Energy Efficiency to Tame Data Center Energy Use

John A. Hodges

The rise of the digital economy presents the potential to save energy in broad swathes of the economy.[1] Data centers provide computing power to digital services driving these energy savings. Ironically, growth in digital services has enlarged data centers' own energy footprint and resulted in mounting pressure to increase data centers' energy efficiency.[2] To date, efficiency gains have helped offset rapid growth in demand for data center services.[3] But anticipated robust growth in computing services, accompanied by flattening trends of energy efficiency gains among data centers, has added further pressure to increase efficiency.[4]

Technology Advances Won't Preclude Regulation. One response to this demand for efficiency has been technological innovation. Photonic chips, which use light particles in place of electrons to transmit information, are being developed to make servers more efficient.[5] New energy sources for data centers, like hydrogen fuel, are being explored.[6] Highly efficient data centers, which use innovative waterless cooling systems coupled with other energy efficient systems, are under construction.[7] In the public sector, the Department of Energy (DOE) has announced $40 million in funding of 15 projects to develop efficient cooling systems for data centers.[8]

However, data centers' large energy footprint suggests that industry should not expect such innovation to preclude regulation on data centers' energy efficiency. Therefore, industry should closely monitor regulatory developments in this rapidly evolving field.

Data center energy efficiency is largely regulated in two ways. First, energy efficiency rules can be adopted for computing parts used in data centers, such as servers and storage devices. Second, rules can be adopted for data centers to achieve certain facility-level energy efficiency, often measured through power usage efficiency (PUE)—the total energy used by a data center divided by energy used by information technology components such as servers and storage devices.

United States

Energy Star for Computer Servers. In the United States, Energy Star, a voluntary joint program between the DOE and the Environmental Protection Agency (EPA) begun in 1992, has been the primary energy efficiency benchmark for computer servers.[9] Energy Star Tier 1, issued in May 2009, was a voluntary system to award Energy Star labels to servers that met or exceeded certain energy efficiency criteria.[10] Energy Star Tier 1 covered a limited array of servers with four or fewer processor sockets. It excluded servers with more than four processor sockets; blade systems including blade servers and blade chassis; fully fault tolerant servers; server appliances; multi-node servers; storage equipment including blade storage; and network equipment.[11]

Servers covered by Energy Star Tier 1 could qualify for Energy Star certification by meeting multiple criteria including minimum efficiency levels and idle power level ceilings.[12]

Since the introduction of Tier 1, Energy Star has been regularly updated to expand its coverage and heighten efficiency criteria. In 2013, Energy Star Version 2.0 was issued to include blade, multi-node, and resilient servers in addition to servers covered in Version 1.0.[13] Version 2.0 also required all server products to run Standard Performance Evaluation Corporation's (SPEC) to Server Efficiency Rating Tool (SERT) to evaluate whether it met efficiency criteria.[14] Energy Star's labeling criteria was updated to Version 3.0 in 2018, further raising efficiency criteria required for certification.[15] On April 12, 2023, final specifications for Energy Star Version 4.0 were issued.[16] Version 4.0 introduces different power efficiency requirements for power supply units (PSUs) based on their rated output power and increases energy efficiency levels required for certification across the board.[17] Version 4.0 is scheduled to take effect on January 12, 2024.[18]

Energy Star for Data Centers. In 2010, the United States expanded Energy Star to include data centers as a way to incentivize facility-level energy efficiency.[19] Data center owners can use Energy Star's benchmarking software to analyze their energy efficiency relative to other comparable data centers.[20] The benchmarking software applies a holistic statistical model that accounts for a data center's energy use as well as other factors that may affect energy usage to assign a single Energy Star Score.[21] Data centers that score at least 75 out of 100 may be eligible for Energy Star certification. As of July 20, 2023, 233 data centers in the United States were Energy Star certified.[22]

Energy Act of 2020. The United States currently does not have mandatory energy efficiency regulations for privately owned data centers. However, the Energy Act of 2020 included several measures related to data center energy efficiency including establishing an open data initiative on energy use at federally owned and operated data centers; creating a new metric to evaluate data center energy efficiency; and developing a strategy to maintain, purchase, and use energy efficient and energy saving information technologies at federal agencies.[23] Increased visibility into data center energy efficiency and new measurement techniques could potentially lead to insights that inform future efficiency regulations for data centers.

State Efforts on Data Centers. Individual states have attempted to regulate data centers. A bill to study the impact of data center development, including energy impact, was proposed in Virginia.[24] A bill in Oregon aimed to make data centers reduce emissions from electricity use.[25] Although both bills failed to became law, these and other states may attempt to pass similar measures to impose energy efficiency requirements for data centers where federal regulation is absent.[26]

European Union

Ecodesign Directive for Computer Servers. The European Ecodesign Directive was adopted in 2009 to establish a framework for setting mandatory energy efficiency requirements for 8

product areas (heating equipment, water heaters, electric motors, lighting, domestic appliances, office equipment, consumer electronics, and HVAC systems) with a high potential for cutting back energy consumption.[27] In 2019, the Ecodesign Directive was expanded to include servers and data storage products through European Commission Regulation 2019/424.[28] The Ecodesign Directive requires covered products to operate at or above predetermined minimum energy efficiency at various power levels.[29] It also requires servers and data storage products to be manufactured using techniques that would not prevent their repair or reuse.[30] Certain products such as servers with more than four processor sockets, fully fault tolerant servers, network servers, and small and large data storage products are excluded from these requirements.[31] Additionally, the Directive lays out processes to enforce compliance with efficiency standards through required information disclosures and testing procedures.[32] Manufacturers are required to disclose metrics such as power supply unit efficiency, idle state power, maximum power, and active state energy efficiency of covered products.[33]

Energy Efficiency Directive Proposal for Data Centers. Unlike the United States, the European Union has taken a more prescriptive approach to regulating data centers' energy efficiency at the facility level. The surge in energy prices caused by Russia's invasion of Ukraine in 2022 renewed the importance of energy efficiency in the European Union's broader energy security policy.[34] Consequently, the European Union is currently working to amend its Energy Efficiency Directive to further reduce final energy consumption by 11.7% by 2030.[35] Savings achieved through energy efficiency improvements were given front stage as the proposed amendment calls for energy efficiency solutions to be considered in major planning, policy, and investment decisions in energy system, non-energy, and transportation infrastructure sectors.[36]

The proposed amendment also introduced provisions specifically targeting data centers. First, it would require all data centers with a power demand of over 500 kilowatts to disclose information about its energy consumption and efficiency.[37] The European Commission plans to use this information for an assessment report that could be followed by proposals for measures to further improve data centers' energy efficiency.[38] Additionally, European member states would be required to ensure that data centers with an energy footprint exceeding 1 megawatts use or recover their waste heat from operations.[39] Data centers that are unable to comply would be required to demonstrate why it is technically or financially unfeasible.[40]

Enforcement of the Energy Efficiency Directive will depend on European member states' implementing legislation that is yet to be passed. Germany's Energy Efficiency Act, currently adopted by the German cabinet and scheduled to be voted on by the Bundestag, sheds some light on what implementation of the Directive may look like.[41] The current draft proposes mandatory efficiency requirements for new and existing data centers. Specifically, new data centers would be required to achieve a PUE of 1.5 by July 2026, which would need to be further improved to 1.3 by 2030.[42] In addition to PUE requirements, the Energy Efficiency Act would require new data centers opening in 2026 to reuse 10% of the heat they generate.[43] This number would increase to 20% for data centers built in 2028.[44] As the draft has been going through the enactment process, the German Datacenter Association (GDA) has been an active advocate on this issue, urging the

German government to fine tune heat recapture requirements to bring them down to more practical levels for the industry.[45] The GDA has also pointed out that PUE requirements may cause problems for colocation data centers because uncontrollable factors such as actions by clients and low utilization rates may drive their efficiency down.[46]

China

China has taken a proactive stance in implementing energy efficiency regulation for data centers. In 2021, China's National Development and Reform Commission (NDRC), which wields broad regulatory powers over the economy, is encouraging data centers to be more energy efficient.[47] The NDRC set PUE targets for new large data centers at 1.3 and data centers generally at 1.5 by 2025.[48] In addition to the NDRC, "Eastern Data, Western Computing," China's data computing infrastructure project, seeks to support the data center industry in achieving energy efficiency targets.[49] This project, by developing new data processing hubs in the Chinese interior, seeks to take advantage of cooler and drier climate conditions, which will in turn enable data centers to reduce electricity consumption for cooling systems.[50]

Conclusion. As global computing demand continues to show robust growth amid a push to reduce carbon emissions, governments of the United States and other major economies have increased their attention on data centers' energy consumption and environmental footprint. Although the United States has yet to adopt mandatory energy efficiency requirements for data centers or computer servers, European and Chinese regulations may nudge United States to adopt similar measures in the future. DOE grants exploring innovative technologies for data centers' cooling solutions, as well as reporting mandates for federally owned and operated data centers, signal that more regulations may be on the horizon in the United States. Data center and computer server industries should be prepared not only to respond to future regulatory action in this space but also to actively participate in shaping future regulation.

* * * *

For more information on HWG LLP's energy practice, please contact John A. Hodges.

Hoon Kim, a J.D. candidate at Georgetown University Law Center, who has been a Summer Associate at HWG LLP, contributed to the preparation of this advisory under the supervision of John Hodges.

[1] *See Energy Efficiency and Digitalisation*, Int'l Energy Agency (June 20, 2019), https://www.iea.org/articles/energy-efficiency-and-digitalisation.

[2] *See id.*; *Energy 101: Energy Efficient Data Centers*, Dep't of Energy (Sept. 16, 2013), https://www.energy.gov/eere/articles/energy-101-energy-efficient-data-centers.

[3] *Data Centres and Data Transmission Networks*, Int'l Energy Agency (Sept. 2022), https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks; Urs Hölzle, *Data Centers Are More Energy Efficient Than Ever*, Google Keyword (Feb. 27, 2020), https://blog.google/outreach-initiatives/sustainability/data-centers-energy-efficient/.

[4] *Investing in the Rising Data Center Economy*, McKinsey & Co. (Jan. 17, 2023), https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy; Miranda S. Spivack, *More Data in the Cloud Means More Centers on the Ground to Move It*, N.Y. Times (June 27, 2023), https://www.nytimes.com/2023/06/27/business/data-centers-internet-infrastructure-development.html.

[5] Steve Lundeberg, *Breakthrough in Computer Chip Energy Efficiency Could Cut Data Center Electricity Use*, CARILEC (May 25, 2023), https://www.carilec.org/computer-chip-efficiency-breakthrough-could-vastly-improve-data-center-energy-efficiency/.

[6] Cheryl Tan, *Data Centres Plan to 'Green' Operations with Hydrogen Power*, Mitsubishi Heavy Indus. Grp. Spectra (May 26, 2023), https://spectra.mhi.com/partner-data-centres-plan-to-green-operations-with-hydrogen-power.

[7] Endeavour Energy, LLC, *Edged Energy Breaks Ground on New Ultra-Efficient, Waterless Data Center Campus in Aurora*, Cision PR Newswire (June 8, 2023 8:01 PM), https://www.prnewswire.com/news-releases/edged-energy-breaks-ground-on-new-ultra-efficient-waterless-data-center-campus-in-aurora-301846799.html.

[8] *DOE Announces $40 Million for More Efficient Cooling for Data Centers*, Dep't of Energy (May 9, 2023), https://www.energy.gov/articles/doe-announces-40-million-more-efficient-cooling-data-centers.

[9] John A. Hodges, *Appliances, Lighting, Computers, Data Centers, and Computer Servers, in The Law of Clean Energy: Efficiency and Renewables* 277, 286 (Michael B. Gerrard ed., 2011).

[10] *Id.* at 291.

[11] *Id.*

[12] *Id.*

[13] Env't. Prot. Agency, *Energy Star Servers Version 2.0 Cover Memo* (Mar. 15, 2013), https://www.energystar.gov/sites/default/files/specs//EPA%20Cover%20Memo%20for%20Final%20Version%202.0%20Computer%20Servers%20Program%20Requirements.pdf.

[14] SERT scores a computing server's energy efficiency by measuring and aggregating the server's power demand during 11 different types of computing tasks at several designated utilization levels. *See How to Measure Server Efficiency with SERT*, Energy Star, https://www.energystar.gov/products/ask-the-experts/how-to-measure-server-efficiency-with-sert- (last visited July 20, 2023).

[15] Energy Star, *Energy Star Computer Servers Version 3.0 Final Specification Cover Memo* (Sept. 17, 2018), https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%203.0%20Computer%20Servers%20Program%20Requirements_0.pdf.

[16] Energy Star, *Energy Star Version 4.0 Computer Servers Final Specification Cover Memo* (Apr. 12, 2023), https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%204.0%20Computer%20Servers%20Final%20Specification.pdf.

[17] *Id.*

[18] *Id.*

[19] *Energy Star Score for Data Centers*, Energy Star (Aug. 24, 2018), https://www.energystar.gov/buildings/tools-and-resources/energy-star-score-data-centers.

[20] *How to Apply for Energy Start Certification*, Energy Star, https://www.energystar.gov/buildings/building_recognition/building_certification/how_apply (last visited July 20, 2023).

[21] *How the 1–100 ENERGY STAR Score is Calculated*, Energy Star, https://www.energystar.gov/buildings/benchmark/understand_metrics/how_score_calculated (last visited July 20, 2023).

[22] *Energy Star Certified Data Centers*, Energy Star, https://www.energystar.gov/buildings/certified_data_centers (last visited July 20, 2023).

[23] Energy Act of 2020, Pub. L. 116-260, 134 Stat 2418, 2426-28 (2020).

[24] S.J. Res. 240, 162nd Gen. Assemb., 2023 Reg. Sess. (Va. 2023).

[25] H.B. 2816, 82nd Leg. Assemb., 2023 Reg. Sess. (Or. 2023).

[26] Some jurisdictions regulate data centers' energy efficiency through building regulations that apply to data centers. *See* Cal. Code Regs. tit. 24, § 140.9 (2022) (California regulation requiring "computer rooms" with a power density great than 20W/ft^2 to meet certain cooling and design requirements); The Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015, SI 2015/962, 27, ¶ 2 (United Kingdom statutory instrument prohibiting landlords from leasing non-domestic properties that do not meet certain building energy efficiency standards).

[27] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 Establishing a Framework for the Setting of Ecodesign Requirements for Energy-related Products (recast), 2009 O.J. (L. 285) 10, 21.

[28] Commission Regulation Laying Down Ecodesign Requirements for Servers and Data Storage Products Pursuant to Directive 2009/125/EC of the European Parliament and of the Council and Amending Commission Regulation (EU) No 617/2013, 2019 O.J. (L. 74) 46, 48.

[29] *Id.* at 56.

[30] *Id.*

[31] In Article 8, the Commission decided to assess whether to continue the exclusion of such products from regulation by March 2022. *Id.* at 48. As of July 2023, the Commission has not released assessment outcomes. *Id.* at 51.

[32] *Id.* at 58-60.

[33] *Id.*

[34] Lasse Boehm & Alex Wilson, *EU Energy Security and the War in Ukraine: From Sprint to Marathon* 8, Eur. Parliament Rsch. Serv. (Feb. 21, 2023), https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/739362/EPRS_BRI(2023)739362_EN.pdf.

[35] *Proposal for a Directive of the European Parliament and of the Council on Energy Efficiency (recast)*, at 2, COD (2023) 7446/23 (Mar. 24, 2023), https://data.consilium.europa.eu/doc/document/ST-7446-2023-INIT/en/pdf.

[36] *Id.* at 2.

[37] *Id.* at 4.

[38] *Id.*

[39] *Id.*

[40] *Id.*

[41] *See The Public Sector Set to Become a Role Model*, Bundesregierung (Apr. 19, 2023), https://www.bundesregierung.de/breg-en/news/the-energy-efficiency-act-2184958; Peter Judge, *Germany to Pass Energy Efficiency Act, Demanding Heat Reuse in Data Centers,* Data Center Dynamics (July 7, 2023), https://www.datacenterdynamics.com/en/news/germany-to-pass-energy-efficiency-act-demanding-heat-reuse-in-data-centers.

[42] Judge, *supra* note 41.

[43] *Id.*

[44] *Id.*

[45] *Id.*

[46] *Id.*

[47] *National Development and Reform Commission and Other Departments on the Promotion of Strict Energy Efficiency Constraints: Several Opinions on Energy Saving and Carbon Reduction in Key Areas*, Nat'l Dev. & Reform Comm'n (Oct. 18, 2021), https://www.ndrc.gov.cn/xxgk/zcfb/tz/202110/t20211021_1300583_ext.html.

[48] *Id.*

[49] Seaton Huang, *China's Latest National Infrastructure Project Spotlights Computing Capabilities*, Council on Foreign Rel. Net Politics (Nov. 1, 2022 3:43 PM), https://www.cfr.org/blog/chinas-latest-national-infrastructure-project-spotlights-computing-capabilities.

[50] *Id.*