PRODUCTIVITY RESEARCH NOTES 2610

Importing Bits, Not Watts

AI Infrastructure and Japan's Electricity Constraint

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KEY MESSAGE

AI-driven growth depends not only on expanding computational scale but also on a reliable and economically sustainable electricity supply. While computation can increasingly be traded internationally as digital services, electricity supply remains geographically constrained. The key economic question is therefore not whether all AI computation should be domestically located, but which computation requires domestic infrastructure due to latency, security, industrial linkages, and cluster externalities.

WHY THIS MATTERS

Recent discussions on artificial intelligence increasingly recognize that AI is not merely a digital technology but also a highly electricity-intensive infrastructure industry. PRN2602 discussed the potential productivity gains from AI adoption in Japan. This note focuses instead on the physical and infrastructural constraints underlying AI-driven growth. Large-scale computation requires data centers, cooling systems, transmission capacity, semiconductors, and a stable electricity supply. Mills (2025) argues that the key constraint on large-scale AI deployment may increasingly shift from computation to electricity and physical infrastructure.

For Japan, this issue is particularly important. Unlike fossil fuels, electricity itself is difficult to import at large scale. Japan's Hokkaido–Honshu interconnection, whose transmission distance is broadly comparable to major European cross-border links such as the UK–France interconnector, required substantial infrastructure investment yet provides only about 1.2 GW of capacity—roughly equivalent to a single large nuclear reactor. Cross-border electricity interconnections may also involve significant security and cost considerations. This illustrates the difficulty of transferring electricity at the scale potentially required by future AI-related demand.

IMPORTING BITS, NOT WATTS

Not all AI-related computation needs to be domestically located. In many cases, foreign electricity can be used indirectly through imported digital computation services ("bits") rather than through electricity transmission itself ("watts"). Large-scale frontier model training and commoditized inference services are increasingly tradable internationally. Under persistently high domestic electricity prices, Japan may increasingly rely on overseas computation for such activities.

However, some forms of computation are still likely to favor domestic location. These include activities requiring low latency, frequent real-time updates, data confidentiality, operational resilience, or industrial clustering effects. Examples include manufacturing control systems, logistics, electricity balancing, robotics, medical support systems, finance, and public administration. As a conservative approximation, the SBI-FERI BIP framework assumes that roughly 40 percent of expanded AI-related computation would require domestic data-center capacity under a technology-and-societal-implementation scenario (Nomura 2026).

INDUSTRIAL IMPLICATIONS

The economic value of AI may emerge more from broad industrial applications than from frontier AI model development itself. Productivity gains in manufacturing, logistics, healthcare, and business services depend on the ability to integrate AI into domestic production systems. This creates a new form of industrial infrastructure dependency. Given Japan's electricity constraints, it may be economically more rational to focus industrial policy on AI-enabled manufacturing and business applications rather than on highly electricity-intensive frontier-model training. In this sense, Japan's AI competitiveness may depend less on domestic frontier-model training capacity than on effectively integrating AI into domestic industrial systems.

DISCUSSION: THE UNCERTAINTY OF COMPUTATION DEMAND

Future electricity demand from AI remains highly uncertain because it depends on two evolving factors. The first is the electricity productivity of computation. Improvements in semiconductors, cooling systems, model compression, and inference efficiency may significantly reduce electricity use per computation unit. The second uncertainty concerns the computation demand itself. Many projections implicitly extrapolate current digital consumption patterns into the future. Current digital business models often provide massive storage and computation services at prices that may not fully reflect their long-run economic cost. For example, it is no longer unusual for smartphone users to store and instantly retrieve over 100,000 photos through cloud-connected platforms. Such computation-intensive consumption patterns are sustained partly by business models that heavily subsidize storage and computation costs, and their long-run economic sustainability remains uncertain.

Future electricity demand associated with AI should therefore be interpreted with caution. The growing physical dependence of digital economies on electricity underscores the importance of energy systems capable of delivering genuinely stable, scalable, and economically sustainable power supply under deep uncertainty. Under internationally tradable computation, it becomes increasingly important to avoid unnecessarily raising total system costs through excessively costly power expansion and transmission infrastructure.

IMPLICATIONS

01	02	03
AI competitiveness increasingly depends on stable and economically sustainable electricity systems as much as on advances in computation itself.	The central policy question is not whether all AI computation should be domestically located, but which computation requires domestic location.	Electricity demand projections for AI remain highly uncertain because both computational efficiency and the long-run sustainability of digital consumption patterns remain uncertain.

REFERENCES

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