

**THE CASE FOR  
UNDERGROUND  
DISTRIBUTION**

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# THE CASE FOR UNDERGROUND DISTRIBUTION



**Michael E. Beehler**

The electric power industry has long stated that overhead (OH) electric distribution is more cost-effective than underground (UG) distribution. This was primarily because the capital investment was lower. But this is the 21<sup>st</sup> Century, and we don't need to design electric distribution infrastructure using 20<sup>th</sup> Century wood poles, span guys, down guys, fly taps and aerial mounted equipment like transformers, switches and cap banks.

We need a *new paradigm of thinking* about the electric distribution system.

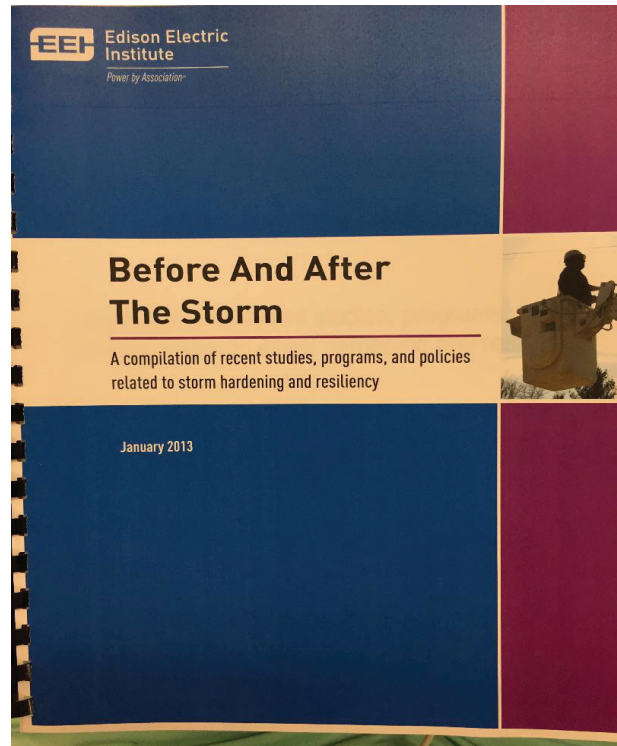
The total cost of ownership of OH versus UG distribution has changed. Recent technological and material advances now make UG more safe, reliable and resilient than OH over the life of the asset. And then, ***there is aesthetics***. Dominion Energy, PEPCO and Florida Power & Light and their regulators are leading the way with strategic undergrounding. Explore the reasons for undergrounding electric distribution and examine their programs in the following pages.



Tree lined street or vegetation management nightmare?  
Do we adequately compensate for this?

Much study on the real cost of electric distribution has been conducted over the years.

The Edison Electric Institute (EEI) published *Before and After the Storm* as a compilation of previous study efforts and recommendations on distribution hardening for improved resiliency at [EEI.org](http://EEI.org).



EEI Compiled Studies Updated for 2014

The Centre for Energy Advancement through Technological Innovation (CEATI) provides technology reports and solutions for members and produced [Lifecyle Costs of Overhead vs. Underground Installation](http://CEATI.com) at [CEATI.com](http://CEATI.com). CEATI reviewed tools that can be used in a comparative analysis of OH vs UG.

*A Method to Estimate the Costs and Benefits of Undergrounding Electricity Transmission and Distribution Lines* dated October, 2016 by Peter H. Larsen and Lawrence Berkeley National Laboratory and Stanford University is an excellent resource to study the costs of OH vs. UG. [Here's more info.](#)



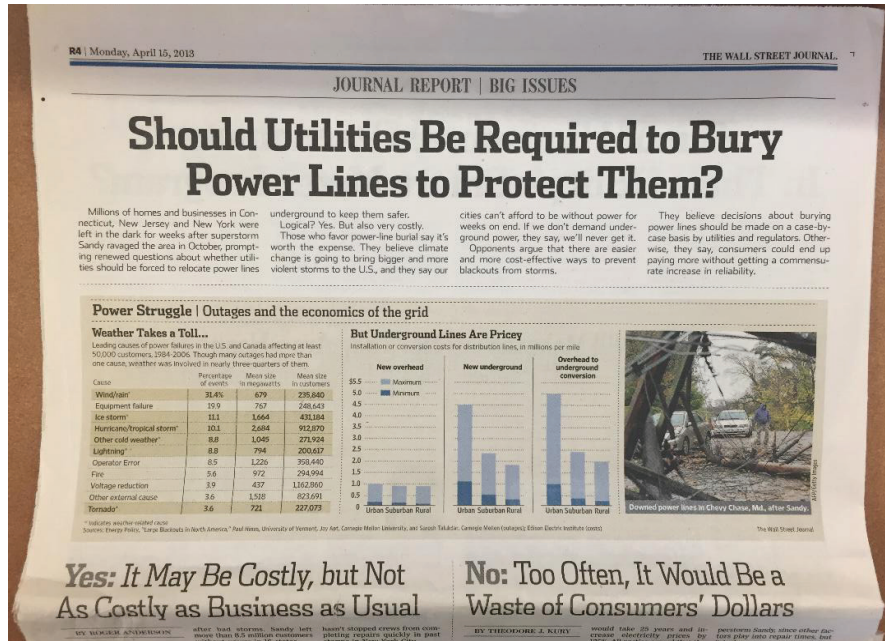
The Florida Public Service commission has search for complied reports on OH vs UG at [StudyLib.net](http://StudyLib.net).

Further, a review of Florida's Electric Utility Hurricane Preparedness and Restoration Actions written in 2018 can be found at [FloridaPSC.com](http://FloridaPSC.com).

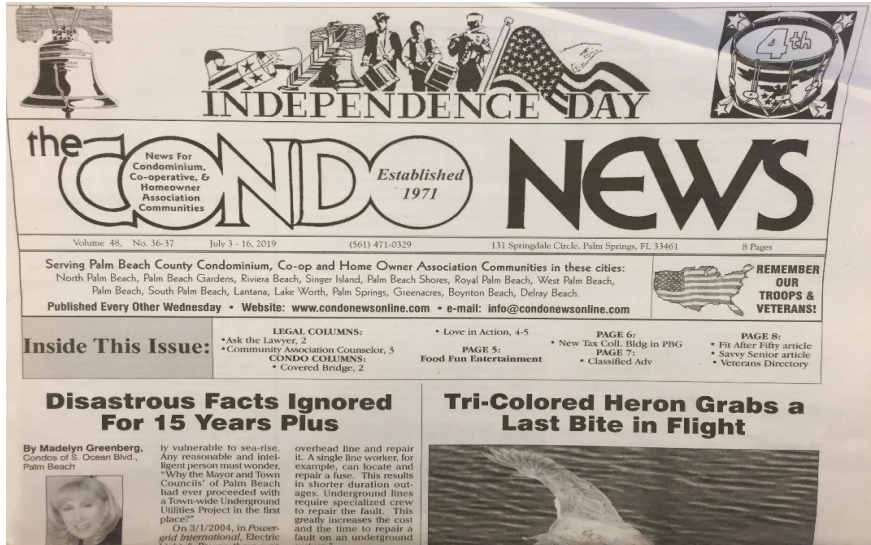
These are excellent resources to reference in any debate about OH vs UG electric distribution.

In addition to these industry studies, the public is in engaged in a mainstream debate. The *Wall Street Journal* had the pros and cons of OH vs UG featured in their Big Issues report dated April 15, 2013 and *Condo News* features ongoing battles with FP&L in Palm Beach. Palm Beach owners voted for underground and renters seem to disagree.

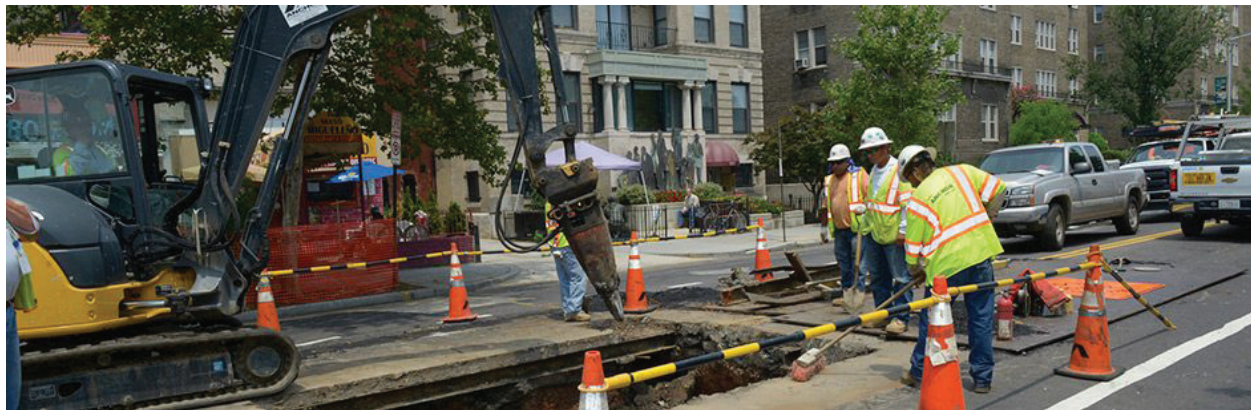
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Even Non-Industry Media is Interested in the Debate



Technological advances like distributed energy resources, evolving customer expectations, new construction methods and the need for resiliency have shifted the opinions of many stakeholders to favor underground electric distribution. As a result, regulators have granted approval to Dominion Virginia Power (DVP), PEPCO Holdings, Inc (PHI) and Florida Power & Light (FP&L) to start *strategic undergrounding programs*.



The District of Columbia Power Line Undergrounding (DC PLUG) initiative is a partnership between the District and Pepco to improve the reliability and resiliency of the District of Columbia electric system by placing select systems underground.

## Distributed Energy Resources

Distributed energy resources (DER) like fuel cells, roof top or community solar, wind micro- turbines, energy storage technologies, electric vehicle (EV) bi-directional charging, demand side management (DSM) and demand response (DR) programs provide consumers with many choices for cost-effective, safe and sustainable power. As these technologies have become more readily available, consumer expectations regarding the reliability and aesthetics of electrical power distribution have evolved.

## Evolving Customer Expectations

Densely populated urban centers place heavy demands on the electrical grid, particularly during peak times and extreme weather. The average American uses a variety of electronic devices, including computers and cell phones to manage almost every aspect of daily life. The benefits of electrification continue to expand. See my [new whitepaper on the subject](#). Accordingly, access to reliable electrical power is more important than ever. The Galvin Institute reports that, on average, the US electric system is 99.97% reliable. See [galvinpower.org](http://galvinpower.org). Still, consumers have little patience for power outages that interrupt access to digital communications, streaming, air conditioning and heating, or their electric mobility.

## New Construction Methods

A number of new construction methods make installing underground electric distribution lines easier and less expensive to build than in the past. Trenchless technology, such as directional drilling, allows long segments of conduit or cable in conduit to be pulled into position without accessing or disturbing customer property. Moreover, pre-planned joint trench installations have the potential to reduce costs for combinations of electric, communications, and in some jurisdictions, water/wastewater or gas. New technologies like [Smart Pavement™ from Integrated Roadways](#) offer new options

for undergrounding the electric and communication at busy traffic intersections improving traffic safety, and aesthetics and adding revenue potential from leased underground space for the evolving 5<sup>th</sup> Generation (5G) network.



Workers safely install pre-cast slabs of Smart Pavement™ in Brighton, CO pilot

Note all the OH utilities are now....UG

## Resiliency

The definition of resiliency is the ability of an infrastructure asset to withstand an High Impact, Low Probability (HILP) event without customer outage impact. In recent years, severe weather has increased the general public's interest in building electrical systems that are more resilient. This is especially true in coastal areas, such as those affected by hurricanes Harvey, Irma and Maria in 2017. Improvements include increased tree trimming and vegetation management, increased pole inspections, and replacement of wood poles with steel and concrete poles. Alternatively, Dominion, PHI and FP&L started to underground strategically selected poorly performing overhead distribution lines to improve the **total restoration time** of storm damaged lines. Utility records showed that certain radial feeders and distribution lines were harder to access and repair after significant storm events and these utilities were able

to improve the resiliency of their systems by strategically undergrounding these lines.

## MORE Reasons to Consider UG

- **Exposed to Damage.** Overhead lines are frequently damaged by ice and or other airborne debris, as well as strong winds, lightning, falling trees, public interference and wildlife.
- **Poor Aesthetics.** Most utility customers prefer a landscape that isn't obstructed by power lines and poles. That said, the actual visual impact of an overhead distribution line depends on factors such as sky-lining, scaling, and proximity to nearby scenic views. The presence of multiple overhead distribution lines increases the visibility of structures and conductors especially when they exceed the height of vegetation around them.



Iconic Saguaro cut to clearance in AZ



- **Safety Concerns.** Overhead distribution lines are susceptible to wood pole fires, impact by vehicles or equipment, collateral damage when falling across property, downed energized wires or guys, unauthorized people climbing the poles or structures, acts of vandalism or even a terrorist attack.,
- **Upgrades and Repairs.** Overhead systems are faster and easier to maintain and upgrade, simply because they are exposed. UG systems can be built with additional conduits for faster repairs, future growth or upgrades, or applications of emerging technologies.
- **Protection from the Elements.** UG lines are less vulnerable to wind and ice. Still, UG related equipment like transformers and switchgear can be damaged by falling trees, traffic, etc. UG can be affected when the root systems of falling trees are displaced. And, while rare, UG is susceptible to flooding which may result in prolonged outages and shortened equipment life.
- **Economic Protection.** The negative economic impact of sustained electric service outages can reduce the local gross domestic product and harm businesses and services. UG reliability tends to protect densely populated areas economically.
- **Better Aesthetics.** Except for the occasional above-ground equipment and risers, UG distribution is out of sight. The only significant aesthetic impact of UG distribution is from possible root damage to trees along the right-of-way.



This streetscape is clear and beautiful

- **Safer Overall.** Underground lines can fault and cause fires, blow manhole lids off of pull boxes, and be subject to dig-ins, but generally they are safer and more secure due to lower public visibility and the difficulty of physical access.



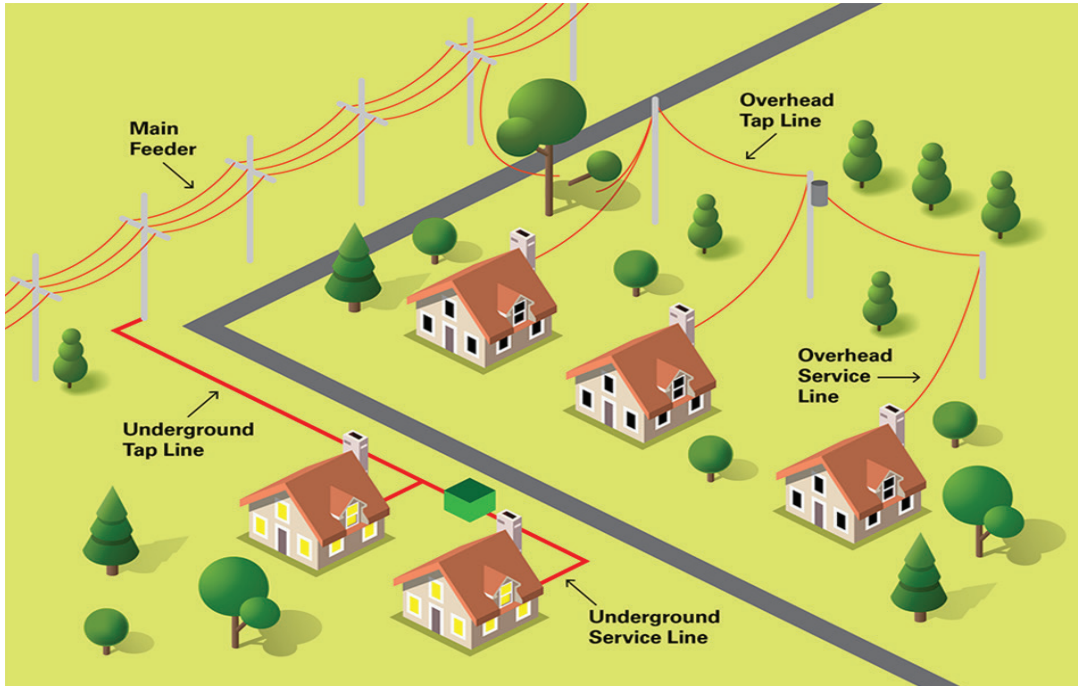
- **Reduced EMF Strength.** At the same voltage and current, an underground cable will typically have a lower electro-magnetic field (EMF) strength than an overhead line. Some underground cables are installed in street right-of-ways at a closer vertical distance to people increasing human exposure.
- **No Fifth Generation (5G) telecom on utility poles every 100-200 yards** creating unsightly clutter on poles and potential, yet undefined, human health impacts.



- **Less Public Resistance.** It is generally easier to obtain an easement for underground lines, and customers tend to be more accepting of new underground projects.
- **Fewer Outages.** Outages are less common, because lines are protected from weather. Outages tend to last longer, because UG failures can be hard to locate and repair.

# Dominion Energy's Resiliency Program

Dominion Energy Virginia's Strategic Underground Program is a system-wide initiative to shorten restoration times following major storms by placing certain outage-prone overhead electrical distribution lines and equipment underground. <https://www.dominionenergy.com/company/electric-projects/strategic-underground-program>



Dominion shows customers how the OH & UG electric distribution system works

## Dominion's Stated Benefits

- OH tap lines historically see the most damage during major storms
- UG reduces time it takes to restore power to all customers significantly (by days).
- A faster restoration decreases the economic impact of major storms
- Undergrounding the most outage-prone parts of the distribution system will increase reliability overall

# PEPCO's Resiliency Program

The DC PLUG initiative is expected to extend for a period of seven to ten years at a total cost of approximately \$500 million and requires a unique financing arrangement in which the District of Columbia, the Department of Transportation and PEPCO contribute a portion of the total financing. <https://dcpluginfo.com/about/>

The funds will be obtained through a combination of PEPCO's traditional funding of debt and equity for \$250 million, \$187.5 million through a charge the District of Columbia imposes on PEPCO that is recovered from customers, and up to \$62.5 million in DDOT improvement funds.



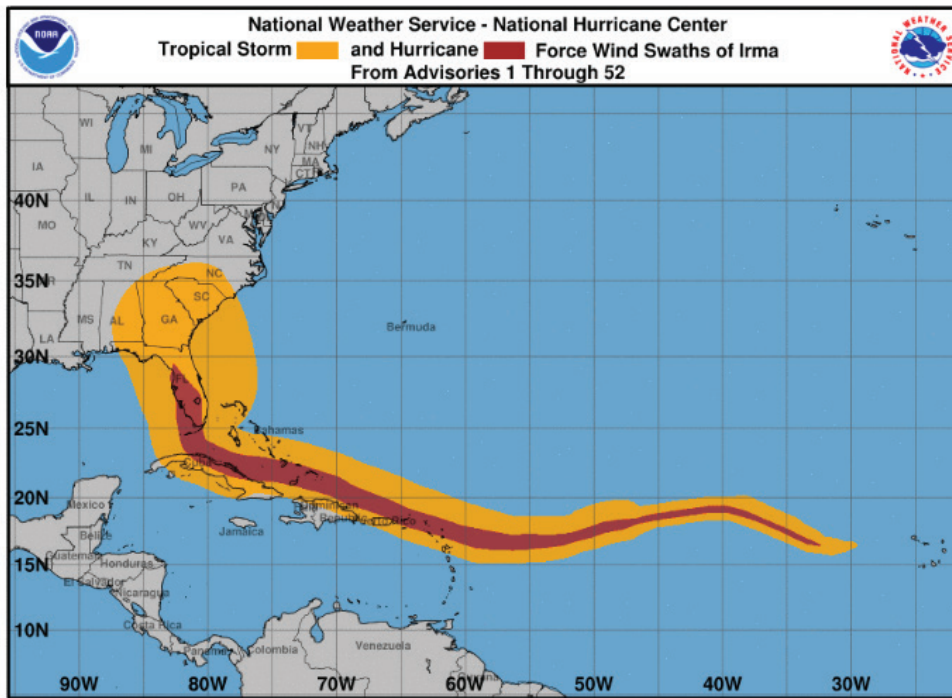
This work is underway...**Friday, October 4, 2019**

- Contractor will continue excavating and laying conduits headed east on the 4700 block of Chesapeake Street NW.
- Contractor will continue constructing flares and tying-in to conduits at manhole-22 at the intersection of 46<sup>th</sup> and Chesapeake Street NW.
- Contractor will be backfilling and pouring concrete from previous day's work.
- Contractor will continue excavating and setting manhole-14 on the 4800 block of Chesapeake Street NW.
- Contractor will complete excavating and tying-in to conduits at manhole-53 on the 5000 block of 44<sup>th</sup> Street NW.

# FPL's Resiliency Program

The Florida Public Service Commission allowed FP&L to spend \$100MM on a three year pilot strategic undergrounding effort commencing in 2018. Approximately 40% of the electric distribution across Florida (including Duke and TECO) is underground. FP&L targeted its worst performing lateral feeders and is putting them underground. Existing storm data and early pilot reports suggest a 40% improvement in reliability and, of course, much better resiliency in major storms. 18% UG outage rates versus 82% and 69% for non-hardened, and hardened OH distribution lines, respectively.

## Hurricane Irma – Tropical Storm and Hurricane Force Winds

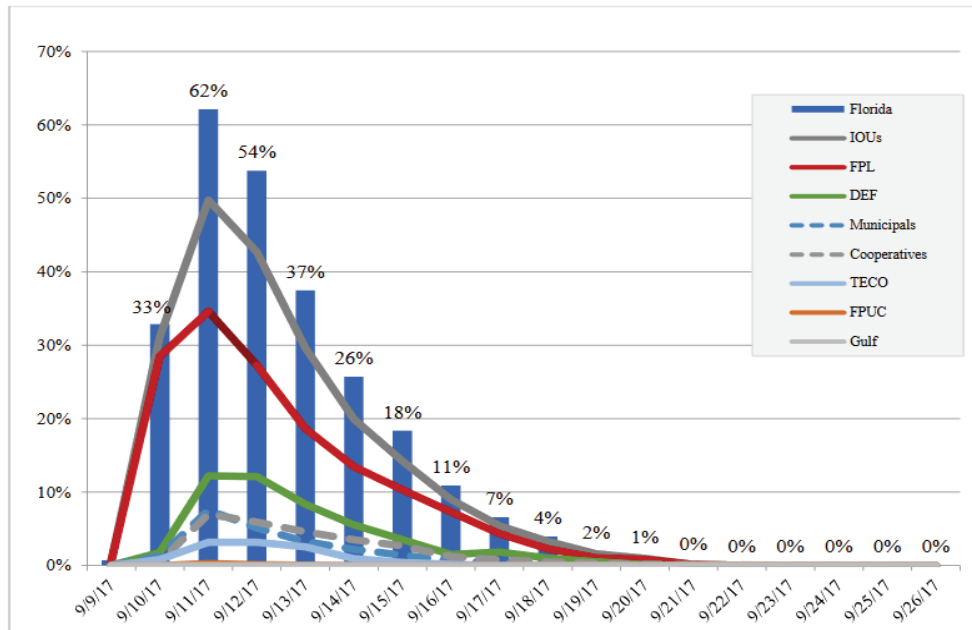


Source: NOAA's National Hurricane Center

## FPL Outage Rates for Facilities Impacted by Hurricane Irma

	Transmissions	Distribution feeders	Distribution Laterals
Overhead, Non-hardened	20%	82%	24%
Overhead, Hardened	16%	69%	N/A
Underground	--- <sup>7</sup>	18%	4%

### Hurricane Irma – Percent of Florida’s Total Customers without Power



Source: State EOC power outage reports.  
 Note: Individual utility outage maximums occurred at different times and do not add to the total.

### FPL’s Feeder and Lateral Outage Performance for Hurricane Irma

Irma - 2017	Overhead Non-Hardened			Overhead Hardened			Underground			Total		
	Out	Pop	% Out	Out	Pop	% Out	Out	Pop	% Out	Out	Pop	% Out
Distribution Feeders	1,609	1,958	82%	592	859	69%	85	470	18%	2,286	3,287	70%
Distribution Laterals	20,341	84,574	24%	N.A.	N.A.	N.A.	3,767	103,384	4%	24,108	187,958	13%

Pop = Population; Lateral population includes laterals with multi-stage fusing  
 Source: FPL’s second supplemental amended response to staff’s first data request No. 29.

The goal for the strategic UG pilot program of the Florida PSC is to test different construction methods and identify issues that slow the conversion of these targeted overhead facilities to underground.

## Conclusions

We need a *new paradigm of thinking* about the electric distribution system.

Technological and material advances now make underground electric distribution more safe, reliable and resilient. And, the benefits of undergrounding have been clearly documented in several industry reports and construction costs are coming down. Dominion Energy, PEPCO and Florida Power & Light and their regulators are leading the way with strategic undergrounding programs. More system and cost data will come from these projects in the coming years.

In the meantime, why wait? Approach your regulator now with the concept of strategic undergrounding. You will better service your customers, improve your communities and satisfy the shareholder....all in one responsible move.



And then, *there is aesthetics.*

Find more at

[MikeBeehler.com](http://MikeBeehler.com)