

In collaboration with
Oliver Wyman, a Marsh business



Data Centre Sustainability and Resilience: A Decision Playbook for AI Infrastructure

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Foreword



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The next phase of artificial intelligence (AI) will depend increasingly on where and how data centre infrastructure is built. Data centres do not operate in isolation: their long-term viability depends on the capacity of surrounding energy, water and infrastructure systems and the confidence of communities that host them. Infrastructure designed for changing operating conditions will be better positioned to expand, adapt and deliver value over time.

For businesses, sustainability and resilience are becoming fundamental conditions of success. They shape the entire business case, from whether projects can proceed to how facilities remain reliable and assets retain value. Organizations that embed sustainability and resilience early can make more informed capital decisions, reduce the risk of costly redesign and strengthen stakeholder confidence. They can also preserve the flexibility needed to respond as technologies, resource constraints and the operating environment evolve.

Policy and regulatory expectations for data centres have expanded in recent years and are likely to continue rising. The European Union's Energy Efficiency Directive and a growing number of national frameworks are setting stronger performance and disclosure requirements. Community opposition is also becoming more consequential, as local concerns over energy availability, water use, land impacts and local benefits increasingly delay or constrain projects. Together, these developments are raising the standard for how data centres need to be planned, approved and operated, turning sustainability and resilience from a compliance obligation into a source of competitive advantage.

The World Economic Forum's December 2025 report, [Nature Positive: Role of the Technology Sector](#), developed in collaboration with Oliver

Wyman, a Marsh business, examined the technology sector's impacts and dependencies on nature and identified practical actions for companies and other stakeholders. The response to its findings pointed to the need for a deeper examination of the sector and the decisions shaping its rapidly expanding footprint.

That deeper focus is warranted because sustainability and resilience outcomes are shaped long before a facility begins operating, through decisions about location, design, technology, financing and supporting infrastructure. Sustainability and resilience should therefore be considered together. More efficient resource use can reduce operating pressure and exposure to constraints, while resilient systems can protect continuity when disruption occurs. An integrated approach helps businesses avoid solutions that improve near-term performance while undermining long-term viability.

This playbook is intended to help data centre developers, operators, customers, investors and policy-makers navigate these decisions. It provides a practical framework for considering local context, lifecycle impacts and the wider systems on which data centres depend, while identifying opportunities for coordinated action across the ecosystem. The scale of capital flowing into AI infrastructure creates a rare opportunity to establish long-term economic value while contributing to climate and nature goals. Grounding investment decisions in sustainability and resilience can strengthen project viability and avoid locking into resource-intensive development pathways. The infrastructure being built today will support digital economies for decades, and its success will depend on matching the speed of investment with the quality of the decisions behind it. The time to shape that outcome is now.

Executive summary

As AI infrastructure expands, sustainability and resilience are central drivers of long-term competitiveness, investment attractiveness and operational success.

Artificial intelligence is rapidly becoming a foundational technology for economies, industries and societies. From scientific discovery and healthcare to manufacturing, finance and public services, AI is transforming how people work, innovate and access digital services. Supporting this transformation requires an unprecedented expansion of digital infrastructure, with global data centre investment potentially reaching \$7 trillion by 2030¹ and electricity demand projected to grow by more than 20% annually through 2030.²

This expansion is increasing demand for reliable access to electricity, water, land, connectivity, critical materials and skilled labour. As digital infrastructure expands, its long-term success will depend not only on advances in data centre and computing technologies, but also on strengthening the systems on which they depend.³ AI can also help address these challenges by improving the efficiency, reliability and resilience of data centre

operations (see [Appendix A2](#)) and the systems that data centres rely on.

Sustainability and resilience are becoming core determinants of long-term business performance (see Figure 1). Projects that are poorly matched to local resource conditions may face higher costs, development delays and increased operational, financial and community risks. Based on current dynamics impacting data centre projects, adopting sustainability and resilience measures could unlock between \$700 billion and \$1 trillion in total planned data centre investment by 2030.⁴ This would be achieved by reducing delays and cancellations through improvements to community relations, along with increased adaptability of infrastructure to local resource constraints, regulatory changes and technological advancements. Integrating these considerations early can strengthen operational performance, stakeholder confidence and long-term asset value.

FIGURE 1 The impacts of sustainability and resilience constraints



This playbook provides a practical decision framework to help developers, operators, enterprise customers, financial institutions and policy-makers make more sustainable and resilient decisions across the data centre development and operations lifecycle. Rather than prescribing a single approach, it provides a common framework

that can be adapted to different market contexts and stakeholder roles.

The playbook is organized around four practical questions, each answered through a corresponding tool (see Table 1).

TABLE 1 How to use this playbook

Question	Tool	Chapter	Purpose
When are key decisions made during data centre design and operation?	Data centre development pathway	2	Maps where consequential decisions are made, who makes them and the factors that influence them, helping identify where sustainability and resilience considerations can have the greatest impact.
What principles and metrics should inform my decision?	Universal decision principles and recommended metrics	3	Provides a common foundation for decision-making and assessment, extending beyond traditional operational efficiency measures.
What choices should be made based on my local context?	Market constraint profiles	4	Helps tailor decisions to local conditions by identifying the top constraints shaping different markets.
Which actions are relevant to my role at this step?	Stakeholder-specific recommendations	5	Provides practical guidance for developers, operators, enterprise customers, financial institutions and policy-makers to apply the framework within their respective roles.

This playbook proposes an expanded set of metrics for assessing the sustainability and resilience of data centres – approximately three-quarters of which are not yet widely adopted in either public or non-public reporting. Existing regulations, frameworks and certifications provide valuable guidance on operational efficiency, climate performance and disclosure, but often focus on individual facilities rather than lifecycle impacts, local resource

constraints and broader system interactions. As a result, facilities with strong operational performance may still depend on constrained electricity networks, operate in water-stressed regions, require significant new infrastructure or face increasing climate, biodiversity and community risks. There is no universally “sustainable” or “resilient” data centre. The appropriate sustainability and resilience strategy depends on local conditions.

DEFINITIONS

Sustainable and resilient practices

Sustainable practices are those that support long-term operation within environmental and social limits by optimizing resource use, minimizing adverse impacts and, where feasible, creating positive environmental and social outcomes.

Resilient practices for data centres are those that help them withstand and adapt to longer-term nature degradation and acute physical, operational and systemic disruptions, which include natural disasters, collapsed infrastructure and other external shocks.

FIGURE 2 | Five considerations for embedding sustainability and resilience in AI infrastructure



Taken together, the considerations in Figure 2 illustrate that decisions about energy, water, land, materials, connectivity, infrastructure and community acceptance will shape the next generation of AI infrastructure as much as advances in computing technology. Organizations that treat

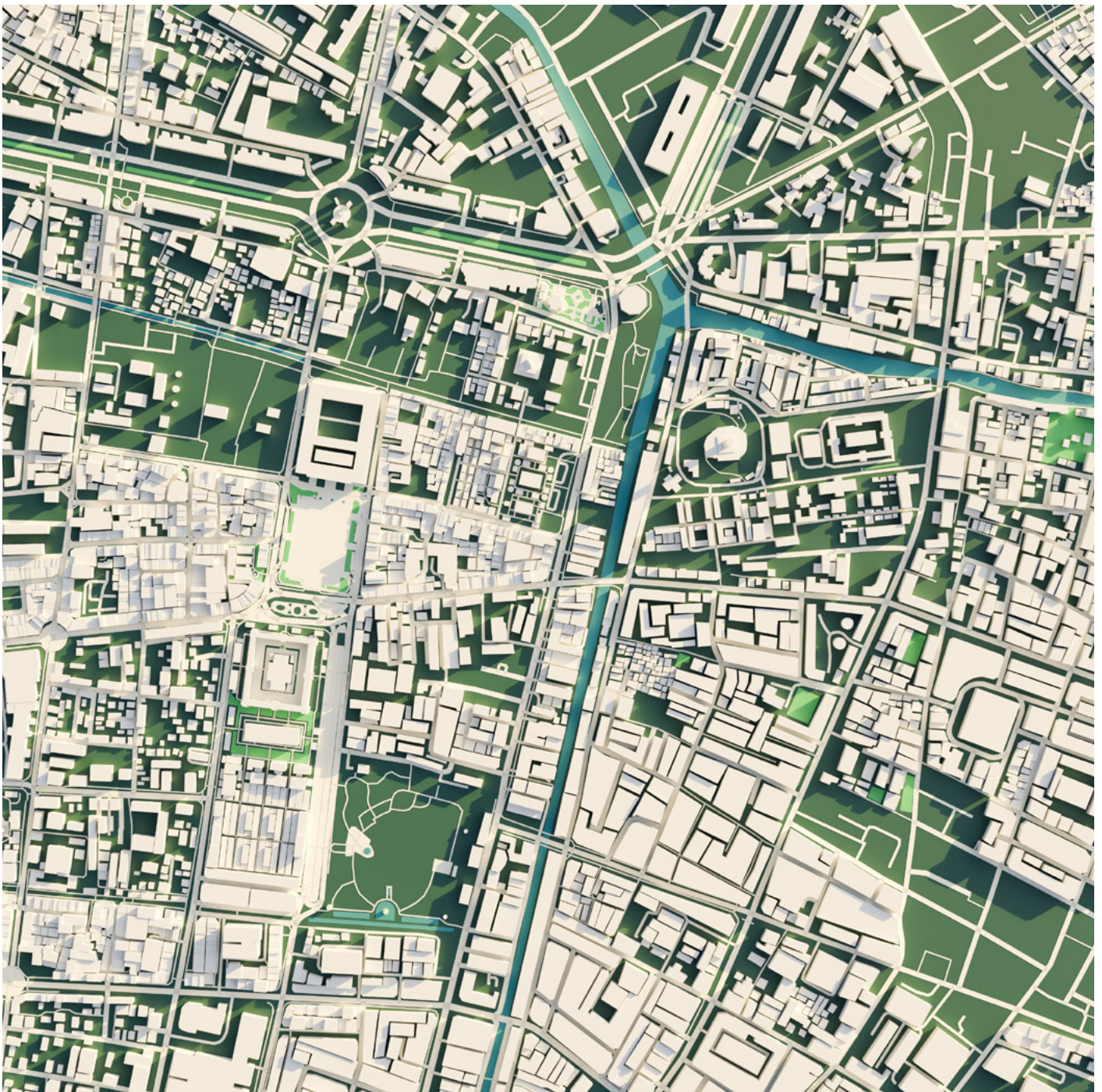
these factors as core design, investment and operational criteria will be better positioned to scale up AI infrastructure while managing execution risk, protecting asset value and supporting the resilience of the systems on which digital infrastructure depends.



1

Why sustainability and resilience are critical in planning data centres

AI is turning power, water, cooling, community acceptance, land and regulation into strategic constraints affecting how facilities are planned, financed and operated.



1.1 Data centre market dynamics are rapidly changing

The data centre market is shifting from cloud-led, general-purpose infrastructure to one increasingly shaped by AI workloads, which place fundamentally different demands on infrastructure. Training new AI models requires specialized cooling and substantial electricity supplies. Rack densities of 30-100 kW per rack,⁵ previously considered characteristic of advanced processor clusters, are giving way to leading-edge systems reaching approximately 250 kW per rack, with next-generation systems expected

to exceed 600 kW.⁶ These requirements extend dependencies beyond the facility to energy, water, critical minerals, semiconductor manufacturing, connectivity and skilled labour.⁷

Countries increasingly view AI infrastructure as a driver of economic growth, innovation and competitiveness, while industry collaboration and continued technological innovation are creating new opportunities to improve sustainability and resilience (see Appendix [A1](#) and [A2](#)).

1.2 Six strategic constraints shape long-term data centre viability and performance

“ Cumulative global data centre investment could potentially reach \$7 trillion by 2030.

The race to scale up AI is driving one of the largest infrastructure buildouts in history, with cumulative global data centre investment potentially reaching \$7 trillion by 2030.⁸ Decisions made during this expansion could lock in resource dependencies and limit the ability of infrastructure to adapt to future technologies and constraints. Six strategic constraints, analysed below, are electricity, water, cooling, community acceptance, land and regulatory complexity.



Constraint 1: Electricity

Electricity is the defining trend shaping future AI infrastructure development. The International Energy Agency (IEA) estimates that global data centre electricity consumption could more than double between 2025 and 2030,⁹ reaching around 3% of projected global electricity use.¹⁰ Market analysts project global data centre power consumption will increase at a compound annual growth rate of more than 20% up to 2030.¹¹

Since demand is often geographically concentrated, rapid expansion can place significant pressure on generation, transmission and distribution infrastructure, making power availability, interconnection capacity and grid resilience central to project viability. For further analysis, see the World Economic Forum's dedicated initiative on [AI Energy Impact](#).¹²



Constraint 2: Water

Water-related risks are becoming increasingly material. Data centres consume water both directly, through cooling systems that dissipate server heat, and indirectly, through the electricity they consume.

Generating electricity, particularly from sources such as gas or coal, requires large volumes of water, which means that even facilities with efficient onsite cooling can carry a significant upstream water footprint through their energy supply.

The water footprint associated with projected 2030 data centre electricity consumption could reach 9.3 trillion litres annually, equivalent to the minimum annual domestic water needs of the population of Sub-Saharan Africa.¹³ At the same time, about 45% of global data centres are in areas with high levels of water stress,¹⁴ and climate change will exacerbate this risk. Much of AI infrastructure's water footprint occurs beyond the facility itself, including semiconductor manufacturing, upstream resource extraction and electricity generation, which will be responsible for 72% of data centre water consumption by 2030.¹⁵ Continued improvements in cooling technologies are critical but will not remove the overall constraint.



Constraint 3: Cooling

Cooling decisions involve a fundamental trade-off between electricity and water use. Evaporative cooling, for example, uses water to dissipate heat and consumes less electricity, while air cooling relies on electricity-intensive systems but uses little or no water. Implementation of advanced cooling technologies remains relatively limited.

In a survey by Uptime Institute, 22% of respondents said they deploy direct liquid cooling technologies, but cost, standardization and reliability concerns constrain wider adoption.¹⁶ The same survey found that 87% of operators prioritize energy efficiency for sustainable cooling, while only 35% prioritize low or zero water use. Cooling for high-density AI workloads¹⁷ is likely to intensify these trade-offs in

9.3 trillion litres per year

Projected data centre water footprint associated with 2030 data centre electricity consumption – equivalent to minimum domestic water needs of Sub-Saharan Africa.

“ In South Korea, 17 of 33 data centre projects with construction permits experienced delays due to community pushback in 2026.

“ Faster hardware refresh cycles driven by rapid technological change could generate up to 5 million tonnes of e-waste by 2030.

some markets. Optimizing this trade-off requires a systems-based and locally tailored approach, balancing energy and water outcomes rather than optimizing for either in isolation.



Constraint 4: Community acceptance

Community acceptance extends beyond permitting and can influence long-term operations and future expansion. At least 75 US data centre projects, representing approximately \$130 billion of investment, were blocked or delayed during the first quarter of 2026 alone.¹⁸ In July 2026, New York introduced a moratorium on the construction of data centres with loads exceeding 50 MW.¹⁹ In South Korea, 17 of 33 data centre projects with construction permits experienced delays due to community pushback in 2026.²⁰ Local opposition has centred on electricity, water, land and broader environmental and community impacts, with advocacy groups increasingly joining local campaigns.



Constraint 5: Land

Sites for large-scale data centres require suitable, “powered” land – offering reliable power supply and transmission connectivity. Currently, around 81 square kilometres (km²) of powered land support data centres worldwide and an additional 160 km² may be needed to support the expansion anticipated by 2030.²¹ The data centre footprint represents only part of the required land, with the associated land footprint of electricity infrastructure projected to exceed 14,500 km² by 2030.²² Land availability must be viewed through the lens of infrastructure readiness rather than physical area alone, while biodiversity and ecological implications will vary globally.



Constraint 6: Regulatory complexity

Regulatory complexity is increasingly shaping the development of data centres. Permitting, environmental approvals and evolving sustainability requirements materially influence project delivery, operating costs and regional competitiveness. In the US, permitting for a new-build data centre typically takes 6-18 months.²³ As governments seek to balance AI infrastructure growth with electricity, water, land and community priorities, regulatory changes are becoming a significant determinant of regional investment attractiveness and project viability.

Additional constraints

Beyond these six primary constraints, AI infrastructure is increasing the demand for semiconductors, batteries, construction materials and other critical minerals.²⁴ Many of these inputs remain geographically concentrated, increasing exposure to geopolitical tensions, trade restrictions and supply disruptions. At the same time, faster hardware refresh cycles driven by rapid technological change could generate up to 5 million tonnes of e-waste by 2030.²⁵

Beyond material supply chains, AI infrastructure increasingly depends on high-capacity, low-latency and resilient fibre networks. AI could drive at least a sixfold increase in data centre interconnect bandwidth demand over the next five years,²⁶ making connectivity availability, redundancy and permitting timelines increasingly important determinants of site selection, deployment schedules and long-term scalability.



1.3 Impacts extend beyond each facility across the entire data centre infrastructure lifecycle

The resource dependencies of data centres extend well beyond those used during operations. Understanding these interconnected lifecycle

dependencies is essential for sustainable planning and infrastructure development (see Figure 3).²⁷

FIGURE 3 Lifecycle resource dependencies

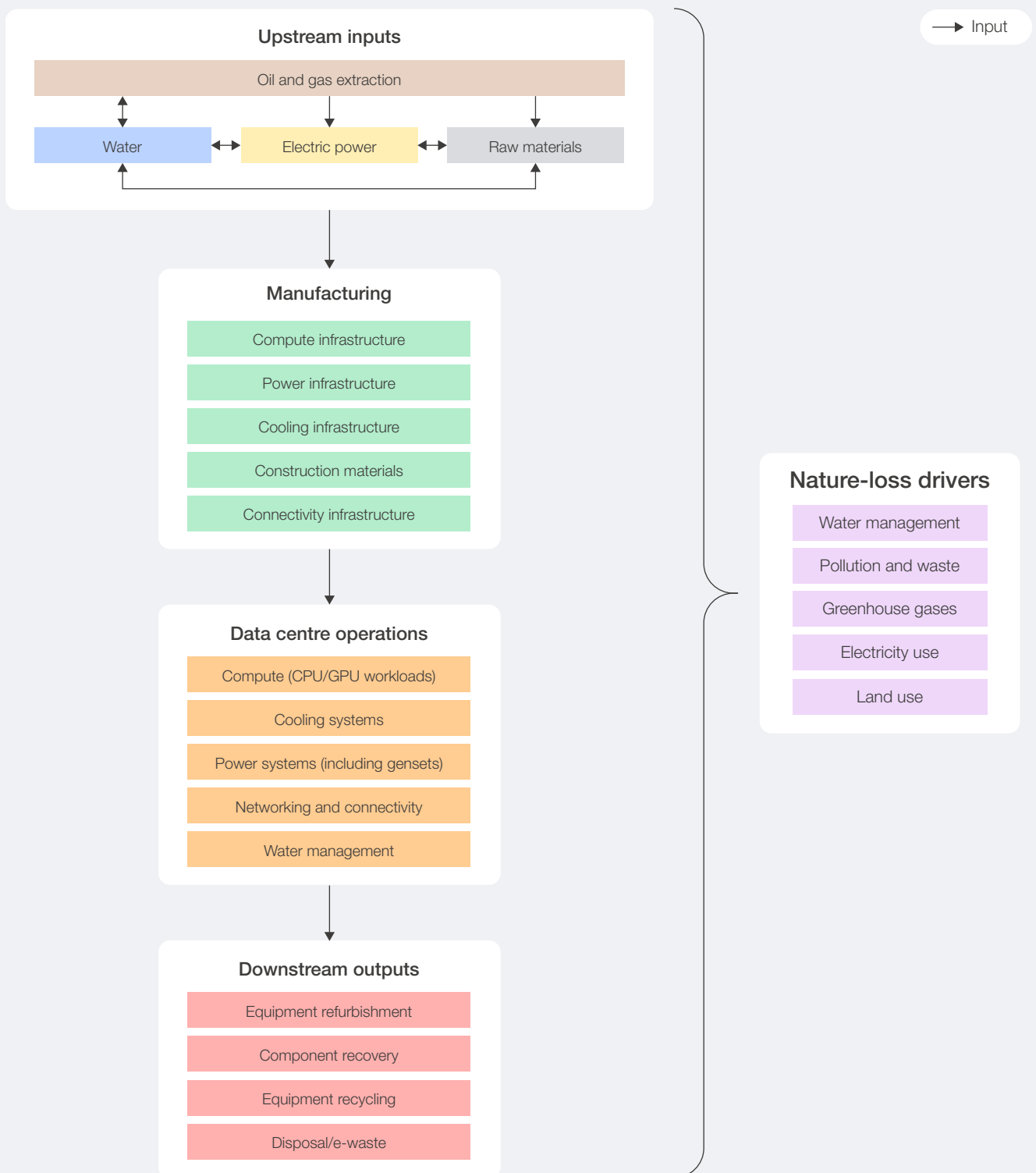


Figure 4 illustrates the interconnected resource dependencies across the data centre lifecycle, with water as an example. The significance of these

impacts depends on local conditions, highlighting the importance of interpreting facility-level metrics alongside lifecycle and context-specific information.

FIGURE 4 Water footprint of data centres



Sources: See endnotes.²⁸

Furthermore, these resource dependencies can be compounded where data centres are geographically clustered to take advantage of existing infrastructure and policy incentives,²⁹ creating cumulative pressures on local electricity, water, land and community systems. Energy suppliers and utilities, equipment manufacturers and other

upstream suppliers directly influence upstream resource impacts. Data centre developers and operators indirectly influence these impacts through siting, procurement and energy-sourcing decisions. Each stakeholder therefore has a different role in addressing upstream impacts, based on the decisions and activities it controls or influences.

CASE STUDY 1

NEC on optimizing data centre development with AI

NEC provides an example of how agentic AI can support integrating local environmental, infrastructure and supply chain considerations into data centre planning. NEC applies agentic AI across 20 data centres in five countries to support site selection, capacity expansion, cooling system design and resilience assessments. Rather than evaluating facilities in isolation, specialized AI agents analyse water availability, infrastructure, regulation, climate exposure, local industries, communities and historical and cultural context before the findings are reviewed by technical specialists.

At the river basin level, the assessment considers surface water, groundwater, drought history, water supply infrastructure, utility capacity, regulation and climate exposure to inform cooling technology selection. NEC assesses both

direct water use at the facility and indirect water consumption associated with purchased electricity generation, supporting location-specific decisions that balance water efficiency, energy efficiency and operational resilience.

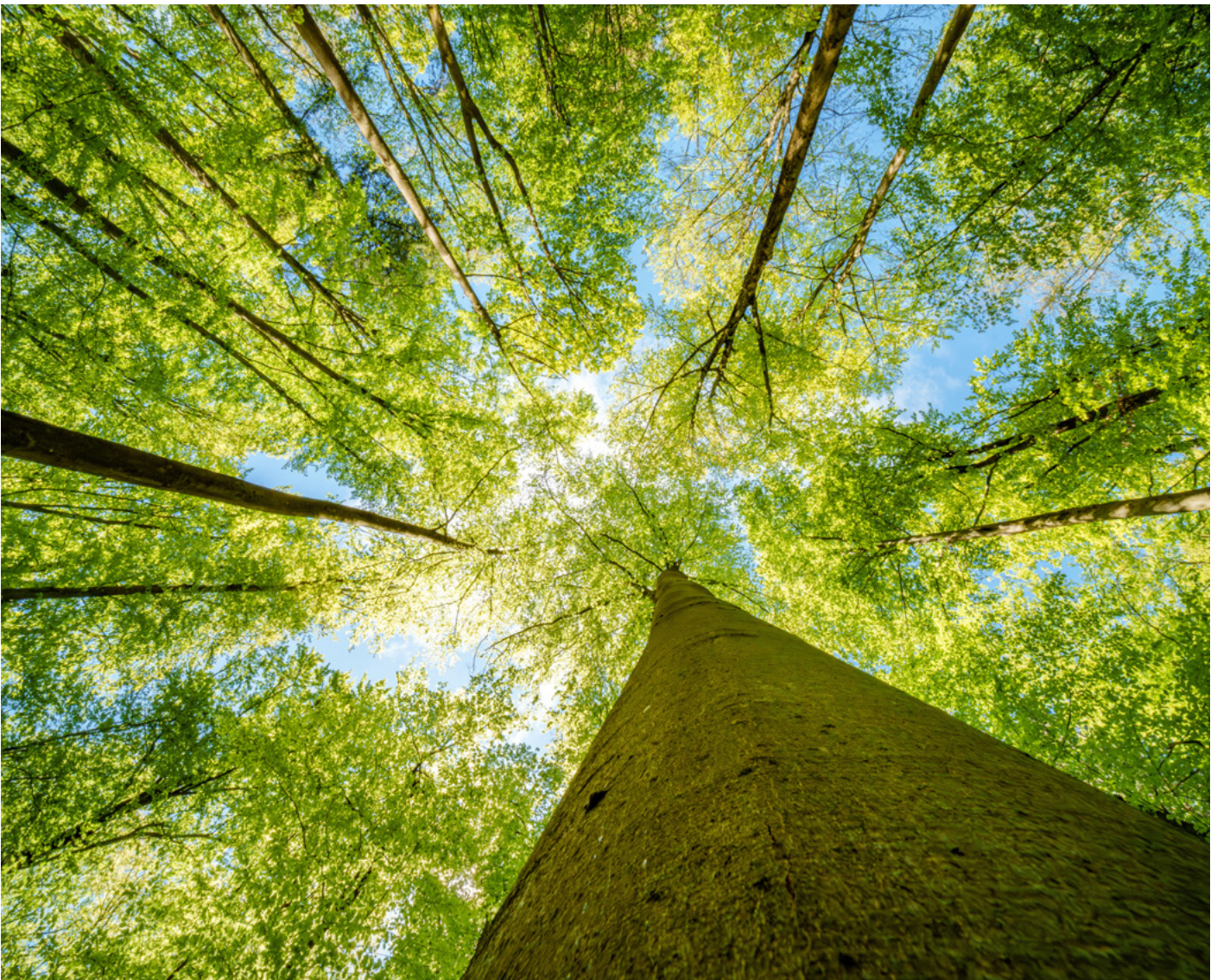
The same assessment process extends to approximately 2,000 supplier locations, including semiconductor manufacturing facilities, helping strengthen resilience across the data centre supply chain by identifying locations where water availability, wastewater management and regulatory conditions may affect the supply of critical equipment. NEC's experience suggests that automating supplier location screening can significantly reduce preliminary assessment time, allowing technical specialists to focus on validation, stakeholder engagement and mitigation planning.

1.4 Four key decision-critical challenges

The strategic constraints noted above, along with lifecycle dependencies and rapid investment in AI, give rise to four recurring challenges that decision-makers encounter across most data centre markets.

- **Power availability and management:** As AI workloads drive rapid increases in electricity demand and density, operators must secure sufficient capacity, maintain reliability and manage rising costs while meeting decarbonization aims. For additional information on how policy-makers can mitigate rising energy costs to underserved communities, see the Forum's latest work on [AI Energy Impact](#).³⁰
- **Managing the water-energy nexus:** Water and energy are closely interconnected through cooling technologies. Reducing cooling energy often increases water consumption and vice versa, making the appropriate balance dependent on local resource conditions rather than optimizing a single resource.
- **Balancing efficiency and resilience:** Measures that improve efficiency can reduce redundancy and flexibility, while measures that strengthen resilience often require additional resources and infrastructure.
- **Balancing speed to market with long-term sustainability and resilience:** Rapid AI growth is increasing pressure to deliver new capacity quickly. At the same time, infrastructure decisions must remain adaptable to changing technologies, resource constraints and future operating conditions to avoid costly retrofits and stranded assets.³¹

Understanding where consequential decisions are made, who makes them and the factors that influence them provides the foundation for the decision framework set out in Chapter 2, which helps developers, operators, customers, investors and policy-makers embed sustainability and resilience at each stage of the data centre lifecycle.



2

Decision framework for sustainable and resilient data centres

Sustainability and resilience metrics and regulations focus on individual facility operations, rather than lifecycle impacts, local context and broader system interactions.



2.1 Defining sustainable and resilient data centre practices

Data centres share common sustainability and resilience challenges across their lifecycle. This

report adopts the definitions in Box 1 to provide a consistent basis for discussion.

BOX 1 Definitions of sustainable and resilient practices

“Facilities that more effectively manage resource, infrastructure and community risks are better positioned to maintain stakeholder confidence and operate reliably over the long term.”

“Sustainable” practices for data centres are those that support long-term operations within environmental and social limits, by optimizing resource use, minimizing adverse impacts and, where feasible, creating positive environmental and social outcomes across natural systems and human communities through the energy, water and other resources consumed, the land altered, the pollution and waste generated, and the social and economic impacts created.³²

“Resilient” practices for data centres are those that help them withstand and adapt to longer-term nature degradation and acute physical, operational and systemic disruptions, which include natural disasters, collapsed infrastructure and other external shocks. These practices also contribute to system resilience by supporting reliable infrastructure, resource security and community well-being.³³

Whether a data centre is sustainable or resilient depends upon its design, operational performance and local context. For example, water consumption is of greater concern in water-stressed regions.

Facilities that more effectively manage resource, infrastructure and community risks are better positioned to maintain stakeholder confidence and operate reliably over the long term.

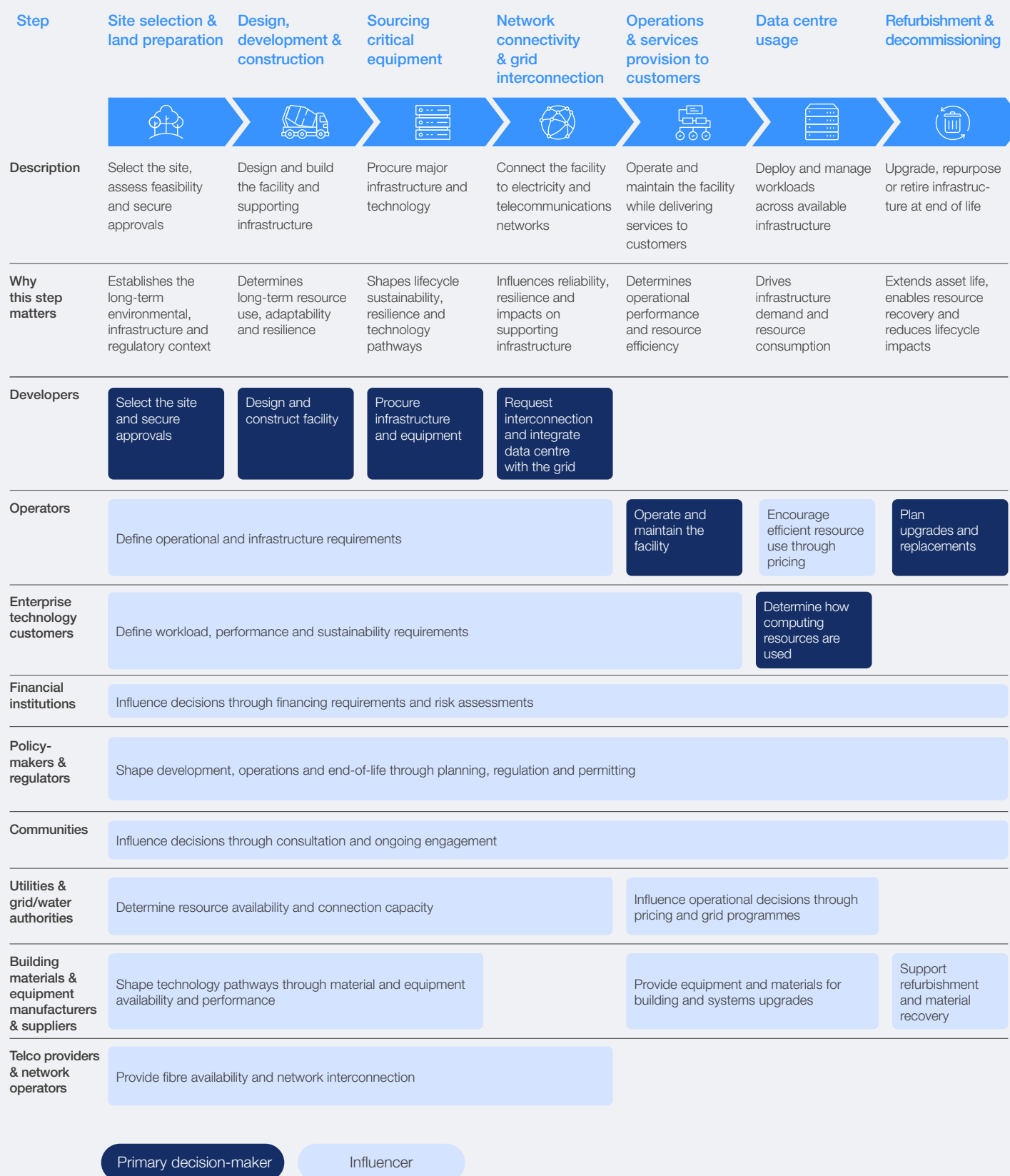
2.2 Where decisions are locked in across development and operations

Data centre development and operations follow a high-level sequence of activities, from site selection and design through to operations and refurbishment or decommissioning. The activities involve a range of stakeholders including developers, operators,

utilities, regulators, investors, customers and local communities. Decisions at each stage are important for sustainability and resilience, and outcomes are often locked in early. Figure 5 illustrates the development pathway.



FIGURE 5 | Data centre development pathway



Note: Activities may overlap or recur across the facility lifecycle. Refurbishment can return a facility or its components to earlier stages, while decommissioning applies where continued use, upgrading or repurposing is no longer viable.

2.3 Key considerations along the data centre development pathway

The key sustainability and resilience considerations across the development pathway influence a series of strategic decisions that shape long-

term outcomes, including site selection, power architecture, cooling architecture and workload placement.

TABLE 2 Considerations across the development pathway (non-exhaustive)

Step	Consideration
Site selection & land preparation	1. Is sufficient power capacity (renewable and/or non-renewable) available or planned?
	2. Is the site exposed to significant physical climate risks, such as flooding, heat stress, drought or wildfire?
	3. Are there impacts on availability of water, energy, landscape, noise etc. for the local community?
	4. Is the site located in a water-stressed basin?
	5. Can the site accommodate future expansion without significant infrastructure upgrades?
Design, development & construction	1. Is the data centre designed for current or future demand and conditions?
	2. What type of air or liquid cooling does it use and what is the source?
	3. Is the power supply grid-only or hybrid energy architecture incorporating onsite generation and carbon-free sources?
	4. What level of resilience and infrastructure redundancy is required?
	5. Does the facility use low-carbon or conventional construction materials?
Sourcing critical equipment	1. How should procurement decisions balance deployment timelines, equipment efficiency, resilience requirements and equipment availability?
	2. What trade-offs between embodied carbon and operational efficiency are acceptable over the facility lifecycle?
	3. How should procurement decisions balance cost, supplier diversification and supply-chain resilience?
	4. What sourcing strategy is most appropriate given cost, availability, resilience and sustainability objectives?
	5. How easily can equipment be upgraded?
Network connectivity & grid interconnection	1. Is the connectivity architecture single-site or geographically redundant?
	2. How should connectivity costs and resilience be determined?
	3. Does it connect through existing utility infrastructure or dedicated grid interconnection infrastructure upgrades?
	4. Does it use single or multiple utility interconnections?
	5. Should it accelerate deployment using available infrastructure and grid infrastructure or delay deployment to secure optimal long-term connectivity and electricity interconnection?
Operations & services provision to customers	1. What should the electricity supply mix be and what are the emissions implications?
	2. How will the facility participate in demand-response and grid-flexibility programmes?
	3. What maintenance strategy should be adopted?
	4. What is the appropriate balance between operational efficiency and operational resilience?
	5. How will the project's costs and benefits be shared between the data centre, utilities and local communities?

Data centre usage	1. Should workloads be concentrated in a small number of facilities or distributed across multiple locations?
	2. Should AI inference workloads be deployed centrally or closer to end users?
	3. Will data and workloads remain within specific jurisdictions to meet data sovereignty, security or regulatory requirements?
	4. How will workloads prioritize performance or resource efficiency?
	5. How do customers prioritize facilities with specific sustainability or resilience characteristics when procuring capacity?
Refurbishment & decommissioning	1. Can the facility or its infrastructure be upgraded, repurposed or refurbished before retirement?
	2. Which components and equipment can be reused, refurbished, resold or recovered?
	3. How will decommissioning minimize waste, embodied impacts and disruption to surrounding communities?
	4. What restoration, remediation or infrastructure commitments apply when the facility or site is retired?
	5. How will data-bearing equipment be securely sanitized to enable reuse where possible?

CASE STUDY 2

NTT Global Data Centers on recovering data centre excess heat for district heating in Berlin

NTT Global Data Centers (GDC), part of NTT DATA, plans to retrofit its existing Berlin 1 co-location facility to supply recovered excess heat to the local heating network serving Das Neue Gartenfeld, a new residential and commercial development in Berlin's Spandau district.

The project is designed to recover excess heat generated by IT operations at temperatures of around 20-30°C and transfer it through a 2-kilometre pipeline to a district energy utility centre. Heat pumps will raise the temperature to around 65-70°C, making the recovered heat suitable for use in the local heating network. The data centre will provide up to 8 MW of heat transfer capacity, while the overall system is expected to deliver approximately 26 GWh of heat annually.

Once operational, the network is planned to serve up to 10,000 people across around 4,500 homes, more than 200 commercial units, as well as educational and childcare facilities. The project is expected to avoid approximately 6,000 tonnes of CO₂ emissions annually. NTT GDC is working with Quartierswerk Gartenfeld, a joint venture between ENGIE Deutschland and GASAG Solution Plus, to deliver the project.

The project demonstrates how coordination between data centre operators and local energy providers can enable recovered excess heat to support local energy demand.



2.4 Building from existing regulatory frameworks and metrics, labels and guidance

“ Many jurisdictions continue to rely on disclosure rather than minimum performance requirements.

Approaches to data centre sustainability differ across jurisdictions. Some regions have introduced reporting and performance requirements, but many continue to rely on voluntary standards or incentive programmes.

The European Union has established one of the most comprehensive regulatory approaches, largely due to the breadth of mandatory sustainability and resilience disclosures required. Other jurisdictions focus on specific issues such as energy efficiency and climate disclosure. These frameworks collectively demonstrate growing regulatory attention to this topic, but major gaps include the following:

- **Binding sustainability requirements remain limited:** Reporting requirements for energy, emissions and sustainability are expanding, but many jurisdictions continue to rely on disclosure rather than minimum performance requirements.
- **Water governance remains limited:** Water reporting requirements are emerging, but existing water permitting and management frameworks may not adequately address the scale and intensity of water demand associated with modern data centres, particularly in water-stressed regions.³⁴
- **Biodiversity requirements remain underdeveloped:** Biodiversity and nature-related considerations are receiving attention through initiatives such as the Global Biodiversity Framework and ESRS (European Sustainability Reporting Standards) E4, but remain less developed than energy, carbon and water requirements. Existing requirements tend to focus on planning and permitting stages rather than ongoing monitoring, restoration or operations.³⁵
- **Regulatory approaches remain fragmented globally:** Sustainability and resilience requirements differ significantly across jurisdictions, creating complexity for operators and limiting comparability for investors.
- **Noise and air quality regulation remain fragmented:** Noise impacts and air pollutant emissions from backup generation are primarily regulated through planning, environmental permitting and nuisance frameworks rather than data centre-specific standards.

Regulatory frameworks establish the obligations and expectations that apply to data centre operators, but performance is ultimately assessed through a set of metrics and thresholds. There is increasing convergence around a relatively small set of indicators focused on energy efficiency,

greenhouse gas (GHG) emissions, renewable energy use, water consumption and operational reliability (see [Appendix A5](#)).

Commonly reported metrics, including power usage effectiveness (PUE), water usage effectiveness (WUE) and renewable electricity share provide valuable insights into operational performance. However, they generally focus on resource consumption and efficiency at the facility level, providing only a partial view of sustainability and resilience. Major gaps include the following:

- **Most metrics do not account for local environmental and infrastructure context:** Existing metrics are generally facility-level performance indicators and do not systematically account for local conditions, such as basin-level water stress or grid carbon intensity. As a result, facilities with similar reported performance may have materially different sustainability and resilience depending on where they operate.
- **Carbon accounting remains incomplete:** Carbon usage effectiveness (CUE) is not required by any binding regulation and no widely adopted approach exists for measuring and comparing embodied carbon.
- **Indirect resource use remains largely unmeasured:** Existing data centre metrics such as WUE and PUE focus on direct facility water and power consumption and do not typically account for water used in electricity generation, fuel production or upstream supply chains, or for the power used to extract, treat and distribute water.
- **Operational emissions beyond electricity consumption remain underrepresented:** Existing metrics focus primarily on electricity use and related efficiency indicators. Emissions from refrigerants, backup generation and other operational sources are generally managed through broader GHG accounting frameworks rather than dedicated data centre metrics.

Hourly carbon-free energy remains an emerging area of reporting. Although more granular reporting remains challenging because of data availability, operational considerations and evolving accounting standards, it could improve transparency around when electricity is consumed and support decisions that better align demand with carbon-free generation. Existing reporting requirements generally focus on annual renewable energy procurement rather than whether electricity consumption is matched with carbon-free generation on an hourly basis.

“ No widely adopted approach exists for measuring and comparing embodied carbon.

The GHG Protocol is currently consulting on proposed revisions to scope 2 accounting. Mandatory hourly matching is no longer the presumed outcome, and multiple approaches remain under consideration.³⁶ Complementary approaches are also emerging, including “impact accounting” advanced by the Emissions First Partnership (EFP),³⁷ which assesses the emissions impact of electricity consumption and clean energy procurement based on time and location. Implementation remains subject to data availability, operational considerations and evolving accounting standards.³⁸ As a result,

this remains an evolving area of reporting and accounting methodology.

A range of overlapping regulatory frameworks, metrics and certification schemes provide an important foundation for improving data centre sustainability and resilience. However, they remain fragmented and do not consistently account for lifecycle impacts, local context or broader system interactions (see Box 2). Chapters 3, 4 and 5 seek to address these gaps through universal decision principles, market constraint profiles and stakeholder-specific recommendations.

BOX 2 **Fragmented sustainability frameworks hamper comparability of projects for financial institutions and investors**



Beyond regulations, investors and lenders increasingly rely on certification schemes, sustainability ratings and financing frameworks to assess the sustainability and resilience of data centres. These frameworks serve to enable capital allocation, benchmarking and investment decision-making (see [Appendix A6](#)).

Sustainability and resilience frameworks are difficult to compare: Existing frameworks measure different aspects of sustainability and resilience. For example, broad environmental, social and governance (ESG) assessments such as GRESB evaluate operational sustainability and resilience, while performance disclosure standards such as the International Sustainability Standards Board’s (ISSB) International Financial Reporting Standards (IFRS) S1 and IFRS S2³⁹ require reporting on climate-related financial risks and emissions, requiring stakeholders to rely on multiple frameworks.

Embodied carbon remains underrepresented: Embodied carbon, a significant share of lifecycle emissions for data centre developments,⁴⁰ is

receiving increasing attention through sustainable finance frameworks and building certifications, but most standards remain primarily focused on operational impacts.

Nature and biodiversity considerations are limited: While some frameworks incorporate land-use, ecological or “do no significant harm” considerations, nature and biodiversity impacts are generally not assessed with the same level of rigour or standardization.

Sustainability-linked financing remains difficult to compare: Targets for sustainability-linked loans (SLLs) and sustainability-linked bonds (SLBs) are tailored to individual borrowers and transactions. As a result, metrics and ambition vary considerably, limiting comparability.

Limited alignment across frameworks: Definitions, methodologies and performance thresholds vary across standards, certifications and sustainable finance frameworks, limiting comparability and increasing reporting complexity for operators and investors.



3

Universal decision principles and recommended metrics

Sustainable and resilient data centre development requires decisions that account for long-term impacts, uncertainty and broader system effects.



3.1 Six universal decision principles

This chapter introduces six universal decision principles (see Figure 6) and a complementary set of metrics that provide a common foundation for decision-making across the data centre lifecycle.

Their application is shaped by local market conditions, which are explored in the following chapter.

FIGURE 6 Six universal decision principles for sustainable and resilient data centres



The six principles presented in this chapter provide a common framework for making sustainability and resilience decisions across the data centre lifecycle. Rather than prescribing a specific approach, they highlight key considerations that can guide decisions across stakeholders, market contexts

and pathway steps. For more detailed guidance on reducing data centres' impacts and dependencies on nature, see the priority actions presented in the Forum's December 2025 report [Nature Positive: Role of the Technology Sector](#) (summarised in [Appendix A6](#)).⁴¹

“ A facility that performs well in isolation may contribute to resource competition, infrastructure bottlenecks or community pressures when considered alongside others.

1 Evaluate sustainability and resilience over the full data centre lifecycle

Many sustainability and resilience outcomes are determined well before a data centre becomes operational. Siting, design, procurement and financing decisions influence long-term resource consumption, emissions, adaptability and resilience.

EXAMPLE: Metrics such as whole-life carbon and total water footprint capture operational and embodied impacts across the facility lifecycle (see Table 3).

2 Assess future scenarios alongside current conditions

Developers are increasingly planning for data centre lifespans of 30 years or more,⁴² so facilities must remain relevant and resilient amid evolving environmental conditions, AI and compute demand, and infrastructural and technological changes.

EXAMPLE: Given future uncertainty, stakeholders can conduct climate change risk assessments (CCRAs)⁴³ and climate risk and vulnerability assessments (CRVAs)⁴⁴ to identify the most material physical climate hazards and inform design and/or adaptation decisions. They can complement these assessments with scenario planning and risk-adjusted forecasts that consider infrastructure bottlenecks, supply-chain constraints, permitting delays, resource availability, changing market conditions and evolving climate risks. Together, these approaches can identify risks and opportunities that may not be apparent from present-day assessments, supporting long-term planning under uncertainty.

For example, Rystad Energy's risk-adjusted estimate is that under half of announced global AI data centre capacity (262 GW) is likely to materialize by 2030, illustrating the wide range in future infrastructure outcomes.⁴⁵ Long-term “financeability” and insurability are indicators of infrastructure resilience, reflecting how climate and other systemic risks are assessed over time.

3 Consider system and social implications alongside project-level impacts

Existing frameworks focus on individual facility performance, which provides an important foundation, but sustainability and resilience are additionally shaped by systems. A facility that performs well in isolation may contribute to resource competition, infrastructure bottlenecks or community pressures when considered alongside others. A more complete understanding of how decisions affect regional sustainability and resilience is critical.

EXAMPLE: Various guidance and frameworks introduced in previous Forum reports⁴⁶ provide useful tools for assessing system-level dependencies, impacts, risks and opportunities. These include:

- Taskforce on Nature-related Financial Disclosures (TNFD)'s LEAP approach.⁴⁷
- TNFD's draft sector guidance on technology and communications.⁴⁸
- United Nations Environment Programme (UNEP)'s guidelines for conducting integrated environmental assessments.⁴⁹
- Business for Nature's Assess, Commit, Transform, Disclose (ACT-D) framework.

Similarly, stakeholder engagement assessments, community perception surveys and resource impact assessments can improve understanding of impacts on surrounding communities throughout planning, construction and operations.

4 Preserve optionality and adaptability where possible

The pace of technological innovation is increasing and future infrastructure requirements are difficult to predict. Decisions that preserve future options can provide greater long-term value even at the expense of near-term performance or higher upfront capital cost.

EXAMPLE: Decisions relating to cooling, power systems, facility layouts and procurement can preserve flexibility and reduce future retrofit requirements (see Table 5).

5

Use context-aware metrics to complement operational performance metrics

Operational efficiency metrics remain foundational for measuring facility efficiency and can be complemented by context-aware metrics that account for local resource constraints, climate and broader system interactions. Facilities with similar operational performance can have very different impacts on sustainability and resilience depending on where they operate.

EXAMPLE: WUE is an important measure of water efficiency, but it does not reflect the degree of local water constraints. The water usage impact (WUI) metric developed by The Green Grid complements WUE by incorporating regional water stress.⁵⁰

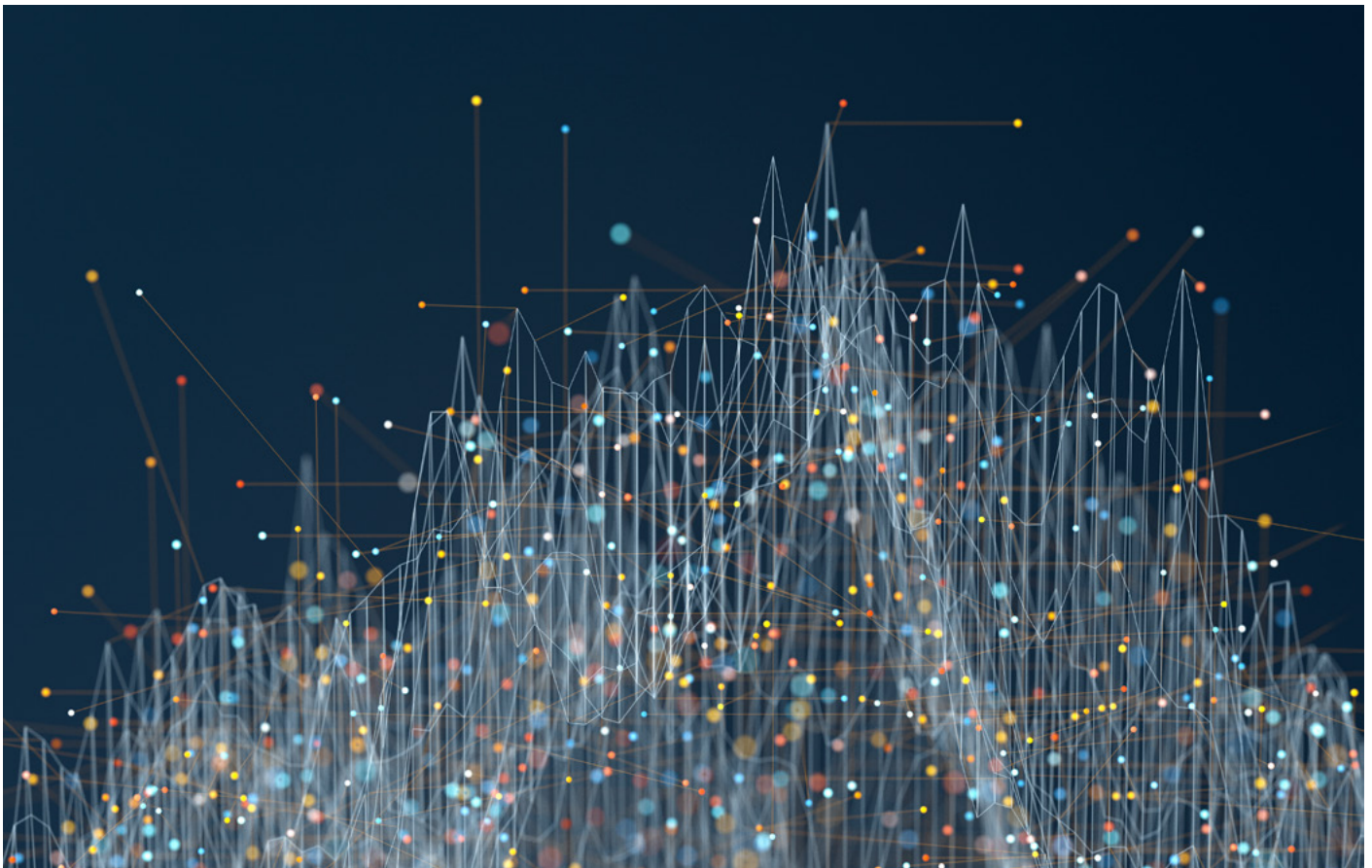
6

Consider the sustainability implications of connectivity and interconnection

Decisions about how data centres connect to digital and energy infrastructure can have sustainability and resilience implications beyond the facility boundary. While utilities and network operators are primarily responsible for the sustainability and resilience of this infrastructure, stakeholders directly involved in data centre development or operations can influence associated impacts through siting, infrastructure requirements, and their choice of energy and connectivity providers. Considering these implications alongside facility-level impacts provides a more complete understanding of a data centre's sustainability and resilience footprint.

EXAMPLE: Assessing transmission connections, substations, fibre routes and other enabling infrastructure alongside the facility provides a more complete understanding of a data centre's broader sustainability and resilience footprint. High-capacity, low-latency connectivity can also enable more sustainable siting by allowing compute to be located where power is more abundant or lower-carbon and can support the distribution and shifting of workloads across facilities.

These six principles provide a common foundation for decision-making across stakeholders and stages of development.



3.2 Recommended metrics

Table 3 presents a set of recommended metrics that stakeholders can track and, where appropriate, disclose to evaluate data centre sustainability and resilience. These metrics provide a starting point across stakeholder groups, supporting operational improvement, customer procurement, investment due diligence and policy design. Metrics may extend beyond stakeholders' spheres of control, therefore requiring engagement and collaboration with upstream stakeholders. Chapter 5 outlines how different stakeholders can apply these metrics within their respective roles. Additional metrics may be appropriate depending on local conditions and stakeholder priorities.

The metrics have been classified as follows, to reflect both the maturity of each metric and the extent of its current adoption across public and non-public disclosure practices:

- **Foundational:** Well-defined and more widely reported across the industry.
- **Emerging:** Well-defined but not yet widely reported.
- **Aspirational:** Not yet comprehensively defined or consistently reported.

BOX 3 Aims of these metrics

Collectively, these metrics set out to achieve four aims:

1. **Retain operational efficiency** (e.g. PUE, WUE and CUE).
2. **Add total footprint and lifecycle metrics** (e.g. whole-life carbon, total water footprint and material circularity indicator).
3. **Incorporate local context** (e.g. WUI, climate risk exposure and community benefit).
4. **Capture resilience, community and nature outcomes** (e.g. service availability/uptime, biodiversity net gain (BNG) and land-use change).

The metrics support decision-making rather than prescribe universal reporting. They are intended to be considered collectively, recognising that trade-offs between objectives, such as energy and water use, may require different decisions depending on local resource constraints, climate conditions and available technologies. Their application, whether for tracking, reporting or other purposes, will

depend on continued alignment around definitions, methodologies and reporting practices. They complement existing guidance, including from TNFD's draft sector guidance⁵¹ and the Open Compute Project,⁵² which proposes metrics such as energy reuse factor (ERF), species extinction risk, ecosystem condition and use of alternative water sources.



TABLE 3 | Recommended metrics to assess data centre sustainability and resilience



Foundational



Emerging



Aspirational

Dimension	Metric	Description	Unit	Range; ideal	Classification
Energy	PUE	Total facility energy consumption divided by IT equipment energy, ⁵³ including servers, storage and network gear	Ratio	≥1.0; 1.0	
	Total energy consumption (EDC)	Total energy consumed by the supporting equipment and IT hardware ⁵⁴	MWh/year	Context dependent; lower	
	Hourly carbon-free energy share (CFE) (%)	% of electricity supplied by carbon-free energy generation on an hourly basis ⁵⁵	%	0-100%; 100%	
Water	WUE	Water consumed per unit of IT equipment energy ⁵⁶	L/kWh	≥0; approaching 0	
	WUI	Water consumption adjusted for local water stress ⁵⁷	L/kWh	0-12; 0	
	Total water footprint	Total direct, indirect and embodied water consumption across lifecycle ⁵⁸	m³ over asset lifetime	≥0 (context-dependent); lower	
Carbon	Whole-life carbon ⁵⁹	Total embodied and operational carbon emissions across lifecycle ⁶⁰	kg CO ₂ e over asset lifetime	≥0; lower	
	CUE	Carbon emissions per unit of IT equipment energy consumed ⁶¹	kg CO ₂ e/kWh IT energy	≥0; 0	
IT	IT equipment utilization (ITEU)	% of available capacity actively being used	%	0-100%; context-dependent	
	IT energy efficiency (ITEE)	Number of tasks performed over energy consumed ⁶²	Capacity/kW	≥0; higher	
Resilience	Service availability / uptime	Percentage of time services remain operational ⁶³	%	0-100%; 100%	
	Climate risk exposure	Exposure to climate hazards (e.g. flooding, heat, drought and wildfire)	Score	Context-dependent	
Social & health	Community benefit	Benefit to local employment, tax revenue and community partnerships	Composite index score	Context-dependent	
	Air pollution	Change in air quality and levels of pollutants from facility development and operations	%	Context-dependent	
	Community disturbance	Noise, light and visual impacts on surrounding communities	Composite index score	Context-dependent	

Dimension	Metric	Description	Unit	Range; ideal	Classification
Land & biodiversity	Biodiversity net gain (BNG)/loss	Change in biodiversity value between pre- and post-development ⁶⁴	%	No defined range; higher gain	
	Land-use change	Change in land use from development and impacts on ecosystems ⁶⁵	%	Lower conversion of high-value land; prioritize previously developed or appropriately zoned commercial and industrial land where feasible.	
Materials & circularity	Material circularity indicator (MCI)	Composite measure of recycled material content, the recovery potential of equipment and construction materials and minimization of waste to landfill across the lifecycle ⁶⁶	Composite index score	0-1; 1	

Note: MWh = megawatt hours, kWh = kilowatt hours, L = litres, kg CO₂e = kilograms of carbon dioxide-equivalent.

As the measurement of sustainability evolves, organizations such as The Green Grid are refining metrics including data centre resource effectiveness (DCRE) and energy usage impact (EUI) to support more comprehensive assessment of data centre sustainability and resource impacts. Approaches such as sustainable water use factor (SWUF) can complement water-use metrics by capturing positive contributions to water resilience.⁶⁷ Similar gaps exist in energy efficiency: PUE does not distinguish energy used for computation from auxiliary IT loads and losses, such as fans, pumps and power conversion losses. Emerging compute-

level metrics can complement PUE by relating energy or carbon consumption more directly to computational performance.

As these metrics mature, they can support broader and more comprehensive sustainability and resilience assessment. Furthermore, the Forum’s December 2025 report, [Nature Positive: Role of the Technology Sector](#),⁶⁸ addresses important topics that are not readily captured by the recommended metrics, including circularity and refurbishment through priority actions (see [Appendix A6](#)).

CASE STUDY 3

Google on extending the life of data centre hardware through component harvesting and reverse logistics

Google’s approach to data centre hardware provides an example of how circularity principles can extend the useful life of hardware and components through reuse, repair and recycling.

Google operates a value-preservation hierarchy spanning internal reuse, remarketing and recycling for critical raw materials. Google tests and securely wipes decommissioned assets for reintegration into its own inventory and server fleet, reselling into the secondary market and, at the absolute end of their functional life, recycling for material recovery. Earlier in the equipment lifecycle, Google applies design for sustainability (DfS) guidelines through its new product introduction (NPI) process to prioritize modularity, standardization,

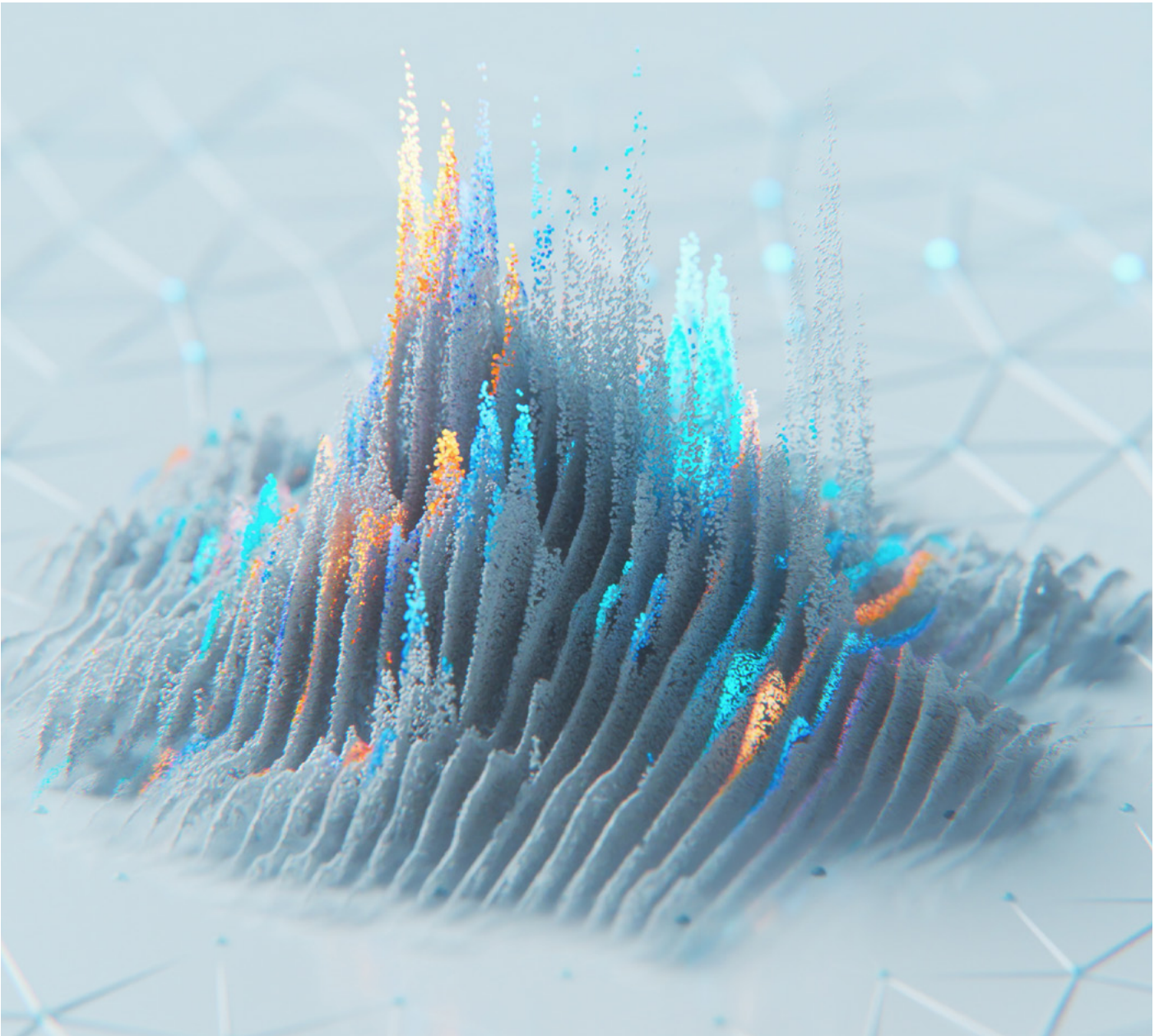
durability and ease of disassembly. By baking in circularity principles at the blueprint stage, Google can enable smoother circular operations when hardware enters the data centre.

In 2025, Google reported harvesting more than 7.5 million components from decommissioned hardware for internal reuse and reselling 2.6 million components into secondary markets for reuse by other organizations, bringing the total number of components resold from 2015 to 2025 to more than 54 million. The company also reported an 88% operational waste diversion rate across Google-owned and operated data centres and estimated that its fleet deployment sustainability programme avoided 1.5 million tonnes of CO₂-equivalent in lifecycle emissions in 2025.

4

Market constraint profiles: why local context changes the answer

There is no universal blueprint for sustainable and resilient data centres. Understanding local context and constraints enables actors to adapt decisions and improve outcomes.



4.1 Six market constraint profiles

Data centre sustainability and resilience are increasingly shaped by factors beyond the facility itself, from resource availability to regulatory and community conditions. Building on the analysis presented in the previous report,⁶⁹ this chapter identifies six constraints that consistently emerged across literature, stakeholder discussions and market assessments as the most significant determinants of data centre sustainability and resilience.

These constraints rarely occur in isolation. Instead, recurring combinations create distinct patterns of

trade-offs, risks and opportunities across markets. These recurring patterns are grouped into six illustrative market constraint profiles that help stakeholders apply the universal decision principles in ways that reflect local conditions. The ratings indicate how strongly each constraint typically impacts data centre buildout and long-term sustainability and resilience within each profile. The profiles can be used as archetypes rather than prescriptive classifications, recognising the diversity of individual markets. Individual sites within the same market may not align perfectly with a single profile.

TABLE 4 Data centre market constraint profiles

Constraint severity: Low Medium High

Market constraint profile	Cooling requirements*	Water scarcity	Land trade-offs	Power scarcity	Regulatory complexity	Local community resistance
Heavily constrained hub markets: highly mature markets where competition for power, water and land is intensifying and expansion is increasingly met with community resistance and shaped by infrastructure and regulatory constraints. ⁷⁰ e.g. Northern Virginia, Santa Clara						
Policy-shaped established markets: growth strongly shaped by policy choices, grid allocation and efficiency requirements. ⁷¹ e.g. Amsterdam, Seoul, Dublin						
Hot, resource-constrained growth markets: fast-growth markets where hot climates drive cooling demand, and power and water face trade-offs. ⁷² e.g. Texas, Spain, UAE, Phoenix						
Urban infrastructure-constrained markets: strong demand, but with utility, land and permitting complexity. ⁷³ e.g. London, Sydney, Beijing						

Market constraint profile	Cooling requirements*	Water scarcity	Land trade-offs	Power scarcity	Regulatory complexity	Local community resistance
Land and power bottleneck markets: scarce developable land and power resources, often with strict permitting. ⁷⁴ e.g. Frankfurt, Tokyo						
Grid-limited expansion zones: grid capacity constraints, despite favourable cooling or renewable characteristics. ⁷⁵ e.g. Nordic markets						

Note: *Cooling requirements refers to increased cooling demand associated with high ambient temperatures and climate conditions, rather than the availability of cooling infrastructure itself.

4.2 How to use the market constraint profiles

When assessing specific data centre projects, stakeholders can apply these profiles as follows:

1. Identify the top constraints in the sited market.
2. Map the facility/site to the closest applicable profile.
3. Use the profile to stress-test key decisions against local market constraints.

4. Apply the stakeholder recommendations in Chapter 5 using the context of the relevant market profile (see [Appendix A7](#) for examples of market constraint profile-specific recommendations).
- As markets evolve, the top constraints affecting individual facilities may also change. These profiles provide a flexible framework for adapting the stakeholder recommendations in Chapter 5 to local conditions.

CASE STUDY 4

AWS on reducing potable water demand through recycled water

AWS provides an example of how data centres can combine alternative water sources with cooling system design and operational controls to reduce reliance on potable water. All AWS data centres in Singapore use NEWater, Singapore’s high-grade recycled water, for cooling.

The facilities combine recycled water with measures to reduce water consumption for cooling. These include real-time monitoring to identify leaks, automated cooling tower water treatment that enables water to be reused more times before discharge, and rainwater harvesting. AWS also piloted and deployed an electro-oxidation water treatment technology designed to improve cooling tower efficiency.

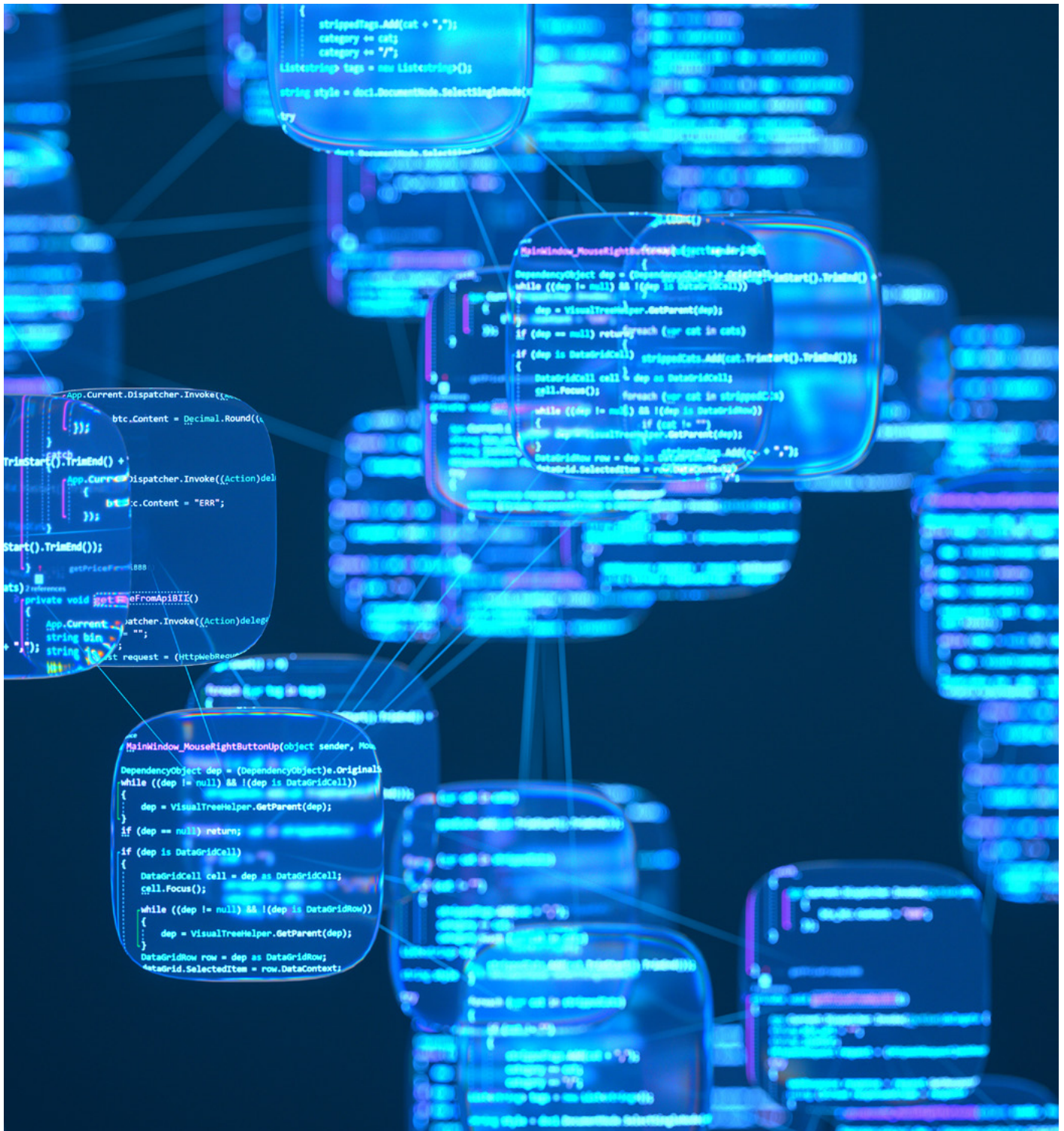
AWS collaborated in Singapore to implement a sidestream water treatment system that treats cooling tower water for reuse, reducing overall fresh water demand. Singapore’s national water agency (PUB) reported that the facility performs within the top 10% of the country’s data centre sector for water efficiency.

The case demonstrates how water source selection, cooling system design and operational water management can be considered together in water-constrained locations. Combining non-potable water sources with technologies that increase reuse can reduce demand on potable supplies and improve the efficiency of water used for cooling.

5

Stakeholder playbook and recommendations

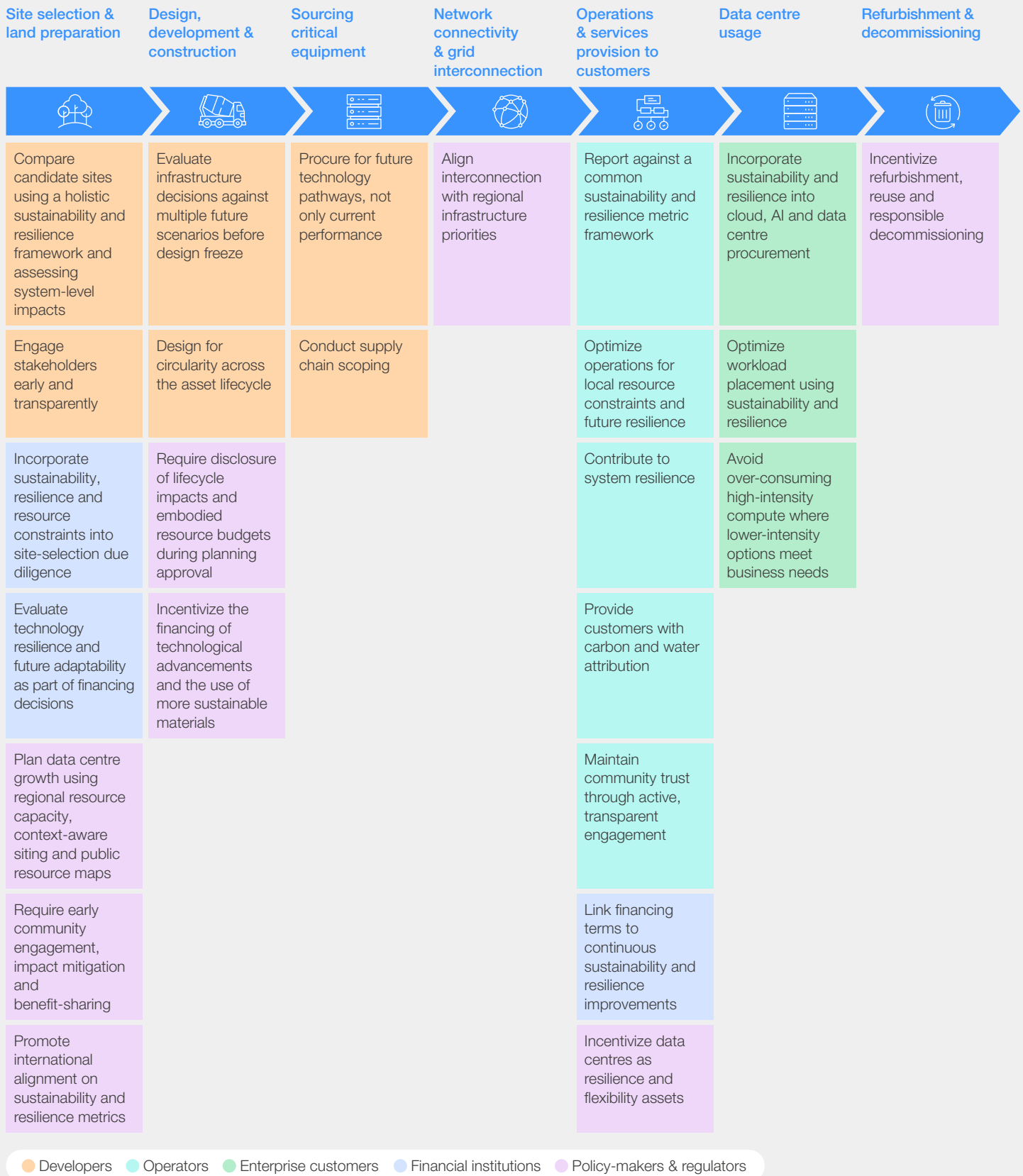
Improving sustainability and resilience involves coordinated action across developers, operators, customers, financial institutions and policy-makers.



This chapter builds on the universal design principles and metrics recommended in Chapter 3 to offer practical recommendations for five key sets of stakeholders across the data centre ecosystem: developers, operators, enterprise customers, financial institutions and policy-makers.

Recommendations are summarised in Figure 7, while [Appendix A7](#) provides more detailed recommendations by market constraint profile. [Appendix A8](#) proposes a data centre assessment checklist.

FIGURE 7 Stakeholder-specific recommendations



Siting and land considerations

1 Compare candidate sites using a holistic sustainability and resilience framework and assess system-level impacts

Integrated sustainability and resilience siting frameworks can identify trade-offs early, when mitigation is typically more effective and less costly. Early assessment can strengthen long-term resilience and support the future availability and affordability of insurance. These frameworks encourage consideration of resource availability, environmental conditions and community impacts alongside traditional technical and commercial criteria.

Tools and approaches to support the assessment of technical, environmental and social considerations alongside cumulative impacts on shared systems include the following:

- Geographic information systems (GIS)
- Multi-criteria decision analysis (MCDA)⁷⁶
- TNFD's LEAP⁷⁷
- International Finance Corporation (IFC)'s Performance Standards⁷⁸
- AI Data Center Energy Performance Framework, published by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers), NEMA (National Electrical Manufacturers Association) and PNNL (Pacific Northwest National Laboratory)⁷⁹
- Business for Nature's ACT-D framework⁸⁰
- Climate change risk assessment (CCRA)⁸¹
- Climate risk and vulnerability assessments (CCRAs)⁸²
- International Organization for Standardization (ISO) 14091⁸³
- Physical Climate Risk Appraisal Methodology (PCRAM) 2.0⁸⁴

“Early engagement, transparent communication and collaborative partnerships can strengthen the social licence to operate, reduce permitting risks and build long-term community trust and project success.”

These frameworks can inform strategic siting and infrastructure planning, including opportunities to redevelop brownfield sites and minimize impacts on high-value ecosystems and agricultural land. They can also help identify material physical climate hazards, evaluate adaptation options and inform site selection and design.

2 Engage stakeholders early and transparently

Affected communities, utilities and other stakeholders are best engaged early, to identify potential concerns and opportunities before they become major barriers. Early engagement, transparent communication and collaborative partnerships can strengthen the social licence to operate, reduce permitting risks and build long-term community trust and project success. This includes sharing expected resource demands, identifying opportunities for mutual benefit and coordinating decisions where infrastructure and resource planning are interconnected.

Design, development and construction

1 Evaluate infrastructure decisions against multiple future scenarios before design freeze

Future scenarios to plan for include changes in AI adoption, technology, climate, infrastructure development and resource or regulatory conditions. Frameworks such as ISO 14090 and British Standard (BS) 8631⁸⁵ can support long-term adaptation planning by identifying adaptation pathways and decision points as climate conditions evolve. Considering a range of plausible futures helps identify risks, trade-offs and mitigation opportunities before design freeze.

Design strategies such as flexible loads, battery energy storage systems, intelligent energy management and advanced controls (see Table 5) can improve adaptability while supporting demand response programmes and evolving electricity markets.



TABLE 5 | Design decisions and optionality enabled

Infrastructure system	Design strategy	Example implementation	Future optionality enabled
Cooling systems	Design for future liquid-cooling integration	Reserve space, piping routes, utility capacity and structural floor loading capacity for future liquid-cooling infrastructure and higher-density AI hardware ⁸⁶	Supports transitions from air cooling to liquid cooling as rack densities increase
	Use modular cooling architectures	Install chilled-water distribution systems and connection points that can support both current air-cooling systems and future liquid-cooling loops ⁸⁷	Enables phased adoption of higher-capacity cooling technologies
Water infrastructure	Design for future connection to alternative water sources	Design dual-piping systems or reserve connection points for recycled, reclaimed or non-potable water supplies ⁸⁸	Reduces exposure to future water constraints and supports alternative water sourcing
	Design for future water reuse	Reserve space for future water treatment, recycling and reuse systems ⁸⁹	Supports future water-efficiency improvements and water reuse opportunities
Electrical infrastructure	Build expansion capacity into electrical systems	Reserve space within substations, switchgear rooms and electrical distribution pathways for future transformers, switchgear and higher-capacity feeders ⁹⁰	Supports future increases in power demand and rack densities
Power systems	Enable future integration of alternative power technologies	Design electrical systems to accommodate battery energy storage, onsite generation and future carbon-free energy technologies ⁹¹	Supports evolving resilience and decarbonization strategies
Backup power systems	Preserve flexibility across backup power pathways	Design electrical architecture to support battery storage, alternative fuels and emerging backup power technologies ⁹²	Reduces technology lock-in as backup power solutions evolve
Facility layout	Design for future expansion	Reserve white space, mechanical space and utility corridors for future equipment deployment ⁹³	Supports expansion and infrastructure upgrades without major redesign
Building structure	Design for future increases in equipment density	Incorporate sufficient floor loading, ceiling heights and structural capacity for future equipment requirements ⁹⁴	Supports evolving compute and cooling requirements
	Design for future increases in natural hazard risk	Design data centres with wind- and impact-resistant building envelopes in hurricane-prone areas, and reinforced structural systems in tornado-prone areas ⁹⁵	Reduces exposure to physical damage and disruption from natural hazards
Connectivity infrastructure	Preserve connectivity expansion pathways	Provide spare conduit, fibre routes and interconnection capacity ⁹⁶	Supports future growth, redundancy and network upgrades
Equipment procurement	Prioritize modular and upgradeable systems	Select equipment with standardized interfaces, upgrade pathways and modular components ⁹⁷	Reduces technology lock-in, extends asset life, supports circularity through refurbishment and critical material recovery, and improves long-term resource security

2 Design for circularity across the asset lifecycle

Developers can incorporate circularity into initial design decisions by considering how buildings, infrastructure and equipment can be upgraded, refurbished, reused or repurposed over time. Adaptable and modular designs can enable component replacement and technology upgrades without extensive reconstruction, extending asset life and reducing the resource use and waste associated with major refurbishment or decommissioning. Design strategies – such as modular and upgradeable equipment and infrastructure that accommodates future technology changes – can support these outcomes (see Table 5).

Critical infrastructure equipment sourcing

1 Procure for future technology pathways, not only current performance

Apart from ongoing performance, cost and availability, procurement decisions can also

consider upgradeability, interoperability, future cooling compatibility and support for evolving workloads. Infrastructure designs that reserve space, utility capacity and connection points for future technologies can further improve adaptability, reducing retrofit costs, extending asset life and enabling future technology adoption without major reconstruction.

2 Conduct supply chain scoping

This includes scoping for critical equipment and construction materials, while engaging suppliers on embodied carbon, water use, material sourcing and circularity through recognised disclosure frameworks where appropriate. These approaches improve procurement transparency while reducing exposure to resource constraints, supply-chain disruptions and geopolitical risks. Publicly Available Specification (PAS) 2080⁹⁸ provides an established framework for managing and reducing whole-life carbon across design, procurement and construction, supporting more informed infrastructure decisions early in the project lifecycle.



“Cooling, power and water systems need continuous optimization in response to changing resource constraints and customer demand.”

Operations and service provision

1 Report against a common sustainability and resilience metrics framework

Consistent reporting improves visibility into operational performance while providing greater transparency on lifecycle impacts and local context, supporting a more complete understanding of sustainability and resilience. Operators can draw on the metrics presented in [Table 3](#), as well as voluntary industry initiatives in [Table 6](#), such as the Climate Neutral Data Centre Pact (CNDP).⁹⁹

2 Optimize operations for local resource constraints and future resilience

Cooling, power and water systems need continuous optimization in response to changing resource constraints and customer demand. Strategies that are effective during commissioning may become less appropriate as workloads, climate conditions and regional resource constraints evolve. This reinforces the need for adaptive operational strategies. Digital monitoring, automation and AI can support adaptive operations by coordinating computing workloads, network traffic and electricity availability.

3 Contribute to system resilience

Operational decisions and collaboration with utilities and other stakeholders, where appropriate, can contribute to the resilience of electricity and water systems on which facilities depend. This may include participating in demand response programmes, shifting flexible computing workloads across geographically distributed sites or supporting water stewardship initiatives, such as water replenishment or watershed restoration. These approaches can strengthen regional infrastructure resilience while supporting local communities, ecosystems and the facility's social licence to operate.

4 Provide customers with carbon and water attribution

Providing customers with more granular attribution of the environmental impacts associated with their workloads supports more informed customer decisions and enables greater transparency on the sustainability implications of different digital services.

5 Maintain community trust through active, transparent engagement

Sustained community engagement, through transparent communication and responsiveness to local concerns, can build trust, reduce operational risks, support future expansion and strengthen the facility's long-term social licence to operate.

CASE STUDY 5

Ant Group on improving AI computing efficiency and cleaner electricity use

Ant Group's approach provides an example of how improving AI computing efficiency and increasing the use of cleaner electricity can be considered together to manage the energy and carbon impacts of growing AI workloads.

To consolidate computing resources, Ant Group uses a unified platform for LLM training and inference and has transitioned from direct GPU allocation to a token-based service model. This approach can allow computing resources to be pooled and allocated according to demand, potentially reducing underutilized capacity.

At the training and inference level, Ant Group optimizes its inference engine for online and offline scenarios and adapts it for heterogeneous accelerators, alongside intelligent

scheduling and other optimization measures. According to the company, these measures increased GPU utilization during inference by 2.3 times compared with before optimization, reducing the computing resources required for the same workload.

Ant Group also considers data centre deployment and electricity sourcing, prioritizing additional computing capacity in regions with greater renewable energy availability. It forecasts computing and electricity demand and coordinates with Alibaba Cloud to increase clean-electricity sourcing based on regional availability. In 2025, Ant Group reported that clean electricity accounted for approximately 65% of data centre electricity use, including ~37% from renewable energy.

Recommendations for enterprise customers

Data centre usage

1 Incorporate sustainability and resilience criteria into procurement

Enterprise customers hold the power of change in their procurement processes – as detailed in the Forum’s October 2025 report, [Green Procurement Playbook: The CPO’s Guide to Delivering Value for Business and Planet](#).

By requesting greater transparency from providers on their performance and decision-making, chief procurement officers can help ensure that sustainability and resilience criteria are embedded into the design and delivery of data centres, AI capacity and cloud services. Procurement decisions can influence provider investments in energy efficiency, water stewardship, resilience and long-term sustainability, strengthening market signals for more sustainable and resilient digital infrastructure.

“ Procurement decisions can influence provider investments in energy efficiency, water stewardship, resilience and long-term sustainability.

2 Optimize workload placement using sustainability and resilience

As sustainability information becomes more granular, digital service providers can provide end users with greater transparency about the environmental implications of different digital services. Enterprise customers can prioritize deployment options that consider local environmental conditions and infrastructure resilience alongside performance and cost requirements.

3 Avoid over-consuming high-intensity compute where lower-intensity options meet business needs

Periodic review of AI models and usage patterns enables customers to match their compute intensity to business requirements. Practices such as using lower-intensity models or non-AI approaches where appropriate, as well as scheduling flexible workloads during periods of lower environmental impact, can reduce costs while improving the efficient use of constrained computing, energy and water resources.



Site selection and land preparation

1 Incorporate sustainability, resilience and resource constraints into site-selection due diligence

As part of their underwriting and due diligence, financial institutions can assess how developers evaluate candidate sites – including their future resource, climate and sustainability risks – across the project lifecycle and supply chain. This includes evaluating whether siting, design and adaptation decisions were informed by CCRAs, CRVAs or equivalent methodologies, such as the physical climate risk appraisal methodology (PCRAM) 2.0 assessments and GRESB.¹⁰⁰ Labels such as the FAST-Infra Label¹⁰¹ and frameworks like the Equator Principles,¹⁰² together with the metrics in Table 3, can help evaluate the robustness of these assessments and whether climate and resource risks have been appropriately incorporated into project design before major capital is committed. Financial institutions can consider whether developers and operators provide sustainability-related financial disclosures aligned with IFRS S1 and IFRS S2,¹⁰³ where applicable, to support assessment of material sustainability- and climate-related risks and opportunities; they can also consider how projected climate risks may influence the long-term availability and cost of insurance.

Beyond individual projects, due diligence can also consider cumulative infrastructure pressures, community acceptance and long-term regional growth pathways. Facilities that improve the productivity of constrained resources without requiring proportional increases in resource

demand may be better positioned to maintain competitiveness and long-term asset value as regional constraints intensify.

2 Evaluate technology resilience and future adaptability as part of financing decisions

Financing decisions can include an assessment of whether facilities are designed to accommodate future increases in compute density, evolving cooling requirements and infrastructure expansion. Consideration must also be given to the long-term insurability of assets, as technology, climate risks and asset values evolve. Facilities that support multiple future technology and infrastructure pathways present lower stranded-asset risks.

Operations and service provision

1 Link financing terms to continuous sustainability and resilience improvements

Financial institutions can link financing terms to performance trajectories rather than one-time thresholds, rewarding continuous improvements in sustainability and resilience throughout the asset lifecycle. Application differs across financing instruments. Sustainability-linked loans and bonds can incorporate sustainability and resilience performance targets and reporting requirements, while project finance may use financing conditions, covenants and due diligence requirements to manage project risks. Equity investors may place greater emphasis on long-term asset adaptability, resilience and value creation when assessing investment opportunities.

“As part of their due diligence, financial institutions can assess how developers evaluate future resource, climate and sustainability risks across the project lifecycle and supply chain.”



Recommendations for policy-makers and regulators

Site selection and land preparation

1 Plan data centre growth using regional resource capacity, context-aware siting and public resource maps

Policy-makers can deploy a range of tools to steer development towards locations that can support sustainable and resilient growth. Publishing data on regional resource capacity (assessments of the availability of resources such as energy, water and land) and public resource maps (that visualize these constraints and opportunities) can help distinguish areas constrained by fundamental resource limitations from those where targeted investments in energy, water or other enabling infrastructure could responsibly support future growth. Developing these tools in collaboration with utilities, industry, local communities and other stakeholders can help ensure they reflect local conditions, infrastructure plans and evolving resource constraints.

Combined with permitting frameworks and incentives, these tools can encourage development in lower-impact locations while directing growth to areas where digital infrastructure can scale up without shifting costs and risks onto local communities, utilities or ecosystems. Regional adaptation planning approaches, including ISO 14092,¹⁰⁴ can help policy-makers integrate climate risks into long-term infrastructure, land-use and community planning.

2 Require early community engagement, impact mitigation and benefit-sharing

Policy-makers can require developers to engage with communities early in the siting process, disclose anticipated resource demands and environmental impacts, and report on mitigation and benefit-sharing measures. Community benefit agreements can reflect local priorities and include investments in shared infrastructure, education and workforce development, environmental restoration, water stewardship or other initiatives that strengthen long-term community resilience.

3 Promote international alignment on sustainability and resilience metrics

By working with industry, standards bodies and international organizations, policy-makers can promote alignment around a common set of sustainability and resilience metrics for data centres,

together with consistent definitions, methodologies and reporting approaches. Greater international consistency can improve benchmarking, reduce reporting burdens, support investment decision-making and enable more effective comparison of facilities across markets.

Building on existing international reporting frameworks and standards where possible can avoid unnecessary duplication, while encouraging interoperability between regulatory and voluntary reporting approaches.

Design, development and construction

1 Require disclosure of lifecycle impacts and embodied resource budgets during planning approval

As part of planning approval, regulators can require disclosure of embodied carbon, embodied water, construction waste and material circularity, alongside projections of how major design decisions influence sustainability over the project lifecycle. Where possible, these disclosures should build on existing planning and environmental assessment processes to minimize additional reporting burdens.

Extending assessment beyond operational performance into the design and development phase enables policy-makers to influence sustainability and resilience at the moment when many of the most consequential infrastructure decisions are made.

2 Incentivize the financing of technological advancements and the use of more sustainable materials

Policy-makers can create incentives that encourage financial institutions to invest in technological innovation and developers to adopt more sustainable technologies and materials. These could include grants, tax breaks, procurement policies, public-private partnerships or other financing mechanisms linked to measurable sustainability and resilience outcomes.

Priority areas include advanced cooling and water reuse technologies, grid modernization and connectivity infrastructure, lower-impact construction materials, and other innovations that improve the efficient use of constrained resources.

“ Building on existing international reporting frameworks and standards can avoid unnecessary duplication, while encouraging interoperability between regulatory and voluntary reporting approaches.

“ Well-designed market mechanisms can improve grid reliability, facilitate renewable energy integration and reduce the need for additional infrastructure investment.

Network connectivity and grid interconnection

1 Align interconnection with regional infrastructure priorities

Where multiple projects compete for limited grid interconnection capacity, policy-makers and regulators can work with utilities and grid operators to establish transparent frameworks for managing and, where appropriate, prioritizing connection requests. Regional resource-capacity assessments and public resource maps developed during planning and siting can help identify where grid constraints are most acute and inform locally appropriate interconnection strategies.

Criteria such as infrastructure readiness, efficient use of constrained capacity, demand flexibility and contributions to grid resilience can help inform how competing requests are assessed. Transparent and consistently applied approaches can provide developers with greater certainty while helping align limited grid capacity with regional infrastructure and energy-system priorities.

Operations and service provision

1 Incentivize data centres as resilience and flexibility assets

Policy-makers can offer incentives and market mechanisms that reward data centres for contributing to the resilience and flexibility of the electricity and water systems on which they depend. These incentives should reward demonstrable resilience and flexibility services rather

than routine energy-price arbitrage. Market rules can also ensure that programme costs and benefits are shared equitably across electricity system users.

Examples include demand-response programmes operated by grid operators such as ERCOT in Texas and National Grid in the United Kingdom, together with district heating networks in Denmark, Sweden and Finland that utilize waste heat from data centres. Well-designed market mechanisms can improve grid reliability, facilitate renewable energy integration and reduce the need for additional infrastructure investment, while encouraging positive system contributions.

Refurbishment and decommissioning

1 Incentivize refurbishment, reuse and responsible decommissioning

Policy-makers can use incentives, standards and waste-management requirements to encourage refurbishment, reuse and repurposing of data centre infrastructure and equipment before decommissioning. Measures can include incentives for extending asset lifetimes, requirements for decommissioning and material-recovery plans, extended producer responsibility (EPR) requirements¹⁰⁵ for relevant equipment and electronics, and policies that support secondary markets for reusable equipment and components.

Prioritizing refurbishment and reuse where appropriate can reduce waste and demand for newly extracted materials while preserving the economic value embedded in existing buildings, equipment and infrastructure.



6

Call to action

Organizations that embed sustainability and resilience into planning, investment and operations will be better positioned to navigate future risks and protect long-term value.



The decisions made today shape the long-term environmental, social and infrastructure impacts of AI infrastructure for decades. The critical task is to future-proof rapidly deployed AI infrastructure by embedding sustainability and resilience from the outset.

The long-term competitiveness of individual facilities and data centre hubs increasingly depends on resilient resource access, adaptability and stakeholder confidence.

To strengthen long-term data centre sustainability and resilience, developers, operators, investors and policy-makers can reference the five considerations in [Figure 2](#). Each stakeholder has a distinct role to play:

- **Developers** should choose sites and designs that remain viable under future resource, climate and technology conditions.
- **Operators** should optimize facilities against local constraints and provide customers with transparent sustainability and resilience information.
- **Enterprise customers** should incorporate sustainability and resilience into procurement, workload placement and compute demand decisions.

- **Financial institutions** should underwrite based on the impact of resource constraints, adaptability, climate exposure, supply-chain risk and community acceptance on asset value.
- **Policy-makers and regulators** should move from project-by-project permitting towards regional resource planning, context-aware siting, lifecycle disclosure, community safeguards and incentives for data centres that support system resilience.

The rapid expansion of AI presents a once-in-a-generation opportunity to reshape how digital infrastructure is planned, financed and operated. Public and private investment in AI infrastructure is driving one of the largest infrastructure build-out cycles in recent history, making the decisions taken today increasingly consequential. These decisions will determine not only the environmental footprint of future data centres, but also their long-term resilience, business continuity and ability to support sustained economic growth. Organizations that integrate sustainability and resilience into investment, design and operational decisions are likely to be better positioned to navigate future resource constraints, protect long-term asset value and adjust to changing stakeholder expectations.

Appendix

A1 Industry coalitions and initiatives

Table 6 summarises selected industry initiatives supporting sustainable and resilient data centre development.

TABLE 6 Coalitions and initiatives

Initiative	Lead	Primary focus
Greening AI Data Centres Coalition	World Green Building Council (WorldGBC)	Develops guidance and shares best practices to improve the sustainability of AI data centres ¹⁰⁶
Data Center Innovation Initiative	Elemental Impact (partnered with Google, Meta and Microsoft)	Scales up innovative technologies that improve energy efficiency, cooling performance and lower-carbon construction ¹⁰⁷
Climate Neutral Data Centre Pact (CNDCP)	European industry	Coordinates voluntary industry commitments on climate neutrality, renewable energy, energy efficiency, water stewardship and circularity ¹⁰⁸
iMasons Climate Accord	Infrastructure Masons	Coordinates industry collaboration to reduce carbon emissions and accelerate decarbonization across digital infrastructure ¹⁰⁹
Open Compute Project (OCP)	OCP Foundation	Develops open hardware designs and technical specifications that improve the efficiency, scalability and sustainability of data centre infrastructure ¹¹⁰
European Green Digital Coalition	European Commission	Promotes digital technologies that support the green transition by illustrating how the digital infrastructure can reduce environmental impacts across sectors ¹¹¹
Water-AI Nexus Center of Excellence	Water Environment Federation, Amazon, The Water Center at the University of Pennsylvania and Leading Utilities of the World	Advances research, knowledge sharing and cross-sector collaboration to improve water sustainability, management and resilience for AI infrastructure ¹¹²
Danish Data Center Alliance	The Trade Council of Denmark	Connects Danish technology providers with the North American data centre market to promote sustainable and resilient infrastructure solutions, including renewable integration, water management and district heating ¹¹³
Emissions First Partnership (EFP)	Emissions First Partnership	Advances emissions-based approaches to GHG accounting that help organizations assess the emissions impact of clean energy investments and prioritize actions that support grid decarbonization ¹¹⁴

Impacts of tech innovation and advancements on data centre design

Alongside rapid growth in demand, the sector is experiencing significant advances in data centre design, operations and resource efficiency. The industry is pursuing innovations that reduce resource intensity while supporting increasingly power-dense AI workloads, including more efficient chip architectures,¹¹⁵ advanced liquid cooling technologies¹¹⁶ and heat recovery systems.¹¹⁷

For example, NVIDIA's latest AI infrastructure reference architecture demonstrates fully liquid-cooled systems operating with coolant temperatures of up to 45°C, enabling some facilities

to operate without chillers for much of the year and, in suitable climates, substantially reducing cooling-related water consumption.¹¹⁸ AI is also increasingly being deployed to optimize facility performance. AI-enabled monitoring systems can improve energy efficiency, detect water leaks, optimize cooling loads and support environmental monitoring programmes.¹¹⁹

Table 7 provides alternative data centre deployment concepts. While these concepts illustrate the pace of innovation, they remain at an early stage of deployment.

TABLE 7 Emerging data centres, advantages and challenges

Data centre type	Example	Potential advantages	Key limitations
Orbital data centres	Starcloud-1 , a technology demonstrator launched into low Earth orbit by SpaceX in November 2025, carried the first NVIDIA H100 GPU operated in space to test high-performance AI computing and data processing in orbit ¹²⁰	– Abundant solar energy – Proximity to satellite systems and space-based sensors – Potential to reduce latency for some space-based applications – Reduced exposure to terrestrial natural hazards and land-use constraints	– Extremely high deployment and launch costs – Limited maintenance opportunities – Radiation exposure and thermal management challenges – Orbital congestion, collision risk and space debris – Re-entry management and environmental uncertainty – Potential impacts on astronomy and increasing regulatory scrutiny
Underwater data centres	Shanghai Lin-gang Underwater Data Centre became operational in May 2026 ¹²¹ and is planned to scale up from 2.3 MW to 24 MW ¹²²	– Passive seawater cooling – Potential reductions in cooling energy demand – Potential integration with offshore carbon-free energy – Reduced land requirements – Reduced community opposition	– Maintenance and repair complexity – Corrosion and durability concerns – Environmental permitting requirements – Network connectivity and deployment costs – Impacts on marine life
Underground data centres	Iron Mountain has built a commercial underground data centre in Western Pennsylvania located approximately 67 metres (220 feet) below ground in a former limestone mine ¹²³	– Potentially lower cooling demand due to stable underground temperatures – Enhanced physical security – Protection from some natural hazards – Potential reuse of existing underground infrastructure – Reduced community opposition	– Limited availability of suitable sites – Higher retrofit or excavation costs – Ventilation and access challenges – Expansion constraints

Data centre type	Example	Potential advantages	Key limitations
Desert data centres	Envision's "Mission Gobi" aims to develop 5 GW of AI data centre capacity in desert regions by 2030, integrating renewable energy generation, energy storage and AI infrastructure ¹²⁴	– High potential for renewable energy (particularly solar) – Large areas of relatively low-cost land – Opportunity for direct integration with renewable generation and storage – Potential to reduce pressure on constrained electricity networks through co-located generation	– High ambient temperatures increase cooling demand – Water scarcity constrains cooling options – Significant transmission and telecommunications infrastructure may be required – Remote locations may limit workforce availability and supporting infrastructure
Ocean-powered / floating data centres	Panthalassa is piloting ocean-based energy platforms intended to power data centres using wave energy ¹²⁵	– Potential access to wave-powered, zero-emissions energy – Natural seawater cooling opportunities – Reduced competition for land – Potential scalability in coastal regions – Reduced community opposition	– Early-stage technology maturity – Harsh marine operating conditions – Impacts on marine life – Regulatory and maritime permitting challenges – Maintenance and workforce access constraints

A3

Data centre 101: types of data centres

Data centres support cloud computing, telecommunications and AI, but differ in scale, purpose and resource requirements. Table 8 summarises the main facility types and their requirements.

TABLE 8

Types of data centres and their primary functions

Type	Primary purpose	Typical users	Typical design	Resource intensity (MW)
Hyperscale/cloud	Large-scale cloud and AI services	Cloud providers, technology companies	Large, standardized modular campuses designed for rapid expansion, high automation and cloud-scale operations	100-500 ¹²⁶
Wholesale co-location	Large-scale capacity leasing	Hyperscalers, large enterprises	Large, shared facilities with dedicated suites for major tenants and flexible power and cooling configurations	50-300 ¹²⁷
Enterprise	Internal information technology and business applications	Corporates, governments	Facilities designed around an individual organization's internal IT requirements, often integrated with corporate campuses or government sites and optimized for dedicated workloads rather than maximum scale	10-50 ¹²⁸
Retail co-location	Shared infrastructure and connectivity	SMEs, enterprises, cloud providers	Multi-tenant facilities with shared power, cooling and security infrastructure supporting customers of different sizes	1-15 ¹²⁹
Edge	Low-latency processing and content delivery	Telecoms, cloud providers, enterprises	Smaller distributed facilities located close to users, emphasizing low latency, compact footprints and rapid deployment	1-10 ¹³⁰

Site selection and land preparation

- Power-first siting: As transmission and interconnection constraints intensify, access to electricity is increasingly becoming the primary determinant of site selection.¹³¹
- Increasing scrutiny of impacts: Developers face growing expectations to assess and manage water, biodiversity and community impacts earlier in the planning process.¹³²
- Fragmented sustainability assessment approaches: There is currently no widely adopted framework for evaluating sustainability and resilience during site selection, resulting in inconsistent consideration of lifecycle impacts, local context and system interactions (see Table 9).

Design, development and construction

- Increasing rack densities and power requirements: AI workloads require higher-capacity power and cooling infrastructure and more flexible facility designs.¹³³
- Increasing use of onsite and hybrid energy solutions: Longer grid connection timelines are increasing interest in hybrid energy solutions and onsite generation.¹³⁴
- Transition to liquid cooling: Growing adoption of liquid cooling is reshaping facility design and infrastructure requirements.¹³⁵
- Greater demand for adaptable infrastructure: Rapid advances in AI hardware are driving modular, upgradeable designs that can accommodate future technologies without major reconstruction.¹³⁶

Sourcing critical equipment

- Growing supply-chain constraints: Rising demand for AI infrastructure is increasing lead times for critical equipment, making procurement decisions increasingly important for project delivery and long-term resilience.¹³⁷
- Shorter technology lifecycles: Rapid advances in AI hardware are increasing demand for upgradeable, future-compatible infrastructure.¹³⁸

- Increasing scrutiny of embodied impacts: Growing attention to embodied carbon, water and material sourcing is increasing demand for lifecycle information and more transparent environmental product data.¹³⁹

Network connectivity and grid interconnection

- Grid and network connectivity are becoming critical constraints: Expanding data centre capacity increasingly depends on timely electricity and fibre connections, extending development timelines and increasing permitting complexity.¹⁴⁰
- Growing emphasis on network resilience: Operators are increasingly adopting geographically diverse and redundant network architectures to reduce single points of failure.¹⁴¹
- Connectivity infrastructure is becoming a larger sustainability consideration: Transmission, fibre and other supporting infrastructure can contribute to land-use, environmental and community impacts beyond the facility boundary.¹⁴²

Operations and services provision to customers

- AI is changing operational requirements: Higher-density workloads are increasing demands on power, cooling and operational management.¹⁴³
- Expanding reporting expectations: Investors and regulators increasingly expect reporting on sustainability, resilience and lifecycle impacts.¹⁴⁴

Data centre usage

- Regional data residency requirements: Privacy, cybersecurity and sovereignty requirements increasingly shape where workloads can be processed.¹⁴⁵
- Limited comparability across providers: Differences in sustainability metrics and reporting continue to make providers difficult to compare (see Table 10).

Refurbishment and decommissioning

- Data sanitization is enabling greater equipment reuse: Verified data-erasure practices can allow storage devices and other equipment to be reused rather than physically destroyed.¹⁴⁶
- Circularity is moving upstream: Modularity, repairability and end-of-life recovery are increasingly considered during design and procurement rather than only at decommissioning.¹⁴⁷

A5

Existing regulations, metrics and labels

Regulatory landscape

The frameworks in Table 9 have been selected because they are among the most mature, directly applicable or internationally influential examples of regulations.

TABLE 9

Regulatory frameworks affecting data centre sustainability and resilience

Jurisdiction	Framework	Regulatory status	Regulation enforcement date	Primary purpose	Key relevance to data centres
Australia	Net Zero in Government Operations (NZGO) Strategy	Mandatory for government operations	November 2023	Decarbonization and energy efficiency	Encourages low-emissions infrastructure and energy-efficient operations ¹⁴⁸
	National Greenhouse and Energy Reporting (NGER) Framework	Mandatory	July 2016 ¹⁴⁹	Emissions and energy reporting	Requires reporting of GHG emissions, energy production and energy consumption metrics ¹⁵⁰
Brazil	National Policy for Conservation and Rational Use of Energy (Law 10.295/2001)	Mandatory	October 2001 ¹⁵¹	Energy efficiency	Establishes minimum energy performance standards and promotes energy-efficient infrastructure ¹⁵²
Canada	Federal Greenhouse Gas Reporting Program	Mandatory	March 2004 ¹⁵³	Emissions reporting	Requires qualifying facilities to report GHG emissions ¹⁵⁴
China	National Development and Reform Commission (NDRC) Green and Low-Carbon Data Centre Action Plan	Mandatory policy targets	July 2024 ¹⁵⁵	Energy efficiency and decarbonization	Establishes PUE thresholds, renewable energy targets and carbon-intensity reduction objectives ¹⁵⁶

Jurisdiction	Framework	Regulatory status	Regulation enforcement date	Primary purpose	Key relevance to data centres
European Union	Energy Efficiency Directive (EED)	Mandatory	October 2023	Sustainability reporting and transparency	Requires facilities ≥500 kW to report energy, water, renewable energy and waste heat metrics; implementing regulation establishes 24 reporting metrics and four core indicators (PUE, WUE, ERF and REF) ¹⁵⁷
	Corporate Sustainability Reporting Directive (CSRD) / European Sustainability Reporting Standards (ESRS)	Mandatory	November 2022 / July 2023	Corporate sustainability disclosure	Requires reporting through the ESRS, including climate (E1), water (E3) and biodiversity (E4) impacts relevant to data centre operations ¹⁵⁸
	Digital Operational Resilience Act (DORA)	Mandatory	January 2023	Operational resilience and risk management	Establishes resilience, continuity, risk management and security requirements for critical information and communication technology (ICT) providers ¹⁵⁹
	NIS2 (Network Information Security 2) Directive	Mandatory	December 2022 ¹⁶⁰	Cybersecurity and operational resilience	Requires cyber risk management, incident reporting, supply-chain security and governance controls ¹⁶¹
	Water Framework Directive (2000/60/EC)	Mandatory	December 2000 ¹⁶²	Water resource management	Requires protection, enhancement and restoration of all water bodies ¹⁶³
	Environmental Noise Directive (2002/49/EC)	Mandatory	June 2002 ¹⁶⁴	Noise pollution management	Requires assessment and management of environmental noise exposure in urban areas (not data centre specific) ¹⁶⁵
France	REEN Law	Mandatory	November 2021 ¹⁶⁶	Digital sustainability and energy efficiency	Requires data centres to report environmental performance, recover waste heat and implement energy efficiency measures ¹⁶⁷
	DDADUE Law (No. 2025-391)	Mandatory	April 2025 ¹⁶⁸	Sustainability reporting	Implements EU data centre reporting and sustainability indicators (EDC, share of renewable energy, PUE, water consumption for cooling, share of recovered waste heat etc.) ¹⁶⁹
Germany	Energy Efficiency Act (EnEfG)	Mandatory	September 2023 ¹⁷⁰	Energy efficiency and decarbonization	Establishes requirements relating to PUE, renewable electricity sourcing, waste heat reuse (ERF), reporting and energy management systems ¹⁷¹

Jurisdiction	Framework	Regulatory status	Regulation enforcement date	Primary purpose	Key relevance to data centres
India	Perform, Achieve and Trade (PAT) scheme	Mandatory for covered entities	2012 ¹⁷²	Energy efficiency improvement	Uses energy reduction targets and tradable certificates to incentivize operational efficiency improvements ¹⁷³
Japan	Energy Conservation Act	Mandatory	April 2023 ¹⁷⁴	Energy efficiency improvement	Establishes PUE targets and promotes advanced cooling, energy management and renewable energy adoption ¹⁷⁵
Saudi Arabia	Data Centre Services Regulations	Mandatory	January 2024 ¹⁷⁶	Data centre development and service standards	Establishes requirements supporting the development and operation of Tier 2 and Tier 3 facilities ¹⁷⁷
Singapore	Green Data Centre Roadmap	Government strategy	May 2024 ¹⁷⁸	Sustainable sector development	Establishes national objectives relating to energy efficiency, renewable energy adoption and sustainable data centre growth ¹⁷⁹
	PUB (Public Utilities Board) Mandatory Water Efficiency Management Practices	Mandatory for covered facilities	January 2015 ¹⁸⁰	Water resource management	Requires monitoring and management of water consumption to improve water efficiency ¹⁸¹
United Kingdom	National Planning Policy Framework (NPPF)	Mandatory through planning approvals	March 2012 ¹⁸²	Sustainable development and planning	Incorporates BNG requirements and may require water and energy impact assessments ¹⁸³
	Cyber Security and Resilience Bill	Proposed mandatory	N/A	Cybersecurity and resilience	Would establish cyber risk management, incident reporting and supply-chain security requirements ¹⁸⁴
	Environment Act 2021	Mandatory	November 2021 ¹⁸⁵	Biodiversity conservation and development planning	Requires most developments in England to deliver at least a 10% BNG using the statutory biodiversity metric ¹⁸⁶
	Water Resources Act 1991	Mandatory	December 1991 ¹⁸⁷	Water resource management	Regulates water abstraction, pollution control and flood defence ¹⁸⁸
United States	California SB 253	Mandatory (pending implementation)	October 2023 ¹⁸⁹	Climate disclosure	Requires disclosure of scope 1, 2 and 3 GHG emissions ¹⁹⁰
	California SB 261 ¹⁹¹	Mandatory	October 2023 ¹⁹²	Climate risk disclosure	Requires reporting of climate-related financial risks and mitigation measures ¹⁹³

Required metrics

Table 10 includes only metrics referenced in existing regulatory frameworks. [Table 3](#) in Chapter 3 recommends a broader set of metrics that complements existing operational metrics with lifecycle, context-aware and system-level indicators.

TABLE 10 Metrics and thresholds mandated by jurisdictions

Dimension	Metric	Description	Required frameworks with metric guidance and/or thresholds
Energy	Power usage effectiveness (PUE)	Ratio of total facility energy consumed ÷ IT energy consumed	– EU EED (2023/1791) / Delegated Regulation (EU) 2024/1364 requires reporting of PUE for data centres with installed IT power demand ≥ 500 kW¹⁹⁴ – Germany's EnEfG requires PUE ≤ 1.2 for new data centres within two years of operation (with transitional requirements for existing facilities)¹⁹⁵ – China's Green and Low-Carbon Data Centre Action Plan establishes a target of PUE ≤ 1.3 for new large data centres¹⁹⁶ – Japan's Energy Conservation Act establishes a national benchmark of PUE < 1.4 by 2030¹⁹⁷ – France's REEN Law requires reporting of data centre environmental performance, including energy-efficiency indicators such as PUE¹⁹⁸ – Singapore's proposed Digital Infrastructure Act will require a PUE $\leq 1.3$¹⁹⁹
	Total energy consumption	Total electricity consumed by the data centre	– EU EED (2023/1791) / Delegated Regulation (EU) 2024/1364 requires reporting of total energy consumption for data centres with installed IT power demand ≥ 500 kW²⁰⁰ – Germany's EnEfG requires reporting of total electricity consumption and energy management information²⁰¹ – Australia's NGER Framework requires covered facilities to report total energy consumption, energy production and GHG emissions²⁰² – Japan's Energy Conservation Act requires designated facilities to monitor and report total energy consumption²⁰³
	Energy reuse factor (ERF)	Energy reused externally ÷ total facility energy	– EU Delegated Regulation (EU) 2024/1364 requires reporting of ERF – Germany's EnEfG establishes minimum waste heat recovery requirements for qualifying data centres²⁰⁴
	Renewable energy factor (REF)	Total renewable energy consumed ÷ total facility energy	– EU Delegated Regulation (EU) 2024/1364 requires reporting of REF²⁰⁵
	Renewable electricity share (%)	Electricity from renewable sources ÷ total electricity	– Germany's EnEfG requires 100% renewable electricity sourcing by 2027²⁰⁶
Carbon	Scope 1, 2 and 3 emissions	Direct, purchased electricity and value-chain emissions	– CSRD / ESRS requires reporting of scope 1, 2 and 3 GHG emissions for covered companies²⁰⁷ – California's SB 253 requires companies with annual revenue over \$1 billion that do business in California to disclose scope 1, 2 and 3 GHG emissions²⁰⁸
Water	Water usage effectiveness (WUE)	Water consumed (litres) ÷ IT energy (kWh)	– EU Delegated Regulation (EU) 2024/1364 requires reporting of WUE²⁰⁹ – China's Green and Low-Carbon Data Centre Action Plan establishes a target of WUE ≤ 1.3 L/kWh for new large data centres²¹⁰
	Total water consumption / withdrawal	Total water used by the data centre	– EU EED (2023/1791) / Delegated Regulation (EU) 2024/1364 requires reporting of total water consumption²¹¹ – Singapore PUB Mandatory Water Efficiency Management Practices require covered facilities to monitor and report water consumption²¹²

Labels, standards, certifications and methodologies

Table 11 includes industry-specific sustainability disclosure frameworks, reporting standards, finance frameworks, certification systems and voluntary initiatives.

TABLE 11 Labels, standards, certifications and methodologies

Jurisdiction	Framework	Regulatory status	Primary purpose	Key relevance to data centres
Australia	National Australian Built Environment Rating System (NABERS) Energy for Data Centres	Voluntary (mandatory for some government procurement)	Operational performance rating	Measures and benchmarks operational energy performance ²¹³
	EU Taxonomy	Mandatory for certain financial disclosures and products	Sustainable finance classification	Defines technical screening criteria covering PUE, WUE, renewable energy use, waste heat reuse and climate mitigation requirements ²¹⁴
European Union	Sustainable Finance Disclosure Regulation (SFDR)	Mandatory for covered financial market participants	Sustainable finance disclosure	Requires disclosure of sustainability risks and principal adverse impacts, influencing investment decisions relating to data centre assets ²¹⁵
	European Green Bond Regulation (EuGB)	Voluntary standard with regulatory oversight	Sustainable finance and green bond issuance	Provides a framework for financing taxonomy-aligned sustainable infrastructure projects ²¹⁶
	EU Data Centre Rating Scheme	Voluntary (under development)	Sustainability benchmarking	Establishes a common framework for comparing operational sustainability performance using metrics such as PUE, WUE, ERF and REF ²¹⁷
	EU Code of Conduct for Data Centre Energy Efficiency	Voluntary	Energy efficiency best practice	Provides operational guidance and reporting practices to improve energy efficiency and reduce environmental impacts ²¹⁸
	Climate Neutral Data Centre Pact (CNDP)	Voluntary industry initiative	Industry sustainability commitment	Establishes commitments relating to climate neutrality, renewable energy, water conservation and circular economy practices ²¹⁹

Jurisdiction	Framework	Regulatory status	Primary purpose	Key relevance to data centres
Global	ISO (International Organization for Standardization) / IEC (International Electrotechnical Commission) 22237	Voluntary	Data centre facility and infrastructure standard	Establishes requirements for data centre design, construction, operations, security, availability and energy efficiency ²²⁰
	ISO 50001	Voluntary	Energy management standard	Establishes processes for monitoring, managing and continuously improving energy performance ²²¹
	ISO 14001	Voluntary	Environmental management standard	Establishes environmental management systems and continuous improvement processes ²²²
	TIA-942 (ANSI/TIA-942)	Voluntary	Data centre infrastructure standard	Establishes requirements for telecommunications infrastructure, redundancy, reliability and facility design ²²³
	ASHRAE Thermal Guidelines	Voluntary	Thermal management and energy efficiency guidance	Provides recommended operating temperature and humidity ranges to improve reliability and energy efficiency ²²⁴
	LEED (Leadership in Energy and Environmental Design)	Voluntary	Sustainable building certification	Assesses site selection, energy, water, materials and environmental performance ²²⁵
	BREEAM (Building Research Establishment Environmental Assessment Method)	Voluntary	Sustainable building certification	Assesses sustainability performance across design, construction and operations ²²⁶
	ISSB IFRS S1 and IFRS S2	Application depends on jurisdictional adoption	Sustainability-related and climate-related financial disclosure	Establish disclosure requirements for sustainability-related financial information and climate-related risks and opportunities relevant to investors ²²⁷
	Equator Principles	Voluntary	Environmental and social risk management framework	Provides a framework for financial institutions to assess and manage environmental and social risks associated with financing data centre developments ²²⁸
	Adaptation Planning for Business	Voluntary	Business adaptation planning	Provides a structured process for developing climate adaptation and resilience plans ²²⁹
	PCRAM 2.0	Voluntary	Physical climate risk appraisal	Supports systematic assessment of physical climate hazards, adaptation options and residual risks ²³⁰
	BS 8631	Voluntary	Adaptation pathways	Provides guidance for developing adaptation pathways and identifying future decision points under uncertainty ²³¹

Jurisdiction	Framework	Regulatory status	Primary purpose	Key relevance to data centres
	ISO 14090	Voluntary	Climate adaptation guidance	Provides guidance for integrating climate adaptation into organizational planning, investment and long-term decision-making ²³²
	ISO 14091	Voluntary	Climate risk assessment	Provides guidance for assessing climate vulnerability ²³³
	ISO 14092	Voluntary	Local adaptation planning	Provides guidance for planning and implementing climate adaptation at the local and community level ²³⁴
	FAST-Infra Label	Voluntary	Sustainable infrastructure assessment	Provides a project-level label assessing sustainability and resilience performance across environmental, social, governance and resilience dimensions ²³⁵
	PAS 2080	Voluntary	Whole-life carbon management	Provides a framework for managing and reducing whole-life carbon across design, procurement, construction and operations
Singapore	Green Mark for Data Centres	Voluntary	Sustainable building certification	Evaluates energy efficiency, cooling performance and sustainable operations ²³⁶
	SS 715:2025	Voluntary	Data centre sustainability standard	Provides guidance on sustainability management, energy efficiency, water use and environmental performance ²³⁷
	Tropical Data Centre Standard (SS 697:2023)	Voluntary	Energy efficiency guidance	Provides guidance on increasing operating temperatures to reduce cooling energy consumption while maintaining equipment reliability ²³⁸
United Kingdom	Climate Change Agreement (CCA) scheme	Voluntary	Energy efficiency improvement	Provides incentives for operators to improve energy performance and reduce energy consumption ²³⁹
	ENERGY STAR	Voluntary	Energy performance benchmarking	Benchmarks facility energy performance and efficiency ²⁴⁰
United States	Green Globes certification	Voluntary	Sustainable building certification	Assesses sustainability performance across building design, construction and operations, including energy, water, materials and indoor environmental quality ²⁴¹

The Forum's December 2025 report [Nature Positive: Role of the Technology Sector](#)²⁴² highlighted priority actions to mitigate nature impacts and dependencies across semiconductor manufacturing, data centres and e-waste. Table 12 presents the specific priority actions from this report that apply to data centres (preserving the 2025 report's original numbering).

TABLE 12 Data centre priority actions

Priority action	Action
Advance resilient and restorative water use	1.1: Review site locations for water stress levels and work with local and regional officials to ensure availability.
	1.2: Pre-construction, design buildings and processes for water efficiency. During operations, update existing processes to improve inefficiencies and reduce water use.
	1.3: Implement a standard (e.g. ISO 46001) to conduct a full accounting of water use in operations and key supply chain components.
	1.4: Prioritize using non-potable water, where feasible, and utilize closed-loop water systems for both server and facility cooling, with onsite water purification to minimize net freshwater withdrawals.
	1.5: Champion and support projects to monitor and restore local aquifers and watersheds.
Mitigate pollution and pursue circularity	2.1: Optimize hardware and process design with circularity in mind, e.g. utilize recycled materials and design with a modular focus to support reparability.
	2.2: Prioritize maintenance and replacement of individual components to extend product lifespan.
	2.3: Embed digital circularity practices to minimize data waste and associated resource needs.
	2.5: Develop collection programmes to streamline recycling processes, encourage proper disposal at authorized end destinations and harvest working components of unusable devices for reuse.
	2.6: Invest in e-waste recycling infrastructure to expand recovery of valuable metals.
	2.7: Avoid pollution and contaminants (e.g. wastewater, waste heat, solid waste) impacting the environment by using advanced waste control systems and setting zero-waste-to-landfill standards (e.g. UL2799).
Tackle non-power operational and embodied GHG emissions	2.8: Rehabilitate areas damaged by pollutants and waste by investing in and supporting land and water restoration efforts.
	3.4: Invest in high-quality, verified carbon offset and removal credits to account for any remaining emissions, considering biodiversity and other co-benefits.
Promote land stewardship and restoration	4.1: Prioritize new developments in brownfield areas to avoid net new impact.
	4.2: Utilize biodiversity risk assessments when conducting site selection to avoid construction on any high-value ecosystems, such as critical habitats or protected areas.
	4.3: For new sites, conduct land assessments to identify any existing harm and establish a baseline to compare against when decommissioning a site to ensure any impact is remediated.
	4.4: Consider green roofs and utilize native landscaping that promotes local biodiversity, is pollinator friendly and eliminates or reduces irrigation requirements.
	4.5: Use biodiversity offsetting to account for any unavoidable habitat conversion, ensuring no net biodiversity loss.
	4.6: Engage community stakeholders to ensure those stakeholders recognise and benefit from project value.

Priority action	Action
Power operations sustainably	5.1: Minimize nature impacts (e.g. water use, pollution, emissions) from electricity generation, by utilizing onsite low-carbon power sources and PPAs.
	5.2: Sponsor development of additional generation capacity, storage and transmission and distribution infrastructure to enable additional renewable energy.
	5.3: Design buildings for efficiency in power use (considering building envelope, HVAC, lighting etc.).
	5.4: Monitor and optimize cooling systems for efficiency and conditions (e.g. updating technology, climate monitoring to switch to free air cooling when conditions allow, raising operating temperatures).
	5.5: Install dynamic process management systems, in alignment with ISO 50001, to avoid idle energy use.

A7 Market constraint profile-specific notes for stakeholder recommendations

Developers

Site selection and land preparation

● **RECOMMENDATION: Compare candidate sites using a holistic sustainability and resilience framework and assessing system-level impacts**

In heavily constrained hub markets, developers can place greater emphasis on interconnection timelines, opportunities to redevelop or densify existing sites and the availability of infrastructure that can support future expansion without requiring substantial additional power, water or land resources.

In policy-shaped established markets, developers can place greater emphasis on locations that support low-carbon energy procurement, future lifecycle performance improvements and compliance with anticipated planning and disclosure requirements.

In hot, resource-constrained growth markets, evaluate cooling technologies, alternative water sources and future climate projections together during site-selection decisions to help identify locations where future increases in cooling demand are less likely to create operational or permitting constraints.

In urban infrastructure-constrained markets, developers can evaluate opportunities to reuse existing industrial sites, coordinate infrastructure upgrades with local authorities and reduce community impacts through compact development approaches. Considering these broader interactions early can improve permitting outcomes and strengthen long-term community acceptance.

In grid-limited expansion zones, developers can place greater emphasis on interconnection lead times, committed generation and transmission

upgrades and opportunities to secure long-term low-carbon power procurement. Evaluating these considerations alongside future electricity demand can help identify locations that remain viable as regional power constraints intensify.

Design, development and construction

● **RECOMMENDATION: Evaluate infrastructure decisions against multiple future scenarios before design freeze**

In heavily constrained hub markets, developers can prioritize modular electrical architectures, higher-voltage distribution systems and facility layouts that support future densification without requiring major reconstruction. Reserving substation capacity, switchgear space and utility corridors can also reduce future upgrade costs as power densities increase.

In hot, resource-constrained growth markets, developers can prioritize cooling architectures that reduce dependence on potable water, including closed-loop cooling systems, while reserving infrastructure to support future liquid-cooling deployment and alternative water supplies such as reclaimed or recycled water. Evaluating these decisions alongside backup-power strategies can help identify trade-offs between cooling demand, electricity consumption and long-term resource resilience.

In grid-limited expansion zones, developers can prioritize electrical architectures that accommodate higher power densities over time, reserve capacity for future substations and switchgear and evaluate backup-power strategies alongside long-term electricity procurement. Designing electrical infrastructure with sufficient flexibility can reduce future retrofit requirements as regional power systems evolve.

Sourcing critical equipment

● **RECOMMENDATION:** Procure for future technology pathways, not only current performance

In land and power bottleneck markets, developers can prioritize modular cooling systems, higher-density electrical equipment and infrastructure components with defined upgrade pathways that increase compute output without requiring proportional increases in land or power resources.

Operators

Operations & services provision to customers

● **RECOMMENDATION:** Optimize operations for local resource constraints and future resilience

In hot, resource-constrained growth markets, if facilities support multiple cooling modes or water sources, operators can prioritize closed-loop cooling systems, increase the use of reclaimed or recycled water where available and adjust cooling strategies according to seasonal temperatures and electricity-system conditions to reduce dependence on potable water.

In urban infrastructure-constrained markets, operators can prioritize operational strategies that improve equipment utilization, reduce noise and traffic impacts, optimize maintenance scheduling and maximize compute output from existing infrastructure before pursuing physical expansion.

In land and power bottleneck markets, operators can prioritize workload placement, cooling optimization and infrastructure utilization strategies that increase compute density and resource productivity without requiring proportional increases in electricity, water or land.

Enterprise customers

Data centre usage

● **RECOMMENDATION:** Incorporate sustainability and resilience into cloud, AI and data centre procurement

In policy-shaped established markets, enterprise customers can place greater emphasis on providers that demonstrate transparent sustainability reporting, lifecycle resource disclosures and alignment with emerging regulatory expectations.

● **RECOMMENDATION:** Optimize workload placement using sustainability and resilience

In hot, resource-constrained growth markets, workload placement can consider local water availability alongside electricity carbon intensity. Where operational requirements allow, organizations can prioritize regions that reduce exposure to water stress while maintaining service requirements.

In grid-limited expansion zones, workload placement strategies can prioritize regions with greater available electricity capacity or higher proportions of carbon-free electricity, helping reduce pressure on constrained power systems while supporting long-term infrastructure resilience.

● **RECOMMENDATION:** Avoid over-consuming high-intensity compute where lower-intensity options meet business needs:

In dense land and power bottleneck markets, maximizing compute output from constrained infrastructure becomes increasingly important. Enterprise customers can prioritize efficient model selection, higher infrastructure utilization and workload optimization before increasing overall compute demand.

Financial institutions

Site selection and land preparation

● **RECOMMENDATION:** Incorporate sustainability, resilience and resource constraints into site-selection due diligence

In heavily constrained data centre hubs, financial institutions can extend due diligence beyond current project feasibility to assess long-term access to power, land and infrastructure capacity, future permitting risks and the potential for community opposition to constrain expansion.

In hot, resource-constrained growth markets, investors can place greater emphasis on cooling technology selection, access to reclaimed or alternative water supplies and the ability of facilities to maintain reliable operation under future climate conditions, providing greater confidence in long-term operational resilience.

In grid-limited expansion zones, financial institutions can place greater emphasis on interconnection agreements, long-term power procurement strategies, transmission expansion plans and the flexibility of backup-power systems when evaluating future growth potential.

Policy-makers and regulators

Site selection and land preparation

● **RECOMMENDATION: Plan data centre growth using regional resource capacity, context-aware siting and public resource maps**

In heavily constrained hub markets, policy-makers can prioritize the redevelopment and expansion of existing data centre sites before allocating scarce resource capacity to new developments. This can help increase computing capacity while limiting additional demand for electricity, water and land.

In hot, resource-constrained growth markets, policy-makers can develop regional capacity budgets using integrated resource planning approaches that evaluate electricity and water constraints together rather than independently. This can help identify hidden trade-offs between cooling strategies, resource consumption and future growth trajectories.

In policy-shaped established markets where policy intervention already plays a significant role in shaping development, planning can focus on identifying locations where targeted investments in enabling infrastructure could responsibly support future data centre development. This can encourage developers to contribute capital towards shared infrastructure while directing growth to suitable locations.

In urban infrastructure-constrained markets, siting frameworks can place greater emphasis on minimizing impacts on surrounding communities by encouraging redevelopment of existing industrial sites, coordinated infrastructure planning and designs that improve infrastructure utilization rather than relying on outward expansion.

In grid-limited expansion zones, siting frameworks can place greater emphasis on electricity availability, interconnection timing and long-term power-system development. Evaluating these considerations alongside resource and environmental constraints can help align development with future electricity-system capacity rather than current availability alone.

A8 Data centre assessment criteria

Table 13 translates the playbook's recommendations and metrics into a practical assessment checklist to help stakeholders evaluate the sustainability and resilience of AI data centre projects.

TABLE 13 **Sample data centre assessment checklist (illustrative)**

Category	Criteria	Guidance
Energy	Grid interconnection capacity	Existing or planned grid capacity sufficient to support current operations and future expansion
	Carbon-free electricity	Majority of electricity supplied through carbon-free sources, where feasible
	Power usage effectiveness (PUE)	Best-in-class: ≤ 1.2 ; regulatory thresholds typically range from 1.2-1.4 depending on jurisdiction
	Demand response capability	Participation in demand response or other grid flexibility services
	Backup energy systems	Low-emission backup generation, battery storage or other resilient alternatives incorporated, where feasible
Water	Water source suitability	Location avoids water-stressed regions, where feasible, or demonstrates robust water stewardship
	Water usage effectiveness (WUE)	China's target: ≤ 1.3 L/kWh for new large data centres; water efficiency optimized for local climate and cooling technology
	Water usage impact (WUI)	Lower WUI reflecting reduced water-use impacts relative to local basin conditions
	Cooling system suitability	Cooling technology matched to local climate, water availability and computing requirements
	Alternative water capability	Reclaimed, recycled or non-potable water used, where technically and economically feasible
	Water attribution	Workload or customer-level water attribution available, where feasible
Carbon	Whole-life carbon	Embodied and operational emissions minimized across the facility lifecycle
	Embodied carbon assessment	Low-embodied-carbon materials incorporated into design and procurement
	Waste heat recovery	Waste heat recovered and utilized, where suitable local demand exists
	Carbon attribution	Workload or customer-level carbon attribution available, where feasible
IT	Modular and adaptable infrastructure	Infrastructure supporting phased expansion, higher rack densities and future technology upgrades
	IT equipment utilization	Compute resources optimized before additional infrastructure deployment
	IT equipment energy efficiency	Energy-efficient hardware selected according to workload requirements
Resilience	Service availability	High operational reliability supported through resilient infrastructure and redundancy
	Physical climate resilience	Infrastructure designed for current and projected climate hazards
	Supply chain resilience	Diversified suppliers and contingency planning for critical equipment
	Infrastructure redundancy	Redundant power, cooling and network systems supporting service continuity

Category	Criteria	Guidance
Social & health	Community impacts and benefits	Ongoing community engagement, community benefit agreements and demonstrable local social and economic benefits
	Workforce health and safety	Robust health and safety practices throughout construction and operations
	Public sustainability disclosure	Sustainability and resilience performance publicly reported using recognised frameworks
Land & biodiversity	Biodiversity and land use	Sensitive ecosystems protected, biodiversity impacts minimized and net gains pursued, where feasible
	Cumulative regional impacts	Regional electricity, water, land-use and community impacts assessed alongside project-level impacts
Materials & circularity	Equipment circularity	Equipment supporting repair, refurbishment, upgradeability and component replacement
	Recovery rate	Equipment and materials prioritized for reuse, refurbishment and recycling before disposal
	Circular procurement	Procurement incorporating lifecycle and circular economy principles

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