

16

**REPORT PREPARED BY
DUKE POWER**

**Report to the Town of Chapel Hill
Duke Power Underground Facilities**

October 15, 2002

When Communities Change

Commitment

Duke Power is committed to partnering with the communities it serves to create positive, managed growth that preserves and enhances the quality of life for all citizens and customers. Growth brings both opportunity and challenge to every community, from newly developing areas to rural surroundings to more urban settings. Duke Power seeks to work with decision-makers in communities of all types to preserve the quality of life and to best position those communities to welcome new businesses and opportunity with reliable efficient electricity.

When communities are in the midst of change, as many communities in the U.S. are, leaders and citizens often find before them a vast array of decisions and choices about serving current and future basic needs, including energy. Duke Power stands ready to help communities learn more about their energy choices, especially those that have significant fiscal impact.

Duke Power engineers and management can assist local planners, elected officials and business and civic leaders in making sound, well-informed and cost-effective decisions. There is no universal solution for all communities, but Duke Power is a partner in crafting customized solutions for each community.

The Distribution of Energy

Customers in Duke Power communities enjoy efficient, reliable and dependable electricity. To sustain this high level of service, Duke Power employs a network of overhead and underground distribution systems that must be a planning priority as communities grow or wish to renovate existing areas. Duke's Service Regulations approved by the North Carolina Utilities Commission (NCUC) provide that transmission, distribution and service facilities will be installed above ground on poles, towers or other fixtures. **Generally, the standard rates for electric service reflect the cost of installing facilities overhead.** Duke Service Regulations also provide that Duke will install underground service under the provisions of the Underground Distribution Installation Plan (current approved copy attached) which is also approved by the NCUC. The requesting party is responsible for the costs of underground installations, unless otherwise provided for under this Plan.

Duke Power can work with customers and communities to:

- design systems that continue to be fiscally sound while providing reliable, dependable power
- outline and describe the fiscal and physical impacts of switching overhead distribution systems to underground systems in already developed areas
- provide information on the true cost of underground versus overhead distribution employing a comprehensive set of considerations

- dispel myths surrounding installation, maintenance, repair and replacement of distribution systems
- prepare engineering and a coordinated program of work that will meet the needs of customers throughout the communities Duke Power serves
- design solutions that meet that community's needs now and in the future

Underground: Greenfield and Established

Duke Power serves customers in a broad spectrum of environments, from urbanized settings to rural locations, including newly developing areas. The challenges and obstacles that must be addressed for underground service in a newly developing area are much less complex than in an already established service area.

Engineering and installation of underground networks in a newly developing area, or "greenfield" can be performed without some of the typical delays associated with conversion in an established area, including:

- trees that must be removed and possibly replaced, an impossibility for old-growth trees
- potential damage to property and landscaping
- parking lot damage or reduction, a critical factor in areas where parking may already be in short supply
- providing space for pad-mounted transformers
- moving feeders and cost of service upgrades to businesses

Coordination with other utilities such as cable, telephone, gas, water and sewer in building underground cabling conduits is much easier in a greenfield environment. Unlike conversion in an established area, rights-of-way do not typically need to be negotiated with a large number of property owners to complete an underground network in a greenfield environment. Typically, traffic delay and safety problems and re-location of service for customers are also eliminated as factors in installing underground networks in newly developing areas.

Costs for greenfield underground installation

Experience has demonstrated that the *cost to install underground in a Greenfield environment can run upwards of six times the cost to install overhead.*

It is important to note, also, that maintenance and repair costs for underground networks in both greenfield and established areas remain higher than overhead systems.

The Cost of Conversion – From Here to There

In already developed areas, converting an overhead power supply network to an underground network is, in most cases, a very expensive and time-consuming process. Conversion cannot be performed without significant engineering study to determine cost, and involves removing, replacing and repairing already existing development. Added to this set of challenges is the disruption of everyday living and business that occurs while conversion takes place, often for weeks at a time.

While some communities are drawn to the aesthetic attraction of burying power lines, the complex technical, economic and political issues surrounding converting from overhead supply to an underground network are often overlooked or underestimated.

Sometimes options such as raising the height of the overhead poles and lines can diminish the visual impact on a cityscape. Duke Power can review other choices with communities during the planning phase including installing taller poles, coordinating with other utilities to lessen the visual impact of existing lines, setting up a special tax district, seeking public/private grants, etc.

Conversion Costs

- *Converting from overhead to underground systems in established areas can be three times the cost of installing underground systems in newly developing areas. Please remember that the cost to install underground in a Greenfield environment can run upwards of six times the cost to install overhead. So, in extreme cases conversion costs can multiply upwards of eighteen times that of installing the same facilities overhead.* This cost may exceed more than \$2 million per mile for some major feeders. In extreme cases, this figure could exceed \$4 million per mile.
- Conversion means taking into account many other components of a community that are affected and contain hidden costs, including:
 - trees that must be removed and possibly replaced, an impossibility for old-growth trees
 - potential damage to property and landscaping
 - parking lot damage or reduction, a critical factor in areas where parking may already be in short supply
 - providing space for pad-mounted transformers
 - moving feeders and cost of service upgrades to businesses
- During conversion, businesses and access to services or residences can be disrupted, potentially for long periods of time.
- Overhead networks provide reliable, dependable service in already established areas without the complexities of conversion, allowing a community's resources to be directed to more urgent needs.

Something to Think About

The cost of restoring power after Hurricane Hugo in 1989, in today's dollars, would cover the cost of converting only a small town of 3,000 Duke Power customers to underground service out of a total customer base of 2 million customers.

After Conversion – Repair and Maintenance

Duke Power engineering, installation, repair and maintenance conforms to National Electric Safety Code (NESC) standards. Therefore, engineering and conversion services must comply with stringent guidelines to ensure safety and reliability. This means that underground networks, despite the difficulty of locating and repairing disruptions, must conform to the same high standards as overhead lines that are relatively easy to access and repair.

While it might appear that buried power lines are protected from dangers like weather, automobile accidents, high winds and wildlife that can disrupt overhead networks, there are other factors that can affect underground cabling that are difficult and expensive to repair compared to overhead lines. These repairs can also take much longer, meaning communities affected by underground power loss may not resume normal activity as quickly.

Underground repair and maintenance – points to consider:

- underground connectors and equipment are much more complex and costly than overhead connectors, and must be additionally protected against water, erosion and sediment intrusion
- areas of potential outages are nearly impossible to predict, and preventative maintenance options are very limited
- problem sites are not easily located when outages occur without specialized equipment, trained personnel and significant time delays; problems in overhead systems are more easily assessed using visual inspection and infrared technology
- an entire electric system may need to be de-energized before performing work, creating unplanned outages
- restoration time is much longer and requires a minimum of two personnel who must be specially trained, using expensive equipment. Often, deep trenching, reinforcement and even a temporary vault are necessary to ensure worker safety. In addition, this work can impact established landscaping or parking areas, etc.
- in the event of a sustained outage, power cannot be diverted or re-located easily as in an overhead system
- upgrades and/or additional service needs are more difficult and expensive to provide as communities change or grow

Understanding Overhead to Underground Conversion Costs

To better assist communities in making decisions on overhead power delivery systems compared to underground systems, Duke Power can prepare specific cost comparisons based on engineering studies.

However, it is important to note that each community's needs are different, and the challenges for conversion in one community may be very different than another. This means that costs for one area, such as a newly developing area, will be significantly lower than costs in an already developed area.

There are also cost differences associated with the amount of power needed in an area based on past use, current needs and future expected needs. Significant equipment, maintenance and repair considerations must be taken into account in comparing conversion costs based on these differences. Costs in one area for conversion may be increased two or three times from that of another area based on power needs. It is important to work closely with Duke Power when considering conversion in order to fully understand the complex decisions that must be made and factors to be considered when making cost comparisons.

There are also options for lower cost aesthetic improvements or streetscape improvements in some areas that do not require total conversion. Typically, these are areas in which lighting and traffic control systems can be placed in underground conduits without the entire power supply network in the area undergoing conversion.

This alternative can provide a community many of the aesthetic benefits of underground conversion without the cost of a total underground conversion. Duke can explore these options in your community.

- Duke Power can prepare cost analysis for conversion, however, a non-refundable deposit is required for the engineering study
- each community's needs are different, and costs for conversion will vary
- costs also vary with power supply needs and equipment, maintenance and repair required
- Duke Power policies are very consistent with industry general practices lower cost alternatives include underground networking for lighting

Five Common Myths About Underground Networks

As communities consider converting from reliable overhead electric distribution systems that have served them well to underground networks, there are five commonly-held myths that must be dispelled, and replaced with facts based on engineering and experience.

Duke Power is ready to assist community leaders, elected officials, planners and others who are at the center of discussions around conversion in understanding these facts so that decisions can be made from an informed perspective.

Myth #1: Underground lines are easier to maintain – you can put them in the ground and forget about them.

Facts: Maintenance on an underground network cannot be performed on a regularly scheduled basis, as access to these networks requires significant digging, the de-energizing of the network and coordination with other utilities that have buried lines. Components used for underground networks are much more complex than their overhead counterparts, and cannot be replaced on a rotating schedule to preclude outages. In addition, it is nearly impossible to determine where a possible problem may occur in an underground network, as the lines and connectors are hidden.

Myth #2: Underground lines are protected – they are less likely to cause outages and service interruptions.

Facts: While it is true that underground networks are not exposed to high winds, weather, wildlife and other factors affecting overhead systems, they are not immune to outage-causing problems that are difficult and expensive to repair. These include:

- breakdown of complex connectors
- damage caused by flooding and sediment intrusion
- accidental severance by unauthorized digging
- unintended damage caused by other utilities (cable, communications, water, street repair) in the course of repair or upgrading

In addition to these dangers, underground line problems are difficult to locate and repair, requiring specialized equipment, highly trained and experienced personnel, and digging and trenching.

Myth #3: It would be cheaper to bury our power networks than continually replace overhead lines after major storm damage.

Facts: Studies conducted after Hurricane Hugo, the most severe and damaging weather incident in recent history in Duke Power's customer area, show that overhead systems are much cheaper to maintain and repair than overall conversion. The cost of restoring power after Hurricane Hugo in 1989, in today's dollars, would cover the cost of converting only a small town of 3,000 Duke Power customers to underground service out of a total customer base of 2 million customers.

All overhead cabling and lines in Duke Power's overhead networks have been designed to sustain all but the most severe weather, impacts and damage. Under normal conditions, most customers enjoy nearly outage-free service using overhead systems. Even when an outage occurs, overhead lines are significantly easier to repair because the problem is more easily located, identified and accessible to repair crews.

Myth #4: While it costs more on the front end to convert to underground, the long-term costs are justified because of lower repairs and maintenance and the increased value of real estate due to more pleasing aesthetics.

Facts: Converting to an underground system of electrical service in established areas is very time-consuming, expensive and disruptive. Resources devoted to conversion must be taken away from other community needs that may be more critical to the long-term sustainability of the community and the quality of life of its residents.

Evidence on repair and maintenance shows that underground networks are more expensive, not less, to maintain and repair. There is no long-term evidence showing that burying power lines significantly affected the long-term value of a community's real estate base, but evidence does show that reliable, dependable electric service is a top consideration for re-location by both individuals and businesses of all sizes.

Myth #5: Other cities have converted their OH to UG for free.

Facts: In communities that have chosen to finance costs of underground conversion by setting up special tax districts, enabling legislation is needed. The additional tax may discourage business development. Many customers may pay increased rates for years and never see the aesthetic benefit of underground conversion, while more pressing needs remain a lesser priority.

Duke Power is open to discuss options that allow coverage of regulated costs. As a regulated utility, Duke Power has an Underground Distribution Installation Plan, approved by the North Carolina Utilities Commission (attached) for addressing relocation of power lines which clearly outlines our method for relocating lines that will not result in an unfair increase in costs applied to the entire customer base.

When Utilities Go Underground

For many decades, the familiar site of utility poles and lines in cities has been a symbol of efficient, safe and reliable access to power and energy. But today, the lines and cables on utility poles carry much more than energy, to include telephone access, cable access, traffic control systems and other basic services vital to everyday life.

When a community begins to make choices about conversion in established areas to an underground system of power delivery, one factor that must be taken into account is the need to place all lines and cables that are on utility poles underground at the same time. Added to this is the need to engineer and coordinate the placement of overhead lines alongside other basic utilities that already lie underground, including water and sewer lines.

Today's data distribution and transmission lines are complex, requiring the use of expensive and complicated couplings and housings to be placed in an underground environment. These lines also require a higher degree of maintenance than their overhead counterparts, and when repair is required, a great deal of care must be taken not to damage other lines contained in shared trenches or conduit.

When contemplating moving from overhead power supply systems to underground systems, a community must also take into account the many factors that may affect other utilities. All affected utilities that are using overhead systems must agree to re-locate their facilities to a new underground network. This can be a time-consuming and cumbersome process, adding to overall costs for conversion.

- All utilities using overhead line systems must agree to underground placement in an orderly and logical sequence.
- Customers must agree to rearrange their service entrances to accept power from the re-located electric distribution feeders.
- Underground placement of lines must also be coordinated with utilities already underground such as water and sewer.
- Maintenance and repair of any underground line requires digging, trenching and repair of streets, parking lots and other landscaping. There is also risk of damage to other lines in the proximity of the repair.
- Duke Power can assist in joint planning for underground location of all affected utilities as a part of overall engineering costs for underground conversion.

We hope this information provides some clarity to the issues surrounding the placement of electrical facilities underground. We welcome the opportunity to discuss this matter further and address any questions you may have.

AVAILABILITY

Normally, the Company's distribution and service facilities are installed above-ground on poles, towers, or other fixtures. At the request of an owner (including builders, developers, contractors and customers), the Company will install, own and maintain underground facilities under the terms and conditions of this Plan.

At the determination of the Company, in those areas where it is physically or economically infeasible, or impractical, to place facilities above-ground due to structural or geographical congestion or load density, the Company may place its facilities underground at its own option and expense.

DEFINITIONS

The term "**overhead facilities**" as used in this Plan, means an electrical distribution system having all components installed above ground level.

The term "**underground facilities**" as used in this Plan, means an electrical distribution system having some, or all, components installed below ground level.

A "**bulk feeder**" is a conductor system transporting the total electrical requirements of a large area from a substation or other supply point into such an area, which may consist of several residential developments and other loads. A "**sub-feeder**" is a conductor system branching off of the bulk feeder to supply the requirements of a certain portion of the area. The subfeeder may terminate in a given development, but the bulk feeder may, or may not, pass through the development to serve adjacent areas.

A "**primary voltage loop system**" of conductors provides multiple supply routes to more than one transformer serving the load requirements. A "**primary voltage radial extension**" of underground facilities consists of a single supply route to a single transformer serving the load requirements.

"**Secondary facilities**" consist of equipment necessary to provide secondary voltage from the Company's transformer to the owner's delivery point. "**Primary facilities**" consist of equipment, including transformation, to supply primary voltage into the owner's property or development.

"**Cost difference**" is the amount by which the estimated cost of underground facilities exceeds the estimated cost of comparable overhead facilities, but not less than zero.

"**Loss due to early retirement**" is the original cost of the facilities involved, less accrued depreciation, less salvage, plus the cost of removal.

SERVICE CATEGORIES

I.

RESIDENTIAL SERVICE

At the request of an owner, the Company will install, own and maintain underground facilities for service to single residences, apartments, condominiums, and manufactured homes following these Plan provisions. Any charge to the owner is for the cost difference of the necessary underground facilities requested and is non-refundable. The signed agreement with the owner for underground service shall specify the payment arrangements.

A. Permanent Residences

Residences which are to be permanent customer locations on a residential rate schedule of the Company will be served from underground facilities as shown below.

(1) New Service Installations Located in New Developments

Service to new residences on lots averaging an acre (43,560 sq. ft.), or less

No Charge

Service to new residences on lots averaging more than one acre

No charge except for cost difference of new primary facilities exceeding 300 feet per lot.

(2) New Service Installations Not Located in New Developments

Service to new residences requiring new underground secondary voltage facilities from an above-ground distribution line on, or adjacent to, the lot on which the residence is located

No Charge

Service to new residences requiring new underground primary and secondary voltage facilities

No charge except for cost difference of new primary facilities exceeding 300 feet.

(3) New Three-Phase Service Installations

Three-phase service to new single-residence structures, where this type of service is available

No charge except for cost difference of new primary facilities exceeding 300 feet.

Three-phase service to new multi-residence structures, where this type of service is available

No Charge

B. Other Residences

Residences which are in service categories not described above, will be served from underground facilities installed, owned, and maintained by the Company under an agreement with the owner providing for payment to the Company of the charges, if any, equal to the cost difference.

II.

NON-RESIDENTIAL SERVICE

At the request of an owner, the Company will install, own and maintain underground facilities to new general service and industrial service installations following these Plan provisions. Any charge to the owner is for the cost difference of the necessary underground facilities requested and is non-refundable. The signed agreement with the owner for underground service shall specify the payment arrangements.

(1) New Service Installations Requiring Only Secondary Voltage Facilities

No Charge

(2) New Service Installations Requiring Primary Voltage Loop System Facilities

No Charge

(3) New Service Installations Requiring Primary Voltage Radial Extension Facilities

No charge except for cost difference of single-phase primary facilities exceeding 300 feet, or three-phase primary facilities exceeding 500 feet. For three-phase primary facilities exceeding 500 feet, additional underground footage will be provided at no charge when installation of underground facilities is less than comparable overhead facilities.

(4) New Bulk Feeder and Subfeeders

Cost difference of such primary facilities

CONVERSION TO UNDERGROUND

The Company will replace an existing overhead distribution system with an underground system in an existing residential development or other area under the following terms and conditions:

1. The Company shall place facilities underground by an agreement with the requesting persons which provides for payment of a nonrefundable, contribution-in-aid-of-construction as follows:
 - a. When the existing overhead distribution system is not adequate to supply the customer's load due to added electrical load, the contribution in aid of construction shall be equal to the cost difference between comparable overhead and underground facilities.
 - b. When the existing overhead distribution system is adequate to supply the customer's load, the contribution in aid of construction shall be equal to the cost of comparable underground facilities, less any salvage value of the overhead system.

2. Preliminary engineering studies are necessary to determine the approximate costs of replacing overhead with underground facilities. Persons requesting replacement of such facilities shall pay, prior to commencement of such studies by the Company, a good faith, nonrefundable deposit in an amount of \$100 for each 600 feet of front lot lines for residential development studies, and, for studies of all other service areas, the estimated cost of the preliminary engineering study. If the replacement is undertaken following completion of such studies, actual costs, including preliminary engineering studies, will be charged and credit will be given for the estimated costs, or deposit, which was advanced.
3. The Company need not replace existing overhead systems with underground facilities, except individual services from pole to residence, unless at least one block or 600 feet of front lot line is involved, whichever is less.
4. All customers served directly from the specific section of line or in the area to be replaced with underground facilities shall agree to the conditions outlined for replacement of overhead facilities.
5. Owners shall arrange the wiring of their structures to receive underground service at meter locations which allow unimpeded installation of the underground service facilities.

ESTIMATES

Estimates of the cost of the underground and overhead facilities for the purpose of determining the amount of the contribution-in-aid-of-construction will be in accord with the Company's current construction design practices and shall be based upon the equivalent conductor and transformer capacity required for the electrical load specified by the owner.

GENERAL PROVISIONS

1. Facilities associated with an underground distribution system, other than the conductors, may be installed above or below ground level as determined solely by the Company in accord with the current construction design practices of the Company.
2. The Company will normally not provide underground service at secondary voltages above 480 volts.
3. The Company will provide service to a single transformer using a loop system design at the request of the owner who desires to have a loop system installed and makes a payment equal to the estimated cost of the additional facilities in excess of the radial extension facilities.
4. Existing overhead distribution bulk feeders will remain installed overhead unless the owner desires to have them installed underground. New bulk feeders necessary to serve a new underground residential subdivision will be installed overhead unless the owner desires to have them installed underground, and makes a contribution-in-aid-of-construction equal to the estimated cost difference between underground and overhead facilities. If it is necessary to extend a distribution bulk feeder through an existing underground residential development, it will be installed underground at Company expense.
5. New subfeeders necessary to serve a new underground subdivision or development will be installed underground inside such areas at no charge. New subfeeders outside such areas normally will be installed overhead, unless the owner desires to have them installed underground and makes a payment equal to the estimated cost difference.
6. Developments shall be divided into established and defined lots. For purposes of determining service categories, the average size of lots shall be expressed in square feet.
7. Prior to the installation of the underground distribution system by the Company, the final grade levels of the building sites shall be established by the owner. The building construction program shall be coordinated with the installation of underground electrical facilities to permit unimpeded access of the Company's equipment to the installation sites; to allow installation of underground facilities at proper depth and before streets, curbs or other obstructions are installed; and to eliminate dig-ins to the underground electrical facilities after installation. Should streets, curbs or other obstructions be present prior to installation of underground facilities, resulting in additional expense to the Company, payment for these additional expenses shall be made to the Company by the owner. Should established lots or final grade levels change after installation of underground electrical facilities has begun, or if installation of electrical facilities is required by the owner before final grades are established, and either of these conditions results in additional expenses to the Company, payment for these additional expenses shall be made to the Company by the owner.
8. Should existing sidewalks, septic tank systems, fuel tanks, other utility line, or other man-made obstructions result in additional expenses to the Company, payment for same will be made by the owner.
9. Actual costs brought about in connection with the compliance of special requirements, if any, of municipalities, State and Federal highway agencies or departments regarding the breaking of pavement, ditching back-filling, and other related conditions, will be paid by the owner.

(Underground Distribution Installation Plan (NC & SC) Continued)

- 10. The Company will make, or adjust, charges to the owner to collect the actual additional costs to the Company due to adverse conditions, such as: the composition of the land where the underground facilities are to be installed is such that standard construction equipment cannot be used to complete the installation; or, special equipment and materials are needed for stream crossing structures or concrete structures; or, dynamite is required; or, if abrupt changes in final grade levels exceed a slope ratio of 1 when measured within three feet of the trench.
- 11. The Company's agreement to provide underground service is dependent upon the securing of all necessary rights, easements, rights-of-way, privileges, franchises or permits for the installation of such service from those requesting the underground facilities. The Company shall exercise care in the utilization of its underground equipment during construction, but the ultimate responsibility for the protection of shrubs, trees, and grass sod will be with the owner. Shrubs, trees, or any other obstacle shall not be placed within ten feet of transformer or cabinet openings which would hinder the access of the Company at any time.
- 12. Temporary service will not be available in the area served from underground facilities until the underground system is in place unless the owner elects to pay the "in and out" costs of temporary facilities necessary to deliver the temporary service from overhead distribution lines. After the underground facilities are in place, temporary service may be provided for no charge only at a transformer or pedestal location.
- 13. Underground conductors to provide service to Company-owned outdoor lighting will be furnished under the applicable rate schedule on file with and approved by the Commission.
- 14. The Company will provide and coordinate underground service facilities with other requested facilities which are supplied under the Extra Facilities provision of the Company's Service Regulations.

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