Future-Proofing Legacy Data Centers:

From Aging Infrastructure to High-Performance Assets

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ARCADIS

Executive Summary

In today's digital-first world, data centers are the backbone of global connectivity and innovation. They power essential services such as cloud computing, data analytics, and the Internet of Things (IoT). Yet a significant portion of the existing estate—much of it only five to ten years old—is now confronting legacy-style risks: aging infrastructure, escalating energy demands, and greater vulnerability to extreme weather. This report presents a cohesive strategy for investors, customers, and owner-operators to transform these challenges into opportunities and reposition data centers as resilient, high-performance assets.

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The Current Landscape

Data centers are at an inflection point. Many facilities already exhibit inefficiencies, outdated systems, and rising exposure to risks such as heatwaves and flooding. At the same time, surging energy demand, supply chain constraints, rising capital costs, and land scarcity amplify the urgency of optimizing and modernizing existing facilities. The stakes are high: failure to adapt can result in inefficiency, outages, and lost competitiveness — while modernization can unlock capacity, resilience, and long-term value.

Recent executive orders expand opportunities for both new and existing data centers. Projects exceeding $500 million or requiring more than 100 megawatts of power now benefit from streamlined permitting, reduced regulatory hurdles, and expanded access to financial support through grants, tax credits, and loans. While designed for new builds, these incentives also create pathways for retrofits and upgrades that qualify as "Qualifying Projects." Additionally, the repurposing of Brownfield and Superfund sites offers accelerated approvals and financing, helping stakeholders future-proof portfolios.

Strategic Imperatives

Addressing these challenges requires a sharp focus on efficiency, reliability, and resilience. This report highlights three imperatives:

- Optimize Energy Efficiency: Deploy advanced cooling systems and AI-driven energy management to reduce consumption, lower costs, and maximize utilization.

- Modernize Infrastructure: Retrofit aging facilities with cutting-edge technology to strengthen reliability, expand capacity, and withstand weather-related and operational risks.

- Drive Operational Excellence: Implement proactive management practices to minimize downtime, streamline maintenance, and boost customer satisfaction while reducing cost.

A Resilient Investment Class

Modernized data centers have emerged as a resilient asset class, offering stable returns, strong tenant demand, and enhanced sustainability credentials. Facilities with upgraded systems and improved energy efficiency attract premium clients and deliver reliable long-term cash flows. Modernization not only reduces inefficiencies such as excessive cooling costs but also enhances resilience against environmental and operational risks. By aligning with investor expectations around ESG and resilience, stakeholders can unlock both financial and reputational value.

Pathway Forward

The path forward is clear: modernize, optimize, and fortify. By retrofitting outdated infrastructure, deploying smarter systems, and leveraging regulatory support, stakeholders can transform data centers from aging liabilities into high-performance, future-ready assets. These strategies enhance efficiency, improve resilience, and deliver sustainable financial upside.

Arcadis brings the insights, tools, and innovations to guide this transformation. By focusing on efficiency, resilience, and cost-effectiveness, we help clients ensure that data centers remain reliable, profitable, and equipped to meet the evolving demands of the digital economy.

Derek Sprackett, PhD
Vice President | Asset Advisory Lead
Places North America
derek.sprackett@arcadis.com

Data Centers as Critical Infrastructure

Data centers have become indispensable as the backbone of the digital economy, supporting an array of services crucial to modern life. These facilities enable digital commerce, cloud computing, and data analytics, contributing an estimated $1 trillion to the global economy annually. They are pivotal in driving technological advancements, including autonomous vehicles, smart cities, and the Internet of Things (IoT), all of which rely on real-time data processing and storage capabilities.

Despite their importance, data centers face significant challenges. They account for approximately 1-1.5% of global electricity consumption, equating to around 200 terawatt-hours per year. This level of energy use is comparable to that of some small countries, underscoring the urgency for more efficient energy management practices.

A substantial portion of the data center infrastructure, particularly in North America and Europe, is aging. Over 60% of these facilities were constructed more than five years ago, and they often lack the efficiency and capacity required to meet current demands. This leads to increased operational costs and environmental impacts, which can jeopardize their competitiveness and financial performance.

Moreover, data centers operate in a landscape of evolving regulatory pressures. In regions with stringent environmental regulations, such as the European Union, data centers face additional financial burdens due to carbon pricing mechanisms and emissions penalties. As the demand for digital services continues to grow, the industry is also grappling with supply chain constraints and limited land availability, necessitating a strategic focus on optimizing existing assets rather than relying solely on new builds.

Despite ongoing challenges, data centers continue to be a resilient and attractive asset class, thanks to their essential role in sustaining digital services and business operations. Their stability, underpinned by long-term contracts, appeals strongly to investors. However, as energy demand intensifies and grid congestion becomes a pressing issue, older data center facilities present a timely opportunity for modernization.

Investors can unlock significant value by upgrading these aging assets - prioritizing energy efficiency and the integration of advanced technologies. Targeted improvements not only reduce operational costs and carbon footprint, but also ensure compliance with evolving regulations and positions data centers as future-ready components of digital infrastructure. The following section explores how solutions like advanced cooling systems and AI-driven optimization can transform data centers into future-ready assets capable of meeting increasing digital demands while maximizing profitability.

> Investors can unlock significant value by upgrading these aging assets - prioritizing energy efficiency and the integration of advanced technologies.

Achieving Energy Efficiency

Energy efficiency is one of the most impactful ways to optimize data center operations. With energy costs constituting up to 50% of a data center's operational expenses, improving efficiency is essential to controlling costs, reducing carbon emissions, meeting increasing regulatory and market pressures, and sentiment from local communities where data centers are developed. As digital demands rise, energy efficiency has become a focal point for investors, customers, and owner-operators alike.

The Energy Challenge

Data centers consume approximately 1-1.5% of the world's electricity annually, equating to 200 terawatt-hours - a figure comparable to the energy use of some small nations. The high electricity consumption of data centers is largely attributed to the continuous operation of servers, storage, networking infrastructure, and the energy-intensive cooling systems required to maintain optimal conditions. This challenge is compounded by the dominance of legacy facilities - over 60% of data centers in North America and Europe were built before 2016. These older sites often depend on outdated cooling and energy management systems that fall short of current efficiency and sustainability standards. As digital infrastructure continues to expand, upgrading these legacy data centers has become critical for enhancing operational efficiency, reducing costs, and lowering environmental impact.

This inefficiency results in higher operating costs and an increased carbon footprint. For many operators, a lack of modernization raises the risk of stranded assets, as facilities with poor energy performance struggle to remain competitive. As regulatory pressures and sustainability expectations continue to grow, improving energy efficiency has become essential for both financial and operational resilience.

Innovations in Energy Efficiency

To meet rising operational and sustainability demands, data centers are adopting a range of advanced solutions that significantly improve energy performance while reducing costs and environmental impact.

Advanced Cooling Technologies

Cooling systems are a major contributor to energy consumption, accounting for 30-50% of total usage in data centers. Technological advancements in cooling have revolutionized energy efficiency:

- Liquid Cooling: By using liquid instead of air to dissipate heat, liquid cooling systems achieve higher precision and efficiency, reducing cooling energy consumption by 20-30% compared to traditional systems.

- Free Air Cooling: Facilities in suitable climates can leverage external air to cool equipment, achieving energy savings of up to 50% annually. This approach reduces reliance on mechanical cooling systems and lowers operational costs.

- Chilled Water Systems: Circulated chilled water offers flexibility and scalability for cooling large-scale facilities, optimizing energy use while maintaining reliability.

Modular Design to Existing Data Centers

Legacy facilities can achieve major efficiency improvements through modular retrofits. Installing modular cooling units, hot/cold aisle containment, and prefabricated power modules allows existing data centers to optimize energy use and enhance sustainability without full-scale reconstruction.

AI and Machine Learning

Artificial intelligence (AI) and machine learning technologies are reshaping energy optimization in data centers:

- Dynamic Cooling Optimization: AI systems continuously monitor environmental conditions and IT loads, adjusting cooling parameters in real time to reduce energy waste and maintain efficiency.

- Predictive Maintenance: Machine learning algorithms analyze equipment performance data and predict failures before they occur, allowing operators to proactively address issues and minimize downtime. These systems also optimize energy-intensive maintenance, further lowering operational costs.

Strategic Implications for Stakeholders

Energy efficiency directly impacts the priorities of all major stakeholders in the data center ecosystem:

- Investors: Energy-efficient facilities are more attractive assets, offering lower operational costs, higher margins, and increased availability of sellable power. Facilities aligned with ESG (Environmental, Social, Governance) goals have a competitive edge in the market, attracting sustainable investment vehicles like green bonds and ESG-linked financing avenues. These facilities also mitigate risks from rising energy costs and regulatory uncertainty.

- Customers: Customers, including cloud providers and enterprise users, benefit from energy-efficient operations through reduced energy costs and reliable delivery service. In industries such as cloud services and data centers, energy efficiency ensures that allocated power capacity is utilized effectively, optimizing operational costs and resource use. Additionally, energy-efficient facilities support customers in achieving their sustainability objectives, enhancing reputations, and aiding compliance with corporate ESG standards.

- Owner-Operators: For data center operators, energy efficiency is vital for achieving operational excellence. Lower energy consumption reduces operational costs, allowing operators to maintain profitability while offering competitive pricing. Efficient operations also minimize downtime risks, extend the lifespan of equipment, and ensure compliance with strict energy and emissions regulations.

Energy efficiency is no longer optional; it is essential for the success of data centers as critical infrastructure. By adopting innovative cooling technologies, AI-driven optimizations, and modular designs, operators can significantly reduce energy costs and enhance facility performance. These improvements benefit all stakeholders: investors see maximized returns, customers enjoy reliable and sustainable services, and owner-operators cut costs while boosting competitiveness in a demanding digital and regulatory landscape. However, the full benefits of energy efficiency depend on the condition of the underlying infrastructure. The next section delves into how proactive facility management can amplify energy efficiency gains, protect asset value, and ensure long-term competitiveness.

> Improving energy efficiency in existing data centers is especially impactful, as these facilities represent most of today's digital infrastructure. According to the IEA and Uptime Institute, retrofits—such as advanced cooling and power management—can significantly cut energy use and emissions, offering faster and more cost-effective sustainability gains than new construction.

Facility Condition – A Predictor of Investment Value

Facility condition is a fundamental determinant of a data center's operational reliability, efficiency, and long-term investment value. With digital demands increasing, many data centers are now operating beyond their intended lifespans, leading to challenges related to deferred maintenance and outdated infrastructure. As mentioned in the previous chapter, data centers have a significant energy demand, underscoring the importance of maintaining efficient and reliable operations to minimize both costs and environmental impact. For investors, customers, and owner-operators, proactively managing facility conditions is crucial to mitigating risks, ensuring up time, and maximizing asset value.

Assessing Facility Condition and Its Impact on Performance

Facility conditions directly influence operational reliability and up time, which are essential for meeting service-level agreements (SLAs) and ensuring customer satisfaction. Core infrastructure systems - cooling, power distribution, and security - are fundamental to the functionality of a data center. Poor maintenance and deferred capital expenditures increase vulnerabilities, resulting in equipment failures, downtime, and operational disruptions.

> **Case Example:**
> A global cloud services provider suffered a major operational disruption due to neglected cooling system maintenance. During a heatwave, the outdated cooling infrastructure failed, triggering a 'red event' that required expensive emergency repairs. Although redundancy measures temporarily stabilized operations, the disruption caused reputational damage and financial losses, including SLA penalties and customer churn. Downtime costs for data centers can average $300,000 per hour, and the fallout from such events often extends beyond immediate financial impacts.

Key Risks of Poor Facility Condition:

- Downtime Risks: Outdated systems are more prone to failure, leading to lost revenue, SLA penalties, and reputational harm.

- Higher Operating Costs: Inefficient cooling and power systems drive up energy consumption and shorten equipment lifespans.

- Safety Hazards: Deferred maintenance increases the likelihood of equipment-related accidents, impacting staff and tenant safety.

The Role of Facility Condition Assessments (FCA):

Facility Condition Assessments (FCA) provide a comprehensive evaluation of a data center's physical and operational health, identifying risks and inefficiencies in critical systems. Regular audits allow operators to proactively address vulnerabilities before they escalate into costly failures.

Predictive Maintenance Tools:

IoT sensors and AI analytics are transforming facility condition monitoring by enabling real-time data collection and predictive insights. For example, IoT-based monitoring systems can reduce downtime by up to 30%, while predictive maintenance reduces repair costs by 25%. These technologies optimize resource allocation and extend the lifespan of critical equipment, lowering operational expenditure (OPEX) and improving overall resilience.

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Modernization and Retrofitting Opportunities

Modernization and retrofitting are critical for maintaining the value and competitiveness of aging data center facilities, especially as AI and cloud workloads continue to drive demand. While previous sections have discussed improvements in operational efficiency and reductions in operational carbon emissions, it is equally important to address embodied carbon during upgrades.

By integrating modular, scalable systems and adopting targeted retrofits, operators can optimize both energy use and operational emissions while minimizing embodied carbon. These approaches not only extend the lifespan of existing assets but also future-proof facilities to meet evolving digital and sustainability standards.

The next section will explore the role of embodied carbon in retrofitting and modernization in greater detail.

Case Example:
Arcadis partnered with EkkoSense to implement AI-driven cooling optimization at a legacy facility. By leveraging real-time thermal data, the project reduced cooling energy consumption by 20% within the first year, achieving full ROI in just five months. This modernization not only lowered operational costs but also increased customer satisfaction by improving system reliability.
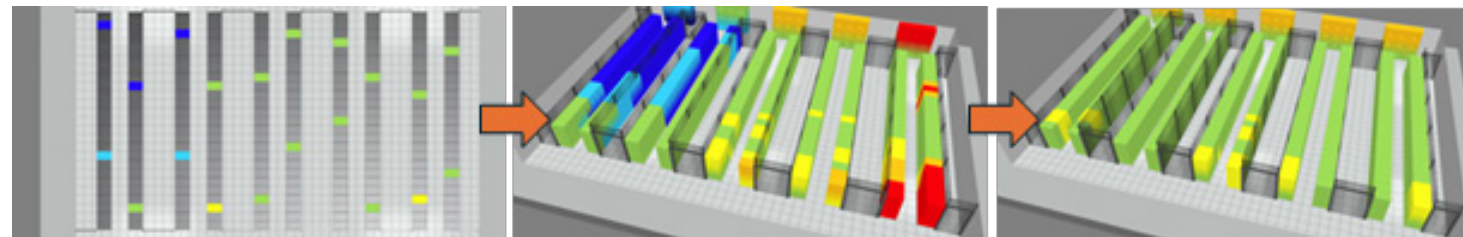
Traditional BMS thermal monitoring

EkkoSense 3D Interactive Digital Twin comprehensive monitoring

EkkoSense AI Machine Learning enables operational fine tuning to maximize efficiency

Embodied Carbon – A Critical Frontier in Sustainability

As advancements in energy efficiency reduce operational emissions, embodied carbon - the emissions embedded in construction materials - constitutes a growing portion of total lifecycle emissions. For older facilities, these emissions are already locked in, offering an opportunity to further decrease carbon impact by reducing the need for new material production through retrofitting and reuse. Mitigating embodied carbon is crucial because materials like concrete and steel are highly carbon-intensive, with concrete production alone responsible for significant emissions. By implementing innovative strategies, facilities can effectively lower their environmental footprint, maintain their value, and prolong their operational life.

Tackling Embodied Carbon in Data Centers: A Strategic Imperative

Embodied carbon - the emissions from building materials and construction - can contribute up to 50% of a data center's total lifecycle emissions, with concrete and steel as the most significant sources.

Concrete alone can account for up to 80% of embodied carbon, due to the high emissions from cement production, which releases approximately 0.9 tons of CO_2 per ton and is responsible for about 8% of global greenhouse gas emissions. A typical data center requires 5,000 to 10,000 tons of concrete, making material choices from the outset critical.

Steel, commonly produced using the Basic Oxygen Furnace (BOF) method, adds further emissions - around 2 tons of CO_2 per ton of steel - further locking in the carbon footprint once construction is complete.

The challenge is not limited to new builds. Much of today's data center capacity is housed in facilities developed under outdated construction practices, where embodied carbon was neither measured nor mitigated. For these sites, deep decarbonization depends on adaptive reuse, targeted deconstruction, and high-efficiency retrofits that prioritize carbon-smart material strategies.

At the same time, operators face increasing material-related risks:

- Volatile pricing for steel and cement is inflating construction budgets.

- Low-carbon alternatives - such as blended cement and Electric Arc Furnace (EAF) steel - remain scarce, causing procurement delays and cost premiums.

- Regulatory and community pressures are slowing permitting and driving design revisions, which increase emissions through inefficient sequencing.

Looking ahead, supply constraints are expected to intensify:

- Demand for green steel is projected to exceed supply by over 300% by 2030.

- Use of low-carbon cement is expected to grow by 40%, though production may lag behind demand.

To meet sustainability goals, reduce exposure to material risk, and maintain long-term resilience, organizations must integrate embodied carbon planning into every stage of data center development and modernization - from material sourcing to retrofit strategy.

Industry Leadership in Embodied Carbon Reduction

Leading tech companies are actively advancing embodied carbon reduction through innovation and strategic investment. Microsoft is investing $10 billion annually in low-carbon AI and cloud infrastructure, including using mass timber and modular designs to cut reliance on high-carbon materials. AWS and Google are conducting circularity audits to enable reuse of structural steel, access flooring, and racking systems in existing sites. Meta is working closely with suppliers to secure low-carbon materials early and applying regional qualification frameworks to accelerate deployment.

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Strategies for Reducing Embodied Carbon

Arcadis helps clients reduce embodied carbon through targeted strategies at both the portfolio and asset levels.

At the portfolio level, strategies include:

- Supply chain mapping to identify regional sources of low-carbon steel and concrete, minimizing procurement risk.

- Carbon benchmarking to establish baselines across projects and prioritize high-impact reductions.

- Standardized material specifications that embed low-carbon materials into future designs for consistency and scale.

> It is essential for project owners to use strategies to reduce embodied carbon through targeted strategies at both the portfolio and asset levels in their data center retrofits.

At the asset level, strategies include:

- Early lifecycle assessments (LCA) during concept design for data center retrofits to optimize material choices and structural systems.

- Material efficiency reviews to identify reuse opportunities and cost-effective alternatives.

- Procurement alignment strategies that balance carbon reduction goals with budget constraints, avoiding unnecessary cost premiums.

Case Example:
Arcadis implemented early-stage LCA and modular retrofit designs for a hyperscale facility. By reducing reliance on high-carbon materials and optimizing reuse, the project cut embodied emissions by 25%.

Facility Management: Driving Operational Excellence

Facility management (FM) in data centers is integral to operational excellence, serving as the backbone for reducing costs, optimizing resource utilization, and enhancing reliability. As data centers adapt to heightened digital demands and sustainability expectations, effective FM transforms them from mere cost centers into strategic assets. By implementing proactive management practices and leveraging advanced technologies, operators can significantly enhance operational efficiency and ensure long-term profitability.

The Financial Impact of Facility Management

Effective FM practices have a measurable impact on the financial performance of data centers by reducing downtime, optimizing scaling strategies, and ensuring inventory management. For investors, customers, and operators, FM is essential in unlocking operational savings and improving profitability.

Key Financial Benefits of FM

- Preventive maintenance reduces downtime by 30%, saving up to $300,000 per hour in avoided disruptions (Centerprise International).

- Strategic inventory management saves up to 20% annually by avoiding emergency purchases (Uptime Institute).

- Smart scaling strategies informed by energy monitoring prevent costly over-provisioning (Schneider Electric).

Lifecycle extension of key systems further amplifies financial value:

Equipment	Typical Cost	Extended Lifespan (Years)	Savings from Prevented Downtime	Cost Savings from Extended Life	Source
Cooling Systems	$500,000+	+5 years	$45,000/year	$250,000	Uptime Institute, ASHRAE guidelines, Industry Case Studies
UPS Systems	$200,000+	+3 years	$25,000/year	$120,000	Electrical Power Research Institute (EPRI), Ponemon Institute's Cost of Downtime Report
Transformers	$150,000+	+4 years	$18,000/year	$80,000	Institute of Electrical and Electronics Engineers (IEEE), Industry Case Studies

Source: Uptime Institute, ASHRAE, Institute of Electrical and Electronics Engineers (IEEE), Industry Case Studies (IEEE), Electrical Power Research Institute (EPRI), Ponemon Institute's Cost of Downtime Report (EPRI)

FM acts as a "fitness coach" for facilities, emphasizing sustained performance and optimization rather than merely reacting to emergencies. By proactively improving efficiency and extending equipment life, FM transforms facilities into strategic assets.

Reducing Costs Through Proactive Management

Proactive FM tackles significant fixed and variable costs in data centers, including energy consumption, cooling, maintenance, and staffing. With energy costs accounting for 40–50% of operational expenses, optimizing power usage and adopting predictive analytics tools are critical for reducing costs and improving efficiency.

Innovative Proactive Strategies
- AI-driven cooling (e.g., Google's DeepMind) reduces energy use by up to 40% (Google AI Impact Report).
- IoT-based monitoring (e.g., Equinix) cuts maintenance costs by 25–30% through real-time failure prediction (Gartner IoT Report).
- Modular cooling systems (e.g., Vertiv) offer 20–35% energy savings with scalable deployment (Uptime Institute).

Financial Impact of Proactive Management

Cost Category	Proactive Practice	Reduction (%)	Example	Source
Energy Costs	AI-driven cooling optimization	Up to 40%	Google DeepMind AI	Google AI Impact Report
Equipment Maintenance	IoT-based predictive monitoring	25–30%	Equinix	Gartner IoT Report
Downtime Costs	Predictive analytics & preventive care	30%	Schneider Electric DCIM tools	Ponemon Institute
Cooling System Scalability	Modular cooling systems	20–35%	Vertiv	Uptime Institute

DCIM: Data Center Infrastructure Management

Smaller Facilities Implementation
Smaller data centers can adopt cost-effective tools to trial proactive management strategies:

- Low-Cost DCIM Platforms: Solutions like Schneider Electric's EcoStruxure IT Expert and Vertiv's Environet Alert enable real-time monitoring without high upfront costs.

- IoT Sensors: Raspberry Pi-based IoT sensors allow small teams to deploy monitoring systems for approximately $500, requiring 75 hours of setup over 1–2 weeks.

- Open DCIM: A lightweight, open-source DCIM platform that enables teams to monitor energy and environmental metrics at a fraction of traditional costs.

For advanced optimization, Arcadis, as an implementation partner of EkkoSense, uses their AI-driven platform to deliver precise cooling and energy efficiency improvements tailored to facility needs.

Operational Efficiency and Sustainability

Operational efficiency in FM is a cornerstone for achieving strategic objectives such as net-zero targets, enhancing resilience to climate risks, and mitigating the impact of adverse weather events. Through efficient FM practices, facilities can reduce costs, extend equipment lifespan, optimize resource use, and ensure compliance with stricter eco-friendly regulations, all while driving long-term profitability.

Certifications Matter
Certifications like LEED and ENERGY STAR are integral to FM strategies, validating a facility's commitment to sustainability and operational excellence. These certifications provide FM teams with actionable frameworks to reduce environmental impact, improve energy efficiency, and enhance preparedness for extreme weather events, such as heatwaves, floods, and storms. Facilities with these certifications benefit from increased reliability, reduced downtime, and improved operational continuity during climate-related disruptions.

Benefit	Impact	Example	Source
Personnel Retention	Reduces turnover by 15–20%	Predictable environments reduce stress	Society of Human Resource Management (SHRM)
Facility Valuation	Increase of 10–15%	LEED-certified facilities	U.S. Green Building Council
Energy Cost Savings	Up to 30% reduction	ENERGY STAR-certified facilities	ENERGY STAR Impact Report
Compliance	Avoid fines in stricter eco-friendly jurisdictions	EU and California regulations	California Energy Commission (CEC)

Facility Management as a Strategic Driver
FM is no longer a back-office function; it's a strategic enabler of performance, sustainability, and profitability. By integrating lifecycle planning, proactive maintenance, intelligent technologies, and sustainability alignment, FM transforms data centers into high-performing, future-ready assets.

Arcadis supports clients in implementing efficient, scalable FM strategies tailored to their portfolio and asset needs - ensuring long-term value, reduced risk, and measurable impact. Building on this foundation, the next section delves into how energy efficiency, facility condition, and proactive management collectively drive ROI and enhance the competitiveness of data centers in today's evolving market.

Driving Data Center Value Through Energy, Resilience, and Operational Precision

As demand for digital infrastructure accelerates, investors are increasingly focused on data centers' ability to deliver long-term profitability, operational resilience, and sustainability. Energy use, carbon performance, facility condition, and FM cost structures are no longer just technical concerns - they are direct drivers of ROI, asset valuation, and competitiveness. Strategic investment in these areas positions data centers to outperform in a volatile and carbon-conscious market.

Energy Efficiency – Maximizing ROI

Carbon and Energy efficiency is increasingly important as data centers face rising regulatory pressures and market expectations for sustainability. Implementing net-zero strategies not only reduces carbon risks and enhances asset resilience, but also drives improved financial performance and return on investment (ROI) by lowering operating costs, attracting green financing, and increasing overall marketability.

Competitive Advantage

Energy-efficient data centers appeal to customers and tenants who prioritize not only operational cost savings and environmental responsibility but also reliability and ethical business practices. Industry leaders like Google and AWS use energy efficiency to differentiate themselves, showcasing a commitment to responsible resource management and operational excellence. Industry surveys also indicate that 35% of enterprises prefer providers that demonstrate strong efficiency and comprehensive accountability in their operations.

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Understanding the Total Cost of Ownership (TCO)

Understanding the Total Cost of Ownership (TCO) is essential for making informed financial and strategic decisions in the data center industry. TCO encompasses all costs associated with a facility from upfront capital investments to ongoing operational expenses and hidden factors that impact profitability and efficiency.

Key Components of TCO

Capital Expenses: Initial investments include infrastructure such as real estate, power distribution, cooling systems, and security measures, alongside hardware like servers, storage devices, and networking equipment. Software, licensing, and virtualization tools also contribute to upfront costs.

Operational Expenses: Recurring costs include energy consumption, often one of the largest expenses. Maintenance and upgrades ensure hardware and software reliability, while staffing costs cover IT personnel, security teams, and operations managers. Network and bandwidth costs support connectivity, redundancy, and scalability.

Hidden Costs and Risks: Downtime and disaster recovery solutions are critical, as unplanned outages can lead to revenue loss and reputational damage. Compliance with regulations like GDPR, HIPAA, or SOC 2 requires additional investment in audits and cybersecurity. Cloud versus on-premises infrastructure decisions also impact long-term costs, with subscription-based cloud services accumulating over time.

Optimizing TCO

Investing in energy-efficient technologies, such as optimized cooling systems and green data centers, significantly reduces operational costs. Virtualization and cloud solutions streamline operations and minimize hardware requirements. Regular audits and performance monitoring help identify inefficiencies early, avoiding costly disruptions. AI-driven tools and automation further enhance efficiency, lower staffing costs, and reduce human error, ensuring sustainable and cost-effective operations.

Effective risk management begins with thorough planning and early consultant engagement, positioning data centers for long-term profitability, resilience, and growth.

Facilities Management Models as a Lever for Long-Term Asset Value

FM is a critical driver of operational efficiency and asset competitiveness in data centers. Choosing the right FM model - whether internal (Model 1) or third-party (Model 2) - directly influences how facility condition is maintained and enhanced, impacting long-term asset value, operational reliability, and scalability. Each model offers distinct advantages and considerations, tailored to the priorities and strategic goals of stakeholders.

Model 1: Internal or In-House Management

Internal FM allows stakeholders to oversee operations directly, enabling a high degree of customization and control. This model is particularly advantageous for those looking to align operations closely with specific business strategies.

Key Benefits:

- Comprehensive Oversight: Direct control ensures tailored solutions that align operations with strategic goals while maintaining high facility standards, such as energy efficiency and reliability.

- Strategic Facility Maintenance: Owners can prioritize upgrades and proactive maintenance to preserve facility condition, reduce downtime, and improve competitiveness.

- Cost Control: Internal management allows for precise allocation of resources, to lower operational costs and enhance asset value.

Considerations include:

- Operational Complexity: Managing staffing, maintenance, and workflows internally can require significant resources, expertise, and time.

- Market Risks: Assets are directly impacted by fluctuations in staffing costs, pricing, and operational schedules, necessitating robust financial planning.

This model aligns well with those seeking to maintain direct control over operations while balancing the complexities of in-house management.

Model 2: Third-Party Management (GMP/Cost-Plus)

Third-party FM offers a streamlined approach, transferring operational responsibilities to an external provider. By simplifying management, this model reduces administrative burdens and allows stakeholders to focus on strategic objectives.

Key Benefits:

- Operational Simplicity: Outsourcing reduces administrative burdens, freeing up resources to focus on strategic objectives while ensuring consistent facility operations and maintenance.

- Cost Stability: Fixed contracts provide predictable budgeting, supporting investments in facility upkeep and modernization without market volatility risks.

- Scalability: Third-party providers often bring expertise in scaling operations efficiently, ensuring facility condition supports growth.

Considerations include:

- Flexibility in Operations: Outsourcing may limit adaptability, with fixed agreements potentially restricting responsiveness to evolving needs.

- Quality Assurance: Maintaining consistent service quality requires proactive contract management to ensure vendor performance aligns with expectations.

This model is particularly suited for stakeholders managing larger portfolios or complex projects where simplicity and scalability are priorities.

Facility Condition as a Competitive Asset

Effective facility management transforms the physical condition of a data center into a true differentiator. By implementing robust maintenance routines and targeted upgrades, FM teams ensure consistent performance and operational reliability. This attention to facility condition helps minimize service interruptions, extends equipment lifespan, and supports seamless expansion as client needs evolve. As competition intensifies, data centers with strong facility management stand out for their dependability and readiness to support advanced technology and growth.

Comparative Considerations

1. Oversight vs. Simplification: Stakeholders choosing Model 1 benefit from comprehensive oversight, enabling tailored solutions and direct control but must navigate increased operational complexity. Model 2 provides operational simplicity, transferring responsibilities and risk to a third party, though this may limit direct influence over day-to-day management.

2. Cost and Risk Management: Model 1 offers precise cost oversight and facilitates strategic resource allocation but exposes stakeholders to market risks such as fluctuating staffing and equipment costs. Model 2 ensures cost stability through fixed pricing, reducing exposure to market variability while requiring careful monitoring to maintain service quality.

3. Strategic Alignment: Model 1 supports direct implementation of operational strategies, offering flexibility for innovation and customization, though it may demand significant time and resources. Model 2 frees stakeholders to focus on broader growth initiatives such as portfolio expansion, sustainability efforts, and advanced technology adoption, making it ideal for scaling operations.

Determining the Path Forward

Choosing between internal and third-party FM models depends on the priorities, risk tolerance, and portfolio size of the stakeholders involved. For those seeking direct control and alignment with specific business goals, in-house management may be the preferred approach. Conversely, outsourcing simplifies operations and supports long-term growth, making it advantageous for larger portfolios or stakeholders prioritizing scalability. Understanding these considerations ensures stakeholders select the path forward that best aligns with their

objectives and operational requirements. With an optimal FM model in place, the focus shifts to maximizing the value of data center investments. The following section explores how strategic enhancements in energy efficiency, facility condition, and management costs are pivotal for driving ROI and ensuring the long-term viability of data centers in a competitive landscape.

> Facility condition remains a critical lever for enhancing asset competitiveness. Well maintained facilities directly influence operational reliability, energy efficiency and market appeal.
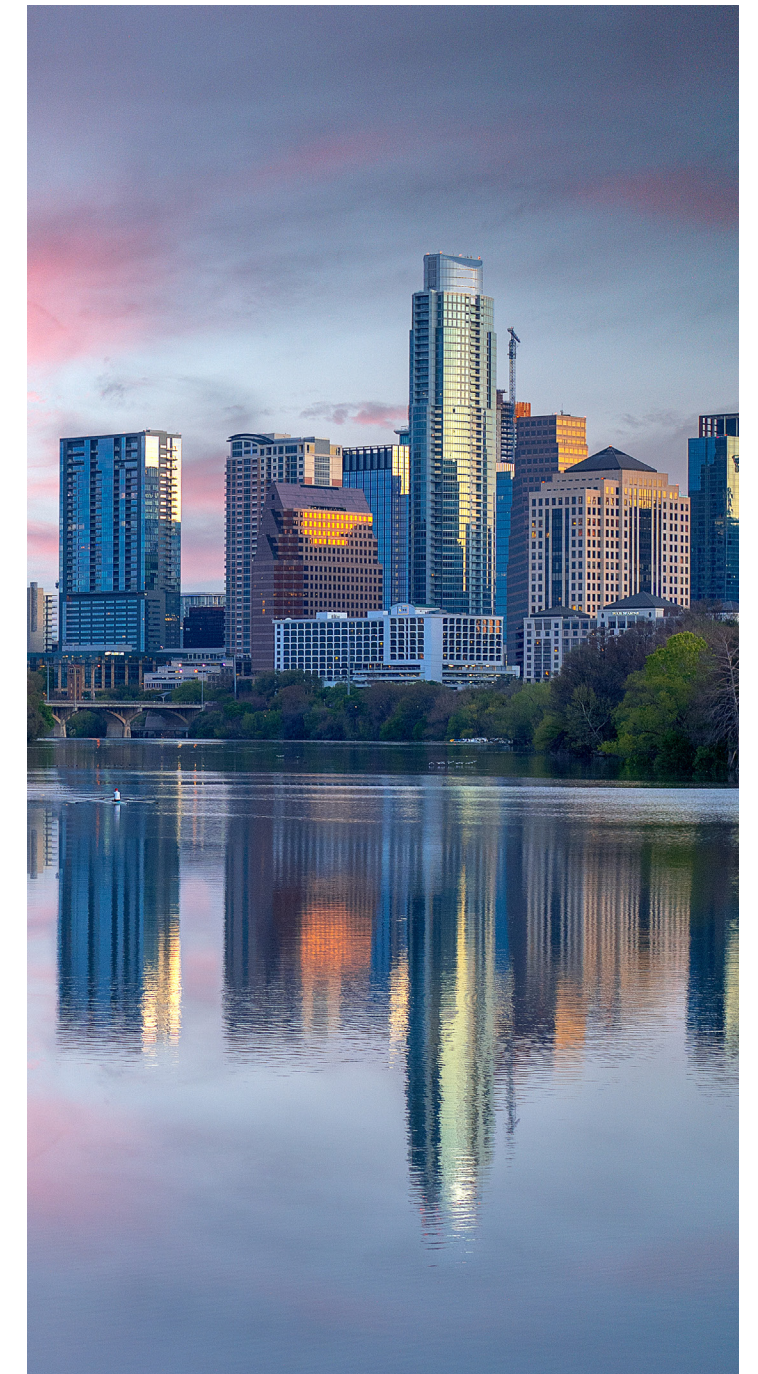
Conclusion

Modernizing Data Centers: Arcadis' Blueprint for Efficiency, Operational Excellence, and Resilience

The accelerating digital economy has transformed data centers into strategic assets at the core of business continuity, innovation, and long-term growth. Yet, much of today's capacity remains in legacy facilities, built to meet standards of a previous era. These assets now face unprecedented pressure to deliver higher performance, achieve ESG and regulatory compliance, and respond to heightened investor scrutiny. While the risks of outdated infrastructure- inefficiencies, downtime, and escalating costs - are significant, they also present an opportunity for decisive, value-creating transformation.

Modernizing existing data centers is now essential for maintaining market relevance and unlocking future value. Through targeted facility upgrades, energy efficiency, decarbonization, and operational renewal, legacy data centers can be repositioned as resilient, high-value assets aligned with the demands of a digital-first, low-carbon world.

This imperative is now further reinforced by recent government action. The current administration has made clear commitments to accelerating data center development through streamlined permitting, direct incentives, and supportive infrastructure policies. These measures are designed to remove barriers, ease supply chain constraints, and catalyze investment in next-generation facilities. Arcadis is well-positioned to help clients navigate and capitalize on these new opportunities - ensuring compliance, expediting project delivery, and maximizing access to financial support.

To unlock this value, three imperatives must guide every data center owner and operator:

- **Energy and carbon efficiency as strategic differentiators.** Deploying advanced cooling, comprehensive energy monitoring, and low-carbon retrofits not only reduces emissions and costs, but also enhances resilience and improves operational margins. These actions can also unlock access to lower operating costs, green financing and public incentives.

- **Facility condition and operational maturity as drivers of asset value.** Predictive maintenance, regular facility condition assessments, and systematic modernization reduce outages, lower lifecycle costs, and ensure regulatory compliance- directly impacting reliability and competitiveness.

- **Integrated facility management as a foundation for operational excellence.** Proactive, data-driven facility management- leveraging AI, IoT-enabled monitoring, and modular service models- reduces total cost of ownership, maximizes asset lifespan, and ensures uptime in a demanding market.

By leveraging Arcadis' technical depth, operational expertise, and strategic technical advisory services, clients can unlock the full value of modernization of their data center assets. Our team assists with portfolio risk evaluation, capital deployment optimization, and prioritization of interventions across the asset lifecycle. We provide support in carbon benchmarking, retrofit design, energy audits, and digital facility management, ensuring each investment delivers measurable performance and resilience.

Ultimately, the future of digital infrastructure will be shaped as much by the transformation of existing facilities as by the construction of new ones. Data centers that are energy-efficient, resilient, and sustainably managed will not only outperform their peers but also command higher valuations and reduce risk.

Now is the time to lead and modernize, optimize and fortify. With Arcadis as your partner, you can leverage emerging policies, unlock incentives, and deploy proven modernization strategies - achieving operational excellence, minimizing risk, and securing your position at the forefront of a sustainable digital future.

About Arcadis

Arcadis is the world's leading company delivering data-driven sustainable design, engineering, and consultancy solutions for natural and built assets. We are more than 36,000 architects, data analysts, designers, engineers, project planners, water management and sustainability experts, all driven by our passion for improving quality of life. As part of our commitment to accelerating a planet positive future, we work with our clients to make sustainable project choices, combining digital and human innovation, and embracing future-focused skills across the environment, energy and water, buildings, transport, and infrastructure sectors. We operate in over 30 countries, and in 2023 reported €5.0 billion in gross revenues.

www.arcadis.com

Contributors

Derek Sprackett
Vice President,
Asset Advisory Lead,
Places, North America
derek.sprackett@arcadis.com

Jay Stevenson
Senior Management Consultant,
Technical Due Diligence
jay.stevenson@arcadis.com

Victoria Pancoast
Associate Vice President,
Director of Client Relations,
Technical Advisory Services,
Places, North America
victoria.pancoast@arcadis.com

Angie Veintimilla
Senior MEP Consultant,
Technical Due Diligence
angie.veintimilla@arcadis.com

Ed Macdonald
Practice Leader Asset Transformation,
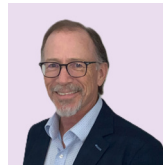Asset Advisory,
Places, North America
ed.macdonald@arcadis.com

Robert Simpson
Project Monitoring Lead
robert.simpson@arcadis.com

Ian Minnes
Practice Leader Net Zero Programs,
Asset Advisory,
Places, North America
ian.minnes@arcadis.com

Randall Ward
Principal Consultant,
Technical Due Diligence
randall.ward@arcadis.com

Anthony Taveras
Practice Leader Program Management Advisory,
Asset Advisory,
Places, North America
anthony.taveras@arcadis.com

Sarah Elanjimootil Varghese
Net Zero Project Specialist
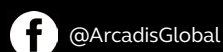sarah.elanjimootilvarghese@arcadis.com

Hocine Remram
Energy Services Subject Matter Expert,
Asset Advisory,
Places, North America
hocine.remram@arcadis.com

Hari Duddela
Management Consultant
harikrishna.duddela@arcadis.com