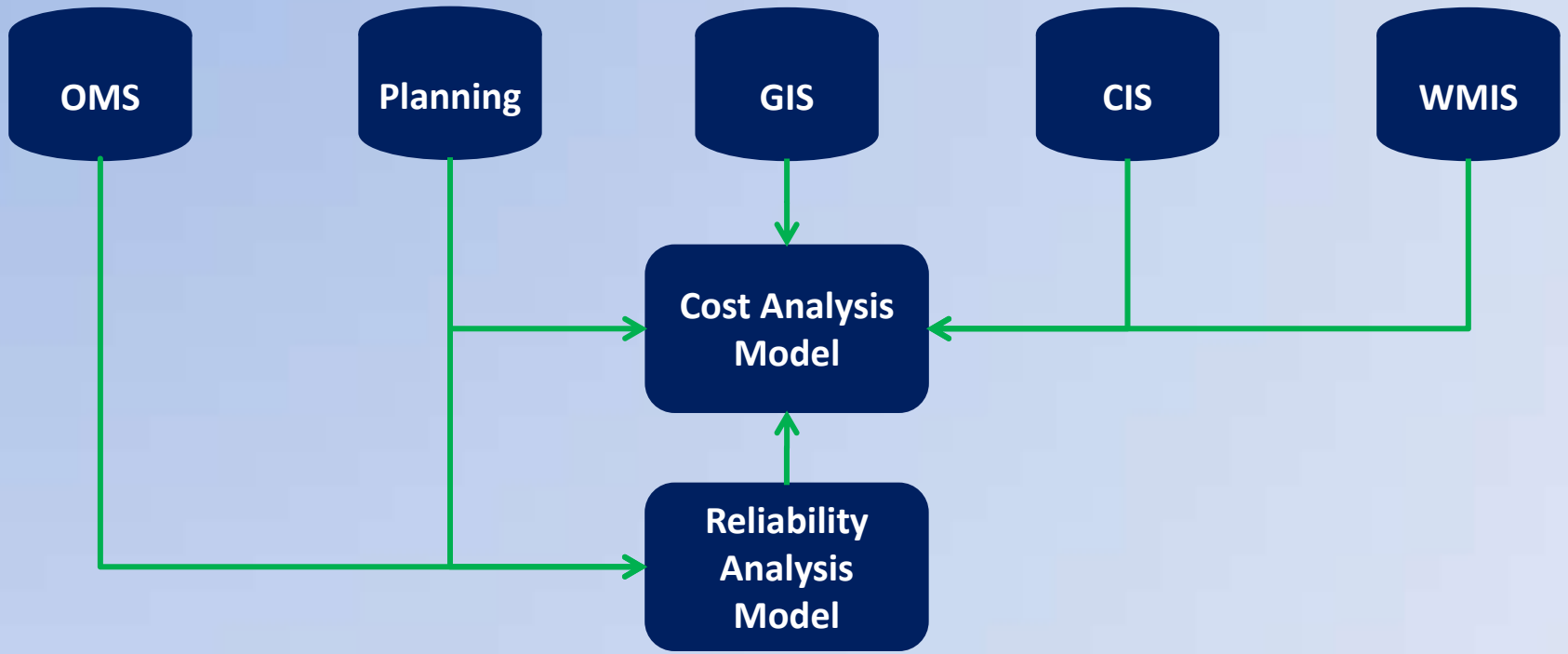
Outages by:
- Date/time
- Cause
- OH, UG, Network
- Voltage
- Mains. Laterals
- Geography

- Network/Radial feeders
- Feeder KVA

- OH, UG, Primary & Secondary line lengths
- Urban, suburban separation
- Rock digging areas

- Customer counts for OH and UG
- Transformer counts by feeder

- Compatible Units and prices
- Design Standards



OMS – Outage Management System manages/depicts outages, causes, and their date/time.
GIS – Geographic Information System integrates hardware, software, and data for capturing, managing, analysing, and displaying all forms of geographically referenced information. (Graphical depiction of the electrical infrastructure and its assets)
CIS – Customer Information System integrates all data related to the customer (billing, customer counts, etc.)
WMIS - Work Management Information System it's a design, planning and work/resource scheduling system.

Pros and Cons of Undergrounding

Pros:

- Protection from outages caused by trees, wind, ice, snow, rain, lightning, animals, and vehicles;
- Ability to optimize capital spending previously dedicated to reliability improvement efforts to offset the cost of undergrounding;
- Improved aesthetics (if cable and phone lines are also placed underground);
- Lower tree trimming cost;
- Lower storm damage and associated restoration cost;
- Fewer long major storm outages and associated lifestyle disruptions and economic impact to customers;
- Fewer momentary interruptions;
- Improved customer relations regarding tree trimming & fewer outages;
- Future construction methods and technology will allow for faster restoration time compared to past design due to greater system interconnection flexibility.

Cons:

- Higher costs than overhead for initial construction;
- UG equipment may not last as long as OH facilities if exposed to harsh environments;
- Failed cable and equipment take longer to locate and repair;
- Possible tree damage in conversion areas;
- Susceptibility to flooding that could result in outages;
- Generally higher replacement costs than overhead lines;
- Potential longer duration to find and fix outage

Impacts of Undergrounding

Impacts to be Considered:

- Undergrounding would be a multi-year project;
- Impacts of construction: noise, traffic and congestion, road closures and restricted parking due to construction;
- Long term road construction can result in reduced business for retail establishments due to limited parking and difficult access;
- Significant financial impact to commercial establishments;
- Possible damage to established areas, shrubbery, flowers, etc.;
- Excavation in close proximity to trees can cause damage to the roots of trees;
- Construction within an area can last 6 to 9 months per project; and
- Potential cost to the customers that want their service placed underground.

Possible Areas for Coordination of Work With DDOT and Utilities

- Major road reconstruction projects not just resurfacing
- Utility infrastructure expansion or rebuild projects
- Large new development projects
- Other?
- Georgetown project possible model for coordination of effort

Next Steps for Committee Action

- Expand the Task Force to include representatives from DC Water and Washington Gas & Light, along with adding them to the Task Force as a means to discuss utility coordination and communication

- Comcast and Verizon to present at the next Technical Committee meeting and present their technical concerns and issues related to undergrounding their lines/cables when Pepco's feeders are designated for undergrounding.

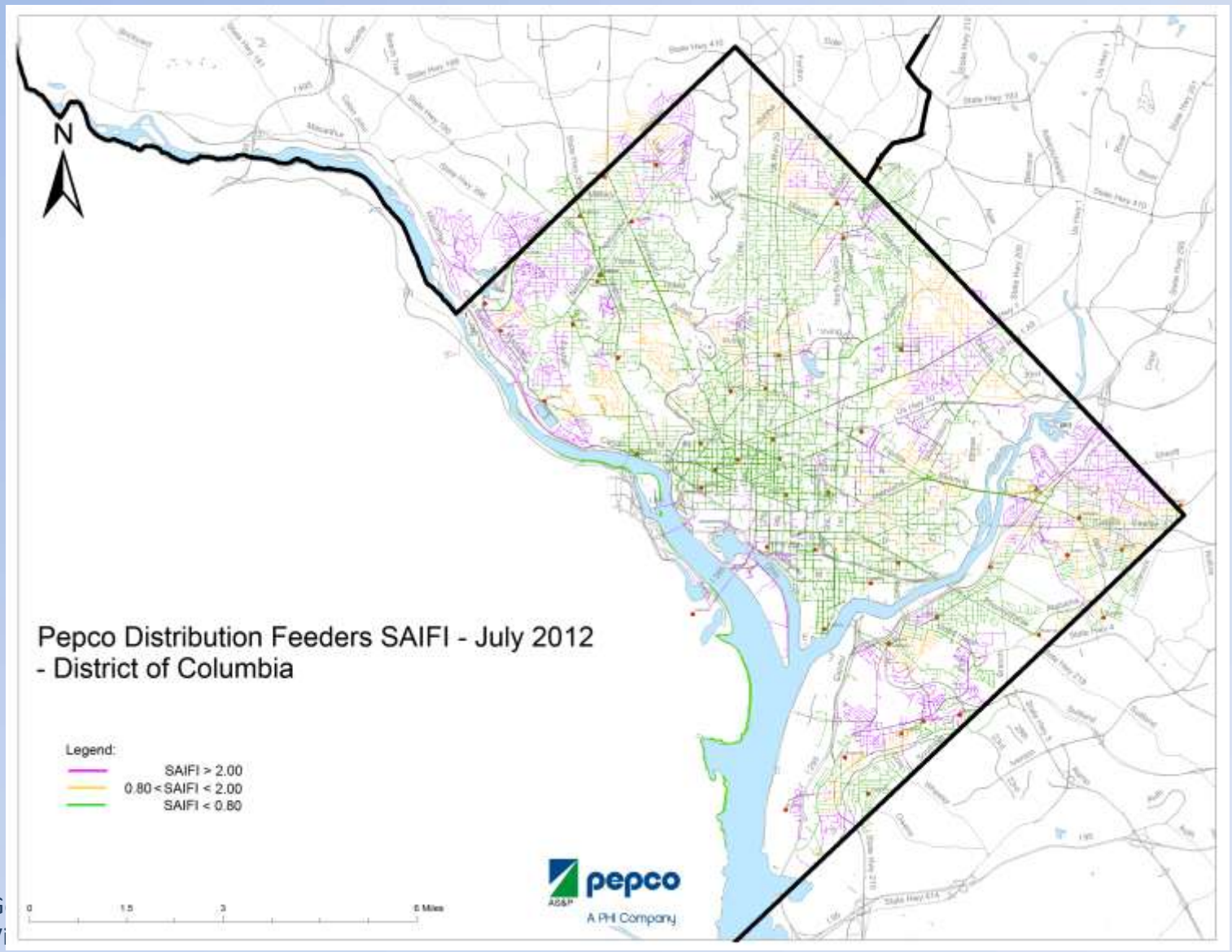
- Pepco working with the UFA will prepare a map that shows tree cover as an overlay for the Distribution Feeders SAIFI map.

- Continue to identify technical issues that need to be considered in making a decision about whether to underground a specific feeder

- Develop informational material for general dissemination to the public is important and would facilitate consumer "buy in". Provide a realistic assessment of how any plan will be implemented on a technical basis, in order to provide understandable and realistic expectations to the public

Appendix

District of Columbia Feeder SAIFI



District of Columbia's Electric System

Number of Substations	UG feed	OH feed	Total
Distribution	36	15	51
Transmission	7	0	7
Total	43	15	58

Circuit Miles	UG	OH	Total
Primary (4 and 13kV class)	1,699 miles (72%)	645 miles (28%)	2,344 miles
Secondary (120/240, 120/208)	937 miles (54%)	788 miles (46%)	1,725 miles
Totals	2,636 miles (65%)	1,433 miles (35%)	4,069 miles

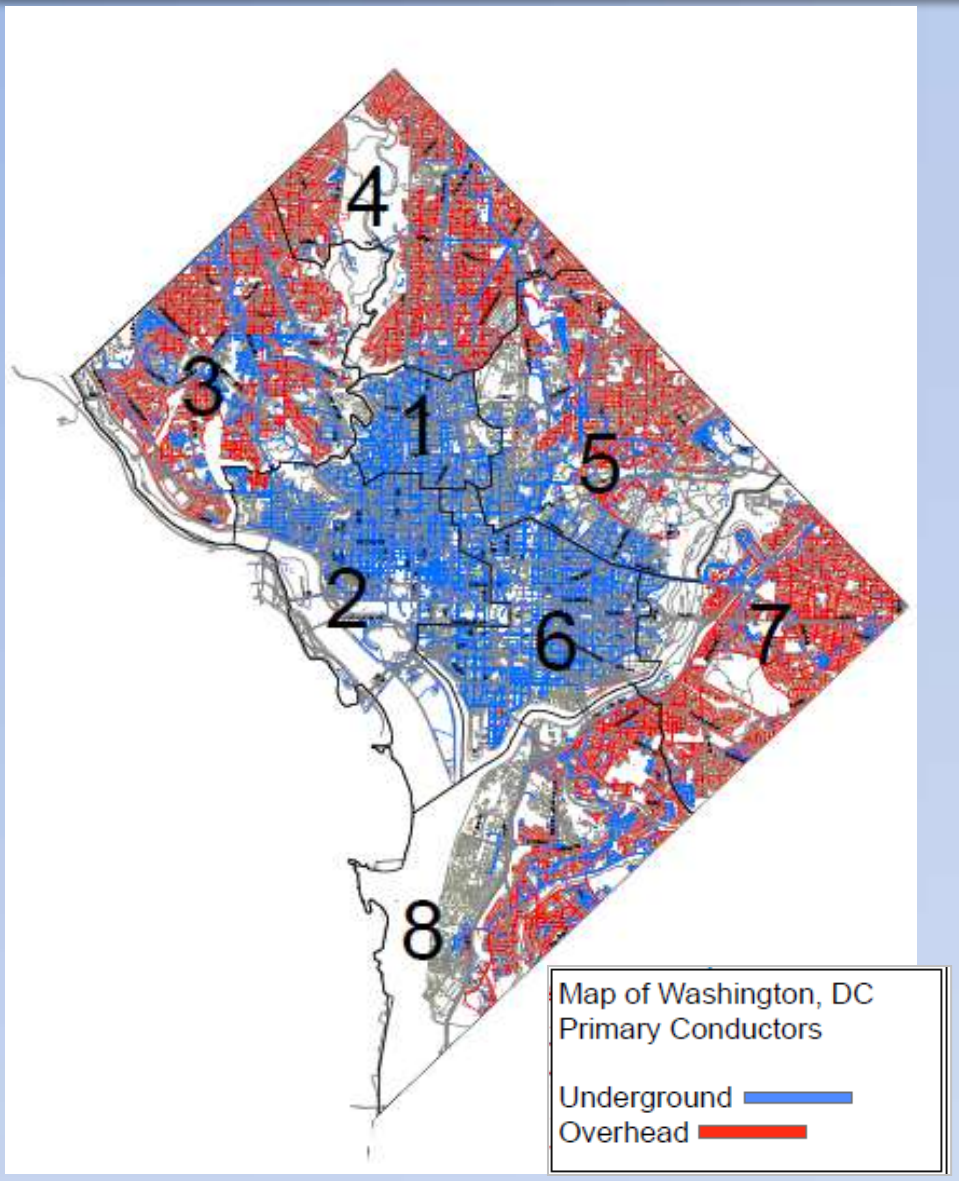
Customers by feeder	4kV	13kV	Total	% of Total
>=85% Overhead	27,742	28,495	56,237	22%
100% Underground	10,168	104,964	115,132	45%
Mixed	10,008	75,048	85,056	33%
Total	47,918	208,507	256,425	100%

Customers by Service	Total	% of Total
Overhead	101,737	40%
Underground	154,908	60%
Total	256,745	100%

The Reliability Enhancement Plan (REP) Initiatives

The REP includes the following increments, it is a dynamic plan and will continue to be updated as necessary and as results demonstrate effectiveness of the mitigations executed

Program	Goal
Vegetation Management	Performing on a 2 year growth cycle (Pepco DC), removal of danger trees and limbs (Enhanced Integrated Vegetation Management)
Feeder Improvement	Focusing on improving the distribution assets that are least performing to drastically reduce outage events
Distribution Automation	Using innovative and proven technologies such as switches for automatic fault isolation and restoration in concert with AMI to monitor and optimize the performance of the distribution system and monitor customers quality of service
Load Growth	Meeting the need for load growth and system enhancement to maintain the required reliability and ability to move load under contingency conditions (DA and Emergency Conditions)
Cable Replacement and Enhancement	Treating and/or replacing cable and related joints/elbows/splices that are reaching "end of life" before failure at an accelerated pace
Selective Undergrounding	Undergrounding selected areas of the mainlines as a pilot to improve reliability and reduce customer impact in areas where reliability cannot be enhanced with other appropriate measures



Pepco DC System

- 1,433 miles of overhead lines (35%)
- 2,636 miles of underground lines (65%)
- 60% of customers are served by underground service
- 40% of customers are served by overhead service

Customers by Feeder

- 45% of customers are on 100% underground feeders
- 22% of customers are on feeders that are >= 85% underground
- 33% of customers are on mixed feeders