Data centers are guzzling up too much electricity. Can we make them more efficient?

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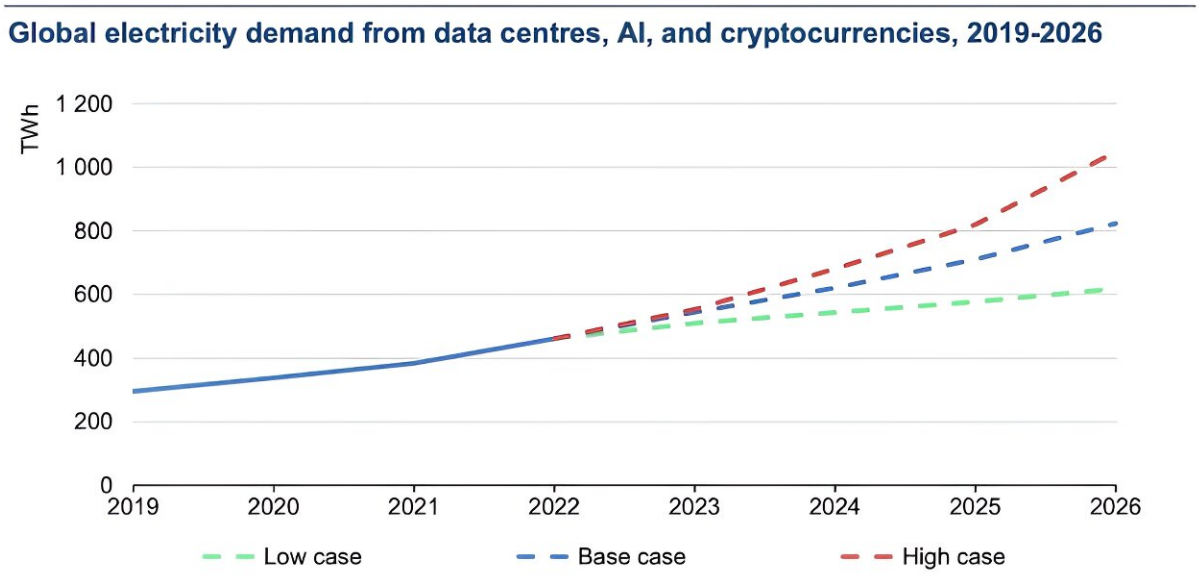

Includes traditional data centres, dedicated AI data centres, and cryptocurrency consumption. Low and high case scenarios reflect uncertainties in the pace of deployment and efficiency gains amid future technological developments. Credit: International Electricity Agency, CC BY

Our insatiable demand for digital content and services has been driving a rise in energy-hungry data centers.

The International Energy Agency reports global data center electricity consumption could double in a few short years, reaching 1,000 terawatt hours (TWh) by 2026. That's roughly the same as generated by the whole of Japan per year.

Some predictions estimate 8%–10% of the planet's electricity production will be needed to sustain the relentless growth in data centers.

These figures are not uniformly distributed across the globe. In Ireland, where the sector is incentivized, data centers are predicted to exceed 30% of the country's electricity demand within the next two years. Similar reports predict an increase in Australia from 5% to 8%–15% of electricity by 2030.

So why do data centers need so much electricity, and is there anything we can do to make them more energy efficient?

Why so much power?

Browsing the web, catching up on our social media feeds and binge-streaming the latest series are just some of the activities data centers support. In addition to these uses, power is also consumed at scale for artificial intelligence (AI) and cryptocurrency.

We may imagine data centers as rows of computers (servers) in racks with flashing lights, but, in terms of power usage, this is only part of the story.

When computers work hard, they tend to generate heat—lots of it. This heat is usually bad for the components within the computer or slows it down. With neither option desirable, data centers use extensive cooling systems to keep the systems running at a tolerable temperature.

Of the power consumed by an entire data center, computers may use around 40%. A similar proportion is typically dedicated to simply keeping the computers cool. This can be highly inefficient and costly.

Where data centers are designed for liquid cooling—for example, by immersing the "hot" equipment in fluid, or cooling air directly—this can result in the waste of considerable volumes of water.

How can we make data centers more energy efficient?

Using more renewable energy can decrease the demand on the electricity grid and the ultimate carbon footprint of a data center. However, there are also many ways to reduce electricity usage in the first place.

Airflow: older data centers may still operate as a single large room (or multiple rooms) where the entire space is cooled. More modern designs make use of warm and cold zones, only cooling the specific equipment where heat production is a problem.

Energy recovery: rather than forcibly cooling air (or liquids) using electricity, the warm exhaust from data centers can be repurposed. This could replace or supplement water heating or central heating functions for the human-centric parts of the building, or even supply surrounding premises.

Examples have included heating homes and businesses in Finland, a swimming pool in the United Kingdom, and even a trout farm in Norway .

Aquifer cooling: in locations with convenient access to underground water sources, groundwater cooling is a viable option to disperse excess heat. One example can be found in Western Australia with a CSIRO Geothermal Project helping to cool the Pawsey data center in Perth.

Optimization: although there are no reliable figures to quantify this type of waste, inefficiently configured software or hardware can use up some of the computing power consumed at a data center. Optimizing these can help reduce power consumption.

Ironically, an increasing number of cooling approaches involve the use of AI or machine learning to monitor the system and produce an optimal solution, requiring additional computing power.

Optimizing energy consumption, in general, can improve the costs of energy production. This idea opens a significant field of research on efficiently running all of the hardware in a data center.

Physical location: by planning where a data center is located, it is possible to significantly reduce cooling requirements. In northern Europe, the local climate can provide a natural cooling solution.

Similarly, recent trials using underwater data centers have proven not only effective in terms of cooling requirements, but also with the reliability of equipment.

The future of data centers

The evolution of AI is currently having the biggest impact on data center power consumption. Training AI platforms like ChatGPT, Gemini, Claude, Copilot and others is having such an impact, organizations like Google have recently increased their greenhouse gas emissions, despite global efforts to invest in carbon-neutral initiatives.

Even once trained, the use of AI-enabled applications represents significant power usage. One estimate suggests AI searches use ten times the power of a more typical Google search.

Our desire to use AI-driven products (and the enthusiasm for vendors to develop them) shows no sign of slowing down. It is likely the predictions for data center energy usage in the coming years are in fact conservative.

The lights are not going out just yet, but we are close to a tipping point where the power requirements of the systems we depend on will outstrip the generation capacity.

We must invest in clean energy production and effective energy-recovery solutions at data centers. And for now, perhaps we should consider if we really need ChatGPT to draw a silly picture.

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