



WHITEPAPER **Wim Boone**

Retrofitting existing data centres

From ageing infrastructure to scalable capacity
for colocation and AI high-density racks

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MANAGEMENT SUMMARY

Many first-generation data centres were built for lower rack densities, different energy prices and a less demanding sustainability framework. Their operators now face a dual requirement: maintain service for existing colocation customers while preparing the site for higher power densities, AI workloads and stricter expectations on energy and resource efficiency.

The main difficulty is not the age of one individual asset. It is the interaction between medium-voltage distribution, transformers, generators, UPS systems, low-voltage boards, cooling production, hydraulic distribution, air management, fire safety, structural capacity and permitting. An intervention that looks efficient in isolation can reduce redundancy, create an unsafe temporary state or block future expansion.

Executive takeaway: Retrofitting decisions should start with an integrated capacity, continuity and phasing model—not with the selection of a new UPS or chiller.

Five conclusions for decision-makers:

- Continuity is the primary design parameter. Every switching step must demonstrate the remaining electrical and cooling resilience.
- The biggest brownfield risks often sit in interfaces: cabling, pipework, valves, buffer vessels, penetrations, fire compartments and limited spare feeders.
- Higher IT capacity requires a complete chain from grid connection to rack, including monitoring, maintainability and fault tolerance.
- A higher chilled-water regime can reduce cooling energy, but only when CRAHs, airflow, containment and rack layouts are ready for it.
- The feasibility study must end in an executable roadmap covering decisions, temporary states, permits, budget, testing and commissioning.

1. THE BROWNFIELD CHALLENGE

A greenfield facility can align its power architecture, cooling concept, technical rooms, fire compartments and logistics from day one. A brownfield facility cannot. Retrofitting takes place around live customers, existing routes, historical additions, limited space and equipment that must remain operational throughout the works.

1.1 WHY LEGACY FACILITIES BECOME CONSTRAINED

Challenge	Typical cause	Retrofitting implication
Historical architecture	Successive zone-by-zone extensions	New capacity does not automatically fit the existing power and cooling topology
Limited technical space	Rooms and routes are already occupied	New equipment competes with live systems and maintenance access
Live customer environment	No distinction between planned and unplanned interruption	Temporary states and rollback become core design deliverables
Incomplete records	Drawings, BMS data and physical reality differ	Survey, measurement and model calibration are required
Changing rack profiles	Average loads evolve toward concentrated peaks	Local electrical and thermal bottlenecks appear despite sufficient total capacity

1.2 RETROFITTING AS A SYSTEM PROBLEM

The usable capacity of a data centre is determined by the weakest link in the chain. Grid capacity is of limited value if it cannot be delivered redundantly to the rack. Chiller capacity is of limited value if hydraulic distribution, pumps, control valves or airflow cannot transport the heat reliably from every room.

- Electrical chain: grid connection, medium voltage, transformers, generators, UPS, MDBs, busways, PDUs and rack feeds.
- Thermal chain: chillers, buffer vessels, pumps, pipework, control valves, CRAHs, containment and liquid-cooling interfaces.
- Availability chain: N, N+1 or 2N architecture, maintenance paths, fault scenarios and recovery.
- Building and compliance chain: structure, floor loads, roof, routes, fire compartments, diesel storage and permits.

2. ELECTRICAL RETROFITTING: CAPACITY WITHOUT LOSING AVAILABILITY

Electrical infrastructure defines how much IT capacity a site can offer and how robustly that capacity remains available. The objective is therefore not only to replace ageing equipment, but also to remove historical dependencies and create a logical, scalable architecture.

2.1 MAIN ELECTRICAL CHOICES

Approach	Strength	Key risk or condition
Like-for-like replacement	Manageable phasing and limited change to customer feeds	Historical topology and inefficiencies partly remain
Shared UPS architecture	Higher UPS utilisation and potential reduction in unit count	Complex low-voltage switching, load mapping and longer cable routes
Independent expansion block	Additional capacity with dedicated reserves	Additional technical rooms, generators, cooling and permitting
Hybrid roadmap	Critical assets first; future capacity through pre-designed interfaces	Requires disciplined architecture and early investment decisions

2.2 PHASING AND TEMPORARY CONTINUITY

Switching transformers, generators, UPS systems and main distribution boards requires an explicit temporary operating mode. Mobile generators may provide temporary resilience, but their number, connection points, fuel logistics, noise, rental period and testing must be defined before execution.

- For each step, identify equipment out of service, temporary feeds, affected customer zones and the rollback route.
- Treat transition states as design states; they may have less redundancy than the final configuration.
- Coordinate MOPs, SOPs, EOPs, integrated systems tests and customer communication before work starts.
- Maintain future reserve capacity for higher rack power, measurement and liquid-cooling loads.

Owner decision: The required continuity level during the works must be agreed before the preferred technical concept is selected.

3. COOLING RETROFITTING FOR COLOCATION AND AI DENSITY

Installed cooling capacity is not automatically usable cooling capacity. Legacy data centres may have sufficient chiller capacity on paper, yet fail to deliver the required cooling to each white space because of hydraulic imbalance, higher temperature working conditions for CRAHs, insufficient pump head, poor control or air-distribution constraints.

3.1 HYDRAULIC AND AIRFLOW PERFORMANCE

- Map all single points of failure, including pipework, valves, buffer vessels, bypasses and make-up systems.
- Verify that redundant connections are hydraulically separated, balanced and controllable.
- Use pressure-independent electronic control valves where loads vary significantly between rooms.
- Model normal operation, maintenance states and failure of a main branch using a calibrated digital twin.
- Resolve hotspots through containment, rack orientation and airflow management; additional water flow does not correct poor air distribution.

3.2 HIGHER CHILLED-WATER TEMPERATURES

Moving from a low-temperature regime such as 13/19°C to approximately 20/30°C can improve chiller efficiency and reduce PUE. It is not, however, a simple setpoint change. Legacy CRAHs may lose capacity at higher supply temperatures, while higher return-air temperatures can expose limitations in older equipment and room layouts.

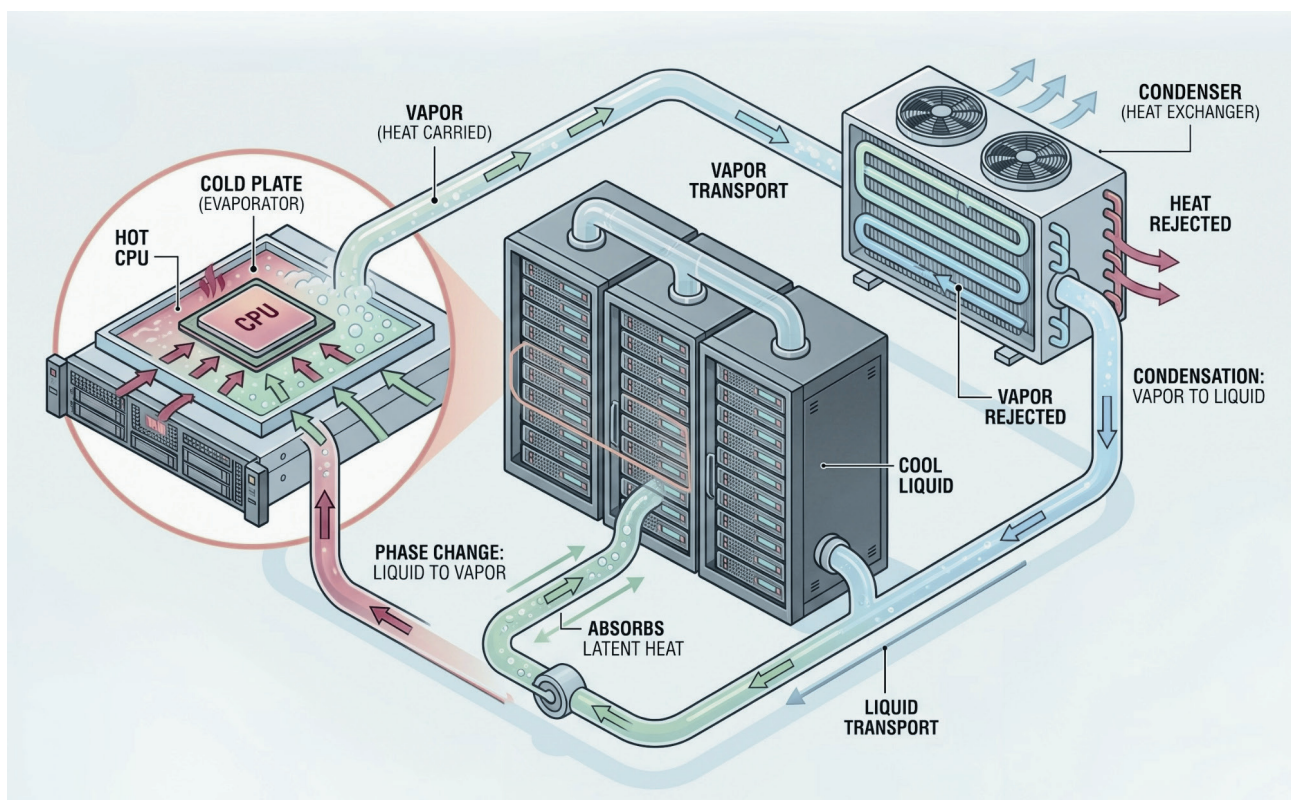


Figure 1: Two-phased liquid cooling

3.3 AI HIGH-DENSITY READINESS

Design topic	Traditional colocation	AI high-density readiness
Power	Flexible A/B feeds for varied rack loads	Higher feeder ratings, busways, selectivity and monitoring
Heat rejection	Air-cooled CRAHs and containment	Air plus liquid cooling; CDUs, heat exchangers and leak detection
Space and structure	Modular rooms and controlled floor loading	Higher local loads, larger routes, maintenance clearance
Availability	Redundant A/B power and cooling	Redundancy of both power and heat rejection; common-mode review
Operations	Customer-level power and temperature data	Rack-level power, flow, temperature and leak monitoring

Design direction: Renovate for interfaces, not only for today's average load: reserve space, electrical connection points, monitoring and cooling interfaces for future high-density deployment.

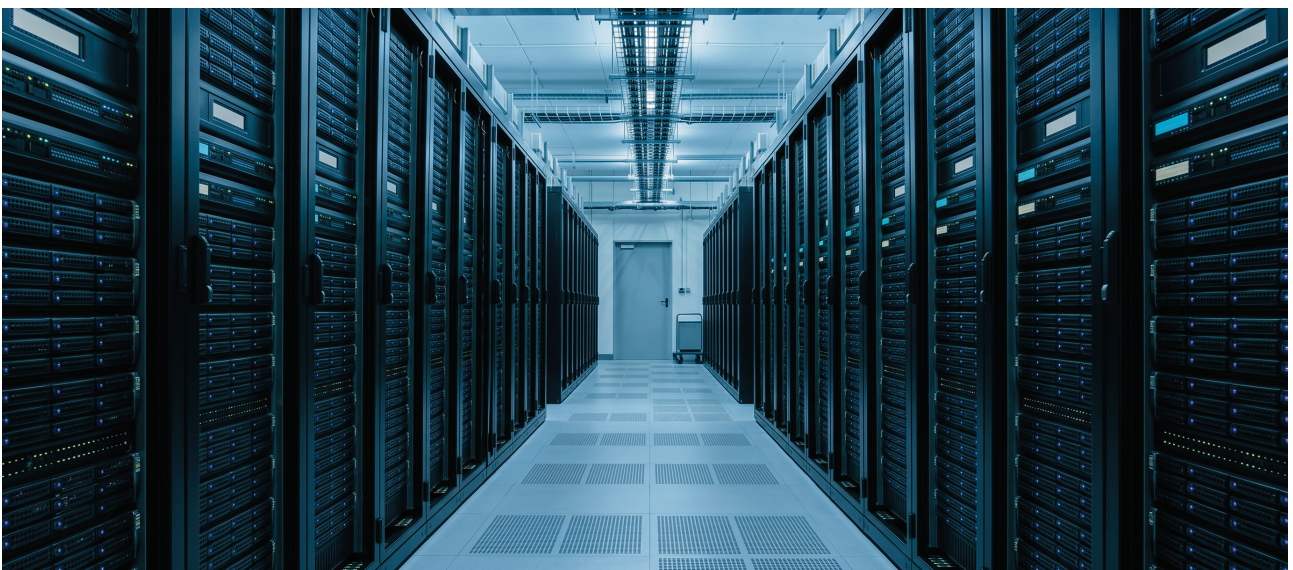


Figure 2: Data centre racks

4. EU SUSTAINABILITY REGULATION AS A RETROFITTING DRIVER

Retrofitting is increasingly driven by more than asset age or customer demand. The EU regulatory framework is moving data-centre sustainability from voluntary reporting toward structured measurement, transparency and efficiency improvement. This creates a compliance, investment and market-readiness case for modernising legacy facilities before their performance gap becomes a constraint.

4.1 WHAT THE EED CHANGES

Directive (EU) 2023/1791 on energy efficiency—the recast Energy Efficiency Directive (EED)—introduced an EU framework for monitoring and reporting the energy performance and sustainability of data centres. The framework is supported by Commission Delegated Regulation (EU) 2024/1364, which establishes the first phase of a common Union rating scheme. The relevant indicators include energy consumption, power utilisation, temperature set points, waste-heat utilisation, water usage and renewable-energy use.

4.2 PUE 1.3 AND WATER PERFORMANCE: IMPORTANT NUANCE

A PUE of 1.3 should be treated as a prudent retrofitting target or market benchmark for a modern, well-designed facility in a suitable climate—not as a blanket EU-wide EED limit that already applies to every existing data centre. The EED framework currently emphasises measurement, reporting, transparency and improvement; national transposition, environmental permits, customer requirements and future policy development may create more demanding obligations for individual sites.

For an older site with a modelled reference PUE of approximately 1.35, a target around 1.3 is therefore strategically relevant. It can separate a facility that is merely reportable from one that remains attractive to customers and resilient to future requirements. The same logic applies to water: WUE and water consumption are now part of the sustainability data set, so cooling-system choices, water sourcing, leak management and heat-rejection strategy must be measured and improved.

4.3 RETROFITTING MEASURES ALIGNED WITH THE EED DIRECTION

- Sub-metering and validated KPI baselines for PUE, WUE, energy reuse and renewable-energy share.
- Chiller sequencing, free cooling, higher-temperature operation and variable-speed pumping.
- Hydraulic balancing, electronic control valves, airflow containment and hotspot reduction.
- Heat-reuse feasibility, where temperature level, local demand and network conditions make it viable.
- PV integration, demand flexibility and electrical optimisation without compromising critical availability.

Regulatory message: The question for a legacy facility is not only “does it comply today?” but also “can it measure, demonstrate and improve its performance as requirements and customer expectations tighten?”

5. BUSINESS CASE AND DELIVERY SUPPORT

The preferred retrofitting scenario should be evaluated on investment cost and on the cost of operation, replacement, maintenance, energy, phasing and future expansion. A lower initial CAPEX can create higher lifecycle cost or reduce the ability to win future high-density customers.

5.1 COST LAYERS THAT MUST BE INCLUDED

Cost layer	Examples	Why it matters
Direct investment	Transformers, generators, UPS, batteries, MDBs, chillers, CRAHs and pipework	Visible in the first budget
Continuity and phasing	Temporary power, mobile generators, testing, night works and logistics	Can be material in a live brownfield site
Building and safety	Reinforcement, penetrations, compartments, roof and technical rooms	Often excluded from early equipment budgets
Operations	Energy, maintenance, fuel, monitoring and spare parts	Determines TCO and operational predictability
Future options	AI cooling interfaces, spare feeders, PV, heat reuse and extra space	Reduces future disruption and lock-in

5.2 HOW AN INTEGRATED TECHNICAL PARTNER SUPPORTS THE PROCESS

The value of an independent multidisciplinary partner lies in connecting the disciplines: validating the existing condition, modelling power and cooling scenarios, coordinating spatial constraints, assessing stability and fire safety, integrating sustainability requirements and converting the result into a transparent decision document. This is how retrofitting moves from equipment replacement to an executable capacity programme.

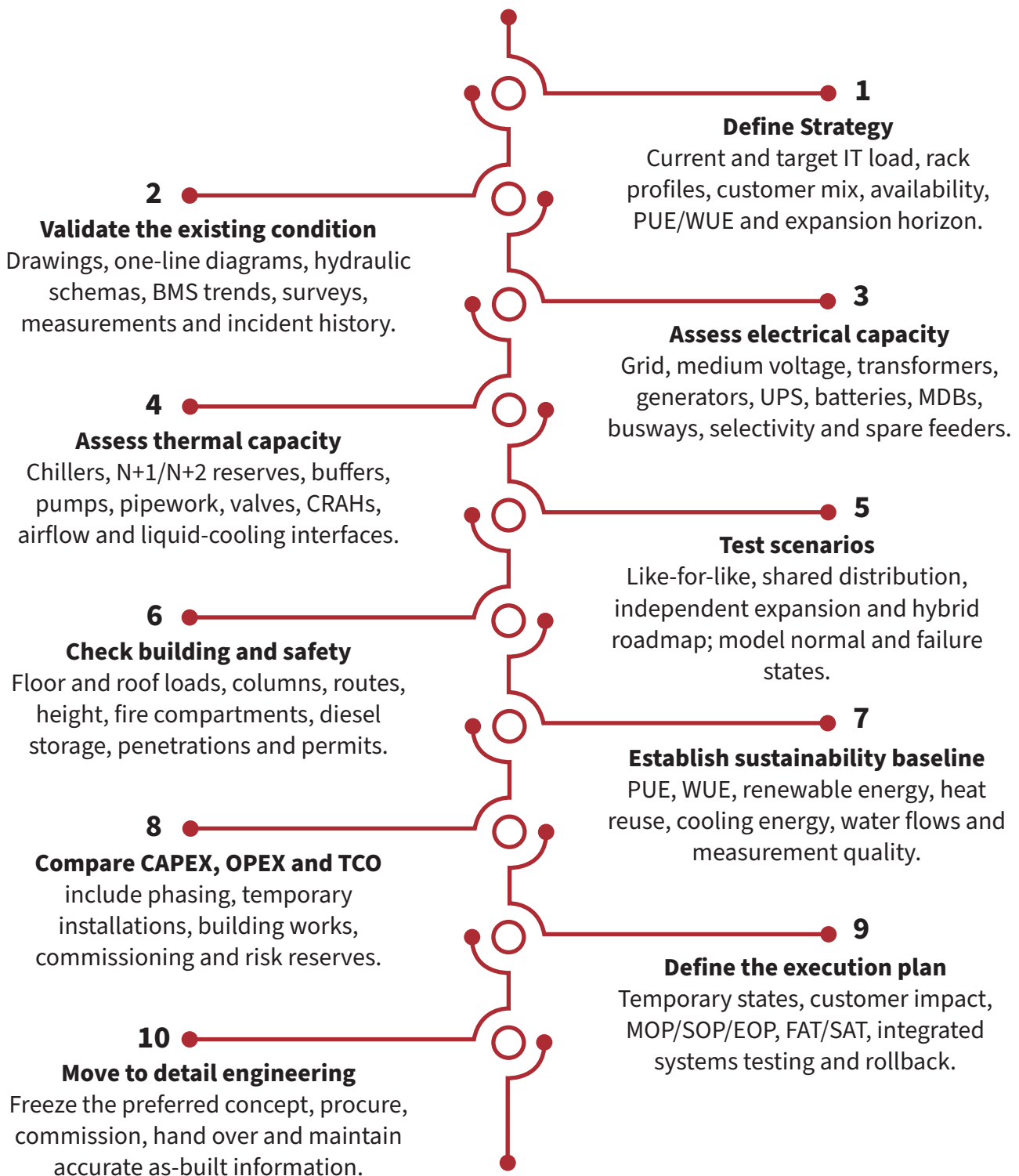
- Existing-condition survey, load mapping, BMS validation and impact on permit level
- Electrical architecture, UPS/generator philosophy, hydraulic distribution and CRAH/rack-cooling concepts.
- Brownfield phasing, clash coordination, temporary feeds, maintenance windows and test strategy.
- PUE/WUE baseline, renewable energy, heat reuse, permitting and environmental considerations.
- CAPEX, OPEX, TCO, risk allowances, scenario comparison and roadmap to detail engineering.

5.3 SCENARIO COMPARISON

1. Like-for-like renewal with targeted quick wins.
2. Distribution redesign to improve utilisation, redundancy and future capacity.
3. Hybrid approach: renew critical assets first and pre-design interfaces for future AI capacity

5.4 RETROFITTING ROADMAP

The sequence may vary by site, but the following ten steps provide a robust basis for a feasibility study and decision process.



6. FEASIBILITY-STUDY CHECKLIST AND CONCLUSION

Domain	Minimum questions to answer
Strategy	What capacity, customer mix, rack density and expansion horizon are required?
Electricity	What capacity and redundancy are genuinely available today, and what topology is future-proof?
Cooling	Can heat be removed in normal, maintenance and failure conditions?
AI readiness	Which power, floor-load, liquid-cooling and monitoring interfaces are required?
Sustainability	Can the facility measure and improve PUE, WUE, heat reuse and renewable-energy share?
Phasing	Which temporary state remains safe and available during every switching step?
Safety and permits	What structural, fire, environmental and permitting constraints affect the concept?
Finance	What are CAPEX, OPEX, TCO, risk reserves and customer-impact costs?
Delivery	What detail engineering, procurement, commissioning and handover are required?

Conclusion

Existing data centres are not obsolete by definition; they become constrained when their architecture, efficiency and reporting capability no longer match the loads, customers and regulatory direction of the market. Retrofitting can restore that competitiveness, but only when electrical capacity, cooling, water, safety, sustainability and phasing are addressed as one system.

The EED and the related EU data-centre reporting framework make performance more visible and comparable. They do not currently impose one universal PUE threshold on every existing facility, but they do create a clear direction of travel: measure energy and resource performance, demonstrate improvement, use waste heat where feasible and reduce avoidable consumption. A retrofitting target around PUE 1.3, a credible water-performance strategy and interfaces for heat reuse are therefore sensible design objectives for many legacy sites—not isolated sustainability add-ons.

The strongest retrofitting programmes begin with a validated baseline, test several scenarios, quantify temporary risks and translate the preferred option into a funded roadmap. This enables the facility to continue serving colocation customers while becoming ready for higher-density, AI-enabled workloads.



**Ready to turn your
existing data centre
into a scalable,
efficient and
compliant asset?**

Ingenium brings electrical, HVAC, structural, fire-safety, energy and permitting expertise together. We assess the full chain—from grid connection and cooling distribution to rack-level readiness. We translate operational constraints into a realistic, phased retrofitting roadmap. We identify the measures that protect availability while enabling colocation and AI growth. We quantify CAPEX, OPEX, PUE, WUE and sustainability opportunities in one decision framework.

Start with an integrated feasibility study and make the next investment decision with confidence. Contact us at wim.boone@ingenium.be.