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Electricity Demand by AI Data Centres and the Role of Nuclear Energy | Yongsoo Hwang and Dongkeun Lee

In 2024, electricity consumption from data centres was around 415 TWh, representing about 1.5% of total global electricity consumption. It has grown at 12% per year on average over the last five years. There are many critical components that consume electricity from data centres: servers, storage systems, networking equipment, cooling and environmental control, UPS batteries and backup power generators, and others as shown in Figure 1 by the International Energy Agency (IEA). A such, global electricity consumption for data centres is projected to double to approximately 945 TWh by 2030, accounting for nearly 3% of global demand. Currently, the growth rate of electricity consumption by data centres is more than four times than that of total electricity consumption. While 3% is still manageable, the real challenge lies in regional concentration.

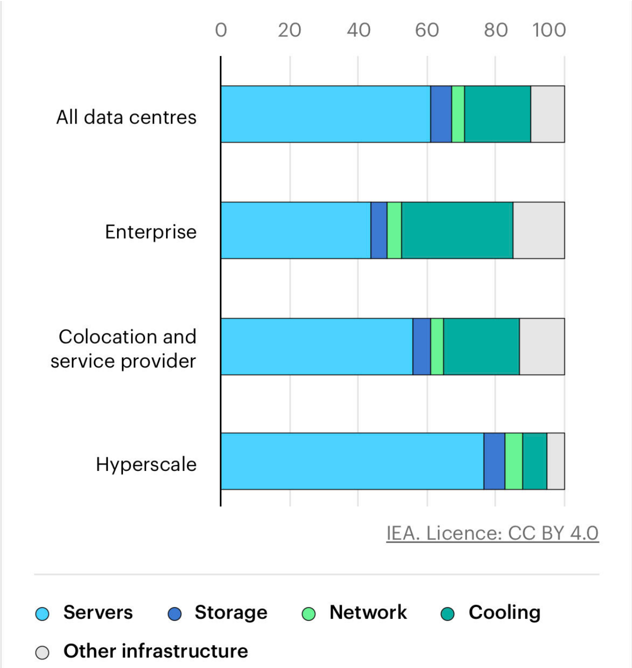

Figure 1. Energy Consumption by Data Centres

Over the next few decades, the United States (US) and China will remain the largest drivers of data centre electricity demands. These two states consume almost 80% of electricity for data centres. At this moment, China is positioning itself for the AI race by adding new power plants every year. Chinese demand is expected to increase by 175 TWh, up 170% from current levels.

Meanwhile, the US' demand is projected to surge 240 TWh by 2030, up 130% from 2024 levels. Unlike China, US infrastructure expansion and development have been slow over the last decade, while transmission lines across states have not been properly managed. This means that the current electricity supply systems in the US are to be re-adjusted for the entirely new AI Transformation Era (AX Era), which is a critical issue. The same issue is expected to happen in Southeast Asia where there will be a series of regional data centre hubs in Singapore and southern Malaysia. Japan is also expected to experience the high rise of electricity consumption from data centres, by almost 15 TWh by 2030. In addition, South Korea is moving quick to become a pioneer in AI industries including the industrialisation of physical AI.

As a result, the US, Southeast Asia, along with Japan and South Korea, need sustainable, stable, and affordable supply of electricity to support the data centre boom and the integration of physical AI in advanced manufacturing industries as shown in Figure 2. The key challenge is securing seamless 24/7/365 electricity power generation and the transmission systems necessary for delivery. There are certain energy sources to meet this ambitious challenge for electricity generation, including coal, natural gas, and nuclear power. Although the energy cost for coal fired stations is low, climate change considerations limit its suitability for future generations. Thus, there are only two viable contributors for the power generation of data centres: natural gas and nuclear power.

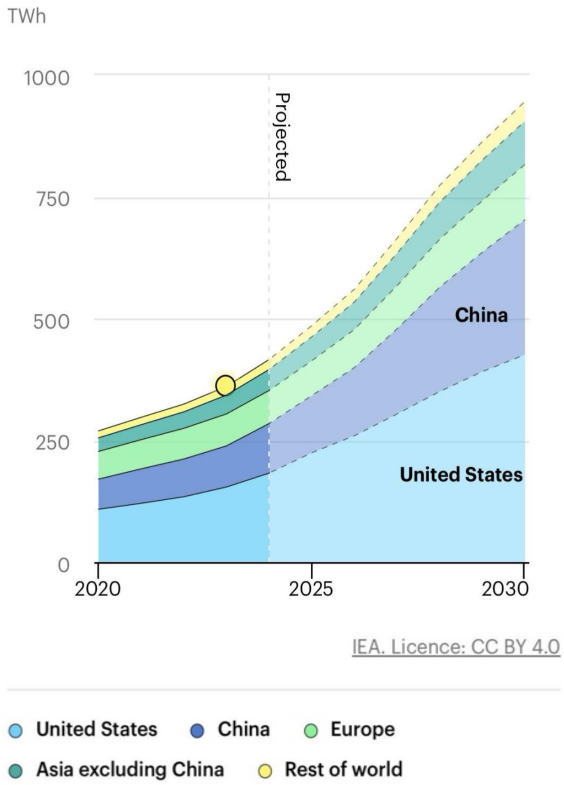

Figure 2. Electricity Demands by Major Players from Data Centres

Currently, the gas-fired option is by far the best option for the new power generation. The timely delivery of Combined Cycle Gas Turbines (CCGTs) by global supply chains, led by GEH Vernova, Siemens, and Mitsubish, is the key to success for the introduction of gas fired stations. The primary advantage of CCGTs is their short construction timeline, which helps to minimise risks. Unfortunately, the order books for these global giants are fully booked by 2030; hence the market requires an alternative approach to secure 24/7 power for data centres.

While emerging players like Doosan Enerbility are doing their best to manufacture large scale CCGT's, the market demand far outstrips their actual manufacturing capacity. The largest customers, the hyper-scalers, also require reliable and timely delivery of stable electricity, and climate change is a persistent concern among global players.

This presents a significant opportunity for the nuclear industry in Western states, which have been largely dormant after the Kukushima event and the struggles encountered during the construction of VC Summer and Vogtle Units 3&4. As a CF100 (Carbon Free 100) energy resource, its ability to provide continuous electricity strongly underpins the future of nuclear power in the US and worldwide.

The most straightforward ways to maximise the use of nuclear power are through uprating and Long Term Operation (LTO) achieved by extending the lifecycle of existing nuclear power plants. Many existing nuclear power stations in the US are expected to operate for 80 years, which is 40 years longer than their originally designed lifetimes. Also there are series of restart movements of plants that were shut down in the US, like Palisades in Michigan, TMI Unit 1 in Pennsylvania, and Duane Arnold in Iowa. Once these nuclear power stations are upgraded for the new generation of power, many prominent hyper-scalers, such as MS and META, would certainly be interested in securing direct electricity supply from them through Power Purchase Agreements (PPA's).

Still, these are far less than what the hyper-scalers need. This is why the Trump Administration is planning to build 10 large scale light water reactors (LWRs), with 80 Billion USD financial packages. To implement this mission, the Western nations should create a new consortium. While the US has the intellectual property rights for GEN III LWR's and upcoming SMR's, they currently lack the critical capacities for the required engineering services. These include detailed reactor design, timely procurement systems, and efficient construction operations and project management, all under the Engineering, Procurement, Construction, and Management (EPCM) framework. By combining US' strengths in global leadership, financial banking systems, and intellectual property ownership with allied EPCM capacities, a new strategic partnership can be established to revive the commercial nuclear industry in the free world.

Currently, China can construct LWR's within 57 months. For Western nations to remain competitive with China in the global AI landscape, they are expected to achieve comparable timely delivery of electricity from nuclear power stations. Strong industrial capabilities, combined with a firm commitment to strengthen global nuclear non-proliferation and security culture, will ensure a reliable and affordable electricity supply to support the emerging AI, Artificial General Intelligence (AGI), and Artificial Superintelligence (ASI) transportation eras.

About the Authors

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