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A sustainable investor's guide to AI

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MAIN TAKEAWAYS:

- *AI's environmental, social and governance (ESG) considerations have wide-ranging implications for energy and water consumption, labour, regulation, data privacy and geopolitics that investors should be mindful of.*
- *Sustainability frameworks tailored to AI will allow investors to assess potential trade-offs and make well-informed investment decisions.*
- *We offer practical guidance for assessing datacentre sustainability characteristics and developing an AI specific corporate engagement programme covering areas such as: environmental, people and workplace, intellectual property, data privacy, and regulatory issues.*

The popularity and the adoption of artificial intelligence (AI) have surged in recent years. More than $650bn[1] of capital expenditures have already been deployed into AI datacentre since the early 2020s with hockey-stick growth forecasts well into 2030 and beyond[2]. While the U.S. public equity markets have performed strongly in 2025[3], that growth has largely been driven by the Magnificent 7 stocks on the back of their forays into AI.

Relative to this, ESG implications of the AI boom receive far less attention and may be less well understood by investors. This paper covers the key sustainability topics that investors should think about critically when considering AI related investments.

These sustainability considerations can be distilled into practical guidance for investors. This guide is relevant to all types of investors across public and private equity and credit, infrastructure and real assets.

THE INVESTMENT OPPORTUNITIES

Before examining these ESG considerations, it should be noted that the AI investment landscape is vast, with opportunities to suit different investor types and investment approaches. At Nuveen, we believe the integration of ESG considerations is critical across asset classes, and when appraising AI related investment opportunities it has the potential to identify key investment risks as well as opportunities to create value.

Without aiming to be exhaustive, the table below summarizes a few AI related investment opportunities and the associated responsible investing (RI) themes:

Examples of investment areas	Asset class	Investment opportunity
Power generation	Public and private equity, credit, and infrastructure	Sustainable power supply to operate AI datacentres
Datacentre projects and assets	Fixed income, infrastructure, real estate	Build or scale energy and water-efficient datacentre assets; these assets should have lower obsolescence risk and potentially higher valuations on exit
Biodiversity	Natural capital and fixed income	Ecosystem regeneration, water conservation, restoration of agricultural land, sustainable landscaping, biodiversity offsetting
Smart-tech	Private equity, venture capital	Innovative technologies enabling power, water, cooling efficiencies and optimisation

THE ENVIRONMENTAL CONSIDERATIONS

AI requires substantial physical infrastructure capabilities. While the question of AI's environmental impact may seem daunting, it can be broken down in three parts: a) power, b) CO2 emissions and c) water and cooling.

Power

Power is the most talked-about area given how energy hungry AI digital infrastructure is. The training and usage of AI models is very energy intensive. These use graphic processing units (GPUs), which use more energy per chip than traditional central processing units (CPUs).

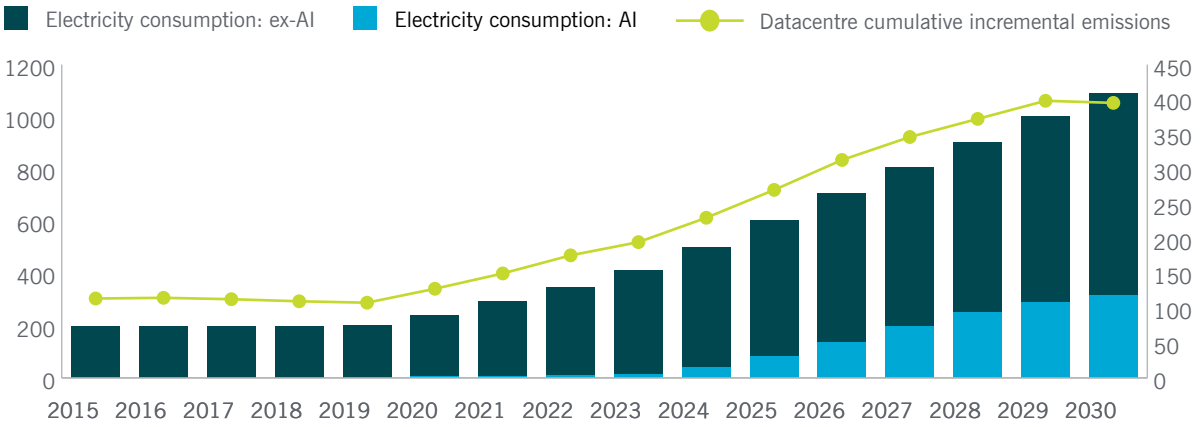
Despite datacentre workloads having tripled between 2015 and 2019, their[1] electricity consumption stayed flat at around 200 TWh globally, as efficiency gains countered the workload increase[4]. However, due to AI, datacentre power consumption has grown significantly in recent years, practically doubling to c.400 TWh in 2024[5]. By 2030, it is expected to more than double again to c.945 TWh, with half of that growth coming from AI.[6]

As a share of global electricity, datacentres represent only c.1.5%, but that share is expected to double by 2030[7]. In terms of growth rates, overall U.S. power demand is expected to accelerate by 2.5% annually through 2030, with c.1% coming from datacentres, half of that driven by AI.[8]

CO2 emissions

The increase in datacentre power consumption will likely contribute to rising global CO2 emissions. Some commentators[9] estimate carbon emissions

Figure 1: Electricity consumption and CO2 emissions



Source: IEA, GS GIR, Nuveen

from datacentres could rise from c.200 MtCO2e in 2023 towards 350-400 MtCO2e by 2030 (see chart above). For perspective, U.K.'s 2024 greenhouse gas emissions were estimated at 476 MtCO2e.[10]

Water and cooling

In the context of AI, water consumption refers to the water lost during the cooling process of GPUs in the data servers. AI models consume a lot of power which generates heat that needs to be removed for datacentres to operate effectively. Removing that heat requires water that is lost through evaporation. As GPU sophistication and the number of GPUs per server racks increase, the need for more cooling increases as well.

There are several issues with these dynamics:

- Around 20%[11] of U.S. datacentres are already located in areas under moderate to high water stress. Due to increasing physical climate change, this poses real operational disruption risks.
- Datacentres often use potable water directly from the water utility distribution system, which competes with the water needs of the local communities. A 2022 study has shown large U.S. tech companies consume approximately 20 billion litres a year, roughly the same as 1.2 million Americans. In other parts of the world, such as Chile and Uruguay, Google's datacentres have been subject to community and local government backlash. The U.S. state of Virginia, which is one of the most concentrated datacentre locations in the world, is proposing legislation to require datacentres to submit water use estimates as part of the building requirements.

Some sources[12] estimate that in 2023 U.S. hyperscale and colocation datacentres consumed 55bn litres of water for direct cooling, which could double by 2028. The indirect water consumption, through the electricity needed to power U.S. datacentres is estimated as at even more staggering c.800bn litres for 2023.[13]

In terms of technology developments, liquid cooling is becoming the preferred approach as the GPU density per server increases in a way that air-cooling cannot keep up with. Liquid is a lot more thermally efficient than air and more energy efficient as well. A study by Vertiv and NVIDIA found that a mix of 75% the load cooled by direct-to-chip liquid and 25% by air could reduce a datacentre's power consumption by around 10% versus full air cooling, translating into a 10% reduction in both energy costs, and Scope 2 emissions assuming the energy is sourced from fossil fuels.[14]

Despite the importance of this issue, corporate disclosure of water usage and water usage effectiveness (WUE) varies greatly. Even among the top technology companies, there are large inconsistencies around which water metrics are disclosed to investors. Disclosures do not always include the indirect water consumption (e.g. that from electricity use), while some only show overall water usage and do not split the datacentre component. These issues make comparability all but impossible.

Investment implications

The costs and risks associated with ensuring a reliable source of electricity and water for AI datacentres to function as expected have direct operational implications. Different types of investors (e.g. developer, operator, lender etc.) will have varying levels of risk exposure to this issue and different appetites for the risk level that they may wish to bear, therefore there is no one-size fits approach to actively managing these considerations.

Investors should carefully weigh the pros and cons of the electricity costs with regard to its availability, redundancy (e.g. backup generation) and its type (e.g. fossil/gas, solar/wind, green plus battery storage, nuclear (i.e. cut "/large scale/small scale") etc.). Linked to the power access, investors should consider the quality of the grid interconnection and its stability with regard to intermittency.

Topic	Investment implications	
	Risks	Opportunities and risk mitigants
Electricity availability, reliability	Development costs, power price inflation, grid stability - implications for net operating income, returns projections, valuation multiple	Access renewable energy through PPAs[15], assess and be selective about datacentre physical locations, conduct comprehensive scenario-based financial modelling
Residential energy prices	Potential reputational, regulatory risks	Engagement with communities, regulators, transparency in communication
CO2 emissions	Jurisdiction-dependent regulatory risks (e.g. ETS,[16] carbon taxes), ability to meet carbon targets, ambitions	Consider clean energy sourcing, carbon capture and storage, battery storage, carbon offsets
Water availability, reliability	Ability to operate due to the impact on local communities particularly in water-stressed areas, reputational, regulatory risks, potential cost increase	Forward-looking, climate change informed assessment of water-stress, engagement with communities, upgrades towards more efficient cooling technologies (e.g. liquid cooling), investments in projects providing water benefits and efficiencies

Regarding water, investors should ascertain datacentre locations in the context of forward-looking, climate-informed, water-stress projections, as well as the balance with local community water requirements and the potential legal risks associated with these. Additionally, a dynamic integration of climate change considerations, both from a transition to clean energy and an acceleration of physical risks, are paramount.

At a company level, investors should consider how AI affects a company's CO2 trajectories, particularly alongside any decarbonisation targets. Companies using AI heavily in their operations will probably see their Scope 2 emissions increase, which increases the risk of missing carbon reduction targets. That said, companies have the opportunity to mitigate these risks through increased efficiencies, accelerating their sourcing of renewable energy and purchasing carbon offsets.

The table above brings together the key environmental angles that investors should consider as part of their AI-related datacentre investment risk and opportunity assessment.

THE SOCIAL CONSIDERATIONS

AI is often hailed for its revolutionary improvements in productivity, such as automation and more efficient processes (e.g. customer support service, inventory management and more). Acknowledging the complexity of these topics, and the risk of rapid developments as AI scales further, we consider four specific angles: a) data privacy and trust, b) energy affordability, c) AI usage for societal benefits, and d) potential implications for the labour market.

Data privacy and trust

The issues of trust and data privacy are important across each of the two main phases of AI: model training and model inference. With AI model training taking place on ever larger and more specialised datasets, it is of central importance that companies (and investors) ensure that appropriate guardrails are set around the data used as inputs, and their appropriate curation of personal, or private information. The AI regulation put in place in the EU for instance aims to address these issues, while supporting innovation and technological advancement; see more details in the governance section below.

The continuation of AI usage (inference) is directly linked to users trust into its outputs as they relate to accuracy, source verifiability, comprehensiveness and balance. For AI to transition from an exploratory tool to a more permanent presence in our corporate and personal lives, avoiding misinformation, biases, and hallucinations are paramount to maintain trust between the AI models and its users.

Investors need to develop more comprehensive stewardship and engagement approaches, incorporating high expectations for companies on data privacy and ethics specifically tailored for AI. Practical guidance on this can be found in the section below.

Energy affordability

As AI's power usage grows, datacentre operators' buying power may bid up the electricity prices that end-consumers also have to pay. This dynamic is already evident in parts of the U.S., where the average residential electricity bill rose 17.5% in the summer of 2025 versus the previous year[17]. The energy affordability issue has political dimensions with lawmakers in certain U.S. states introducing legislation proposing to cap utilities' allowed returns on equity.

AI usage for societal benefits

Given the significant physical resources (e.g. energy, water and others) consumed by AI models, we believe investors should put in perspective the extent to which AI's enhancement of companies' products and services also provide measurable societal benefits.

For example, AI models are able to analyse vast datasets related to weather patterns, carbon emissions and other parameters to generate location-specific forecasts of future climate conditions, which can be used to improve crop yields in the agricultural sector or enhance energy efficiency in buildings. Other society-positive applications relate to pharmaceuticals and life sciences[18], where AI can enhance process design and development, enhance drug discovery, automate clinical trials and bring life-saving therapies to market faster.

Labour market dynamics

Like with other step-change technological revolutions in human history, AI has the capacity to meaningfully alter how work gets done, particularly white-collar, trained professional labour (e.g. financial services, lawyers and operations). AI can essentially disintermediate the translation layer between vast amounts of raw data and value-added information, particularly where data is unstructured and in a variety of formats (e.g. text, video and audio). What would usually take days, weeks (or perhaps months) of white-collar human work could be done by AI a lot faster.

To quote one of the most poignant assertions yet by a Fortune 500 leader, Walmart's CEO recently said, "AI is going to change literally every job", echoing other predictions from leaders at Ford, JP Morgan Chase and Amazon. There is a wide range of jobs where AI can do a lot of the heavy lifting; from the more obvious customer service chats, towards supply chain, product trend monitoring, and even research and development. From an experience level standpoint, a recent study[19] has showed that the trend in junior employee hiring at AI-adopting firms has been slower than at non-adopters, while the hiring had stayed the same for more senior roles.

As some of the intellectual workloads usually done by humans are transferred to AI models, human work will likely evolve to areas that demand more intuition, creativity, subject-matter expertise and context. In addition, there will still be an edge in constructing, accessing and interpreting proprietary data, and the ability to build trust, forge personal relationships and a develop meaningful brands.

Investment implications

We are in the early innings of AI impacting the labour market, and more change is likely in the coming years. It is crucial for investors to understand how AI can help companies cement their competitive advantages, and to what extent companies' operating models can flexibly adapt to such a rapidly evolving technological landscape.

In addition, it is critical for investors to evaluate companies' approach to developing and retaining a workforce that is both trained to leverage AI capabilities, and flexible to reskill in areas where AI might not be as effective, such as softer skills and management of stakeholder relationships.

THE GOVERNANCE CONSIDERATIONS

Governance is a multi-faceted area, especially in the context of the large and uncertain impacts brought by AI. We highlight three key areas – AI regulation, geopolitics and national security, and corporate governance – noting that these dynamics can change quickly, altering the investment landscape significantly.

AI regulation

Different jurisdictions are taking different approaches to AI regulation. The EU AI Act[20] became effective in August 2024 with the goal of ensuring safe and ethical AI development and deployment across Europe, aligned with protecting citizen rights and safety. The Act takes a risk-based approach. Companies using AI are requested to consider people's fundamental rights particularly with high-risk applications such as management of critical infrastructure, education, hiring and law enforcement. Some specific AI applications are banned in the EU, such as those involving cognitive behavioural manipulation, social scoring and biometric identification.

Various parts of the EU AI Act were meant to come into action by August 2026. However, pressure from the U.S. government, technology firms and European groups has seen the bloc pause the legislation's current path. The EU is expected to soften aspects of the Act, including introducing a grace period for AI companies found to be in breach of the rules.

The U.K. has avoided AI-specific legislation for now and taken a cross-sector principles-based approach built around five areas: safety; security and robustness; transparency and availability; fairness and accountability; contestability and redress. The U.K. framework introduces definitions for three types of the most powerful AI systems: highly capable general purpose AI (e.g. large language models), highly capable narrow AI and agentic AI. So far, the companies belonging to these categories are subject to voluntary safety and transparency measures. In June 2025, the U.K. Government announced that the first U.K. AI Bill covering regulation of advanced AI models and AI copyright rules will not be introduced before the second half of 2026.

In the U.S., there is no comprehensive federal legislation yet that covers the development or the use of AI. In July 2025, Trump published the America AI Action Plan, centred around deregulation and pro-innovation, while the U.S. Congress has also been considering numerous AI bills, many emphasising voluntary guidelines and best practices for AI systems. At the state level, Colorado, California, Texas and Utah, for example, have started to pass their own responsible AI governance bills[21].

Diverging regulations add to the uncertainty and the constraints around a company's legal position. Where suitable, companies may benefit from being proactive and aim to have an open dialogue with policymakers to help shape the AI regulatory landscape in ways that benefit society and their respective industries. Investors should be mindful of these regional nuances, particularly when portfolio companies initially design AI products or services for a target region, before expanding offerings into new territories where AI regulations may be more robust.

Geopolitics and national security

AI has not escaped the geopolitical dimension. Along with the U.S.'s aspiration for global AI dominance, China also aims to be a global leader in AI by 2030[22]. The race for AI supremacy may therefore take both economic and geostrategic dimensions, on a backdrop of deteriorating cooperation, increased anxiety over national security and 'me-first' mentality.

Linked to the previous points on regulations, it may very well be that the urgency of using AI for national security reasons overpower the risk-based approach to regulation, as the race for first-mover advantage accelerates.

Corporate governance

Corporate boards will be under significant pressure to understand, plan and execute (where appropriate) on the AI implications for their businesses and workforce. To be well-prepared for the road ahead, corporate boards and management teams must upskill quickly to fully leverage AI's capabilities and improve their company's competitive position, harness operational efficiencies and drive revenue growth. Investors must engage with boards using an AI-specific stewardship and engagement programme (see next section).

AI'S ESG CONSIDERATIONS: A PRACTICAL GUIDE

A better approach to assess datacentre environmental sustainability

Better metrics are needed to understand and assess a datacentre's sustainability. When considering energy efficiency, investors use the power usage effectiveness (PUE) as the main metric. The PUE is the ratio between the facility's total energy consumption and the energy used by the IT equipment. For example, in the U.S. the average datacentre PUE is 1.6, meaning for 1 KWh consumed by servers, 0.6 KWh more needs to be consumed by non-server related functions such as cooling[23].

While a lower PUE means a more energy efficient asset, the PUE itself does not factor in the source of the power used (e.g. renewable, fossil or nuclear). For instance, a higher PUE datacentre that is solely powered by clean energy would have a lower environmental impact than a lower PUE datacentre powered by fossil fuels.

Investors should use a broader lens, alongside metrics such as PUE and WUE, to assess datacentre environmental performance, focusing on both the energy efficiency and availability of renewable energy. Globally recognised certifications such as LEED and BREEAM provide helpful information on energy use and other environmental aspects of real estate, and in the U.S., Energy Star certification promotes energy efficiency. Incorporating these measures integrates additional angles to the analysis.

Regarding water efficiency, investors should be aware of the potential inconsistencies in corporate disclosures, making comparisons difficult. Investors can play an important role by engaging with datacentre operators and encouraging standardized water disclosure covering both onsite and offsite water usage, as well as supply chain impacts.

An AI-specific corporate engagement programme

Given the complexity and overarching implications of AI, investors should develop a tailored approach when engaging with companies.

Nuveen's responsible investing team has engaged with companies on AI for several years, as AI technologies have gained momentum across industries. Informed by these initial dialogues, the team has developed and continues to refine an AI-specific engagement framework.

The AI-engagement framework builds on Nuveen's T-A-I stewardship approach: transparency, accountability and impact. It tailors the investor conversation according to whether the company is an AI developer or user, and across the risk spectrum.

AI user ↕ AI developer	Lower risk	The company deploys AI for business-as-usual process productivity enhancements.
	Medium risk	The company deploys AI to replace decision-making processes.
	Higher risk	The AI model is the product to be sold to/used by external customers.

Our corporate engagement framework is further tailored across key themes and financially-material topics. Here's an example of our blueprint for these conversations.

Key theme	Key engagement questions on AI
Environmental	T: How does the company's AI infrastructure investment impact its climate commitments and targets? How does the company's water metrics disclosure compare to best practices? A: How is the company assessing the financial, operational and reputational risks linked to increased energy and water demand? I: How is the company mitigating the above risks?
People and workplace	T: What share of company's workforce may be impacted by AI? A: What training opportunities does the firm offer to employees to reskill? I: What type of new roles are created thanks to AI?
Intellectual property	T: How informative is the company's disclosure around AI model training, data sourcing and licensing? A: How does the company ensure that the AI models are trained on datasets that consider privacy and safety?
Data privacy and responsible AI (RAI)	T: Does the company disclose how user data is collected and used when used by its AI models? T: Does the company have and publish RAI principles? A: Is there a board committee responsible for AI safety and ethics? I: Does the company partner across its industry to support AI acceptance and trust of AI for the purpose of societal value-add?
Regulatory	T: Does the company's public reporting reflect a fair appraisal of its AI risks? A: How does the board keep abreast around AI legislations in its relevant jurisdictions? I: How does the company engage with policymakers to shape AI regulations, standards and guidelines?

AI engagement case study: Company A in the Technology sector

Issue & opportunity:

Company A's ability to provide commercially safe AI-integrated technology products to its customers is a key differentiator at a time of rapid technological developments.

Engagement activities:

During engagement, we discussed the company's strategy and approach on:

- **Responsible AI** considerations linked to intellectual property and product development
- Managing **regulatory risks & opportunities**

Outcome and next steps:

Responsible AI: the company has articulated a set of robust "AI Ethics Principles" which inform AI features in new product development.

Regulatory: the company is leading the industry through its "Content Authenticity Initiative" and active engagement with policymakers and regulators in the U.S. and EU.

Next steps: discuss how the company's AI ethics framework integrates with partner AI models (OpenAI, Google)

MAKE SUSTAINABILITY CONSIDERATIONS CENTRAL TO THE AI INVESTMENT CASE

AI offers significant investment opportunities, and as it becomes the norm across multiple industries, investors need to critically evaluate the ESG aspects of their AI-centric investment and business cases. AI's wide-reaching implications mean ESG considerations are increasingly important in terms of energy and water consumption, labour force and societal impacts, regulation, data privacy and geopolitics.

Sustainability frameworks tailored to capture the complexity of AI, its investment implications and potential trade-offs are needed for investors to effectively balance AI investments and ESG considerations in portfolios. We expect more innovation in this area as industries respond and adapt to the challenges. This will enable investors across a broad spectrum of asset classes, from public to private markets, to make better-informed decisions to achieve their investment goals.

For more information about RI, visit us at nuveen.com/responsible-investing.

Endnotes

1 Capex spending of Amazon AWS, Microsoft, Google, Meta and Oracle from 2020 to 2024
2 Source: Goldman Sachs
3 S&P500 rallied c. 15.8% year to date as of 26th November 2025
4 Source: Goldman Sachs, IEA
5 https://www.iea.org/reports/energy-and-ai/. For context, the US consumed about 4,000 TWh in 2024.
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