EDISON ELECTRIC INSTITUTE

Out of Sight, Out of Mind?

A study on the costs and benefits of undergrounding overhead power lines

Prepared by:

Bradley W. Johnson

Prepared for:

Edison Electric Institute

July 2006

Attribution Notice and Disclaimer

This work was prepared by Bradley W. Johnson for the Edison Electric Institute (EEI). When used as a reference, attribution to EEI is requested. EEI, any member of EEI, and any person acting on its behalf (a) does not make any warranty, express or implied, with respect to the accuracy, completeness or usefulness of the information, advice or recommendations contained in this work, and (b) does not assume and expressly disclaims any liability with respect to the use of, or for damages resulting from the use of any information, advice or recommendations contained in this work.

The views and opinions expressed in this work do not necessarily reflect those of EEI or any member of EEI. This material and its production, reproduction and distribution by EEI do not imply endorsement of the material.

Published by:
Edison Electric Institute
701 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2696
Phone: 202-508-5000
Web site: www.eei.org

Bradley W. Johnson, is the President of ACN Energy Ventures, which provides energy-consulting services to government and private sector clients. Mr. Johnson is the former President of Pepco Technologies and has more than 20 years of electric utility industry experience. He can be contacted at bwjohnson@acninc.net.

Edison Electric Institute (EEI) is the association of United States shareholder-owned electric companies, international affiliates, and industry associates worldwide. Our U.S. members serve 97 percent of the ultimate customers in the shareholder-owned segment of the industry, and 71 percent of all electric utility ultimate customers in the nation. They generate almost 60 percent of the electricity produced by U.S. electric generators.

Organized in 1933, EEI works closely with its members, representing their interests and advocating equitable policies in legislative and regulatory arenas. In its leadership role, the Institute provides authoritative analysis and critical industry data to its members, Congress, government agencies, the financial community and other influential audiences. EEI provides forums for member company representatives to discuss issues and strategies to advance the industry and to ensure a competitive position in a changing marketplace.

EEI's mission is to ensure members' success in a new competitive environment by:

- Advocating Public Policy
- Expanding Market Opportunities
- Providing Strategic Business Information

For more information on EEI programs and activities, products and services, or membership, visit our Web site at www.eei.org.

Report Outline

Executive Summary

It is an unpleasant fact of modern day life that big storms, such as hurricanes and ice storms, often cause major power outages. Sometimes these outages can last for days or even weeks in heavily damaged areas. In the post mortem that follows a major storm-related power outage, there is almost always a public clamoring for electric utilities to bury overhead power lines. For many, it seems only intuitive that placing electric wires underground should protect them from severe storms.

This report provides a summary of previously completed studies and examines historical performance data for underground and overhead lines to evaluate the benefits and costs of placing more of our nation's existing overhead electric distribution infrastructure underground. (Overhead transmission lines are much more difficult to place underground and were not considered as part of this report.)

The report finds that burying overhead power lines has a huge price tag, costing about $1 million a mile on average, or about 10 times what it costs to install overhead power lines. Studies of statewide undergrounding initiatives in Florida and North Carolina suggest undergrounding would require rate increases ranging from 80 percent to 125 percent. A Virginia study calculates the annual cost of a statewide undergrounding initiative would be approximately $3,500 per customer.

Recent surveys suggest that many individual electric customers are prepared to pay more to move their power lines underground. However, most consumers do not fully appreciate how much undergrounding costs, and, when faced with the real costs of undergrounding, most individuals are not willing to pay the substantially higher electric bills or monthly payments that are required.

When compared to overhead power systems, underground power systems tend to have fewer power outages, but the duration of these outages tends to be much longer. Underground power systems also are not immune from outages during storms. The bottom line—reliability benefits associated with burying existing overhead power lines are uncertain and in most instances do not appear to be sufficient to justify the high price tag that undergrounding carries.

There are, however, other substantial benefits for burying existing overhead power lines, the most significant of which is improved aesthetics. Many communities and individuals want their power lines removed from sight. While the benefits derived from these kinds of undergrounding initiatives are difficult to quantify, they are real and they are substantial. Because these projects cannot be justified based on standard economic criteria, community and government decision makers often struggle to determine who should pay and who should benefit from undergrounding initiatives based on aesthetics.

The report concludes with summaries of innovative programs that communities and local governments have adopted to help pay for burying their overhead power lines.

Introduction

In the last decade, the U.S. Gulf Coast, East Coast, and Midwest regions have experienced several catastrophic "100-year storms." These storms left widespread electric power outages that lasted for several days, as shown in Figure 1.

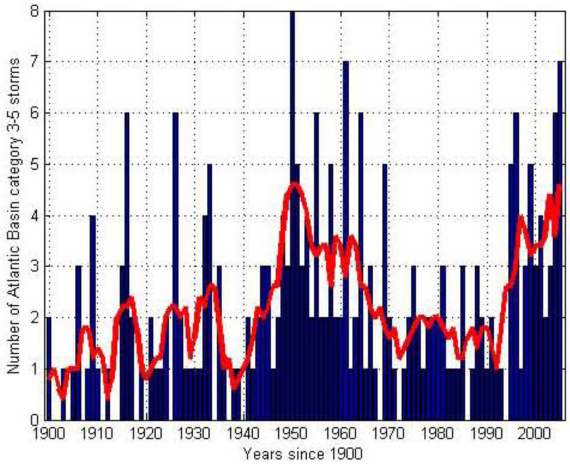
Figure 1: Sample of Electric Outages Caused by Severe Storms: 1996 – 2005 (Not Inclusive of all Storms)

Storm Event	Utility	Date	Customers Impacted	Outage Duration (Days)
Hurricanes Katrina & Rita	Entergy	2005	832,000	Power never restored for some in New Orleans
Hurricane Wilma	Florida Power & Light	2005	3,200,000	18
Hurricane Francis	Florida Power & Light	2004	2,800,000	12
Hurricane Isabel	Dominion Va Power	2003	1,800,000	14
	BGE	2003	790,000	8
Ice Storm	Kentucky Utilities	2003	146,000	8
Ice Storm	Duke	2002	1,375,000	9
	Carolina Power	2002	561,000	8
Ice Storm	KCPL	2002	305,000	10
Snowstorm	Carolina Power	2000	173,000	5
Hurricane Floyd	Virginia Power	1999	800,000	5
	Carolina Power	1999	537,000	6
	BGE	1999	500,000	8
Ice Storm	Pepco	1999	213,000	5
	BGE	1999	360,000	5
Ice Storm	Central Maine Power	1998	250,000	21
Ice Storm	Virginia Power	1998	401,000	10
Hurricane Fran	Virginia Power	1996	415,000	6
	Duke	1996	450,000	9
Ice Storm	Duke	1996	650,000	8
	Carolina Power	1996	61,000	4
	Carolina Power	1996	790,000	10

Source: Press Accounts of Storms

Of great concern are forecasts indicating that we are in the middle of a cycle of increased hurricane activity and that for the next several years the United States can expect to see larger numbers of hurricanes (and potentially other severe storms) that will impact the Gulf and East Coasts, as shown in Figure 2.

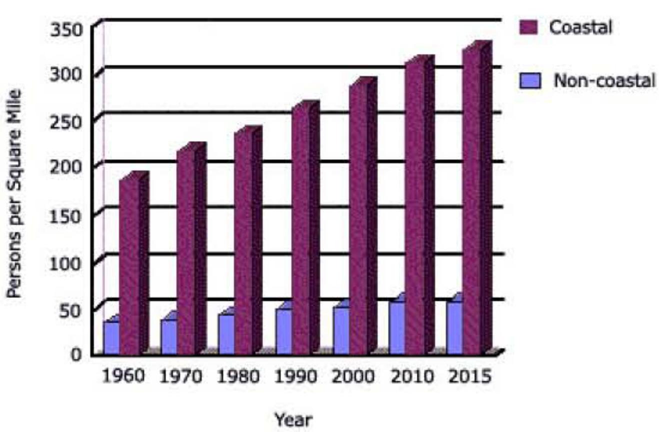
Figure 2: Number of Atlantic Category 3-5 Hurricanes Between 1900 and 2005 and Five-Year Running Mean



Source: Risk Management Solutions, March 2006
“U.S. and Caribbean Hurricane Activity Rates”
http://www.rms.com/Publications/60HUActivityRates_whitepaper.pdf

This trend is particularly bothersome when it is viewed in the context of demographic data (see Figure 3) that suggest large numbers of people have been moving to coastal regions of the country that are particularly prone to hurricanes and other severe coastal storms.

Figure 3: Population Growth in Coastal Areas Between 1960 and 1990 Was 38 Million People



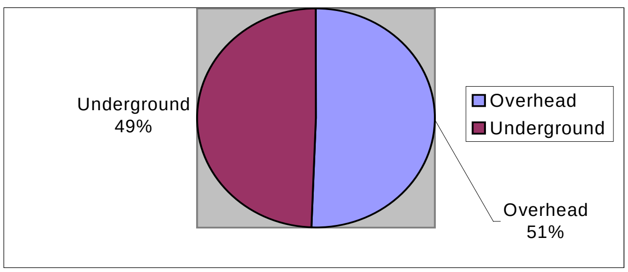
Source: Storm Center Communications
http://wrc.iewatershed.com/index.php?pagename=education_coast_03

Given the critical role that electricity plays in today's high-tech society, even a momentary power outage is an inconvenience. Extended power outages present a major hardship and can be catastrophic in terms of health and safety consequences and the economic losses created.

Given the vulnerability of electric power lines to storms, why don't electric utilities simply bury these lines so they will be protected?

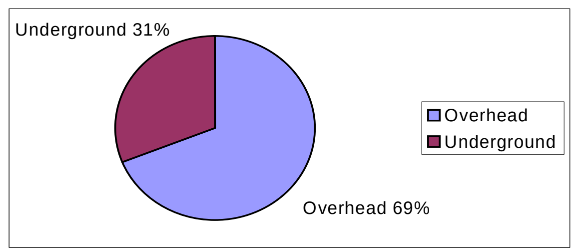
The fact is that utilities already are placing significant numbers of power lines underground. Over the past 13 years, approximately half of the capital expenditures by U.S. investor-owned utilities for ***new*** transmission and distribution wires have been for underground wires, as illustrated in Figure 4. Figure 5 shows that almost 70 percent of the nation's distribution system, however, has been built with overhead power lines. Would electric reliability be improved if more of these existing overhead lines were placed underground as well?

Figure 4: Allocation of Investments in New Power Lines (1992 – 2005 Average)



Source: FERC Form 1 Data 1993-2005

Figure 5: Miles of Overhead and Underground Lines (2005 U.S. Total)



Source: EEI Statistics

This report examines the major issues associated with undergrounding existing overhead power distribution lines.[1] It summarizes reliability comparisons between underground and overhead power lines, and presents data on the costs and benefits of undergrounding. The report also looks at what customers are willing to pay for undergrounding. Finally, the report concludes with summary information on programs that have been developed around the country to fund undergrounding initiatives.

What the report finds is that burying existing overhead power lines does not completely protect consumers from storm-related power outages. While underground power lines do result in fewer overall power outages, the duration of power outages on underground systems tends to be longer than for overhead lines.

Also, undergrounding is expensive, costing up to $1 million per mile on average, or almost 10 times the cost of a new overhead power line, and would likely require large rate increases for electric customers. This means that most undergrounding projects cannot be economically justified and must cite intangible, unquantifiable benefits, such as improved community or neighborhood aesthetics, for their justification. Determining who pays and who benefits from undergrounding projects can be difficult and often requires the establishment of separate government-sponsored programs for funding.

[1] This report only considers the undergrounding of electric distribution lines and does not address the undergrounding of transmission lines. The vast majority of power outages are caused by failures of distribution lines. Transmission lines are also much more difficult and expensive to place underground. Most industry experts agree that it would be impractical to consider undergrounding significant portions of existing overhead transmission systems.

I. How Much Does Undergrounding Improve Electric Reliability?

Many consumers assume that if electric power lines are buried, they will be protected from power outages caused by storms and that overall power reliability will be significantly improved. This is not necessarily the case.

Underground power systems are not immune to storm-related outages. Figure 6 shows the destruction of a pad-mounted transformer that occurred in 2004 when Hurricane Ivan struck Florida. Figure 7 shows the equipment failures Baltimore Gas & Electric suffered on its underground system from Hurricane Isabel in 2003.

Figure 6: Destruction of Pad-Mounted Transformer Caused by Tidal Surge And Beach Erosion from Hurricane Ivan (2004)

Source: Florida Public Service Commission

Figure 7: BGE Underground Failures, Hurricane Isabel (2003)

Equipment Item	Total
1000 kva Network Transformers	3
Network Protectors	5
Switchgear Fuses	26
4kv D&W Fuses	17
Pad-mounted Switchgear	5
Pad-mounted Transformers	12
Primary Ductlilne Failures	8
Secondary Ductline Failures	10
Sections of Cable Renewed	14
Underground Cable Faults	100 +

Source: Baltimore Gas & Electric Co.
"Major Storm Report: Hurricane Isabel", Attachment 5

Measuring Electric Reliability

Accurately measuring electric reliability is difficult. Most measures of electric reliability focus on two metrics:

- The frequency with which a customer sustains a power outage, i.e., the number of power outages per year, or the number of outages per year for a mile of distribution circuit.
- The duration of power outages, i.e., the number of minutes per year a customer is without power.

For most utilities, it is extremely difficult to track the number of outages that occur on their systems and to determine the number of customers impacted by these power outages. Utility switching actions, for example, can result in momentary outages that last only a fraction of a second.

In spite of these difficulties, utilities worldwide collect data on both the frequency and duration of power outages. Increasingly, these data are used to measure utility performance against reliability standards, and utilities are rewarded and penalized based on how the data indicate they are performing.

Comparing the reliability of overhead power lines to underground power lines is even more difficult. Many utility outage-reporting systems do not separately track overhead and underground systems.

Another problem in trying to evaluate underground lines is that most underground circuits have at least some component above the ground. Installing monitoring equipment to distinguish between outages on the overhead and underground components of the same circuit can be prohibitively expensive.

Comparing Overhead Reliability to Underground Reliability

A review of the comparative reliability data that are available indicates that the frequency of outages on underground systems can be substantially less than for overhead systems. However, when the duration of outages is compared, underground systems lose much of their advantage.

Figure 8 compares the reliability of underground and overhead electric distribution systems in 2003 for the investor-owned electric utilities operating in Virginia. The data are presented to show the frequency and duration of outages for underground and overhead circuits with and without storms. The data were obtained directly from Virginia utilities through data requests by the Virginia State Corporation Commission as part of a comprehensive undergrounding study released in January 2005.[2]

[2] Virginia State Corporation Commission, "Placement of Utility Distribution Lines Underground," January 2005.

Figure 8: 2003 Outage Data for Virginia Investor-Owned Utilities

	Outages (Events) /Mile		Outage Duration (Minutes)	
	Includes Storms	Excludes Storms	Includes Storms	Excludes Storms
Old Dominion Power				
Overhead	0.53	0.52	113	111
Underground	0.11	0.11	795	795
Kentucky Utilities				
Overhead	0.66	0.61	352	111
Underground	0.08	0.07	634	176
Conectiv Power				
Overhead	0.84	0.59	293	118.5
Underground	0.28	0.21	316.9	122.3
Allegheny Power				
Overhead	1.1	0.64	1,086	294
Underground	0.12	0.11	480	438
Va Electric Power				
Overhead	1.32	1.00	132	87
Underground	0.4	0.38	116	110

Source: Virginia State Corporation Commission Data Requests

Figure 9 uses the Virginia data and data from a Long Island Power Authority study to compare the frequency of outages on underground distribution circuits to overhead circuits. The data show that, on average, underground circuits in Virginia and Long Island experience only 20 percent to 25 percent of the outages that overhead circuits experience.

Figure 9: Reliability of Underground vs. Overhead (2003 data)

	Ratio of Underground Outages/ to Overhead Outages (Excludes Major Storms)	Ratio of Underground Outages/ to Overhead Outages (Includes Major Storms)
Long Island Power Authority[1]	.2 -.25	N/A
Va Electric Power[2]	0.38	0.30
Old Dominion Power[2]	0.21	0.21
Kentucky Utilities[2]	0.11	0.12
Conectiv Power[2]	0.36	0.33
Allegheny Power[2]	0.17	0.11
Average	**0.25**	**0.21**
Median	**0.23**	**0.21**

[1]Navigant Consulting, March 2005, "A Review of Electric Utility Undergrounding Policies and Practices", page 15

[2] Virginia State Corporation Commission Data Requests Based on 2003 Outage Data

Figure 10 also uses the Virginia data to compare the duration of underground outages to overhead outages. The data suggest underground outages in Virginia take approximately 2.5 times longer to repair than overhead outages.

Figure 10: Ratio of Duration of Underground Outages to Overhead (2003 data)

	Ratio of Underground Duration(Min) /Overhead Outages (Min) (Excludes Major Storms)	Ratio of Underground Duration(Min) /Overhead Outages (Min) (Includes Major Storms)
Va Electric Power	1.26	0.88
Old Dominion Power	7.16	7.04
Kentucky Utilities	1.59	1.80
Conectiv Power	1.03	1.08
Allegheny Power	1.49	0.44
Average	**2.51**	**2.25**
Median	**1.54**	**1.44**

Source: Virginia State Corporation Commission Data Requests Based on 2003 Outage Data

Figure 11 presents data from a 2000 report issued by the Maryland Public Service Commission. Maryland utilities were asked to select "comparable" overhead and underground feeders and provide comparative reliability data for an historical period.

Figure 11: Maryland Overhead vs. Underground Feeder Reliability Comparison

	Overhead		**Underground**	
Allegheny Power		Avg		Avg
1996 SAIFI	0.11		0.28	
1997 SAIFI	1.73	0.6	0.91	0.8
1998 SAIFI	0.04		1.29	
1996 SAIDI	25.16		49.49	
1997 SAIDI	124.96	51.6	569.88	236.8
1998 SAIDI	4.59		91.07	
BGE				
1997 SAIFI	3.43		0.58	
1998 SAIFI	0.45	2.6	1.72	1.2
1999 SAIFI	3.84		1.39	
1997 SAIDI	65.00		178.00	
1998 SAIDI	242.00	152.7	94.00	130.0
1999 SAIDI	151.00		118.00	
Conectiv				
1997 SAIFI	1.84		1.25	
1998 SAIFI	0.29	0.8	1.47	1.0
1999 SAIFI	0.34		0.21	
1997 SAIDI	129.04		11.80	
1998 SAIDI	23.48	65.6	129.61	53.3
1999 SAIDI	44.30		18.59	
Pepco				
1997 SAIFI	2.59		0.22	
1998 SAIFI	2.47	2.1	0.93	0.7
1999 SAIFI	1.31		1.07	
1997 SAIDI	4.55		2.21	
1998 SAIDI	0.78	3.2	0.71	2.1
1999 SAIDI	4.39		3.29	

Source: "Report to the Public Service Commission of Maryland on the Selective Undergrounding of Electric Transmission & Distribution Plant" Februrary 14, 2000.

Note:

SAIFI = Total Number of Customers Interrupted/Total Customers

SAIDI = Sum of All Customer Interruption Minutes/Total Customers

Based on the data summarized in Figure 11, the Maryland commission concluded in its final report that the impact of undergrounding on reliability was "unclear."[3]

Figure 12 summarizes five years of underground and overhead reliability comparisons for North Carolina's investor-owned electric utilities—Duke Energy, Progress Energy Carolinas, and Dominion North Carolina Power. The data indicate that the frequency of outages on underground systems was 50 percent less than for overhead systems, but the average duration of an underground outage was 58 percent longer than for an overhead outage.

Figure 12: North Carolina Reliability Comparison of Overhead and Underground Feeders 1998-2002

Reliability Category	**Overhead**	**Underground**
System interruption rate per mile	0.6	0.3
Tap line interruption rate per mile	0.4	0.2
Average outage duration (minutes)	92.0	145.0
Service interruptions per 1000	9.7	9.6

Source: "The Feasibility of Placing Electric Distribution Facilities Underground"
North Carolina Utilities Commission, November 2003

In other words, for the North Carolina utilities, an underground system suffers only about half the number of outages of an overhead system, but those outages take almost 1.6 times longer to repair.

Based on this data, Duke Power has concluded, "underground distribution lines will improve the potential for reduced outage interruption during normal weather, and limit the extent of damage to the electrical distribution system from severe weather-related storms. However, once an interruption has occurred, underground outages normally take significantly longer to repair than a similar overhead outage."[4]

Other Undergrounding Considerations

The following summary points, taken from reports produced by utilities and from conversations with industry experts, provide additional information on the reliability characteristics of overhead and underground power lines:

- Overhead lines tend to have more power outages primarily due to trees coming in contact with overhead lines.[5]

3 "Report to the Public Service Commission of Maryland on the Selective Undergrounding of Electric Transmission and Distribution Plant," prepared by The Selective Undergrounding Working Group, February 14, 2000, page 2.
4 North Carolina Utilities Commission, "The Feasibility of Placing Electric Distribution Facilities Underground," November 2003.
5 Duke Power.

- It is relatively easy to locate a fault on an overhead line and repair it. A single line worker, for example, can locate and repair a fuse. This results in shorter duration outages.[6]
- Underground lines require specialized equipment and crews to locate a fault, a separate crew with heavy equipment to dig up a line, and a specialized crew to repair the fault. This greatly increases the cost and the time to repair a fault on an underground system.[7]
- In urban areas, underground lines are four times more costly to maintain than overhead facilities.[8]
- Underground lines have a higher failure rate initially due to dig-ins and installation problems. After three or four years, however, failures become virtually non-existent.[9]
- As underground cables approach their end of life, failure rates increase significantly and these failures are extremely difficult to locate and repair. Maryland utilities report that their underground cables are becoming unreliable after 15 to 20 years and reaching their end of life after 25 to 35 years.[10]
- Pepco found that customers served by 40-year-old overhead lines had better reliability than customers served by 20-year-old underground lines.[11]
- Two Maryland utilities, Choptank and Conectiv, have replaced underground distribution systems with overhead systems to improve reliability.[12]
- Water and moisture infiltration can cause significant failures in underground systems when they are flooded, as often happens in hurricanes.[13]
- Due to cost or technical considerations, it is unlikely that 100 percent of the circuit from the substation to the customer can be placed entirely underground. This leaves the circuit vulnerable to the same types of events that impact other overhead lines, e.g., high winds and ice.

It is unlikely that 100 percent of the circuit from the substation to the customer can be placed entirely underground.

This leaves the circuit vulnerable to the same types of events that affect other overhead lines, e.g., high winds and ice.

---

6 North Carolina Utilities Commission.
7 Id.
8 North Carolina Utilities Commission, "The Feasibility of Placing Electric Distribution Facilities Underground," November 2003.
9 Duke Power.
10 "Report to the Public Service Commission of Maryland on the Selective Undergrounding of Electric Transmission and Distribution Plant," prepared by The Selective Undergrounding Working Group, February 14, 2000, page 9.
11 Id., page 2.
12 Id., page 9.
13 Duke Power.

II. The Costs of Undergrounding

Undergrounding electric distribution systems carries an enormous price tag, particularly when it comes to moving existing overhead distribution circuits underground. Four undergrounding studies released in 2005 and 2006 contain estimates of the cost to underground large existing overhead electric distribution systems:

- The Florida House of Representatives requested that the Florida Public Utility Commission prepare a proposal to underground all electric facilities in the state following the unprecedented landfall of four major hurricanes in Florida in 2004.[14]
- In Virginia, following on the heels of Hurricane Isabel in 2003, the 2004 Regular Session of the Virginia General Assembly requested the State Corporation Commission to study the placement of all of the state's utility lines underground.[15]
- In 2004, the Long Island Power Authority commissioned KeySpan to perform a quantitative cost-benefit analysis on undergrounding the Long Island distribution system.[16]
- In February 2006, the Tahoe Donner Association in Truckee, California, released an engineering feasibility study that examined the costs of undergrounding the existing overhead utility distribution system for approximately 6,500 homes.[17]

The High Cost of Undergrounding

The underground cost data presented in these four studies are summarized in Figure 13. The data indicate that statewide undergrounding costs can be as high as $94 billion, and, on average, the cost of undergrounding existing overhead distribution systems is approximately $1 million per mile.

Figure 13: System Undergrounding Cost Estimates

Scope of Estimate:	Total Cost $Billion	Total Miles New UG	Cost/ Mile
State of Florida	$ 94.50	115,961	$ 814,929
Virginia Investor Owned Utilities	$ 75.09	62,830	$ 1,195,050
Long Island Power Authority	$ 28.55	18,075	$ 1,578,976
Tahoe-Donner	$ 0.12	102	$ 1,191,176
Average Cost Weighted by Miles			**$ 1,006,491**

Source: Underground Studies

What many people fail to comprehend is the enormous magnitude of the resource commitment that is behind the kinds of numbers presented in Figure 13. The Florida underground study, for example, calculated that a

14 Florida Public Service Commission, "Preliminary Analysis of Placing Investor-Owned Electric Utility Transmission and Distribution Facilities Underground," March 2005.
15 Virginia State Corporation Commission, "Placement of Utility Distribution Lines Underground," January 2005.
16 Navigant Consulting, "A Review of Electric Utility Undergrounding Policies and Practices," March 2005.
17 CVO Electrical Systems, "Undergrounding Feasibility Study for Tahoe Donner Association Truckee, California," February 2006.

workforce of 3,600 individuals working 2,000 hours for 10 years would be required to underground the state's existing overhead electric wires.[18]

Care should be taken in placing too much confidence in a single point estimate, like $1 million per mile, as an indicator of undergrounding costs. A number of variables come into play in determining what the ultimate cost of placing an existing underground cable underground will be, including the power rating of the cable, soil conditions, and whether the cable will be located in a rural, urban or residential area. Figure 14 shows Dominion Virginia Power's estimates for placing different types of cables underground in different locations.

Figure 14: Dominion Virginia Power Underground Cost Estimates

	Heavy Commercial/ Urban Residential ($ Million/Mile)	Suburban ($ Million/Mile)	Rural ($ Million/Mile)
3 Phase Bulk Feeder	$ 3.1	$ 2.5	$ 2.7
3 Phase Tap	$ 3.1	$ 2.0	$ 2.1
Single Phase Tap	$ 1.4	$ 1.4	$ 1.0
Service Drop	$4,269/Service	$4,269/Service	$7,092/Service

Source: Virginia State Corporation Commission, January 2005, "Placement of Utility Lines Underground"

Additional information on the cost drivers for undergrounding existing overhead distribution lines is provided in Figure 15 and indicates that material costs constitute only about one-third of the total cost.

Figure 15: Dominion Virginia Power Underground Cost Detail

Cost Item:	% of Total
Materials	34%
Contractor Labor & Equip	29%
General & Admin Overhead	22%
Company Labor	8%
Other	8%
Total	100%

Source: Virginia State Corporation Commission, January 2005, "Placement of Utility Lines Underground"

Other studies also have examined the cost of undergrounding large electric distribution systems. In 2003, the North Carolina Utilities Commission estimated it would take its three investor-owned utilities 25 years to underground all of their existing overhead distribution systems at a cost of approximately $41 billion. This six-fold increase in the existing book value of the utilities' current distribution assets would require a 125-percent rate increase.[19]

[18] Florida Public Service Commission, "Preliminary Analysis of Placing Investor-Owned Electric Utility Transmission and Distribution Facilities Underground," March 2005, page 22.

[19] North Carolina Utilities Commission, "The Feasibility of Placing Electric Distribution Facilities Underground," November 2003.

Underground cost data for other U.S. utilities are summarized in Figure 16, which indicates that the cost of placing overhead power lines underground is five to 10 times the cost of new overhead power lines.

Figure 16: Utility Underground Costs

	Average Cost/ Mile
Allegheny Power[1]	$ 764,655
BGE[1]	$ 952,066
Pepco[1]	$ 1,826,415
Conectiv[1]	$ 728,190
Va Power[2]	$ 950,000
California[3]	$ 500,000
FPL[4]	$ 840,000
Georgia Power[5]	$ 950,400
Puget Sount Energy[7]	$ 1,100,000
Average Overhead Line [6]	***$ 120,000***

Sources:
[1] Maryland Selective Undergrounding Working Group
[2] Dare County North Carolina Underground Study
[3] "Utility Undergrounding Programs", Scientech, May 2001, page 21
[4] "Utility Undergrounding Programs", Scientech, May 2001, page 30
[5] "Utility Undergrounding Programs", Scientech, May 2001, page 42
[6] "Utility Undergrounding Programs", Scientech, May 2001, page 4
[7] Puget Sound Energy

Putting Undergrounding Costs in Perspective

Figures 17 and 18 put the U.S. underground cost data in perspective. Figure 17 illustrates that, at a cost of $1 million per mile, a new underground system would require an investment of more than 10 times what the typical U.S. investor-owned utility currently has invested in existing distribution plants.

Figure 17: Investment Statistics for Investor-Owned Utility Distribution Plant

Investment Category	Existing Plant	New Underground
$/Customer[1]	$ 2,199	$ 29,854
$/Mile	$ 73,666	$1 Million

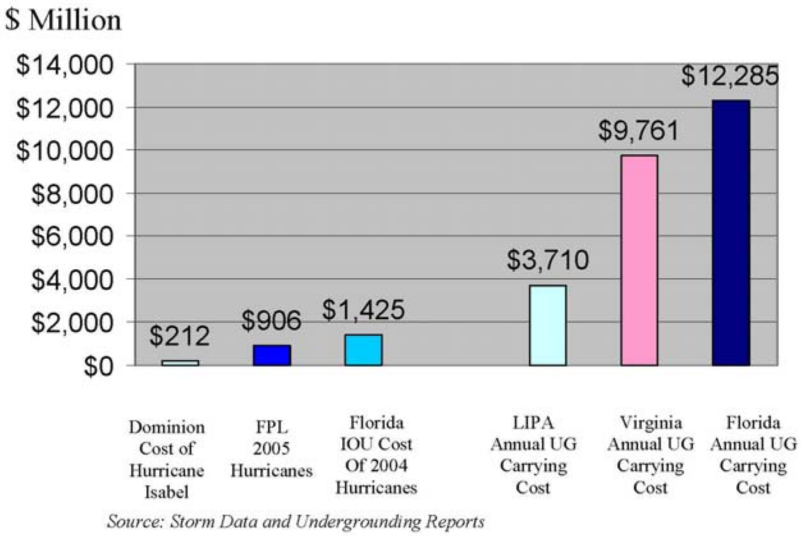
[1] Assumes U.S. average of 33.5 customers/mile of IOU distribution line
Source: NRECA Statistical Comparison
http://www.nreca.org/nreca/About_Us/Our_Members/Statistics/Statistics

Figure 18 compares the costs of undergrounding major electric distribution systems to the costs that some utilities have incurred recently to repair their systems after major storm events.

The data in Figure 18 indicate that even in an extreme situation, such as the four hurricanes that struck Florida in 2004, storm restoration costs are only a fraction of the annual carrying costs that would be required to support the undergrounding of existing overhead lines. Recently, the Chairman of the Florida

Public Service Commission observed that even if utilities were able to combine the costs of restoring their downed lines after 10 hurricanes it likely would "still be under the cost of burying them underground."[20]

Figure 18: Annual Cost of Major Storm Events Compared to Annual Costs For Major Undergrounding Projects



Other Undergrounding Cost Drivers

Other factors also can result in substantial additional customer costs for undergrounding projects.

Electric undergrounding strands other utilities, e.g., cable and telephone companies, which must assume 100 percent of pole costs if electric lines are underground. These additional non-electric costs likely will be passed on to cable and telephone consumers. Figure 19 indicates that the cost of undergrounding these "other" utilities can add approximately 25 percent to total undergrounding costs.

Figure 19: Overnight Cost Data for Undergrounding All Utilities – Tahoe Donner System

	Total $	% of Total	
General Contractor	$ 76,881,639	65.8%	
Electric	$ 11,207,828	9.6%	
Telephone	$ 11,858,615	10.1%	24.6% of Total Cost
Cable TV	$ 9,697,150	8.3%	
Broadband Fiber	$ 7,276,709	6.2%	
Total	$ 116,921,941	100.0%	

Source: CVO Electrical Systems, February 2006, "Undergrounding Feasibility Study For Tahoe Donner Association Truckee, California"

[20] Mary Ellen Klaus, "Benefits, Costs of Pushing Power Lines Underground Debated," The Miami Herald, August 2005.

Customers also may incur substantial additional costs to connect homes to newly installed underground service, possibly as much as $2,000 if the household electric service must be upgraded to conform to current electric codes.

Customer Impact

The studies cited earlier also provide insight into the potential customer costs of undergrounding. Figure 20 summarizes the potential costs of undergrounding on a per customer basis and shows costs as high as approximately $27,000 per customer.

Figure 20: Undergrounding Costs/Customer

	UG Cost ($ Billion)	Total Customers	UG Cost/ Customer
Florida[1]:			
Residential	$ 65.47	5,800,000	$ 11,288
Commercial	$ 26.45	720,000	$ 36,737
Virginia[1]	$ 75.00	2,726,000	$ 27,544
LIPA	$ 28.54	1,084,300	$ 26,321
Tahoe-Donner	$ 0.12	6,500	$ 18,692

[1]Includes investor owned utilities only

Source: Undergrounding Reports

While it is unlikely that customers would ever be expected to pay this cost up front, rate treatment solutions do not appear to be much more palatable for individual customers. Figure 21 shows the potential rate impact on customers from undergrounding projects expressed as either a percentage increase in rates or an annual increase in customer revenue requirements.

Figure 21: Projected Customer Impact from Undergrounding

	Rate Increase	Annual Revenue Requirement
Florida	81%	
LIPA	126%	
North Carolina	125%	
Virginia		$ 3,577
Tahoe-Donner[1]		$ 1,924

[1]Assumes 6% 15-year bond to finance $121,500,000

Source: Undergrounding Reports

The data in Figure 21 suggest that undergrounding could increase electric bills for individual customers by as much as 125 percent, or $3,500 per year.

In addition to the sheer magnitude of rate increases needed to support undergrounding projects, there are numerous social equity issues that likely will have to be addressed. If the costs of undergrounding are fully allocated, only the wealthy may be able to afford them. On the other hand, if undergrounding is financed or socialized through a broad-base tax or through electricity rates, people may end up paying for undergrounding projects that do not get to their neighborhoods for a decade or more (or after they have already moved).

III. The Benefits of Undergrounding

Potentially offsetting the high costs of undergrounding are the benefits that result from improved aesthetics, reduced utility costs, and broader economic benefits. These potential benefits are summarized below.

Aesthetic Benefits of Undergrounding

One of the most commonly cited benefits of undergrounding is the removal of unsightly poles and wires. Local communities and neighborhoods routinely spend millions of dollars to place their existing overhead power lines underground.

Similarly, when given the option, builders of new residential communities often will pay a premium of several thousand dollars per home to place utility lines underground. These “aesthetic” benefits are virtually impossible to quantify but are, in many instances, the primary justification for projects to place existing power lines underground.

The “aesthetic” benefits are virtually impossible to quantify but are, in many instances, the primary justification for projects to place existing power lines underground.

Utility Benefits of Undergrounding

For utility companies, undergrounding provides potential benefits through reduced operations and maintenance (O&M) costs, reduced tree trimming costs, less storm damage, reduced loss of day-to-day electricity sales, and reduced losses of electricity sales when customers lose power after storms.

Figure 22 compares 2003 O&M costs for underground and overhead distribution systems. The data show that undergrounding does not necessarily result in lower O&M costs; indeed, in some cases O&M costs for undergrounding can be substantially higher than for overhead systems. As a result of this information, the Virginia Public Service Commission concluded in its undergrounding study that there are likely not to be substantial reductions in O&M costs due to undergrounding.[21]

[21] Virginia State Corporation Commission, “Placement of Utility Distribution Lines Underground,” January 2005, page 22.

Figure 22: Comparison of 2003 O&M Costs for Overhead and Underground Power Lines

	Total Miles		O&M Cost/Mile[1]	
	Overhead	Underground	Overhead	Underground
Virginia Electric Power	30,826	16,639	$ 854	$ 1,854
Appalachian Power	25,853	3,165	$ 548	$ 473
Kentucky Utilities	1,030	10	$ 1,123	$ 6,953
Conectiv	N/A	N/A	$ 971	$ 776
Allegheny Power	N/A	N/A	$ 287	$ 483

[1]Includes Tree Trimming for Overhead & Excludes Major Storm Costs

Source: Virginia State Corporation Commission Data Requests

The Virginia State Corporation Commission also attempted to quantify the other potential utility benefits associated with undergrounding. For tree trimming, the commission calculated that if undergrounding resulted in no tree trimming at all, annual savings for the state would be $50 million.

To determine the benefit of reduced storm damage for Virginia utilities, the Virginia commission estimated the costs of two one-hundred-year storms similar to Hurricane Isabel. The annual savings that might be expected totaled approximately $40 million.

Projections also were made to determine the increase in electric sales that would result from higher overall levels of reliability due to undergrounding and having fewer customers out of power during major storms. These values were calculated at $12 million and $2 million, respectively, per year.

Figure 23 summarizes the total benefits that the Virginia State Corporation Commission calculated Virginia utilities might realize if the state's entire electric distribution system were placed underground. It shows an annual projected savings of approximately $104 million.

Figure 23: Estimates of Potential Utility Company Savings from Undergrounding Virginia's Electric Distribution System

Cost Saving Item:	$/Year
Operations & Maint	no savings
Tree Trimming	$ 50,000,000
"Hundred-Year" Post Storm Rebuild	$ 40,000,000
Reduction in Day-to-Day Lost Electricity Sales	$ 12,000,000
Elimination of Lost Electricity Sales From "Hundred-Year" Storms	$ 2,000,000
Total	$ 104,000,000

Source: Virginia State Corporation Commission, January 2005, "Placement of Utility Distribution Lines Underground"

Broader Economic Benefits of Undergrounding

In addition to the undergrounding benefits that accrue to electric utilities, there are other cost savings that provide societal economic benefits. These benefits include enhanced electric reliability to the economy, reduced economic losses to customers due to fewer power outages after major storms, and reduced injuries and deaths from automobiles striking utility poles. These benefits also were calculated by the Virginia State Corporation Commission as part of its undergrounding study and are summarized in Figure 24.

Figure 24: Estimate of Potential State-Wide Economic Benefits from Undergrounding Virginia's Entire Electric Distribution System

Cost Savings Item:	$/Year
Avoided Impact of Day-to-Day Outages	$ 3,440,000,000
Avoided Impact of "100-Year" Storm Outages	$ 230,000,000
Avoided Impact of Motor Vehicle Accidents	$ 150,000,000
Total	$ 3,820,000,000

Source: Virginia State Corporation Commission, January 2005
"Placement of Utility Distribution Lines Underground"

IV. Cost-Benefit Summary

Based on the projected costs and benefits for undergrounding much of its state's electric distribution system, the Virginia commission calculated that the benefits would offset only about 38 percent of total costs (Figure 25) and concluded that a comprehensive statewide effort to underground the state's electric distribution system appears "unreasonable."[22]

In 1998, Australia completed a major cost-benefit analysis of undergrounding all existing power lines in urban and suburban areas throughout the country.[23] The study cost more than $1.5 million Australian (equivalent to $1.05 million U.S. at current exchange rates), and represents what may be the most comprehensive undertaking to date to quantify the benefits and costs related to undergrounding.

The Australian undergrounding study reached a conclusion similar to the Virginia study and estimated that the benefits of undergrounding would offset only about 11 percent of the costs, as shown in Figure 26.

[22] Virginia State Corporation Commission Press Release, January 11, 2005.
[23] "The Putting Cables Underground Working Group Report" (http://www.dcita.gov.au/cables/report_x.htm#intro).

Based on the conclusions of these two studies, it appears that placing existing overhead lines underground is difficult to justify economically. Today, most undergrounding costs appear to be justified by aesthetic and public policy considerations.

Figure 25: Projected 30 Year Costs and Benefits from Virginia Undergrounding Study

Cost Item	Estimated $/Yr	Benefit Item	Estimated $/Yr
Annual Carrying Cost On ~ $83 Billion Underground Cost	$ 10,400,000,000	**Utility Savings:**	
		Operations & Maintenance	Negligible
		Tree Trimming	$ 50,000,000
		"100-Yr" Post Storm Rebuild	$ 40,000,000
		Avoided Sales Lost in Day-to-Day Outages	$ 12,000,000
		Avoided Sales Lost in "100-Yr" Storms	$ 2,000,000
		Statewide Economic Benefits:	
		Avoided Impact of Day-to-Day Outages	$ 3,440,000,000
		Avoided Impact of "100-Yr" Storm Outages	$ 230,000,000
		Avoided Impact of Motor Vehicle Accidents	$ 150,000,000
Total Annual Cost	**$ 10,400,000,000**	**Total Annual Benefit**	**$ 3,924,000,000**

Source: Virginia State Corporation Commission, January 2005
"Placement of Utility Distribution Lines Underground"

Figure 26: Projected 20 -Year Costs and Benefits from Australia Underground Study

Quantifiable Costs (US $Billion)		**Quantifiable Costs (US $ Billion)**	
Excavation	4.5	Tree trimming	0.5
Installation & material	3.8	Repairs & maint	0.1
Service connection	2.3	Motor vehicle accidents	1.1
Reinstatement	1.9	Line Losses	0.005
Transformers	2.0	Other	0.2
Street Lights	1.1		
Dismantling & disposal	0.7		
Total	16.3	Total	1.9

Source: The Putting Cables Underground Working Group Report
(http://www.dcita.gov.au/cables/report/report_x.htm#Intro)

V. What Are Customers Willing to Pay for Undergrounding?

A key consideration that policy makers must carefully weigh when considering whether to underground existing power lines is how much customers are willing to pay. Summaries of three undergrounding initiatives where customers were provided an opportunity to see and respond to the costs of undergrounding are presented below.

Tahoe Donner Association Undergrounding Initiative

A recent initiative by a California homeowners' association in Truckee, California, helps provide insight into how individual homeowners (who also often happen to be ratepayers and voters) are likely to make decisions regarding undergrounding when presented with objective information concerning its true costs.

The Tahoe Donner Association represents approximately 6,500 property owners in an established residential community near Lake Tahoe in California. The community was first developed in the early 1970s and was built with overhead utility lines. Home values have increased dramatically in recent years, and prices now range, on average, from $600,000 to $800,000. More than 60 percent of households have an annual income that exceeds $150,000 per year.[24] Twenty percent of homes in the development are primary residences while 80 percent are second homes. Of the second homes, 55 percent are owned by individuals from the San Francisco Bay area and 13 percent from the Sacramento area.[25]

For the last several years, there has been a growing sentiment among Tahoe Donner members that they should invest in undergrounding their utility lines. Members generally feel that their electric reliability has been good, although there is a feeling that undergrounding might provide an additional degree of protection from severe storms that can leave as much as 20 feet of snow on the ground in the winter. The real driver for undergrounding Tahoe Donner's utilities is aesthetics. Many association members would like to remove utility wires from their mountain views, and there is a perception that undergrounding would help to preserve property values especially in light of newer developments nearby that have underground lines. Managers of the Tahoe Donner Association report instances of members coming into their offices and offering to write $10,000 checks to move overhead wires underground.

In January 2005, the Tahoe Donner Association commissioned CVO Electrical Systems to conduct an undergrounding feasibility study to assess the costs of undergrounding the overhead lines. After nearly a year, CVO produced a report with the following findings:

- Time required to complete underground conversion – 8 to 10 years
- Individual share of main underground system cost ~$25,000
- Individual share cost total with 15-year, 6% financing - $39,000
- Additional cost of individual service-drop - $5,000 to $12,000
- Likely range of total individual share cost - $44,000 to $51,000

24 Phone conversation with Tahoe Donner Association.
25 Tahoe Donner Web site, http://www.tahoedonner.com.

In early 2006, managers of the Tahoe Donner Association presented the results of the underground study to their members and asked them to vote on whether they wanted to proceed with the undergrounding activity. When the final votes were tallied, only 600 members—less than 25 percent of those who voted—wanted to proceed with undergrounding. As a result, the Tahoe Donner Association has tabled the undergrounding initiative.

Follow-up conversations between Tahoe Donner managers and their members revealed that members viewed the costs of undergrounding as being too high and not being justified by the aesthetic benefits.

Virginia State Corporation Commission Willingness to Pay Survey

As part of its 2004 undergrounding study, the Virginia State Corporation Commission conducted an unscientific survey of homeowners who participated in its study to gain some insight into what typical homeowners might be willing to pay for undergrounding. The results of the survey are summarized in Figure 27.

Figure 27: Result of Virginia Willingness to Pay for Undergrounding Survey

Name	Generator? (yes or no)	Perceived Income	Perceived Reliability	Outage from Isabel (days)	WTP for UG Whole State ($/mo.)	WTP for UG Part of State ($/mo.)	WTP for UG Indiv. Lateral ($)
Cust #1	no	above	fair	3	$ 12	$ 5	$ 300
Cust #2	no	above	fair	1	$ 15	$ 10	$ 150
Cust #3	yes	average	excellent	1	$ 100	$ 50	$ 750
Cust #4	no	above	good	0	$ 50	$ 50	$ 500
Cust #5*	no	above	fair	10	$ 20	$ -	$ -
Cust #6	no	above	good	0	$ 8	$ -	$ 250
Cust #7	no	above	good	1	$ 20	$ 10	$ 1,000
Cust #8	maybe	above	good	0	$ -	$ -	$ 750
Cust #9*	no	above	good	1	$ 6	$ 6	$ 200
Cust #10	no	above	fair	1	$ 50	$ 50	$ 1,000
Cust #11	no	above	fair	9	$ 25	$ 10	$ 300
Cust #12	no	average	poor	15	$ 5	$ -	$ -
Cust #13	no	above	good	8	$ 10	$ -	$ 100
Cust #14	no	above	fair	0	$ 100	$ 100	$ 1,000
Cust #15	no	below	fair	1	$ 5	$ 4	$ 500
Cust #16*	no	above	excellent	3	$ 30	$ 20	$ 1,000
Cust #17*	no	average	good	2	$ 15	$ 15	na
Cust #18	maybe	above	fair	9	$ 5	$ -	$ 100
Cust #19	no	above	fair	8	$ 10	$ 10	$ 200
Cust #20	no	above	good	8	$ 25	$ 25	$ 300
Cust #21	no	above	excellent	0.1	$ 5	$ 5	$ 200
Cust #22	yes	average	good	0	$ 10	$ 10	$ 25
				Average	**$ 23.89**	**$ 17.27**	**$ 410.71**
				Median	**$ 13.50**	**$ 10.00**	**$ 300.00**

*Customer already has an underground lateral to their home

Source: 2004 Virginia State Corporation Commission Willingess to Pay Survey

The Virginia survey indicates that survey participants were only willing to pay on average about $285 per year ($23.89 per month) for statewide undergrounding and a little more than $400 total for the lateral feeder to connect their homes to the underground electric system. The Virginia underground study, published in 2005, estimated the average annual costs for customers for statewide undergrounding to be approximately $3,600, or more than 12 times what homeowners indicated they were willing to pay. The Virginia study also revealed that Dominion Virginia Power's estimate for a typical lateral feeder was approximately $4,270, or about 10 times what homeowners indicated they were willing to pay.

Edmond Electric

In July 2004, Edmond Electric, a small municipal utility located in Edmond, Oklahoma, just north of Oklahoma City, completed an undergrounding project, converting nearly 500 residents to buried electric cable in conduit. The primary justification for the undergrounding project was to improve reliability. Poles in the area were beginning to rot, and the area had a high numbers of outages.

While the costs of undergrounding the existing distribution system were borne by the municipal utility, homeowners were responsible for paying for a new meter base installation to connect to the new underground service. The average cost for this meter base installation was $400.

Of the 500 residents who were served by power lines moved underground, 250 chose not to pay the $400 for the meter base conversion. For these customers, Edmond Electric was required to install a new pole to bring the underground service above ground and then run an overhead service drop to the customers' existing meter bases.[26]

This experience suggests that customers would not have even been willing to pay a one-time cost of $400 to underground their utilities.

Summary

At least two of the three examples cited suggest that residential customers place a value on undergrounding their utilities and are willing to pay an incremental cost to have their power lines placed underground. It appears, however, that there is a large gap between the public's perception of what it should cost for undergrounding and what it actually costs. When faced with the real costs of undergrounding, it appears many individuals prefer to keep their overhead service and their money in their checking accounts.

The final section of this report examines innovative programs being developed around the country that are being used to finance undergrounding projects—in spite of their high costs.

When faced with the real costs of undergrounding, it appears many individuals prefer to keep their overhead service and their money in their checking accounts.

[26] "Overhead to Underground Conversion in Oklahoma," Transmission and Distribution World, August 2004.

VI. Alternative Ways of Paying for Undergrounding

Even with its high cost and lack of economic justification, undergrounding is very popular across the country. In nine out of 10 new subdivisions, contractors bury power lines.[27] In addition, dozens of cities have developed comprehensive plans to bury or relocate utility lines to improve aesthetics, including:[28]

- San Antonio, Texas
- Colorado Springs, Colorado
- New Castle, Delaware
- Saratoga Springs, New York
- Williamsburg, Virginia
- Tacoma, Washington
- Frederick, Maryland

For new residential construction, utilities vary on how they charge for the cost of providing underground services. A sample of these policies is provided in Figure 28.

Figure 28: Sample of Residential Undergrounding Requirements

Utility	State	Requirement
SDG&E, PGE & SCE	CA	Customer/Developer pays for trenching & backfilling. Utility pays remaining costs.
Atlantic City Electric	NJ	Customer/Developer pays $802.74 + $4.35 per front foot for each home. Utility pays remaining costs.
Cobb Electric Membership Corp.	GA	Customer/developer pays $260 per customer. Utility pays remaining costs.
Green Mountain Power	VT	Customer/Developer pays for trenching & backfilling. Utility pays remaining costs.
Nantucket Electric Co.	MA	The utility pays up to $837.85. The customer pays the remaining costs.
Consolidated Edison	NY	The utility charges the customer the differential in charges for equivalent overhead construction
Mississippi Power	MS	Developer pays the cost differential above what it would cost to install overhead lines

Source: "Utility Undergrounding Programs", Scientech, May, 2001

27 "Utility Undergrounding Programs," Scientech, May 2001, page 6.
28 Id.

When it comes to converting existing overhead lines to underground, a variety of programs are being utilized. They include special assessment areas, undergrounding districts, and state and local government initiatives. Details are provided below.

Special Assessment Areas

Several communities are establishing "special assessment areas," where subscribers pay extra on their monthly bill to fund the underground project. These areas typically are created through a petition of the majority of the property owners in an area.

Commonwealth Electric in Massachusetts has used special assessments since 1970 to fund burial efforts in historic communities such as Nantucket. One drawback to special assessments is that the total revenue collected is often minimal, requiring utilities to extend the schedule for undergrounding over an extended period of time.[29]

Undergrounding Districts

Another approach employed in California and Oregon is the establishment of "underground districts."

In California, the Public Utility Commission collects a percentage of revenue from wire-based utilities for a special undergrounding fund. To receive these funds, a community must form an undergrounding district, approved by at least 70 percent of the property owners in that district. The property owners also must agree to pay the $500 to $2,000 that it costs to connect their homes to a new underground system.[30]

Florida Power and Light

In January 2006, as part of a five-point program to strengthen its electric grid, Florida Power & Light announced, subject to Public Service Commission approval, its intention to pay for 25 percent of the cost of converting overhead lines to underground for local government-sponsored conversions. Florida Power & Light is hoping its actions will encourage local governments to take the necessary steps to invest in undergrounding.[31]

> In 2006, FPL announced, subject to commission approval, its intention to pay for 25 percent of the cost of converting overhead lines to underground for government sponsored conversions.

[29] "Utility Undergrounding Programs," Scientech, May 2001, page 5.
[30] Id.
[31] Florida Power & Light Press Release, January 30, 2006.

Hawaii Electric

Hawaii Electric has a program where it pays for up to one-third of the cost to place existing neighborhood electric distribution lines underground. Hawaii Electric will undertake the conversion as part of a community- or government-initiated underground project, subject to Public Utility Commission approval. The program does not include transmission lines.[32]

South Carolina Electric and Gas

SCE&G has established a special undergrounding program, approved by the South Carolina Public Service Commission. Under the program, if the local municipality agrees to contribute a matching amount, SCE&G contributes 0.5 percent of the gross receipts it is obligated to pay to the municipality. This money goes into a special undergrounding fund.[33]

Progress Energy

Progress Energy has included a provision in its line extension policy where, upon request, it will convert overhead facilities to underground without charge in a downtown commercial area, provided the area has sufficient density. The municipality must agree to receive underground street lighting service and satisfy certain other requirements.[34]

Edmund Electric

Edmund Electric, a municipal utility in Edmund, Oklahoma, has determined that the benefits of long-term improvements in system reliability and the benefits of positively affecting customer loyalty outweigh the costs of undergrounding. The city council has approved a budget line item for overhead to underground conversion of $750,000 a year for the next five years.[35]

City of Boulder, Colorado

The city of Boulder assists individuals or groups of property owners with the undergrounding of existing overhead utilities adjacent to their property by sharing costs of the project through the Xcel Energy Undergrounding Credit. Xcel is required to make available each year one percent of the preceding year's electric revenues within the city for the purpose of undergrounding electric distribution line in public places. Approximately $150,000 per year is set aside. Program participants pay 50 percent of undergrounding costs up to $100,000, and 100 percent of program costs in excess of $100,000.[36]

---

32 "Utility Undergrounding Programs," Scientech, May 2001, page 36.
33 Id., page 38. Also phone conversation with SCE&G.
34 Navigant Consulting, "A Review of Electric Utility Undergrounding Policies and Practices," March 2005, page 34.
35 "Overhead to Underground Conversion in Oklahoma," Transmission and Distribution World, August 2004.
36 Virginia State Corporation Commission, "Placement of Utility Distribution Lines Underground," January 2005, Appendix H.

Dare County, North Carolina

In 1999, the North Carolina legislature passed a law allowing Dare County on North Carolina's Outer Banks to form a special utility district for the purpose of funding the conversion of existing overhead power lines to underground.

Under the legislation, once the utility district is created, the county's electric supplier, Dominion Virginia Power, is required to collect a maximum of $1 per month from residential customers in the county and a maximum of $5 per month from all other customers. These funds are placed in a special undergrounding fund, managed by Dominion Virginia Power, to be used on a pay-as-you-go basis to convert the county's existing overhead power lines to underground.

As of 2003, Dare County has not yet elected to form the special utility district. One of the reasons is that two communities in the county, Duck and Southern Shores, have objected to the special assessment. Both of these communities already have underground electric systems they paid for through development fees or special property-tax assessments. Residents in these communities believe it is unfair for them to pay for undergrounding the electric system for other county residents.

Several other counties in North Carolina and in the Tidewater area of Southeast Virginia are studying the 1999 North Carolina legislation with the thought that they may seek similar legislation for their areas.

In communities in Dare County, N.C., residents who have already paid for underground systems through development fees or tax assessments object to a monthly assessment to fund underground conversion throughout the remainder of the county.

VII. Conclusion

Placing existing power lines underground is expensive. Undergrounding an entire state's existing overhead power lines could cost as much as $94 billion and take decades to complete. The average cost of undergrounding existing overhead power lines is approximately $1 million per mile. This is almost 10 times the cost of a new overhead power line.

While communities and individuals continue to push for undergrounding—particularly after extended power outages caused by major storms—the reliability benefits that would result are uncertain, and there appears to be little economic justification or customer support for paying the required premiums.

Indeed, in its study of the undergrounding issue, the Maryland Public Service Commission concluded, "If a 10-percent return is imputed to the great amounts of capital freed up by building overhead instead of underground line, the earnings alone will pay for substantial ongoing overhead maintenance," implying that utilities could have more resources available to them to perform maintenance and improve reliability on overhead lines if they invested less in new underground facilities.[37]

For the foreseeable future, however, it appears that the undergrounding of existing overhead power lines will continue, justified primarily by aesthetic considerations—not reliability or economic benefits. Many consumers simply want their power lines placed underground, regardless of the costs. The challenge for decision makers is determining who will pay for these projects and who will benefit from them.

There are several undergrounding programs around the country that are working through these equity issues and are coming up with what appear to be viable compromises. Once a public-policy decision is reached to pursue an undergrounding project, it is worthwhile for the leaders involved to evaluate these programs in more detail to determine what is working, and what is not.

> "If a 10-percent return is imputed to the great amounts of capital freed up by building overhead instead of underground line, the earnings alone will pay for substantial ongoing overhead maintenance."
>
> —*Maryland Public Service Commission*

[37] "Report to the Public Service Commission of Maryland on the Selective Undergrounding of Electric Transmission and Distribution Plant," prepared by The Selective Undergrounding Working Group, February 14, 2000, page 3.

EDISON ELECTRIC
INSTITUTE

701 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2696
202-508-5000
www.eei.org