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National Trends in Capitalized Life Extension

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Abstract

We are becoming more dependent on an aging and vulnerable grid. Our industry is excited about electrification and data center investment but how can we concurrently keep our aging grid safe, resilient and affordable? What are the primary drivers of asset damage and deterioration? What processes and technologies can be used to accurately identify the condition and enable hyper efficient upgrades to double asset life and achieve reliability and resilience goals while reducing costs and accelerating improvement by up to 5 times? This contribution provides a brief educational overview of national trends in capitalized life extension and resilience strategies for key overhead and underground transmission and distribution assets.

1. Introduction

Electric utilities across North America are navigating a rapidly shifting landscape marked by accelerating load growth, severe weather, aging infrastructure, and rising expectations from both regulators and customers. The convergence of these forces is pressuring utilities to rethink how they invest, maintain, and upgrade their networks. Traditional approaches built around extensive replacement programs are proving insufficient and financially unsustainable. Many utilities are replacing less than one percent of assets per year realistically equating to a one-hundred-year life expectancy or longer. The assets that make up the electric grid were never built to withstand today's demands, and utilities find themselves wrestling with a widening gap between asset age and the oft quoted, thirty-to-fifty-year life expectancy.

At the same time, the energy transition is being driven by the explosive growth of artificial intelligence, electrification, electric vehicles, distributed resources, and high-density urban development. These shifts drive massive new load requirements, which in turn require significant capital investment in new infrastructure. Yet utilities must also meet affordability expectations and reliability obligations, often within tight regulatory frameworks that limit rate increases. As a result, there is a pressing need for innovative strategies that allow utilities to achieve more with less, without compromising safety or resilience.

One solution gaining rapid adoption is capitalized life extension, an approach that uses highly targeted capital investments to restore, harden, and upgrade existing assets rather than replacing them outright. With decades of performance data and millions of assessed assets to support it, capitalized life extension has emerged as a proven method for extending the service life of infrastructure while dramatically reducing capital and operating costs and time requirements. Utilities adopting this strategy consistently see asset life doubled, program execution up to five

times faster and five times lower cost compared to replacement. These outcomes free capital for new construction and modernization while improving reliability in a way that is both economic and sustainable.

2. What is Capitalized Life Extension?

The foundation of "life extension" lies in its targeted methodology. When used correctly, this approach typically finds about twenty percent of assets typically generating around eighty percent of failures. This means utilities can drive outsized improvements by focusing on specific degraded or high-risk assets. The life extension process begins with detailed condition assessments that may include field observations, groundline evaluations, insulation integrity scans, infrared imagery, LiDAR collection, and aerial UAS imagery. These assessments provide the data required for engineering analysis, enabling utilities to determine the precise upgrades that will restore asset integrity and increase resilience. Because these upgrades qualify as "betterments," they meet FERC and other regulatory capitalization requirements, resulting in a long-term rate of return on investments instead of increased operating costs. Capitalized life extension has been successfully applied to substation equipment, insulating and attachment components, underground transmission and primary distribution cables, transformers, overhead distribution and transmission systems, low voltage network cables and equipment and vaults. The following discussion provides examples.

3. Overhead Transmission Lines

Overhead transmission lines, especially steel towers, benefit greatly from life extension techniques. Many of these structures experience corrosion, foundation degradation, coating failures, and mechanical wear long before their theoretical lifespan has been reached. Life extension programs address these issues through condition assessment, integrating structural modeling, coating restoration, cathodic protection, and targeted foundation and damaged component repairs. A compelling example is a steel tower project where replacement would have cost eighteen million dollars and required five years to complete. Through a life extension process, the same system could be restored and upgraded for two million dollars in just four months, delivering an eighty-eight percent savings while enhancing resiliency far more rapidly than replacement would allow.

4. Overhead Distribution Lines

Overhead distribution lines, and especially wood poles, represent another significant opportunity for life extension. With over 100 million wood poles in service in North America, they constitute

one of the largest asset classes in the electric grid. Their degradation patterns vary substantially based on climate, soil chemistry, age, and local hazards such as wildfire or high winds. Life extension programs for wood poles begin with subterranean and groundline assessments to accurately measure remaining strength. They then apply treatments such as internal and external preservatives, fire-resistant coatings or wraps, and engineered structural restoration systems. Engineered trusses, for example, can restore original strength or even increase the structural capability to withstand extreme wind loading and add several decades of service life. Field data from more than four hundred thousand restored poles has demonstrated that engineered trussing extends pole life by over forty years on average. Real-world storm performance further validates this approach: in recent severe weather events, including Hurricanes Ian and Beryl, trussed poles exhibited survival rates between 98.5 percent and 100 percent across hundreds of audited locations. These outcomes underscore the role that life extension can play in building more resilient distribution systems without requiring full replacement cycles.

6. Underground Vaults

Underground infrastructure presents a different set of challenges yet also benefits substantially from life extension strategies. Underground vaults, for instance, can deteriorate due to corrosion, moisture intrusion, and high heat. Traditional replacements are costly, disruptive, and often require excavation in densely populated areas. Utilities using life extension methods can deploy drone-based inspections and internal composite structural rehabilitation techniques to restore vaults without excavation. In one case, a vault replacement estimated at nine hundred thousand dollars and three weeks of construction was instead rehabilitated for one hundred eighty thousand dollars in just three days, achieving eighty percent savings while preserving interior space and guaranteeing decades of extended life.

7. Underground Padmount Equipment

Padmount transformers and equipment in cabinets also benefit from life extension programs designed to evaluate their condition and strategically upgrade them to original performance. Deterioration of connections, tanks, bushing and coils most often originate from poor installation and design practices and over 85% of the time can be externally detected and proactively upgraded in the field at a fraction of replacement costs. For example, many transformers have about a quarter of an inch (about a half centimeter) of oil over the coils and even a small leak, pad out-of-level, or insufficient surge protection can shorten their life by decades. Programs tailored for over fifty utilities have covered more than half a million padmount units, demonstrating that even assets considered low-visibility can play a pivotal role in improving system performance when properly assessed and restored. For example, one utility experienced a reduction of 60 minutes of SAIDI with their underground residential distribution life extension program.

8. Underground Urban Networks

Utilities frequently struggle to assess and maintain assets associated with a low voltage network system. Hidden faults in these networks can lead to cascading reliability problems and safety hazards. These issues include electric shocks reported by the public, equipment damage, manhole fires or explosions, and increased electrical system losses. Root causes include workmanship defects, such as improper wiring or joint construction, third party construction incidents, unauthorized tampering, vehicular impacts, and cable and equipment insulation damage. An effective life extension method uses a vehicle mounted "electrical leak" scanning technology that not only detects the issues but also correlates them with optical location scans and GIS coordinates. One a network fault occurs there is significant stress and damage to the system, even at a considerable distance from the fault. This life extension approach empowers utilities to proactively use capital to address the worst network issues, long before they can be detected with traditional system protection, and thereby improving, safety, affordability, and reliability.

9. Underground Transmission & Distribution Cable Systems

Underground transmission and primary distribution cable systems—both new and aged—represent another area where life extension can transform utility economics. Nearly forty percent of newly installed systems contain defects that go undetected without advanced condition assessment, which is why cable scanning technologies have become central to modern life extension programs. For new systems, these technologies yield cable systems with up to one hundred times the reliability compared to legacy quality control methods. Since most failures, even on aged cable systems, are due to defects existing on day one, rapid returns can be achieved through avoided in-service faults . For aged cable, life extension is particularly compelling since an aged cable is ten times more likely to fail again after the first fault. An aged cable replacement program, originally estimated to cost one hundred ninety million dollars and take forty years to complete, was executed via a life extension program for forty-six million dollars and completed in eight years. The life extension program delivered more than seventy-six percent financial savings across twenty-four thousand cable systems with over eighty percent of assets left in the ground and reliability equivalent to a newly installed underground grid.

10. The Role of Accurate Data in Digital Twins and AI-Enabled Modeling

Beyond the individual asset categories, one of the most critical enablers of life extension is the availability of high-quality asset condition data. The process is now more effective than ever, thanks to AI-enabled modeling, predictive analytics, and digital twins to inform capital planning and risk prioritization. These advanced models require accurate, large-scale datasets, which many utilities currently lack. Life extension programs naturally generate rich condition data because they integrate field observations, engineering assessments, advance non-destructive scans,

imaging technologies, and GIS data. For example, by combining precision LiDAR, pole load analysis, and physics-based modeling to create system-wide digital twins, utilities can get results in weeks rather than months. In one case, a utility reported a thirty percent improvement in pole utilization accuracy, a fifty percent improvement in GIS data accuracy, and enhanced ability to correlate asset conditions across their networks. This clean data foundation becomes an essential accelerator for grid modernization, resiliency planning, and resource optimization.

11. Discussion & Conclusion

Collectively, these elements form a compelling business case for life extension: utilities can achieve faster, more resilient improvements while dramatically reducing costs and freeing capital for new construction. Life extension also provides regulatory advantages by demonstrating prudent stewardship of ratepayer funds and ensuring that capital investments align with long-term affordability goals. As workforce constraints continue to affect the industry, the ability to complete more work with smaller, agile teams further increases the appeal of life extension programs.

In summary, the modern utility environment demands strategies that simultaneously address aging infrastructure, affordability pressures, resiliency expectations, and data needs. Capitalized life extension stands out as a proven, scalable, and financially responsible solution capable of doubling asset life, while accelerating reliability improvements, and dramatically reducing long-term capital requirements by a factor of five. Utilities replacing less than one percent of their assets per year need a solution for one-hundred-year life. As utilities work to prepare their networks for the demands of the future, capitalized life extension provides a clear path toward a more affordable, safer, reliable, and resilient grid