FITZEMEYER & TOCCI ASSOCIATES, INC.

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Replacing Aging Infrastructure:

Addressing Deferred Maintenance and Future-Proofing

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About the Guide

In the ever-changing realm of building systems, replacing aging infrastructure offers a crucial chance to address deferred maintenance and future-proof facilities in an institutional setting. There are many challenges posed by outdated MEP systems, such as inefficiency, increased operational costs, and potential safety hazards. There are opportunities presented by deferred maintenance to enhance resiliency and futureproof campus-wide mechanical, electrical, and plumbing (MEP) systems within the healthcare and academic markets.

This guide emphasizes the significance of leveraging advanced technologies, sustainable practices, and comprehensive planning to both address current deficiencies and anticipate future needs. It highlights the potential use of technologies like AI and Digital Twin to increase maintenance effectiveness, plan for upgrades, improve energy efficiency through evolving technology, and make long-term investments to ensure facilities remain resilient and adaptable. The aim is to prevent costly repairs and downtime while maintaining functionality and sustainability.

By analyzing case studies and best practices, the guide offers insights for industry professionals to enhance system performance and extend the lifespan of critical building infrastructure. This holistic approach emphasizes the necessity of forward-thinking in the maintenance and upgrading of MEP systems to create resilient, efficient, and adaptable built environments.

Learning Outcomes

This guide will enable readers to:

Outcome 1

Proactive Maintenance Strategies to identifying and addressing deferred maintenance issues before they escalate into costly repairs or operational disruptions

Outcome 2

Leveraging technology to help facilities managers plan and execute targeted upgrades.

Outcome 3

Strategies for retrofitting older buildings to meet modern energy efficiency standards, reducing operational costs and carbon footprints.

Outcome 4

Financial and operational planning to ensure aging facilities remain resilient, adaptable, and capable of supporting evolving technology and operational needs.

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BACKGROUND

Aging mechanical, electrical, plumbing, and life-safety (MEP/FP) systems present a growing, and often underestimated, risk across hospitals, universities, and other mission-critical environments. Many of these facilities were built during earlier construction booms under very different operational demands, energy expectations, standards, and regulations. Systems that once performed reliably are now expected to support advanced clinical care, data-intensive research, and continuous operations, often beyond their original design intent.

Today's hospitals require precise climate control for sensitive equipment and reliable power for life-saving devices. Universities depend on specialized ventilation for laboratories and electrical capacity for advanced research and modern computing. As these systems age, failures become more frequent, operating costs rise, and reliability declines—impacts that extend well beyond repair bills. In healthcare, unexpected failures disrupt patient care and compromise safety. In academic settings, inconsistent temperature, poor air quality, and power interruptions undermine learning, research, and institutional credibility.

Facility professionals are on the front line of this challenge. They must keep buildings operational with constrained budgets, incomplete documentation, and systems well past their intended service life. While routine maintenance is generally performed as planned, the larger issue is delayed or deferred capital renewal, the major replacements and upgrades that require institutional investment and long-term planning.

For decades, many organizations have minimized budgets by deferring non-urgent work until failure occurs. Routine tasks get done, but when buildings and major equipment need costly renewal, projects are postponed or canceled. The result is a cycle of emergency repairs that are more expensive, more disruptive, and less effective than planned improvements. Over time, the "fix it when it breaks" approach compounds problems: mechanical rooms, ceiling plenums, and vertical shafts were not designed for modern equipment, higher electrical loads, or future expansion. Like-for-like replacements may seem efficient but often recreate the very constraints that caused performance issues, driving up maintenance demands, extending shutdowns, and reducing flexibility during emergencies.

This reactive model is no longer viable for facilities that must operate continuously. Organizations that manage infrastructure by responding to failures find themselves trapped in crisis, spending more while getting worse outcomes. Buildings become less reliable, less efficient, and less aligned with their core mission. Crucially, responsibility for major renewal lies with institutional leadership, not maintenance staff. When critical upgrades do not occur, it is typically the result of budget and priority decisions. Without substantial renewal funding and coordinated planning, buildings cannot remain safe, efficient, or capable of supporting evolving needs.

Forward-looking organizations now treat infrastructure renewal as a strategic investment, not a maintenance expense. By managing building systems as long-term assets and aligning renewal with institutional goals, they achieve greater predictability, resilience, and reduced lifecycle cost. This shift, moving from emergency repairs to planned improvements, requires better data, early cross-disciplinary collaboration, and a clear rationale for which systems to address first and why.

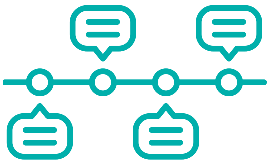
The purpose of this guide is to provide practical strategies for making that transformation, from reactive crisis management to proactive planning and stewardship, using modern technology to understand existing systems and developing long-term improvement plans that minimize disruption, risk, and cost while preparing facilities for future needs.

DID YOU KNOW?

Deferred maintenance is one of the leading contributors to unplanned system failures in hospitals and higher-education facilities, often costing significantly more than planned capital renewal.

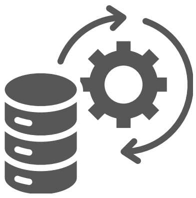
NEED

Renewing aging infrastructure in occupied, mission-critical facilities demands a comprehensive, coordinated approach that maximizes each capital dollar. Organizations see the greatest benefit when they adopt the following principles:



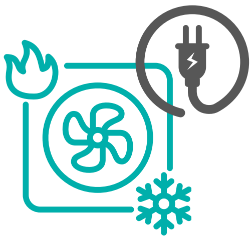
Plan Strategically

Conduct thorough assessments of major building systems, documenting condition, age, performance history, and failure risk. Include spatial constraints, access limitations, and distribution capacity that affect maintainability. Use this information to prioritize improvements based on operational criticality, safety, regulatory exposure, and future demand. Develop multi-year capital plans that phase costs, coordinate upgrades, and reduce disruption and lifecycle expense.



Build Organizational Capability

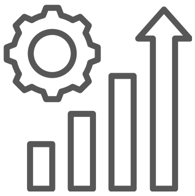
Transitioning from reactive maintenance to proactive asset management requires more than technical skill. Facility teams need training, leadership support, and clear decision criteria. Invest in data systems, consistent evaluation frameworks, and strategic vendor partnerships. Success depends on executive sponsorship and disciplined change management.



Bundle Improvements

Coordinate multiple systems to capture synergies and lower cost. Align mechanical replacements with electrical upgrades and building envelope improvements to maximize energy and operational benefits. Bundled planning reduces redundant work and limits disruption in occupied spaces.

Future-Proof Investments



Design with spare capacity and flexible distribution to accommodate changing programs, electrification, renewable integration, and emerging technologies. Designing strictly for current loads invites premature obsolescence and repeat disruptions; future-ready solutions protect capital and extend the useful life of systems and facilities.

Leverage Modern Technology

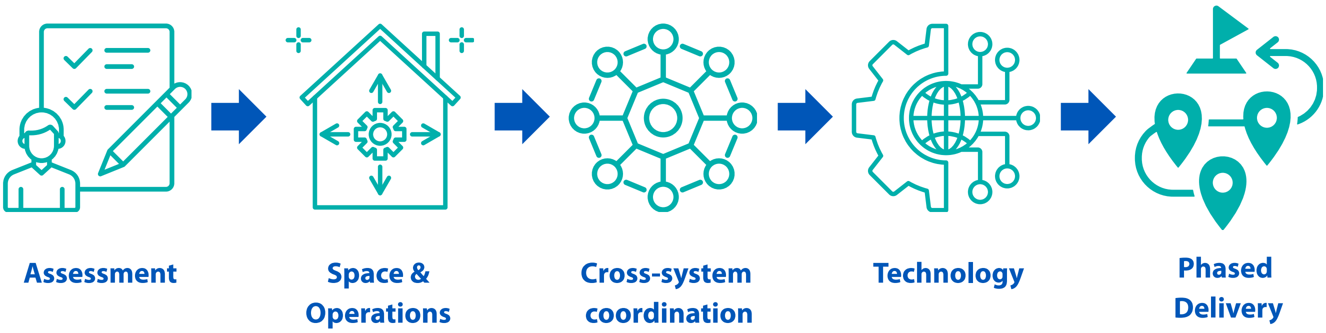
Use 3D scanning and Building Information Modeling (BIM) to accurately document existing conditions, especially where records are incomplete. Apply digital twins, analytics, and monitoring tools to enable real-time insight, predictive maintenance, and performance optimization. Technology should inform both near-term decisions and long-term planning.

Taken together, these principles help transform aging facilities from liabilities into resilient assets—stabilizing operations, reducing risk, and enabling adaptation as institutional demands, regulations, and technologies evolve.

Reactive maintenance may keep buildings running today, but it limits an organization's ability to adapt, expand, or respond effectively to future demands.

SOLUTION

Addressing deferred maintenance and future-proofing aging infrastructure requires a coordinated, multidisciplinary framework that aligns technical performance, spatial planning, operational realities, and long-term institutional goals. Rather than treating renewal as a series of isolated replacements, successful organizations implement an integrated delivery model that enables informed decisions, minimizes disruption, and maximizes long-term value.



Integrated Assessment and Risk Prioritization

Begin with a comprehensive evaluation that looks beyond individual systems. Assess MEP/FP and building envelope holistically, considering age, condition, failure risk, code compliance, operational criticality, and spatial constraints. Understand where systems are located, how they are accessed, and whether they can be replaced or expanded without major disruption. This integrated view produces a clear, risk-based roadmap for action.

Align Infrastructure Planning with Space and Operations

Infrastructure performance is inseparable from the spaces that house it. Evaluate mechanical rooms, shafts, plenums, and service corridors for capacity, access, and future expansion. Where spatial limits constrain performance or maintainability, architectural interventions—reconfigured equipment rooms, improved access routes, or reallocated space—become part of the solution. Align upgrades with building operations, academic calendars, or clinical workflows to maintain continuity in occupied facilities.

Coordinate Cross-System Upgrades for Maximum Impact

Aging systems are interdependent; isolated fixes shift problems rather than solve them. Coordinate improvements across mechanical, electrical, plumbing, and envelope systems to capture synergies, reduce redundant construction, and improve overall performance. For example, electrifying heating requires corresponding electrical service and distribution upgrades; envelope improvements can reduce loads and improve comfort. Bundling work into coordinated phases lowers lifecycle cost and limits repeated disruption.

Design for Adaptability, Resilience, and Future Demand

Plan for change. Incorporate spare capacity, flexible distribution pathways, and clear maintenance access to support evolving technology, program growth, and regulatory requirements. Integrate flood resilience, redundancy, and emergency power strategies early, especially for critical equipment in vulnerable areas. Designing for adaptability reduces premature replacement and protects capital over the long term.

Leverage Technology to Inform and Sustain Performance

Coordinate multiple systems to capture synergies and lower cost. Align mechanical replacements with electrical upgrades and building envelope improvements to maximize energy and operational benefits. Bundled planning reduces redundant work and limits disruption in occupied spaces.

Implement Through Phased, Occupant-Focused Delivery

Execution must preserve operations. Use phased construction, temporary systems, and parallel installations to keep critical services online during upgrades. Communicate clearly with occupants and stakeholders to build trust and reduce disruption. Maintain active construction administration by the design team to ensure intent is met, risks are addressed early, and long-term performance goals are achieved.

IMPLEMENTATION STRATEGY

A successful infrastructure renewal program depends on a clear, phased approach that reduces disruption, supports long-term performance, and aligns upgrades with the needs of owners and occupants. The following framework outlines how to plan and execute improvements to MEP systems, the building envelope, electrical infrastructure, mechanical equipment, and water systems while keeping facilities operational.

Assessment → **Plan** → **Early Wins** → **Mayor Upgrades** → **Optimization**

Phased MEP Implementation Strategy

Implementation begins with a comprehensive evaluation of existing systems. This includes HVAC, electrical, plumbing, and fire protection equipment. The assessment should identify underperforming components, code compliance issues, safety concerns, and energy inefficiencies. These findings allow teams to prioritize upgrades based on failure risk, operational impact, and the lifecycle cost of repairing or replacing equipment.

Strategic planning follows the initial assessment. Facilities should compare long-term costs, coordinate upgrades to avoid repeated disruptions, and align work with tenant schedules, owner priorities, and operational constraints. Early attention to flood vulnerability is essential. This includes relocating sensitive electrical infrastructure from basements, improving detection and protection measures, and addressing vulnerabilities before efficiency or electrification upgrades begin.

Evolving building and energy codes provide an opportunity to replace fossil-fuel equipment with high-efficiency electric systems. Pairing electrification with upgraded building automation and renewable-ready electrical pathways helps facilities prepare for future demand and reduces emissions.

Introducing advanced technologies early in the process, such as AI-driven controls, predictive maintenance platforms, and real-time monitoring, helps optimize system performance and demonstrates early value. This encourages continued investment in long-term improvements.

Building Envelope Upgrades

A strong building envelope is essential for energy efficiency, indoor comfort, and long-term system reliability. Roofs, walls, and windows naturally deteriorate over time, and deferred maintenance can lead to higher costs, moisture problems, and increased loads on mechanical systems.

Projects should begin with the support of an architect or building envelope consultant who can evaluate material options, address code requirements, and coordinate envelope improvements with MEP strategies. Roof replacement is typically addressed first because it provides the greatest protection from weather and offers opportunities to add insulation, improve access, and prepare for future rooftop equipment.

Exterior cladding systems require regular maintenance to prevent water infiltration and insulation damage. Window replacements can significantly improve thermal performance and reduce infiltration, which supports the efficiency of new mechanical systems. Renovation budgets may also trigger accessibility upgrades, so early code review is important to avoid unexpected scope changes.

Close coordination is critical. MEP projects may require temporary removal or modification of walls, roofs, or window systems to install equipment. Addressing these needs early prevents delays, reduces change orders, and ensures long-term maintainability.

Electrical Infrastructure Modernization

Modern electrical systems must support increased loads from electrification while ensuring safety and resilience. Upgrades may include main electrical services, distribution panels, feeders, and emergency power systems. These changes prepare buildings for higher electrical demand associated with electric heating, domestic hot water, and ventilation equipment.

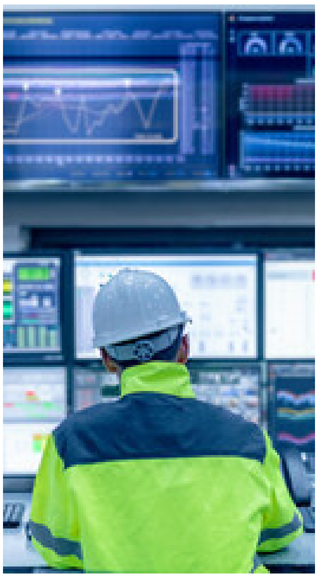
Facilities should consider integrating infrastructure for solar photovoltaic systems and battery storage, even if the renewable components are not installed immediately. Installing conduit, structural supports, and electrical pathways early avoids costly future disruptions. Smart inverters and grid-interactive capabilities also create opportunities for utility demand-response participation and strengthened energy resilience.

Flood risk remains a major concern. Critical electrical equipment, including switchgear and generators, should be positioned above expected flood levels or placed in protected rooms. Establishing redundant power pathways improves reliability and prevents localized failures from affecting the entire building.

Mechanical Systems for Decarbonization

Replacing fossil-fuel heating systems with electric heat pumps offers substantial efficiency gains and reduces greenhouse gas emissions. Air-source and ground-source heat pumps are increasingly capable of meeting load demands even in colder climates. Variable refrigerant flow systems further improve heating and cooling efficiencies and offer precise zoning control.

Mechanical system upgrades should also incorporate heat recovery ventilation and demand-controlled ventilation to reduce energy use while maintaining proper airflow and indoor air quality. Flood risks must be considered during planning. Mechanical equipment located in basements should be relocated when possible. If relocation is not feasible, elevated mounting, protective enclosures, and automated shutdown mechanisms should be included.



Integrated Control Systems for Optimization

Advanced building automation systems help ensure that mechanical, electrical, and plumbing improvements operate efficiently. Controls that use machine learning and real-time analytics can adjust equipment operation based on weather, occupancy, energy prices, and system performance.

Predictive maintenance tools identify issues before they cause failures, which reduces operational costs and improves reliability. Real-time monitoring also supports carbon accounting, energy benchmarking, and indoor environmental quality assessments. Flood monitoring systems can link to building controls to shut down equipment, issue alarms, and activate protective measures during emergencies.

Water Systems and Conservation

Upgrading domestic hot water systems offers an opportunity to improve efficiency and reduce emissions. Electric heat pump water heaters, solar thermal preheating, and point-of-use water heaters enhance performance while reducing distribution losses.

Water conservation strategies, including low-flow fixtures, waterless technologies, greywater reuse, and rainwater harvesting, reduce consumption and operating costs. Facilities should also incorporate protective measures such as backflow preventers, sump pumps with battery backup, and smart leak detection to prevent water damage and support operational continuity.

Managing Implementation While Minimizing Occupant Disruption

Maintaining operations during construction is essential for healthcare, academic, and other mission-critical facilities. Effective projects rely on phased work plans, temporary systems, and precise scheduling to maintain essential services.

Mechanical upgrades may require temporary heating or cooling equipment. Electrical improvements benefit from installing new infrastructure parallel to existing systems so that outages are brief and predictable. Water system upgrades often use bypass systems or temporary connections to maintain service during major work.

Clear communication with occupants, including outage schedules, anticipated disruptions, and progress updates, helps maintain trust and reduces operational challenges throughout the project.

CONCLUSION

These strategies shift infrastructure renewal from a reactive, failure-driven process to a proactive model of long-term stewardship. By integrating technical expertise, architectural planning, and operational insight, organizations can move beyond crisis management and instead make informed, coordinated investments that strengthen reliability and reduce lifecycle cost. When approached holistically, infrastructure renewal transforms aging facilities from operational liabilities into resilient, high-performing assets that support mission continuity today while maintaining the flexibility and capacity needed to adapt to tomorrow's demands.

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