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Electricity Demand Growth in the Digital Economy: Implications for Power Infrastructure, Climate Change, and Sustainable Development

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Abstract

The digital economy is becoming one of the main drivers of electricity demand growth. Cloud computing, artificial intelligence (AI), streaming, digital payments, and the digitalization of sectors from manufacturing to tourism all depend on data centers and networks that run around the clock. The International Energy Agency (IEA, 2025) projects that global data center electricity use will more than double from about 415 TWh in 2024 to around 945 TWh in 2030. This article examines what this growth means for power infrastructure, climate change, and sustainable development. It reviews the drivers of digital electricity demand, the pressures it places on generation, transmission, and grid stability, and its implications for greenhouse gas emissions. It also considers how digitalization reaches beyond technology firms into sectors such as tourism and rural development, and how the benefits and costs of digital growth can be shared fairly. Drawing on Anioke's (2025, 2026) work on the grid impacts of data centers and the use of stranded power, the article argues that digital electricity demand can be met sustainably if efficiency, flexibility, clean energy procurement, and fair cost allocation are made central to energy planning.

Keywords: Digital economy; electricity demand; data centers; power infrastructure; climate change; sustainable development

1. Introduction

For much of the past two decades, the digital economy seemed to grow without a matching rise in electricity use. Efficiency gains in servers, storage, and cooling, together with the shift of computing to large and efficient cloud facilities, kept data center electricity demand relatively flat in many countries. That period has ended. The rapid adoption of artificial intelligence, the continued migration of business systems to the cloud, and the digitalization of daily life have made the digital economy a major new source of electricity demand.

This shift has important consequences. Anioke (2025) shows that data centers raise total electricity demand, create new risks for grid stability, and complicate the transition to sustainable energy. Because data centers are large, concentrated, and fast to build, they can strain regional grids that were planned for slow and predictable growth. At the same time, the digital economy offers tools that can make energy systems more efficient and flexible. Anioke (2026) highlights that much of the power capacity in and around data centers is stranded, either unused within facilities or curtailed on the grid, and that finding productive uses for it can ease pressure on power systems.

This article examines electricity demand growth in the digital economy from three perspectives: its implications for power infrastructure, for climate change, and for sustainable development. It concludes with recommendations for policymakers, utilities, and digital businesses.

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2. Drivers of Electricity Demand in the Digital Economy

2.1 Data Centers and Artificial Intelligence

Data centers are the physical foundation of the digital economy. The IEA (2025) estimates that they used about 1.5% of global electricity in 2024, with consumption growing around 12% per year since 2017. Electricity use in AI-focused data centers is projected to more than quadruple by 2030. In the United States, Shehabi et al. (2024) report that data center electricity use rose from 58 TWh in 2014 to 176 TWh in 2023, about 4.4% of national consumption, and project that it could reach 6.7% to 12.0% by 2028.

AI is the main driver of this acceleration. Training large AI models and serving millions of users requires dense clusters of specialized processors that draw far more power than conventional servers. Single AI campuses can now require hundreds of megawatts, comparable to the demand of a small city.

2.2 Enterprise Digital Transformation

Beyond AI, businesses across all sectors are moving their operations to digital platforms and the cloud. Asuri (2021) examines enterprise digital transformation through the modernization of supplier relationship management systems and the adoption of a clean core architecture in preparation for transition to cloud-ready enterprise platforms. Such transformations improve business processes but also shift computing workloads from on-site servers to large data centers. While cloud facilities are often more efficient than scattered company servers, the overall effect of widespread digitalization is a growing and more concentrated demand for electricity in data center hubs.

2.3 Networks and End-User Devices

Data centers are only one part of the digital economy's electricity footprint. Mobile and fixed communication networks, which carry data between users and data centers, also consume significant amounts of power, and their demand grows as data traffic rises. Billions of end-user devices, including smartphones, laptops, televisions, and connected sensors, add further demand at homes and businesses. As digital services spread to more people and more aspects of daily life, the combined electricity use of networks and devices becomes an important part of the overall picture, particularly in emerging economies where connectivity is expanding rapidly.

2.4 Digitalization of Services and Sectors

The digital economy also reaches into sectors not traditionally seen as technology-driven. Tourism is a clear example. Online booking, digital payments, mobile guides, and social media marketing now shape how visitors discover and experience destinations. Seif (2025) shows that sustainable heritage tourism depends on managing heritage preservation, visitor experience, and community well-being; digital tools increasingly mediate each of these. Seif (2026) shows that community-based tourism can drive rural development through local participation, livelihood improvement, and cultural preservation. For rural communities, digital platforms offer access to wider markets, but they also depend on reliable electricity and connectivity. The spread of digital services across such sectors adds to electricity demand both locally, through devices and networks, and centrally, through the data centers that host digital platforms.

3. Implications for Power Infrastructure

3.1 Generation Adequacy

Rapid demand growth requires new generation capacity. The IEA (2025) expects data center electricity demand to be met by a mix of sources, with renewables expected to grow by more than 450 TWh to serve data center demand by 2035, supported by storage and the wider grid. Natural gas and nuclear power are

also expected to contribute. In regions where demand grows faster than new generation can be built, reserve margins shrink and the risk of supply shortfalls rises (Anioke, 2025).

3.2 Transmission and Interconnection

Data centers tend to cluster in regions with favorable power prices, land, connectivity, and policy. This concentration places heavy demands on local transmission lines and substations. A large data center can be built in one or two years, while new transmission infrastructure often takes much longer to plan and build. The IEA (2025) estimates that grid constraints could delay about 20% of planned data center projects worldwide. Interconnection queues, transformer shortages, and permitting delays have become major bottlenecks for digital growth.

3.3 Grid Stability

Data centers also affect how grids behave. Anioke (2025) explains that their large size, concentration, and sensitivity to power disturbances create new stability challenges. AI workloads can change power demand quickly, and data centers connect to the grid through power electronic equipment that responds differently to disturbances than traditional loads. Grid operators need better data and models to anticipate how these facilities will behave during faults and sudden changes in supply or demand.

3.4 Flexibility as an Infrastructure Resource

Not all the infrastructure needed for digital growth must be new. Grids are designed for peak demand, which occurs only in a small number of hours each year. Norris et al. (2025) examined the 22 largest balancing authorities in the United States and found that existing systems could integrate about 76 GW of new load if that load accepted curtailment for an average of just 0.25% of the year. Data centers that can reduce demand briefly during peak periods can therefore be connected sooner and with less new infrastructure. Anioke (2026) adds that stranded capacity inside data centers, power that is reserved but rarely used, can also be recovered, deferring the need for new grid connections.

4. Implications for Climate Change

4.1 Emissions Depend on the Energy Mix

The climate impact of digital electricity demand depends on how the electricity is generated. Where new demand is met by coal or gas, emissions rise; where it is met by renewables and other clean sources, the impact is much smaller. The IEA (2025) expects renewables to meet about half of the growth in data center demand, but also anticipates a significant role for natural gas in some regions. The direction of digital emissions is therefore not fixed; it depends on energy policy and procurement choices.

4.2 Rethinking Clean Energy Procurement

Many large technology companies have committed to powering their operations with renewable energy, traditionally by buying enough renewable certificates over a year to match their annual electricity use. This approach can leave many hours of consumption served by fossil generation. Riepin and Brown (2024) studied a stricter approach, 24/7 carbon-free energy, in which each hour of consumption is matched by clean generation on the same grid. They found that hourly matching allows buyers to eliminate the emissions linked to their electricity consumption and reduces system-level emissions by up to 572 kg of CO2 per year for each MWh of participating load. It also encourages investment in storage and firm clean power, the resources a decarbonized grid needs most.

4.3 Efficiency and Flexibility as Climate Tools

Efficiency remains the most direct way to limit emissions from digital growth. Shehabi et al. (2024) document how earlier gains in server efficiency, virtualization, and cooling kept U.S. data center

electricity use nearly flat for close to a decade. Continued gains in hardware, software, and cooling can slow future growth. Flexibility also has climate benefits: data centers that shift flexible workloads to times and places with abundant renewable energy can make use of clean power that might otherwise be curtailed. Anioke (2026) describes such stranded renewable power as a valuable resource that data centers are well placed to absorb.

4.4 Digital Tools for Decarbonization

The digital economy is not only a source of demand but also a source of solutions. Smart grids, forecasting, demand response, and building automation rely on digital technologies to integrate renewable energy and reduce waste. In sectors such as tourism, digital tools can help monitor energy and water use and manage visitor flows to protect ecosystems (Seif, 2025). The net climate impact of digitalization depends on whether these benefits outweigh the energy used by digital infrastructure.

5. Implications for Sustainable Development

5.1 Economic Opportunity

Digital infrastructure brings investment, jobs, and economic opportunity. Countries and regions that can supply reliable, affordable, and clean electricity are better placed to attract data centers and digital businesses. For many developing economies, access to digital services is increasingly important for participation in global trade, finance, and tourism.

5.2 The Risk of Uneven Benefits

The benefits of the digital economy are not automatically shared. Data centers concentrate in regions with strong infrastructure, while many rural and lower-income areas lack reliable electricity and connectivity. For rural communities seeking to use digital tools for tourism and enterprise, unreliable power can limit participation. Seif (2026) emphasizes that community-based tourism can improve livelihoods and preserve culture, but such benefits depend on the infrastructure that allows communities to reach visitors and markets. Ensuring that electricity and digital infrastructure reach underserved areas is therefore a development priority.

5.3 Affordability and Cost Allocation

Large new loads can raise the cost of electricity infrastructure. If the costs of new generation and transmission built mainly for data centers are passed on to all consumers, households and small businesses may face higher bills. Anioke (2025) notes that fair allocation of these costs is essential for public acceptance and for the sustainability of data center growth. Tariff designs that require large digital customers to pay for the infrastructure they need, while rewarding flexibility, can protect other users.

5.4 Heritage, Communities, and Local Environments

Digital infrastructure also has local impacts. Data centers require land, water for cooling, and power lines, which can affect landscapes, heritage sites, and communities. Seif (2025) highlights the importance of managing the relationship between heritage preservation and community well-being in destination development. Similar principles apply to the siting of digital infrastructure: decisions should consider local environments, cultural assets, and the views of affected communities.

6. A Framework for Sustainable Digital Electricity Demand

Drawing on the analysis above, five principles can guide the sustainable management of electricity demand growth in the digital economy:

1. **Efficiency first.** Prioritize efficient hardware, software, and cooling to slow demand growth (Shehabi et al., 2024).
2. **Flexibility as a resource.** Treat data centers and other digital loads as flexible participants in the grid, and recover stranded capacity (Anioke, 2026; Norris et al., 2025).
3. **Clean and hourly-matched supply.** Encourage procurement of clean electricity matched hour by hour to consumption, supported by storage and firm clean power (Riepin & Brown, 2024).
4. **Coordinated infrastructure planning.** Plan generation, transmission, and grid upgrades for digital growth using scenario-based forecasts, and strengthen grid stability standards (Anioke, 2025; IEA, 2025).
5. **Inclusive and fair development.** Extend reliable electricity and connectivity to underserved communities, allocate costs fairly, and consider local and cultural impacts when siting digital infrastructure (Seif, 2025, 2026).

7. Recommendations

For **policymakers and regulators**:

- Develop long-term energy plans that explicitly account for digital demand growth and its uncertainty.
- Reform interconnection processes to offer flexible connection options for large digital loads.
- Design tariffs that allocate infrastructure costs fairly and reward demand flexibility.
- Support investment in electricity and connectivity for rural and underserved areas.

For **utilities and grid operators**:

- Improve data collection and modeling of data center behavior to protect grid stability.
- Coordinate with data center operators on demand response and use of stranded renewable power.
- Accelerate transmission planning in regions with concentrated digital demand.

For **digital businesses and data center operators**:

- Invest in energy efficiency across hardware, software, and cooling.
- Move toward hourly clean energy procurement and support storage and firm clean power.
- Offer flexibility to the grid where workloads allow, and recover stranded capacity within facilities.
- Engage with local communities and consider environmental and cultural impacts when choosing sites.

For **enterprises undergoing digital transformation**:

- Consider the energy and carbon footprint of digital systems when planning cloud migration and system modernization (Asuri, 2021).
- Choose cloud providers that are transparent about their energy use and committed to clean power.

8. Conclusion

The digital economy has become a major driver of electricity demand growth, led by data centers and artificial intelligence and reinforced by the digital transformation of businesses and sectors such as tourism. This growth carries significant implications. For power infrastructure, it requires new generation, faster transmission development, and closer attention to grid stability. For climate change, its impact

depends on whether new demand is met by clean energy and whether efficiency and flexibility are prioritized. For sustainable development, it brings economic opportunity but also risks of uneven benefits, higher costs for other consumers, and local environmental and cultural impacts. None of these outcomes is predetermined. By treating efficiency and flexibility as resources, matching digital demand with clean energy hour by hour, recovering stranded power, planning infrastructure in a coordinated way, and ensuring that the benefits and costs of digital growth are shared fairly, societies can harness the digital economy as a driver of sustainable development rather than a threat to it.

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