

EXECUTIVE SUMMARY

Underground vs. Overhead Distribution Infrastructure

O&M Cost Analysis Based on FERC Form 1 Data

Prepared by Planmetrix LLC

This executive summary presents findings from an industry-wide analysis of Federal Energy Regulatory Commission (FERC) Form 1 data comparing the operation and maintenance (O&M) costs of underground (UG) and overhead (OH) electric distribution infrastructure. The analysis was conducted to support utility decision-making on selective undergrounding as a grid resiliency strategy.

Background and Purpose

Severe weather events have focused industry attention on the need to enhance the resiliency of distribution systems. Utilities pursuing resiliency improvements consider a range of strategies, including hardening aerial infrastructure and selectively undergrounding distribution lines to shield conductors from wind, ice, and tree-contact damage. A fundamental challenge is identifying the optimal strategy given system-specific needs and regulatory constraints.

The practical question is not whether undergrounding is categorically preferable to overhead construction. Underground systems typically cost more to install, can be more disruptive to build, and can take longer to troubleshoot when failures occur. The relevant question is whether the higher initial capital cost of undergrounding can be partly offset by lower future O&M expense — and whether those lifecycle economics support selective use of undergrounding in locations with high outage exposure or high customer consequence.

Central Finding

Across the selected FERC Form 1 utility sample, average annual O&M expense was 4.77% of overhead distribution plant value and 1.39% of underground distribution plant value. The analysis therefore supports lifecycle comparisons that include both initial capital cost and the present value of future O&M, rather than comparing installation cost alone.

Analytical Approach

FERC Form 1 was selected as the data source because it provides multiple years of uniformly reported financial data across a large, representative set of U.S. investor-owned utilities. The Uniform System of Accounts allows meaningful cross-utility comparison of capital plant balances and associated O&M expenditures, and produces a screening-level estimate of the annual O&M cost that accompanies a new overhead or underground capital investment.

FERC Accounts Analyzed

The following FERC accounts were selected for the analysis:

Account	Description	Category
364	Poles, Towers and Fixtures	OH Capital
365	Overhead Conductors and Devices	OH Capital
366	Underground Conduit	UG Capital
367	Underground Conductors and Devices	UG Capital
583	Overhead Line Expenses	OH O&M

Account	Description	Category
593	Maintenance of Overhead Lines	OH O&M
584	Underground Line Expenses	UG O&M
594	Maintenance of Underground Lines	UG O&M

Accounts 368 (Line Transformers), 369 (Services), 588 (Miscellaneous Distribution Expenses), and 595 (Maintenance of Line Transformers) were excluded because each aggregates both overhead and underground activity, preventing clean separation of OH versus UG costs. This exclusion improves analytical separation but means the results are not a complete cost-of-service model; they are best treated as planning estimates rather than project-specific engineering cost forecasts.

Utility Data and Sample Period

The study stratified 99 utilities by residential customer count — used as a system-size proxy because distribution line-mile data are not reported in Form 1 — and analyzed five years of data (2009–2013) as most reflective of current spending practices.

Utility Group	Residential Customers	Sample Size
Large	More than 1,000,000	26 utilities
Medium	500,000 to 1,000,000	22 utilities
Small	100,000 to 500,000	51 utilities

Operation & Maintenance Characteristics by Infrastructure Type

Maintenance practices vary by infrastructure type, asset age, installation design, tree density, soil condition, weather exposure, and local utility standards. Even with this variation, the analysis identifies recurring activities and a fundamental operational tradeoff that distinguishes the two system types.

	Overhead Distribution	Underground Distribution
Common O&M activities	Vegetation management; wood pole inspection and treatment; visual and infrared inspections; maintenance of reclosers, automated switches, and other line devices; corrective outage troubleshooting and repair.	Pad-mounted equipment inspection; cable diagnostic testing; manhole and vault inspections; maintenance of pad-mounted switchgear, network protectors, and related devices; corrective fault location and repair.
Operational tradeoff	More exposed to wind, ice, and vegetation failures — higher trouble cases per mile. Equipment is visible and accessible, making patrol, fault identification, and repair generally faster.	Less exposed to overhead storm hazards — lower trouble cases per mile. However, failures take longer to locate, excavate, isolate, splice, test, and restore.
Resilience profile	Frequent but typically shorter outages; more corrective events driven by storm exposure and vegetation contact; faster crew response and fault isolation.	Fewer storm-driven events; reduced frequency of vegetation-related failures. When failures occur, extended fault location and repair duration can drive longer individual outages.

This distinction is central to resilience planning. Undergrounding can reduce the frequency of storm-related failures caused by overhead exposure, but it does not eliminate maintenance or restoration risk.

Underground assets shift the maintenance profile toward diagnostic testing, access management, excavation or vault work, and more complex fault repair.

Key Tradeoff: Frequency vs. Duration

Underground infrastructure experiences fewer failure events per mile than overhead but incurs significantly longer restoration times when failures do occur. A complete resilience assessment must consider both expected outage frequency (SAIFI) and restoration duration (SAIDI) — not just the reduction in storm-related events.

Results of Analysis

The central finding is a clear and consistent difference between overhead and underground O&M expense expressed as a percentage of depreciated installed plant value. The pattern is stable across all three utility size categories, indicating it is not an artifact of scale.

- **Overhead O&M:** 4.77% of installed OH capital plant per year (average of all utilities).
- **Underground O&M:** 1.39% of installed UG capital plant per year (average of all utilities).

Utility Group	UG O&M as % of UG Capital	OH O&M as % of OH Capital	Avg Annual Capital/Customer	Avg Annual O&M/Customer
Large (>1M customers)	1.28%	4.71%	\$1,756	\$51
Medium (500K–1M)	1.32%	4.77%	\$1,625	\$53
Small (100K–500K)	1.48%	4.80%	\$1,519	\$55
All Utilities (average)	1.39%	4.77%	\$1,605	\$53

The overhead O&M ratio is remarkably stable across size groups: 4.71% for large utilities, 4.77% for medium, and 4.80% for small. Underground O&M similarly holds in a narrow range of 1.28% to 1.48%. This consistency gives both ratios practical value as first-pass screening assumptions, while still requiring local calibration before use in a rate case, capital plan, or project business case.

Planning Interpretation

For each \$100 of overhead distribution investment, expect approximately \$4.77 of annual overhead O&M. For each \$100 of underground distribution investment, expect approximately \$1.39 of annual underground O&M. This difference does not prove that undergrounding is always economical — it shows why lifecycle cost comparisons must include future O&M savings, not just installed capital.

Breakeven Analysis

Because underground conversion typically carries a higher upfront capital cost than overhead hardening, a net present value framework was developed to determine how much additional underground capital can be justified by lower ongoing O&M expense. The analysis assumes a 30-year asset life and a 3.0% discount rate.

The breakeven multiplier is approximately 1.52. For any given overhead capital investment, an underground alternative can cost up to 52.06% more in upfront capital and still achieve total lifecycle cost

parity over 30 years — because the cumulative NPV of lower UG O&M (1.39% vs. 4.77% annually) offsets the higher initial outlay. This relationship holds linearly across all investment magnitudes.

Overhead O&M % of OH Capital:	4.77%	OH Capital	\$100.00	\$200.00	\$300.00	\$400.00	\$500.00
Underground O&M % of UG Capital:	1.39%	UG Feasible	\$152.06	\$304.13	\$456.19	\$608.26	\$760.32
Life of Assets - Years (n)	30	Variance	52.06%	52.06%	52.06%	52.06%	52.06%
Discount Rate (r):	3.00%						

The breakeven threshold is a limited capital-plus-O&M calculation only. Before using it in a planning or regulatory context, decision makers should recognize what the breakeven does not capture:

- **Reliability and resilience benefits:** Avoided outage costs, major event performance improvements, and reductions in SAIDI/SAIFI are not reflected in the O&M ratio comparison.
- **Customer and system impacts:** Critical customer impacts, safety considerations, wildfire or vegetation exposure, and public acceptance factors are outside the scope of this analysis.
- **Asset life differences:** Overhead and underground assets may carry different expected service lives. The common 30-year horizon used here may understate or overstate the NPV of O&M savings for either type.
- **Restoration duration risk:** Underground cable faults can carry higher restoration duration costs not captured in the O&M ratio.
- **Discount rate sensitivity:** A higher discount rate reduces the NPV of O&M savings and narrows the allowable UG capital premium.

Implications for Utility Decision Making

The FERC-based ratios provide a defensible starting point for comparing overhead and underground alternatives, but they are a screening input — not a project approval. The following implications should guide how utilities incorporate these findings into planning, capital budgeting, and regulatory proceedings.

- **Do not compare installation cost alone:** A narrow capital comparison understates the value of lower future O&M for underground systems and can bias decisions toward overhead solutions even where undergrounding is economically competitive over the asset life.
- **Use undergrounding selectively:** Results support targeted undergrounding where the construction premium is moderate and where expected storm exposure, vegetation risk, outage consequence, or customer impact is high. They do not support blanket undergrounding without location-specific benefit analysis.
- **Calibrate with local data:** Industry-wide averages are useful screening inputs. Utility-specific maintenance cycles, crew costs, vegetation exposure, cable failure rates, soil conditions, and restoration practices can materially change the breakeven result at individual project sites.
- **Separate failure frequency from repair duration:** Underground assets may reduce the number of storm-related interruptions while increasing the duration of the failures that do occur. Resilience analysis must address both dimensions — expected outage frequency and restoration time — not just the reduction in event count.
- **Include the full benefit picture:** The FERC analysis captures O&M expense, not the full value of improved resilience. A complete business case should add avoided outage costs, critical

customer impacts, safety, wildfire exposure, vegetation risk, traffic disruption, and relevant reliability metrics.

- **Document assumptions for regulators:** Regulatory review will require a clear record of selected accounts, exclusions, discount rate, asset life, local cost estimates, and sensitivity of breakeven results to those assumptions. Build the audit trail before committing to a program.

Recommended Planning Framework

The following seven-step framework provides a structured process for applying the FERC O&M ratios within a broader lifecycle cost and resilience evaluation for selective undergrounding decisions.

Step	Planning Action	Output
1	Define the overhead and underground alternatives at the same service level, geography, and reliability objective.	Comparable project scope.
2	Estimate installed capital cost for each alternative using local design, permitting, labor, traffic control, restoration, and customer impact assumptions.	Project-specific capital cost range.
3	Apply O&M ratios as a screening assumption — 4.77% for overhead and 1.39% for underground — then replace or calibrate with utility-specific data where available.	Annual O&M estimate by alternative.
4	Discount annual O&M over the selected asset life and combine with initial capital cost to develop a lifecycle cost comparison.	Lifecycle cost comparison.
5	Add resilience and reliability benefits, including avoided outage costs, critical customer impacts, major event performance, and vegetation and storm exposure reductions.	Benefit-cost comparison.
6	Run sensitivity cases for discount rate, asset life, construction premium, O&M ratio, failure frequency, and restoration duration.	Decision range and breakeven threshold.
7	Prioritize locations where undergrounding is below the breakeven threshold or where resilience benefits justify the capital premium.	Targeted undergrounding candidate list.

Limitations and Considerations

While FERC Form 1 data offer a consistent and comprehensive industry-wide dataset, several limitations should be recognized when applying these findings to site-specific decisions:

- **High-level aggregation:** FERC accounts aggregate expenditures at the utility level. Cost drivers specific to geography, demographics, regulatory environment, or individual circuit characteristics are not captured.
- **No mileage data:** Form 1 does not include distribution line-mile statistics; O&M rates are therefore expressed as a percentage of capital investment rather than per-unit-length metrics.
- **Depreciated plant value basis:** O&M rates are calculated against depreciated installed plant value, which can distort comparisons across utilities with different asset ages, depreciation histories, or accounting policies.
- **Asset life assumptions:** The breakeven analysis assumes an identical 30-year life for both overhead and underground assets. In practice, overhead systems often carry longer expected lives, which would affect the NPV of the O&M comparison.

- **Excluded accounts:** Line transformers and customer services (Accounts 368 and 369) are excluded because they commingle OH and UG costs. The results are therefore not a complete cost-of-service model.
- **Site-specific variation:** Actual O&M costs for a specific project may differ substantially from industry averages depending on soil conditions, conduit type, cable age, local labor rates, tree density, and restoration crew practices.

Conclusions

The FERC Form 1 analysis provides a data-driven, industry-wide foundation for comparing the lifecycle costs of overhead and underground distribution infrastructure. Three principal conclusions emerge:

- **O&M cost differential is material and consistent:** Overhead O&M averages 4.77% of capital annually versus 1.39% for underground — a ratio of more than 3:1 — and this relationship is stable across large, medium, and small utility size classes.
- **Higher UG capital costs can be offset by lower O&M:** Over a 30-year asset life at a 3% discount rate, underground conversion can justify a capital premium of up to 52% relative to an equivalent overhead investment and still achieve lifecycle cost parity on the capital-plus-O&M basis.
- **Project-level analysis is essential:** Industry averages provide a useful starting point, but utilities should conduct project-specific analysis that accounts for local construction cost, circuit length, outage history, regulatory context, and the full benefit picture before committing to a selective undergrounding program.

The right conclusion is not that undergrounding is categorically preferred. Overhead hardening remains appropriate where underground construction is prohibitively expensive, repair access is more important than exposure reduction, or expected benefits do not justify the premium. Undergrounding should be evaluated as a selective resilience strategy whose economics improve where the cost premium is moderate, overhead exposure is high, and customer or system consequences are significant.

Bottom Line

A credible utility screening process must treat undergrounding and overhead hardening as lifecycle alternatives, not just capital comparisons. Capital cost, O&M, resilience benefit, outage consequence, repair complexity, and local field conditions all need to be evaluated together. The FERC-based ratios provide a defensible starting point for that comparison — not a substitute for project-specific analysis.