Altitude

AXA Climate

ADAPT OR COLLAPSE

EPISODE 01

Data Centers,
the example of the United States

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Introduction

The United States (US) has long relied on information technologies (IT) to reshape its economy. **Artificial intelligence** (AI) is a clear example of a fast-growing and transformative technology with wide-ranging applications. Despite its virtual appearance, AI depends on substantial physical resources: **energy**, **materials**, and **infrastructure** such as data centers and power-supply systems. Rising AI usage therefore requires rapidly expanding physical capacity.

In a world of finite resources, this heavy dependence on energy- and material-intensive systems exposes the sector to transition risks such as **rising energy and resource prices** or **tightening regulatory constraints on energy efficiency**. Data centers are also sensitive to climate variability, temperature increases, humidity changes, and other events that can stress infrastructure or cause physical damage.

A central question emerges:

Will the U.S. data-center boom remain a sustained engine of growth, or could it create stranded assets under intensifying climate constraints?

1. A multi-pressure context for US data centers

The US lead a $7 trillion sprint to scale data centers

Driven by the rapid growth of cloud computing and AI, investment in data center infrastructure is accelerating at an unprecedented pace, particularly in the U.S. According to a 2025 analysis by McKinsey & Company, **global data center capital expenditure could reach USD 7 trillion by 2030**, with more than **40% concentrated in the U.S**. In response to this surge in demand, major technology companies such as Microsoft, Amazon, Google, Meta, and Oracle are significantly expanding their capacity.

The projected pace of AI adoption illustrates the scale of this expansion: **global demand for data center** capacity could more than **triple by 2030**. This rapid growth in infrastructure is also expected to drive a significant increase in greenhouse gas (GHG) emissions, which could reach 630–920 $MtCO_2e$ by 2030, potentially equivalent to roughly twice the annual emissions of France.
Yet, this rapid expansion is unfolding in a context of increasing structural constraints and vulnerability.

AGING POWER SYSTEMS AND GROWING CLIMATE EXPOSURE

In the United States, the aging and complexity of the electricity supply infrastructure pose a major challenge. The North American Electric Reliability Corporation has cautioned that rising data center demand is contributing to shrinking reserve margins and **increasing the risk of electricity supply shortfalls** across multiple regions.

Distribution networks already face **reliability challenges**, and this additional load is placing further pressure to systems that are increasingly exposed to climate vulnerabilities.

Indeed, recent **extreme weather events** have amplified these concerns. Climate trends in the United States notably indicate more frequent and intense heavy precipitation, particularly in the Northeast and Midwest, an increase in the density of tornado clusters and of tornado power and a longer storm season (IPCC 6th Assessment Report, Chapter 12 & 14).

These growing energy and climate pressures compound another structural challenge: the resource intensity of data centers themselves.

THE DUAL VULNERABILITY OF POWER AND WATER DEPENDENCE

Data centers are both **power and water intensive**, long-lived assets. Their high electricity consumption and local water use can **strain resources** and expose operators to **regulatory, operational, and reputational risks**. According to the Environmental and Energy Study Institute (EESI, 2025), large data centers can consume up to **5 million gallons of water each day**, an amount comparable to the **daily water consumption of a town of 10,000 to 50,000 residents.**

> **Global demand for data center capacity could more than triple by 2030**

The Uptime Institute's 2025 Global Data Centre Survey reports that **half of data center operators** worldwide experienced at least one **major outage in the preceding three years**, with **power-related failures** accounting for **45%** of these incidents, often linked to **extreme weather conditions.**
For instance, in February 2025, a severe winter storm in Connecticut disrupted the local power grid and temporarily cut off electricity to Pfizer's Groton data center (DCD, 2025).

These incidents underscore the need to examine the specific climate-related hazards that pose the greatest risks to data center operations.

2. Many climate-related challenges for US data centers

Looking more precisely at **climate risks**, data centers located in the United States face challenges related both to changing **physical climate conditions** and to the **transition** to a **low-carbon economy.**

EXTREME HEAT, WATER STRESS AND FLOOD RISKS

Data centers face significant effects from changing physical climate conditions. Their vulnerabilities relate to chronic climate trends, which can induce substantial and persistent operating costs, as well as to acute climate events, which may damage assets, threaten their structural integrity, and disrupt operations.

> Water use is forecasted to rise by 170% by 2030, according to WestWater research

Data centers are particularly vulnerable to **rising temperatures**, which increase **cooling demand**, put additional stress on power grids, and make stable operations more difficult.

As an **illustrative use case**, we screened on Altitude one of several facilities located within "Data Center Alley," the world's largest and most internationally connected data center hub (figure 1). Results highlight a high **risk of extreme heat**.

We rely on several indicators to flag this risk, including the evolution of the number of days with maximum temperatures above 35°C compared with a baseline period. In our assessment, the indicator suggests that, by 2050 in a high-emissions scenario (SSP5-8.5), the data center could experience more than 22 additional days per year with daily maximum temperatures exceeding 35°C compared to 2000, an increase that adds over three extra weeks of extreme heat exposure, materially reshaping how business continuity risk must be assessed.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommends an optimal operating temperature of **18 to 27°C**. Above 27°C, cooling needs increase sharply, leading to **higher energy consumption, reduced equipment efficiency**, and ultimately significant financial impacts, as well as a higher risk of **under-performing operations**.

In this example, Altitude also identifies the asset's exposure to a **high risk of pluvial flood**.

The indicator used is the defended flood depth, which reaches nearly 35 cm for a 1,000-year return-period event. This indicates that, even after accounting for drainage capacity and protective infrastructure, an extreme rainfall episode could generate water levels capable of disrupting the asset. Such conditions can damage critical infrastructure and interrupt data center operations through power or connectivity failures, as well as limit staff access, ultimately driving higher capital expenditures and reducing revenues.

Water scarcity is another critical challenge as data centers consume large volumes of water for cooling, potentially straining local resources. WestWater Research estimates that **water use could rise by 170% by 2030**. Although **alternative** low-water cooling **technologies** exist, they generally require **more electricity** and rely on less mature systems. The upstream water consumed for electricity generation further compounds this risk.

Altitude's screening on another Data Center located in Mesa (figure 2) highlights several climate risks, among which a high risk of water stress. In this example, under a high-emissions scenario (SSP5-8.5) in 2030, regional water demand is projected to be twice the locally available renewable supply. This means that the gap must be filled by unsustainable sources such as groundwater depletion or long-distance transfers. Above 40%, we consider that data centers have limited flexibility to absorb additional demand or to withstand drought episodes.

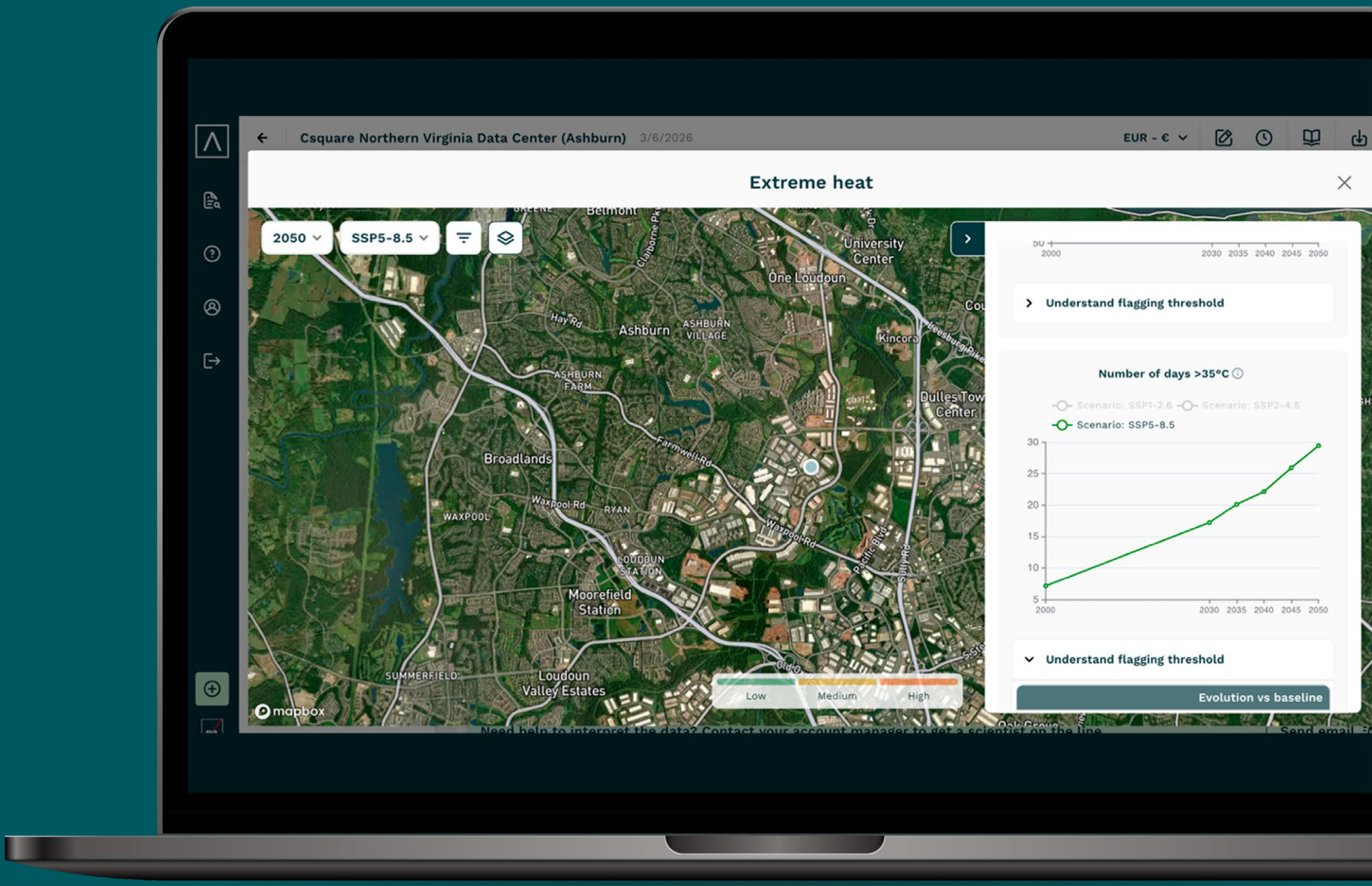


Figure 1: Extreme heat risk flagged by **Altitude** in Data Center Alley

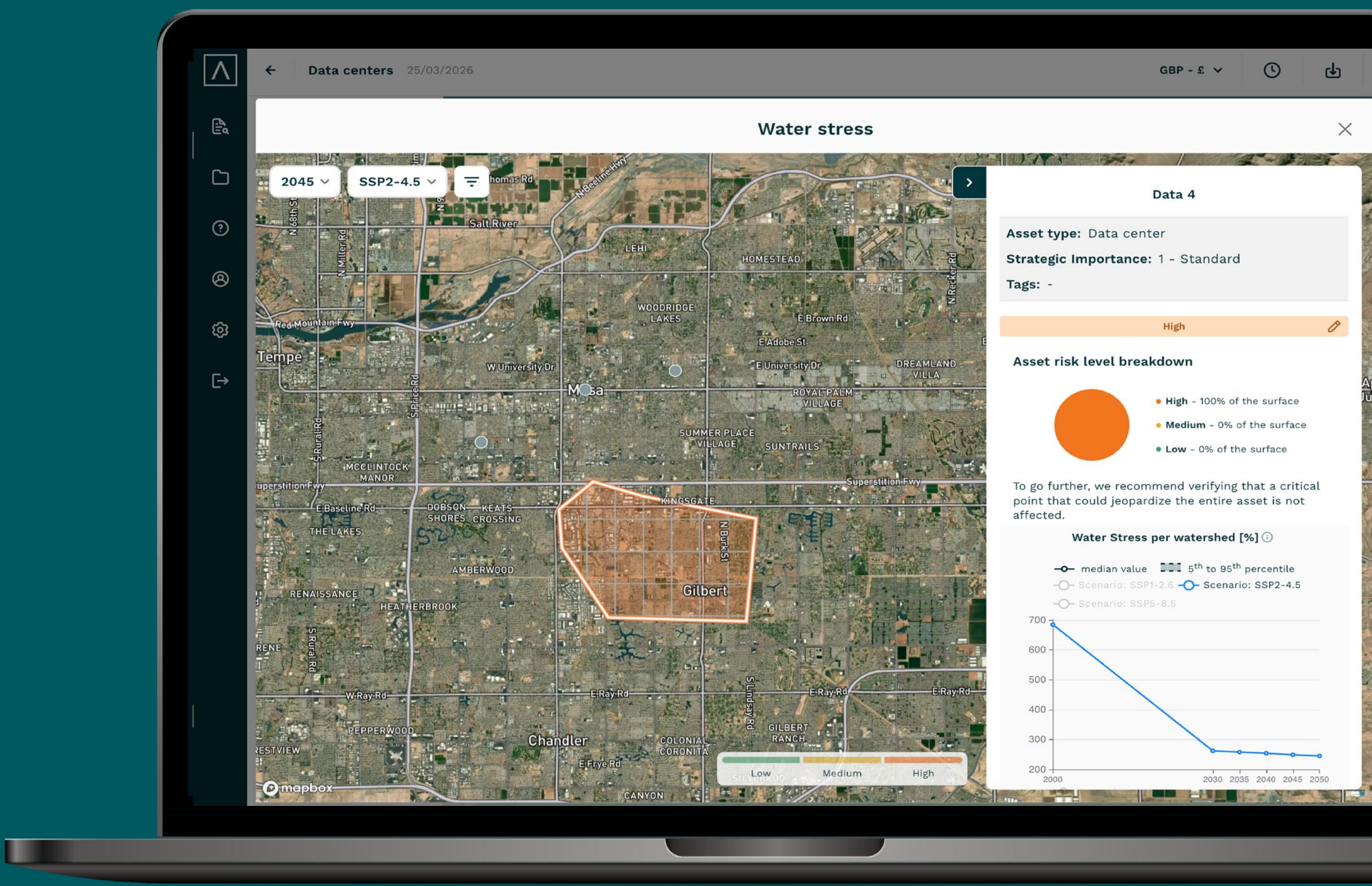


Figure 2: Water stress risk flagged by **Altitude** in Mesa

Insufficient water availability may lead to **severe operational and financial impacts**, especially by preventing data centers from meeting their cooling requirements and increasing outage risks and operating costs. It may also force costly investments in alternative cooling technologies. In parallel, competition with local water needs may lead to transition risks such as litigation, regulatory constraints, and reputational damage.

TRANSITION RISKS DRIVEN BY DATA CENTERS' ENERGY-INTENSIVE AND GHG EMISSION PROFILE

According to the Environmental and Energy Study Institute (EESI, 2025), **data centers' electricity demand in 2030** is projected to reach up to 130 GW, **nearly 12% of annual U.S. electricity consumption, up from approximately 4% today, a threefold increase in less than a decade.** Around **56%** of this electricity currently comes from **fossil-fueled thermal power plants.** The concurrent expansion of gas-fired generation adds tension to state-level decarbonization targets and complicates the balance between growth and sustainability.

AI-related data centers activity could generate up to 44 million tons of CO_2 by 2030

Rising energy dependence exposes operators to GHG-related costs, carbon taxes, pass-through charges, or carbon-pricing schemes. Large technology firms have reported increasing operational emissions in recent years. **AI-related data center activity in the U.S. alone could generate 24 to 44 million tons of CO_2** annually by 2030, within a global data center footprint projected at 630–920 $MtCO_2e$ per year**.** The NGFS database indicates a 169% increase in carbon prices by 2040 compared with 2025 under the Delayed Transition Scenario of the GCAM 6.0 model.

Concretely, rising GHG costs could translate into **higher operating expenditures**, representing a significant financial burden for data center operators.

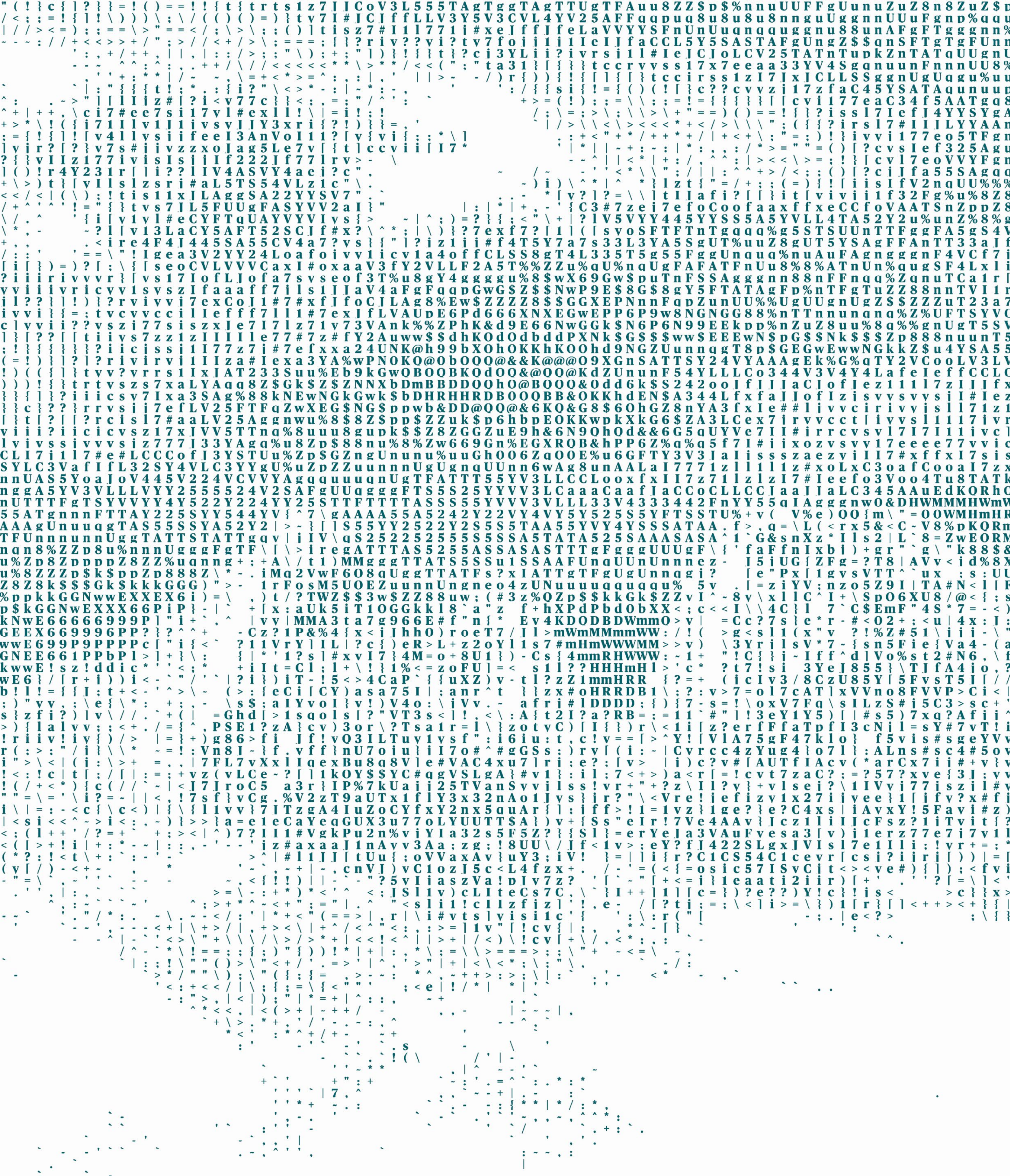
Several states are beginning to implement **energy-based taxes on data centers**. For example, in June 2025, Minnesota removed the sales tax exemption for large facilities and introduced an annual energy-use fee, while similar measures are under consideration in New York, Maryland, and Arizona. Regulatory and certification requirements are also expanding. Wisconsin's December 2025 bill, for instance, mandates that data centers obtain sustainable design certification within three years of construction, echoing policies already in place in Illinois and other states. This **surge in regulatory constraints** could translate into **increasing capital expenditures for the construction of new sites**, with direct implications for investment planning.

Overall, **operational costs are rising** as transition **risks related to energy** intensity and **energy prices** increase the operating costs, in absence of any mitigation measures. Meanwhile **physical risks** such as **extreme heat** require higher-capacity cooling, **driving up electricity and maintenance expenses**. Droughts and **water stress** force facilities reliant on water-based cooling to seek **alternative solutions**, often at **higher cost**, and insurers are increasingly reflecting these exposures in **rising premiums**.

Capital expenditures are also affected. Policy and legal requirements are prompting **investments in lower-carbon technologies**, facility upgrades, and compliance measures, while structural damage from physical events can lead to costly repairs or replacement of servers, power systems, and cooling infrastructure.

More **sustainable data centers** can reduce long-term operational expenses, especially as cooling needs rise. Operators may gain market advantages as customers increasingly demand low-carbon infrastructure. Access **to renewable-energy procurement** mechanisms can help secure **lower-emission power** and **reduce exposure to fuel** volatility.

Fortunately, a growing number of tools now enable investors to **identify and prioritize climate risks** using relatively simple inputs such as asset type and geolocation.



3. Climate adaptation: a solution to manage climate risks for investors and data center operators

DATA CENTERS, A NEW TYPE OF STRANDED ASSETS?

These **transition and physical risks** increase the likelihood that an asset becomes a **stranded asset** if it fails to adapt to evolving climate conditions, transition-related constraints, and resource scarcity, particularly when operating costs persistently exceed revenue potential. In this context, adaptation appears not only necessary but unavoidable.

The World Economic Forum projects that extreme heat, drought, and other climate hazards could raise **annual global data center related costs to USD 81 billion by 2035,** increasing to USD 168 billion by 2065.

Regarding stranded-asset risk, S&P estimates that **annual climate-driven costs could reach 9.5% of total data center asset value by 2055** under a high-emissions scenario (World Economic Forum, 2025), with cumulative losses potentially rising to USD 3.3 trillion. **Extreme heat accounts for more than two-thirds of this impact**, followed by drought and water stress, figures that likely underestimate broader value-chain implications and secondary disruptions.

DECARBONIZATION, A STRATEGIC NECESSITY

In addition to reducing the risk of potentially having stranded assets, investors who proactively support sustainable practices and innovation can benefit from transition opportunities, evolving consumer preferences, and technological advances.

Looking more specifically at U.S. data-center decarbonization, maintaining electricity consumption within a defined cap is pivotal. This depends primarily on two factors:

- **The share of embodied carbon** (servers, IT equipment, cooling infrastructure, and buildings), which account for approximately 25% of total data center emissions.

- **The pace and effectiveness of the energy transition, particularly power sector decarbonization**. The operational (energy use) phase represents around 75% of total emissions.

In addition, U.S. investors seeking to mitigate climate-related risks could look for data-center features such as:

- Replacing Portland cement with lower carbon alternatives, including recycled steel.

- Implementing waste heat recovery systems (e.g., reinjecting heat into district heating networks or supplying tertiary buildings).

- Optimizing operations through hyper-scaling and efficiency improvements, such as achieving a Power Usage Effectiveness (PUE) below 1.2.

CLIMATE ADAPTATION, WHERE TO START?

At Altitude, we combine science-based analysis with deep expertise in transition and physical climate-related risks, drawing on our pool of climate, business, and strategy experts.

Specific to data centers, adaptation measures include prevention strategies, mitigation of exposure to risks, and strengthened resilience to changing climate and market conditions, notably:

• **Avoid or retreat from high-risk areas**. Identify locations exposed to drought, extreme heat, or other climate hazards, and prioritize safer sites for new developments.

• **Invest in water management techniques to reduce consumption**. Depending on the local context, options include closed loop cooling systems that reuse wastewater and freshwater, immersion cooling for energy efficiency, air cooling in water-scarce regions, and free cooling in colder climates.

Climate-driven costs could reach 9.5% of total data center asset value by 2055

• **Obtain adapted insurance coverage**. Ensure policies adequately reflect both physical and transition risks to protect assets and operations.

• **Promote energy efficiency.** Conduct comprehensive energy audits to identify inefficiencies, implement continuous monitoring of energy use and GHG emissions, and invest in the latest energy-efficient technologies for servers, cooling systems, and lighting. Virtualization and server consolidation can further optimize utilization.

• **Establish a compliance team to track evolving regulations and standards**. Proactively pursue relevant certifications for energy efficiency and sustainability (such as ISO 50001, ENERGY STAR, or LEED for Data Centers) depending on jurisdiction.

• **Power data centers with clean energy**. Explore direct procurement of renewable energy or Power Purchase Agreements (PPAs) with renewable providers. This also reduces financial exposure to volatile fuel costs.

• **Promote sustainability throughout the supply chain**. Support responsible stewardship of local resources and encourage sustainable practices among suppliers and vendors.

• **Implement a community engagement plan**. Maintain open dialogue with local stakeholders to address concerns and support shared resource management.

CREATING VALUE THROUGH ADAPTATION AND DECARBONIZATION MEASURES

Adapting and decarbonizing data centers go hand in hand and should therefore be treated as a single priority. By optimizing capital expenditure, preserving operational continuity, accelerating project delivery, and reducing embodied carbon, retrofit and adaptation strategies enhance resilience to environmental threats, protect cash flows, preserve asset liquidity, and support exit valuations.

For infrastructure investors with long-duration exposure, climate-aligned data centers are likely to demonstrate superior risk-adjusted returns, greater regulatory resilience, and stronger long-term demand fundamentals. In this context, integrating climate considerations is not optional ; **it is central to asset and portfolio competitiveness.**

The principles outlined in this paper, from capex optimization to embodied carbon reduction, are not limited to data centers. They apply across real asset classes, wherever physical climate risk meets long-duration capital. In our upcoming publication,
Real Assets: How Climate Adaptation and Resilience Drive Value Creation - A Handbook for Asset Owners and Operators,
we go further: providing an operational framework, financial modelling tools, and sector-specific guidance to help infrastructure and real estate stakeholders identify, prioritize, and quantify the economic value of climate adaptation measures at both asset and portfolio level.
Stay tuned.

Disclaimer

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Anaïs Lorand is Head of Climate & Biodiversity Content at Altitude, where she leads the development of the analytical content available on the Altitude platform. She supports private equity and infrastructure funds, as well as corporates, in assessing and managing their exposure to physical, biodiversity, and transition climate risks, with a particular focus on adaptation. Before joining Altitude, Anaïs worked as an economist at the Banque de France (IEDOM), contributing to macroeconomic and territorial analysis.
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Stefano is a senior expert at AXA Climate, with >20 years of experience in climate change and decarbonization. As Head of the Low Carbon team, he supports investors, large corporations, and public institutions in their transition toward a low-carbon economy. Actively involved in several working groups (France Invest, Invest Europe, Climate Dividends), he works to embed climate issues at the core of investment strategies. Before joining AXA Climate, Stefano was a Partner at the global sustainability consultancy ERM. Over the course of his career, he has led more than 200 operational missions across over 25 countries, working directly in the field with organizations across a wide range of sectors, including hospitality and real estate. His expertise covers carbon inventories, net-zero strategies, climate change mitigation, adaptation and risk assessment, carbon pricing and MACC, funds, Real Estate, Energy, Logistics, as well as broader sustainability advisory. Stefano is an Environmental engineer by training, and holds a PhD in climate modeling.

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Lucie joined AXA Climate in 2023 and works as a sustainable finance and climate consultant to support investors in their Sustainability and Climate Strategy.
Her work includes conducting climate risk analyses, developing responsible investment policies and climate strategies, ensuring compliance with sustainability market standards and regulations, and designing sustainability assessment methodologies and roadmaps for corporates and financial institutions.
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Elise is a consultant at AXA Climate, specializing in low-carbon transition strategies. At AXA Climate, she supports both corporates and investors in their decarbonization pathways, from carbon footprinting to action plan development and definition of Net Zero trajectories. She is trained in carbon accounting methodologies (GHG Protocol, CDP, SBTi, avoided emissions, NZI, ACT Evaluation) and in the design and monitoring of decarbonization plans for economic and social actors. She holds a Master's in Management program with a specialization in Sustainability, "Rethinking Business Models," Elise also holds a Philosophy degree.

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