Joint research on natural capital related to data centers

Modeling impacts on natural capital across the entire supply chain

Report summary

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Executive summary

Objectives of this study

- SoftBank Corp. ("SoftBank") and Mizuho Financial Group, Inc. ("Mizuho") conducted a joint research project from July to December 2025 to model the impact of data centers (DCs) on natural capital across the entire supply chain. The results of this study are hereby published in the form of this report.
- The study comprises a multifaceted analysis of the impacts of DCs on natural capital. SoftBank intends to use the findings as input for considering future DC development, while Mizuho aims to identify DC-specific risks and opportunities and thereby capture future business opportunities, such as opportunities to provide financing support.

Summary

1. Recent sustainability trends surrounding DCs

- With the spread of generative AI driving increased demand for DCs, there is a shift away from their current concentration in major metropolitan areas and toward more regional distribution. From the perspective of energy consumption, operators are increasingly seeking sites in regions endowed with abundant natural capital—such as renewable energy resources and water—and expectations for enhanced sustainability responses are rising.
- Regulations requiring the disclosure and reduction of energy and water use by DCs are being introduced, and international organizations and initiatives are also advancing the development of guidelines, indicators, and standards related to nature.

2. Major nature-related impacts across the DC supply chain

- With reference to regulations and guidelines concerning sustainable DCs, and incorporating additional factors reflecting regional characteristics in Japan, we identified major nature-related impacts across the entire DC supply chain.
- The analysis went beyond direct DC operations (construction and operation) to examine in greater depth the nature-related impacts occurring in the upstream (raw materials and equipment) and downstream (electronic waste) areas of the supply chain.

3. Case study: Measures taken at the SoftBank Hokkaido Tomakomai AI Data Center

- In identifying and further analyzing nature-related impacts in this study, the SoftBank Hokkaido Tomakomai AI Data Center, which is currently under construction, was used as a reference case. This report presents examples of measures taken in response to the nature-related impacts discussed in the study.

Going forward

- Given the increased data-processing demand placed on DCs, their regional decentralization, and the growing expectations not only for decarbonization but also for addressing nature-related issues, it is likely to become increasingly important to confirm the current status of consideration for nature-related impacts and examine additional steps.
- Going forward, SoftBank and Mizuho will consider how to incorporate the results of this study into our respective business practices. In addition, as both of our companies accumulate further project experience, we expect to contribute to enhancing the value of sustainable DCs that give due consideration to nature.

1. Recent sustainability trends surrounding data centers

- Across many countries, regulations requiring the reporting and reduction of energy and water use by data centers (DCs) are being introduced. At the same time, international organizations and initiatives are advancing the development of guidelines, indicators, and standards related to nature.
  - In addition to decarbonization and climate change measures related to electricity use by DCs, there is a growing expectation to address impacts on natural capital and biodiversity. Against this backdrop, the importance of considering nature-related impacts in DC development projects that involve land preparation and site development is increasing.

Evolution and future development of the data center business

1990s

- With the increase in internet users, DCs emerged as hubs for providing internet services.
- Small-scale DCs built mainly in major cities were the norm.

2000s

- As companies began to outsource server management, colocation/housing services[1] gained prominence.
- The construction of medium-scale DCs in suburban areas increased.

2010s

- Cloud services became widespread, driving higher demand for DCs catering to cloud service providers.
- Large-scale DCs (hyperscale DCs) appeared.

2020s

- The market for hyperscale DCs has grown significantly, and many such facilities are being constructed in suburban areas.
- With the emergence of generative AI, demand has increased, and to handle the enormous volume of data processed, the layering of DCs is advancing.
- Regional decentralization is gaining attention as a way to control massive energy consumption.

Steps by governments and international organizations to deal with the environmental impacts of data centers

Government of Japan

- **Public-Private Advisory Council on Watt-Bit Collaboration (June 2025)**
  - ✓ Use existing grid facilities to meet short-term DC demand.
  - ✓ Develop power and telecom infrastructure and create several large-scale DC hubs.
  - ✓ In view of future environmental changes, consider regional decentralization and more advanced DC operations.
- **Energy Conservation Act (amended in 2025)**
  - ✓ DCs above a certain size built from 2029 onward must achieve power usage effectiveness (PUE) ≤ 1.3.
  - ✓ DC operators must set targets for average PUE of their DCs and for improving energy-use intensity.

European authorities

- **EU: Amended Energy Efficiency Directive**
  Germany: Energy Efficiency Act
  - ✓ Require reporting on the reuse of waste heat and reuse rates.

International organizations and initiatives

- **ISO**
  - ✓ In the standards for sustainability metrics of DCs (ISO/IEC TR 30134), eight indicators including PUE are included.
- **Innovation for Cool Earth Forum (ICEF)**
  - ✓ Published a Sustainable Data Centers Roadmap (October 2025).
  - ✓ Organizes recommended actions for electricity use, GHG emissions, water, and electronic waste.

1. Services in which a DC operator leases physical space within a DC to customers.

2. Major nature-related impacts across the DC supply chain | Overview

- We conducted a comprehensive investigation into the impacts not only from the direct operations of DCs but also across the upstream (raw materials and equipment) and downstream (electronic waste) segments of the supply chain.
- With reference to regulations and guidelines for sustainable DCs, and considering Japan's regional characteristics, we identified and examined key nature-related impacts.
  - Transition risks, e.g., stricter environmental laws and regulations and opposition by local residents
  - Physical risks, e.g., water shortages that make water intake difficult
  - We summarized DC-specific considerations compared with general large buildings (★ in the table).
  - This study focuses on impacts on natural capital; local community impacts such as noise were excluded.

Major nature-related impacts across the DC supply chain

★ Impacts specific to DCs

	Upstream	Direct operations	Downstream
Nature-related impact items	**Raw materials for DCs and internal equipment ★** **Mineral resources**: Land use (mining); Water use (mining); Pollution (mining) **Electronic devices / Building materials**: Water use (manufacturing); GHG emissions (manufacturing) **Infrastructure required for DC operation ★** **Submarine cables**: Marine-area use (installation) **Power plants**: Land and marine-area use (construction, operation)	**DC construction**: Land use **DC operation ★**: Electricity use; Water use; Waste heat	**Waste ★**: Electronic waste
Features	✓ Significant impacts from developing facilities such as submarine cables and power plants ✓ High use of mineral resources, building materials, and electronic devices	✓ High electricity use and cooling-water use ✓ Generation of waste heat	✓ Large amounts of electronic waste
Potential risks	✓ Transition risk: Tighter regulations for renewable-energy projects involving land-use change ✓ Physical risk: Water shortages disrupting supply chains of minerals and semiconductors, which require large amounts of water for extraction and manufacturing	✓ Transition risk: Stricter regulations for DC development involving change in land use; opposition from local residents ✓ Physical risk: Water shortages that make water intake difficult	✓ Stricter regulations for electronic waste treatment

2. Major nature-related impacts across the DC supply chain | Upstream

- In the upstream supply chain for DCs, compared with other buildings, larger amounts of raw materials such as mineral resources and electronic devices / building materials are used for DCs themselves and their internal equipment.
- In addition, infrastructure facilities are required, such as submarine cables for data transmission and power plants that supply electricity for DC operation.

Upstream (raw materials)

Mineral resources

Land use (mining)	Water use (mining)	Pollution (mining)

- **When mining the mineral resources widely used in DC power distribution systems, data cables, and cooling equipment, there are impacts in areas such as water use and pollution.**
  - ✓ These minerals include copper, aluminum (bauxite), silicon, lead, gallium, and iron (in particular, copper is used extensively in wiring and other applications, resulting in high consumption).
  - ✓ At the mining stage, copper and aluminum (bauxite) have major impacts in terms of water use and water pollution, and aluminum (bauxite) also has large impacts in the areas of deforestation and ecosystems.

Electronic devices / Building materials

Water use (manufacturing)	GHG emissions (manufacturing)

- **Semiconductor products used in servers inside DCs require large amounts of water during manufacturing.**
  - ✓ In particular, a large volume of water is used in producing the ultra-pure water for cleaning processes.
  - ✓ Water shortages may cause risks such as disruption of semiconductor supply chains (it has been noted that by 2030–2040, about 40% of semiconductor fabs may be located in high water-stress regions[2]).
- **GHG emissions from manufacturing building materials used in DCs may also be large.**
  - ✓ Because DCs are large-scale and often have double-layer structures for load-bearing and cabling, they use large amounts of building materials.

Upstream (equipment)

Submarine cables

Marine-area use (installation)

- **There is a possibility of ecosystem impacts when laying submarine cables required for data transmission.**
  - ✓ Although the impact of marine-area use is limited because the occupied/converted area is small, impacts on shallow waters tend to be large.[3]
  - ✓ Particular attention needs to be paid to ecosystem impacts when laying cables in ecologically important marine areas.

Power plants

Land and marine-area use (construction, operation)

- **Depending on the location of power plants that supply the electricity needed for DC operation, there may be impacts on biodiversity.**
  - ✓ Carbon neutral initiatives using renewable electricity such as solar and wind power are progressing.
  - ✓ On the other hand, while renewable electricity contributes to climate change mitigation, it may, depending on the siting of the facilities, create trade-offs between climate change measures and biodiversity conservation.

2. Lepawsky, J. (2024). Climate change induced water stress and future semiconductor supply chain risk. *iScience*, 27(2).
3. United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and International Cable Protection Committee (ICPC) (2025). *Submarine cables and marine biodiversity*.

2. Major nature-related impacts across the DC supply chain | Direct operations / Downstream

- For the direct operation of DCs, it is necessary to take into account high electricity use for 24-hour operation, high water use for cooling purposes, and the impacts of waste heat.
- Regarding land use at the time of DC construction, impacts are particularly large for decentralized DCs, which are assumed to be often located in nature-rich areas.
- Downstream in the supply chain, large amounts of electronic waste are generated, and improper treatment may cause environmental pollution.

DC construction

Land use

◆ **DCs are becoming larger, and land-use impacts are increasing.**

- ✓ The number of large-scale DCs (with total floor areas of several tens of thousands of square meters) is increasing.
- ✓ When previously unused land is newly developed or prepared, impacts on land areas are large.
- ✓ Decentralized DCs, compared with urban DCs, are often located in areas rich in nature, and land-use conversion is often a concern.

Waste

Electronic waste

◆ **Large amounts of electronic waste are generated, with potential for environmental pollution.**

- ✓ Improper treatment of electronic waste can cause soil and air pollution due to the release of hazardous substances.
- ✓ Some companies outside Japan set quantitative targets for reusing electronic components and are actively engaged in recycling.

DC operation

Electricity use

◆ **Electricity use during operation is large.**

- ✓ Power for servers and electronic equipment accounts for up to 60–70%, and much of the remainder is for cooling.[4]
- ✓ Free cooling using cool outside air and water-cooling systems can help lower power usage effectiveness (PUE).

Water use

◆ **Depending on the cooling method adopted, consumption of cooling water can be large.**

- ✓ Water-cooling systems that use large amounts of water can create a trade-off between water usage effectiveness (WUE) and PUE.
- ✓ In regions with high water stress, such as parts of the United States, there are concerns about environmental and livelihood impacts from water intake.

Waste heat

◆ **Waste heat is generated through cooling.**

- ✓ The temperature range of waste heat varies depending on the cooling method and cooling tower type.
- ✓ There are cases where DC waste heat is used for local agriculture, aquaculture, or district heating systems.

4. International Energy Agency (IEA) (2025). *Energy and AI*. Paris: IEA.

3. Case study: Measures at the SoftBank Hokkaido Tomakomai AI Data Center

- The SoftBank Hokkaido Tomakomai AI Data Center, currently under construction, illustrates some of the measures to address environmental impacts that were identified in this study.

(Conceptual image)

Land use

- ✓ Biological surveys are being conducted before and after development, and land use is being planned with a view to conserving natural environments where conservation-priority species live, as well as to obtaining external certifications.
- ✓ Through collaboration with local stakeholders and ongoing monitoring, the project aims to conserve biodiversity and coexist with the local natural environment.

Electricity use

- ✓ The cooling system looks to achieve high efficiency through the use of outside air cooling that leverages Hokkaido's cool climate, optimization of equipment operation via energy management system[5] controls, and reduction of chiller[6] operation.
- ✓ The aim is to reduce power consumption and improve energy efficiency.

Water use

- ✓ Operations are being put in place that will integrate water resource management, based on assessments of the water system's usage status and water stress, and also reduce water consumption through the use of air-cooling systems
- ✓ The aim is to reduce the load on local water resources and ensure sustainable water use.

Waste heat

- ✓ A reduction in waste heat generation is being targeted by utilizing a cooling system that leverages Hokkaido's cool climate. Ways are also being explored to recover the generated heat and reuse it for applications such as road heating.
- ✓ Through effective utilization of unused energy, the project aims to reduce energy-related CO_2 emissions.

5. Introduction of an energy management system is under consideration.
6. Chiller: Water-circulation cooling unit.

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