International Energy Agency

Data centre modelling approach presentation

Environmental Law Institute

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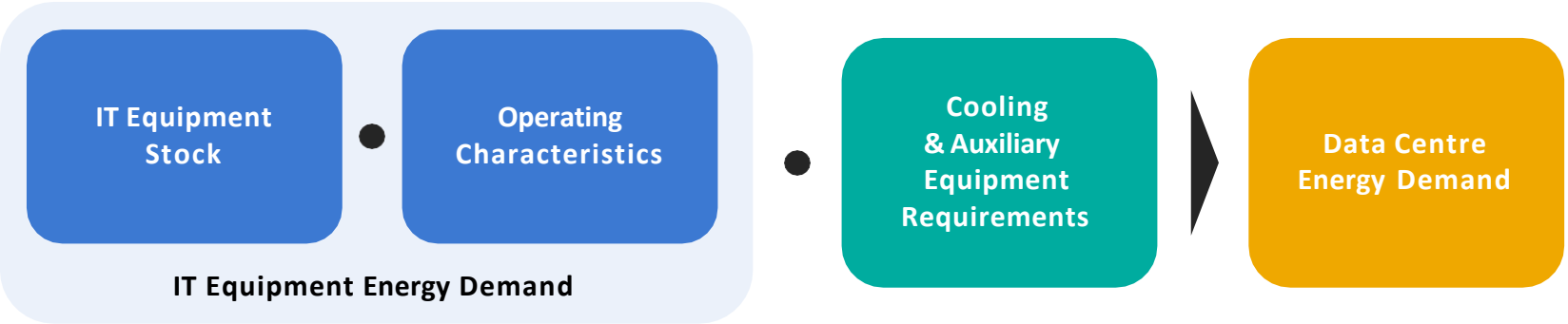
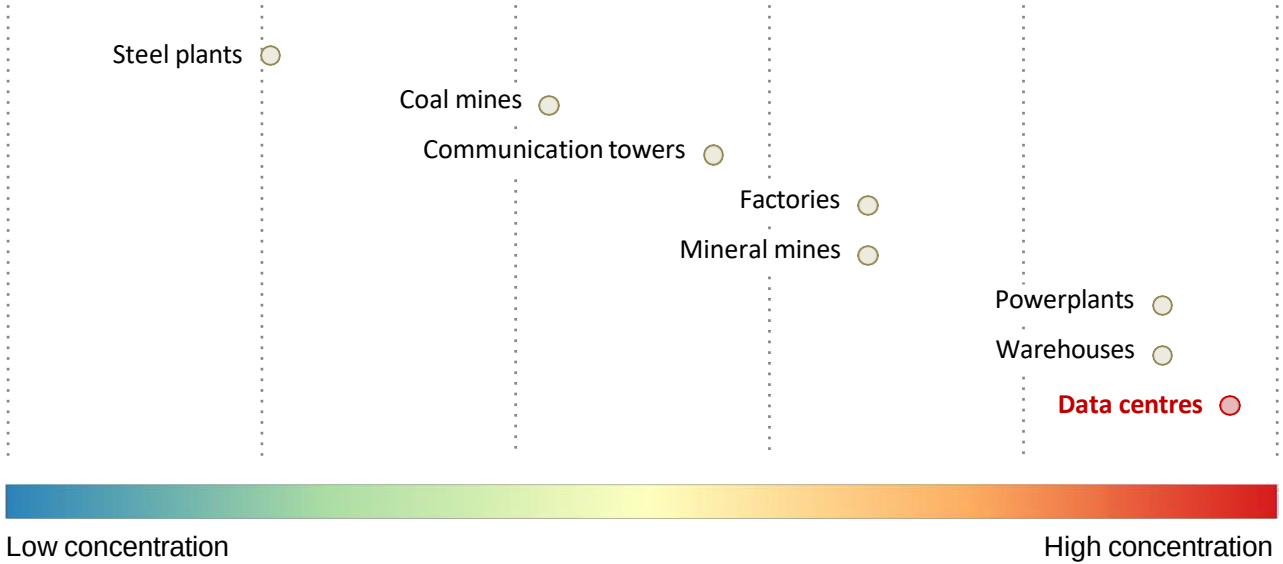
Modelling approach

- **Key Drivers:** Hardware equipment shipments, particularly servers, drive data centre growth projections.
- **Operating characteristics:** Operating characteristics based on utilisation rates of hardware stock are estimated based on scientific literature and third-party data.
- **Global Projections:** To produce worldwide projections, the model also considers the impact of digitalisation across economies.
- **Input data from IDC:** IEA modelling is relying on IDC input data for both stock (IT equipment installed capacity) and operating data.



Data centres have a strong tendency to cluster

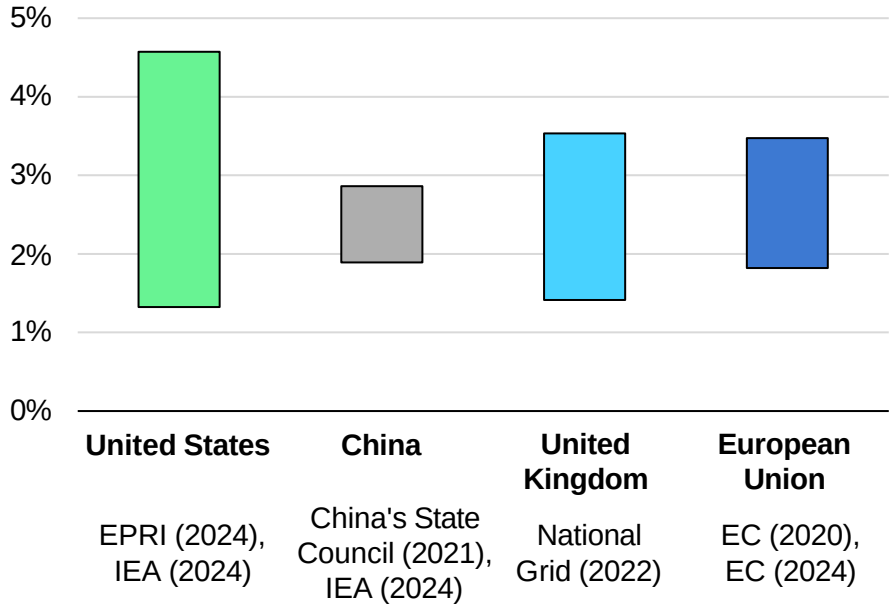
Spatial concentration of selected types of facilities, United States

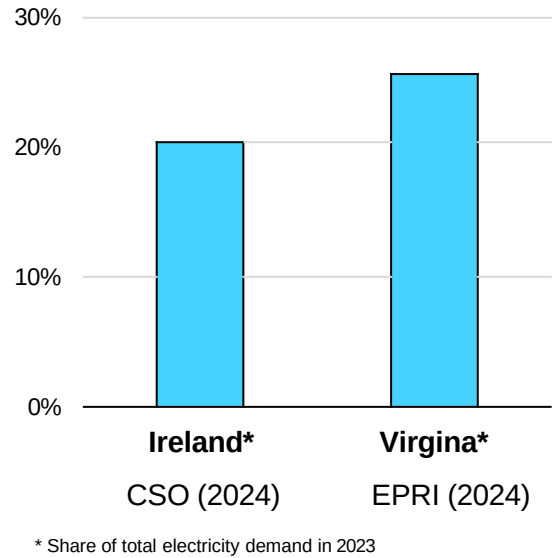


Data centres have an exceptionally high spatial concentration, which has significant implications for local power grids, given their substantial power requirements.

Historical data is quite patchy and uncertain

Range of data centre electricity demand estimates as a share of total electricity demand per selected region in 2022



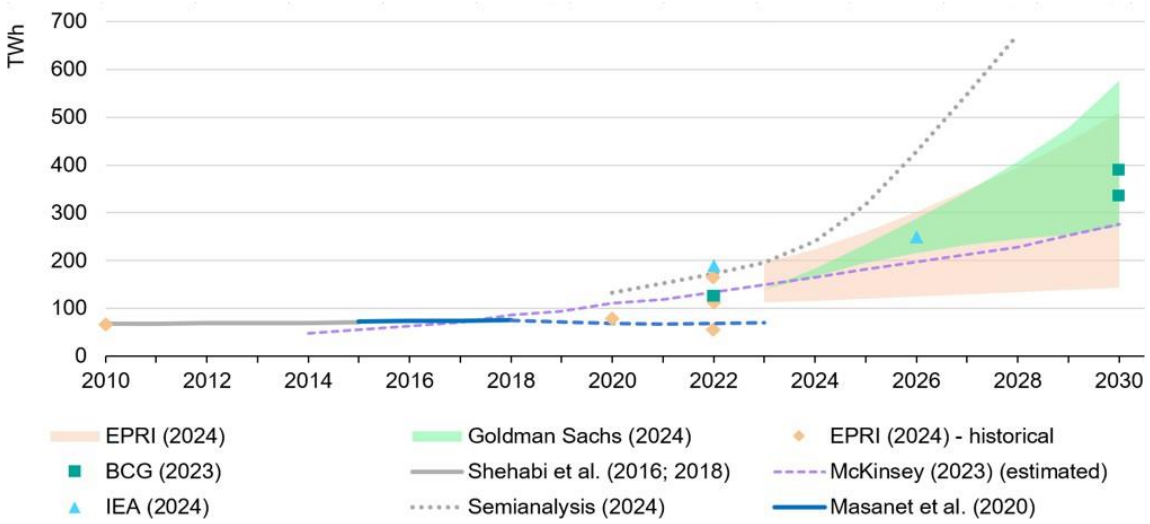


* Share of total electricity demand in 2023

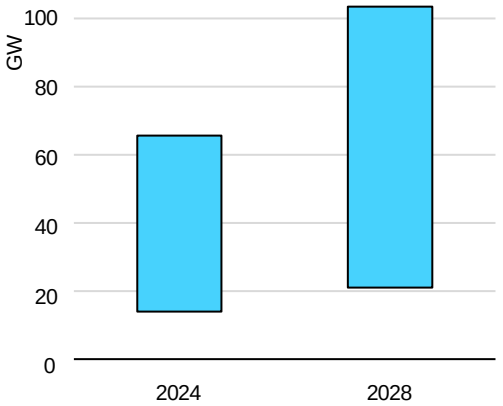
While data centres' share of global electricity demand was limited to 0.9%-1.3% in 2022, there are regions where they already account for a sizeable portion of electricity demand.

Challenges around data centre energy demand projections

US data centre electricity demand projections from different sources, 2010-2030



US data centre capacity uncertainty ranges, 2024-2028



Ranges based on projections from Cushman & Wakefield (2024), McKinsey (2023 & 2024), Semianalysis (2024), Mordor Intelligence (2024), BCG (2023), and IDC (2024)

Uncertainties around data, technological advancements and efficiency improvements, in addition to AI deployment, make it challenging to predict the future energy consumption of data centres

In response to these uncertainties there is a need for cooperation

Identified data gaps to bridge in the modelling	New data initiatives to unlock access to critical data	Involvement of Stakeholders to support these initiatives
While the benefit of the **bottom-up modelling** have proved to be the best option over the past two decades of data centre demand modelling, gaps have been clearly identified, and **new drivers of the demand such as AI** make them more yawning.	Critical stock and operational data necessary to enhance the accuracy of data centre and AI energy estimates have been identified. Initiatives like **power performance standards, reporting incentives and requirements**, and **stronger partnerships for better knowledge sharing** will be cornerstones for improving accuracy.	These new data initiatives will require collaboration across the entire ecosystem, including industry, academia, and governments. Involvement from stakeholders, ranging **from hardware manufacturers and standard organization to power utilities and data centre operators**, is pivotal.

Observatory on Energy, AI, and data centres

Energy demand from AI and data centres

- How much energy will data centres and AI technologies require in the future?
- What measures can be taken to mitigate the increase?

AI applications in the energy sector

- A series of use cases on how AI can be applied in the energy system, covering both end-use sectors and energy supply.

The Observatory data will be **publicly available**

Sources

- International Energy Agency (2024), Electricity Mid-Year Update July 2024, https://iea.blob.core.windows.net/assets/234d0d22-6f5b-4dc4-9f08-2485f0c5ec24/ElectricityMid-YearUpdate_July2024.pdf
- Shehabi, A. et al. (2016), United States Data Center Energy Usage Report, https://escholarship.org/content/qt84p772fc/qt84p772fc.pdf
- Shehabi, A et al. (2018), Data center growth in the United States: decoupling the demand for services from electricity use, https://iopscience.iop.org/article/10.1088/1748-9326/aaec9c/meta
- Masanet, E. et al. (2020), Recalibrating global data center energy-use estimates, https://www.science.org/doi/abs/10.1126/science.aba3758
- Lei, N. and Masanet, E. (2022), Climate- and technology-specific PUE and WUE estimations for U.S. data centers using a hybrid statistical and thermodynamics-based approach, https://www.sciencedirect.com/science/article/pii/S0921344922001719
- IDC (2024), Custom Market Intelligence
- EPRI (2024), Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption, https://www.epri.com/research/products/000000003002028905
- China State's Council (2021), Green data centers in focus, https://english.www.gov.cn/statecouncil/ministries/202112/09/content_WS61b13edac6d09c94e48a1f81.html#:%7E:text=According%20to%20a%20report%20from%20China%27s%20State%20Grid,for%202.7%20percent%20of%20the%20country%27s%20electricity%20consumption.
- National Grid (2022), Data centres, https://www.neso.energy/document/246446/download
- European Commission (2020), Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market, https://digital-strategy.ec.europa.eu/en/library/energy-efficient-cloud-computing-technologies-and-policies-eco-friendly-cloud-market
- European Commission JRC (2024), Energy consumption in data centres and broadband communication networks in the EU, https://op.europa.eu/en/publication-detail/-/publication/f6822d03-cedb-11ee-b9d9-01aa75ed71a1/language-en
- Central Statistics Office (2024), Data Centres Metered Electricity Consumption 2023, https://www.cso.ie/en/releasesandpublications/ep/p-dcmec/datacentresmeteredelectricityconsumption2023/keyfindings/
- Cushman & Wakefield (2024), Global Data Center Market Comparison 2024, https://cushwake.cld.bz/2024-Global-Data-Center-Market-Comparison
- McKinsey (2023), Investing in the rising data center economy, https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy
- McKinsey (2024), How data centers and the energy sector can sate AI's hunger for power, https://www.mckinsey.com/industries/private-capital/our-insights/how-data-centers-and-the-energy-sector-can-sate-ais-hunger-for-power
- Semianalysis (2024), AI Datacenter Energy Dilemma – Race for AI Datacenter Space, https://semianalysis.com/2024/03/13/ai-datacenter-energy-dilemma-race/
- BCG (2023), The impact of GenAI on Electricity: How GenAi is Fueling Data Center Boom in The U.S., https://www.linkedin.com/posts/bcg-on-energy_the-impact-of-genai-in-electricity-activity-7112787574032674816-uDEX/?utm_source=share&utm_medium=member_desktop
- Mordor Intelligence, https://www.mordorintelligence.com/industry-reports/united-states-data-center-market
- Goldman Sachs (2024), Generational growth, AI, data centers and the coming US power demand surge, https://www.goldmansachs.com/pdfs/insights/pages/generational-growth-ai-data-centers-and-the-coming-us-power-surge/report.pdf
- Masanet, E., Lei, N., and Koomey, J. (2024), To better understand AI's growing energy use, analysts need a data revolution, https://www.cell.com/joule/abstract/S2542-4351(24)00347-7