The Stella Group, Ltd.

The Stella Group, Ltd.. is a strategic technology optimization and policy owner's rep firm for clean distributed energy users and companies which include advanced batteries and controls, energy efficiency, fuel cells, geo-exchange, heat engines, micro-hydropower (including tidal and wave), modular biomass, photovoltaics, small wind, and solar thermal (including CSP, daylighting, water heating, industrial preheat, building air-conditioning, and electric power generation). Scott Sklar serves on the national Boards of Directors of the non-profit Business Council for Sustainable Energy and The Small-Scale Sustainable Infrastructure Development Fund (S3DIF). He teaches three unique interdisciplinary sustainable energy courses at The George Washington University (GWU) and serves as Sustainable Energy Director of GWU's Environment & Energy Study Institute (EEMI). Scott Sklar was awarded the prestigious The Charles Greely Abbot Award by the American Solar Energy Society (ASES) and on April 26, 2014 was awarded the Green Patriot Award by George Mason University in Virginia. Sklar is an Adjunct at The George Mason University where he taught a summer cause on "Renewable Energy & Critical Infrastructure for Low Income and Underserved Communities".

The Stella Group, Ltd. 703-522-1195 www.TheStellaGroupLtd.com solarsklar@aol.com

706 North Ivy Street Arlington, VA 22201

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Adj Prof Scott Sklar
Sustainable Energy Director
Environment & Energy Management Institute (EEMI)
and Acting Director, GWU Solar Institute
The George Washington University (GWU)
https://eemi.seas.gwu.edu/ sklar@gwu.edu
Personal email: solarsklar@aol.com Ph 703-522-3049

Data Center Panel 2 Presentation

7th Annual Mason Energy Forum: Data Centers

April 23, 2025

by

Professor Scott Sklar

The George Washington University

The Stella Group, Ltd.

George Mason University

I will be focusing on:

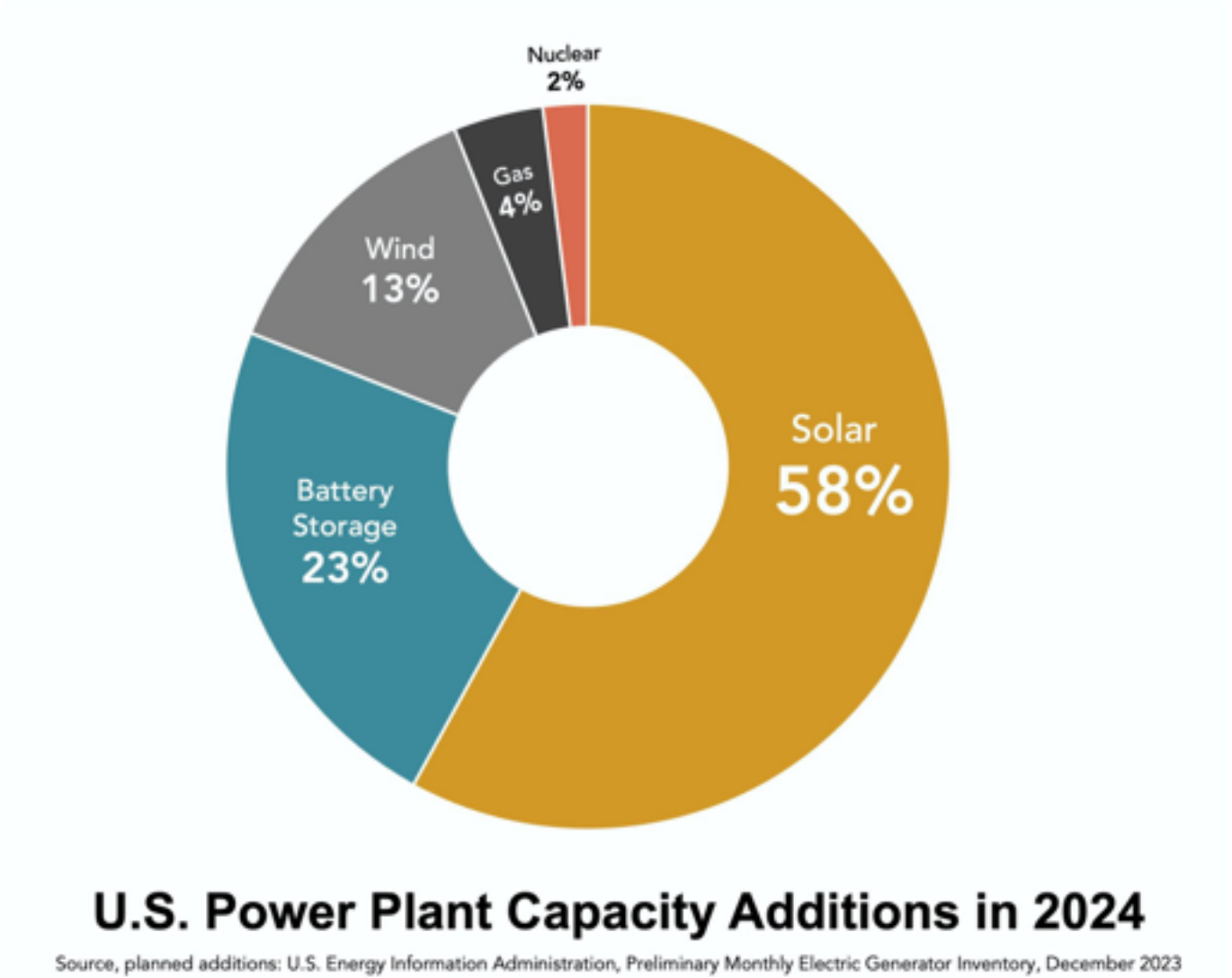
- can the existing US grid handle the expected electric load for new data centers within the next 20 years (absolutely no)

- can maximum energy efficiency and on-site renewables economically & reliably handle this added load (emphatically yes)

- I will draw on experience on my five all-renewable datacenter projects and other projects (articles and pictures) - a fast run through - Scott Sklar

INTRODUCTION

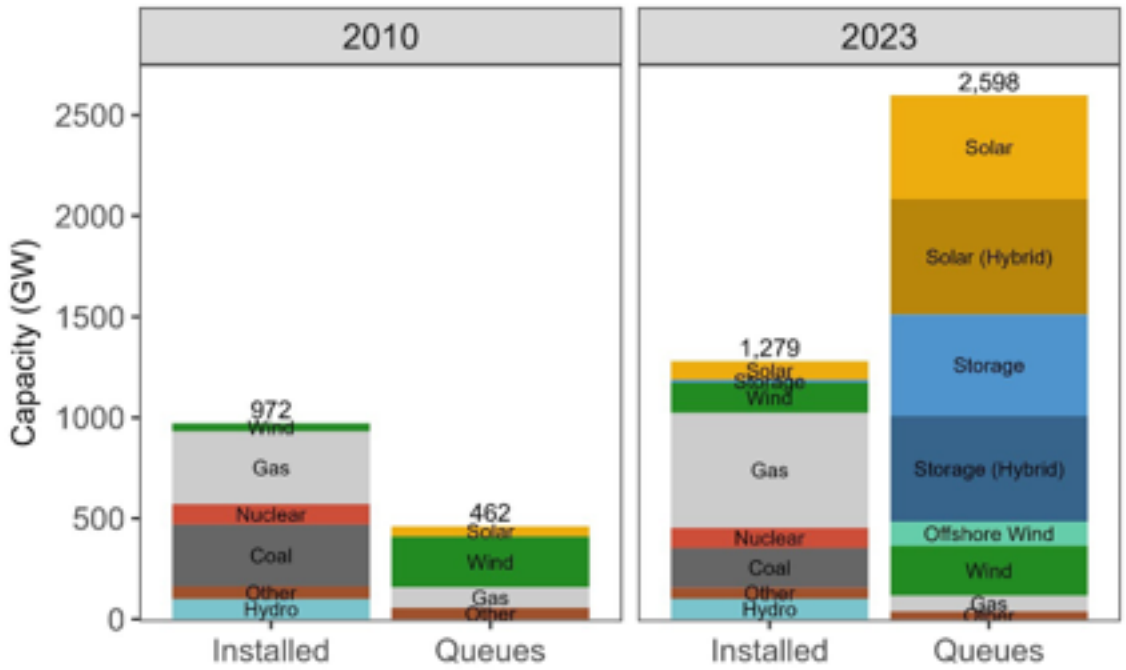
There Is No National Energy Emergency: The U.S. Has Abundant Energy and Is Steadily Transitioning Toward a Cleaner, More Secure Energy Future



https://commonedge.org/dont-buy-the-fossil-fuel-hype-there-is-no-national-energy-emergency/

Grid connection backlog grows by 30% in 2023, dominated by requests for solar, wind, and energy storage
April 10, 2024

The backlog of new power generation and energy storage seeking transmission connections across the U.S. grew again
in 2023, with nearly 2,600 gigawatts (GW) of generation and storage capacity now actively seeking grid interconnection,
according to new research from Lawrence Berkeley National Laboratory (Berkeley Lab). Active capacity in U.S. interconnection queues increased nearly eight-fold over the last decade, and is now more than twice the total installed capacity of the existing U.S. power plant flee olar, battery storage and wind energy, which together accounted



https://emp.lbl.gov/news/grid-connection-backlog-grows-30-2023-dominated-requests-solar-wind-and-energy-storage

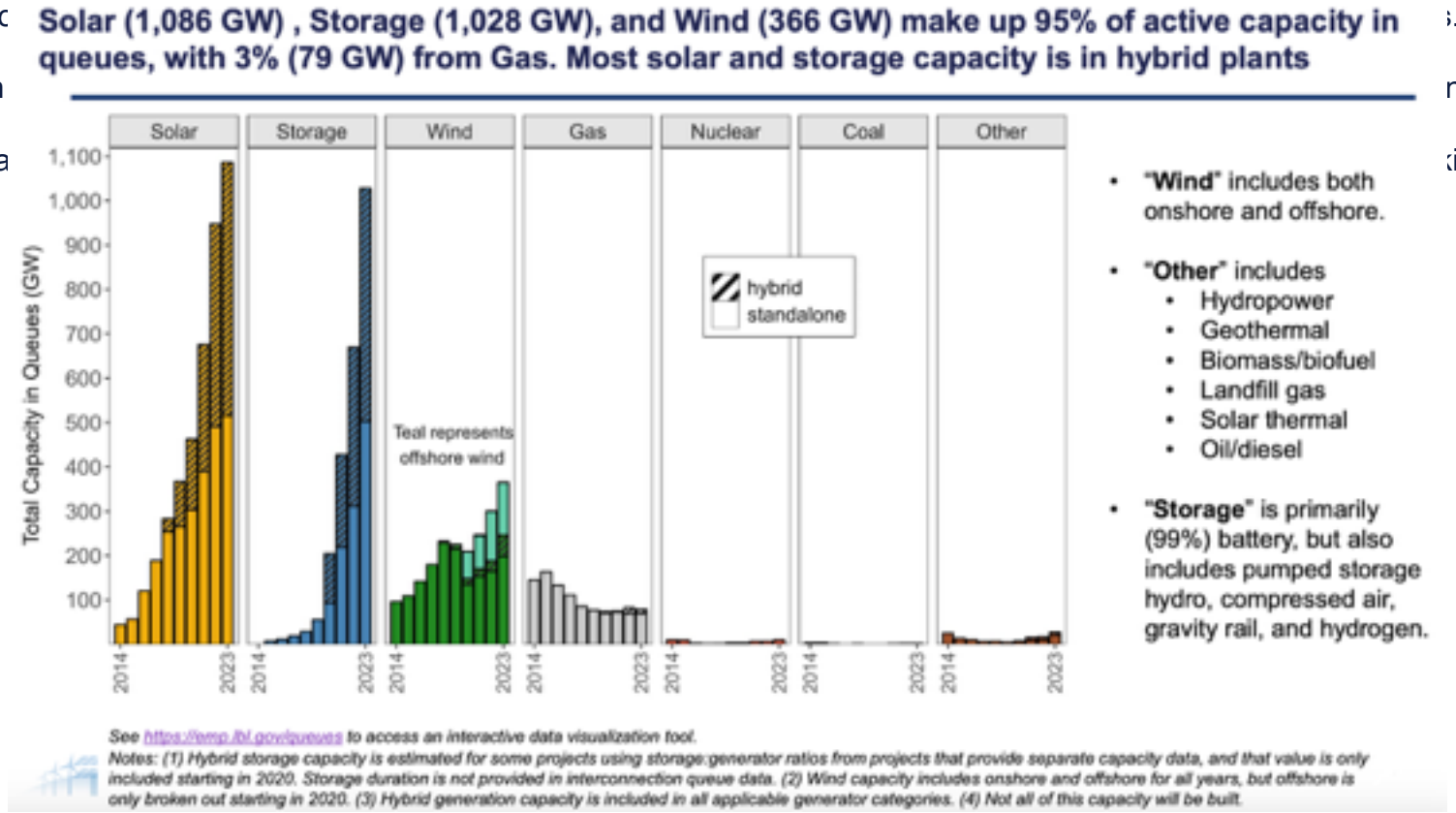
The U.S. interconnection queue is twice its installed capacity

There are now 2.6 TW of active generation capacity waiting to connect — and it's almost all renewables.

BIANCA GIACOBONE. JANUARY 15, 2025

The U.S. has more generation capacity in its interconnection queue than installed nationwide. If all the power projects that are seeking to connect to the grid were to come online right now,
we would solve power demand problems for years to come. According to a new report from Lawrence Berkeley National Lab, there are "nearly 11,600 projects representing 1,57(gigawatts
of generator capacity and 1,030 GW of storage actively seeking interconnection," or 2,600 GW in total. That's more than double the 1,279 GW of installed capacity currently available in the
country. The bulk of the capacity that is waiting for connection is renewable energy; 95% of the queuing generation capacity is from solar, storage, and wind projects, with 3% coming from gas.

Solar and storage, in particular, make up c ;. The researchers pointed ou that over
1,200 GW of requests came post-Inflation ncluding nuclear, hydro, and geothermal,
represents less than 1% of the queuing ca cing interconnection increased to 10 GW,
up from around 6.5 GW in 2022.



https://www.latitudemedia.com/news/the-u-s-interconnection-queue-is-twice-its-installed-capacity/

Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431
U.S. Environmental Protection Agency ENERGY STAR Program August 2, 2007

Data centers are found in nearly every sector of the economy: financial services, media, high-tech, universities, government institutions, and many others use and operate data centers to aid business processes, information management, and communications functions.

The energy used by the nation's servers and data centers is significant. It is estimated that this sector consumed about 61 billion kilowatt-hours (kWh) in 2006 (1.5 percent of total U.S. electricity consumption) for a total electricity cost of about $4.5 billion. This estimated level of electricity consumption is more than the electricity consumed by the nation's color televisions and similar to the amount of electricity consumed by approximately 5.8 million average U.S. households (or about five percent of the total U.S. housing stock). Federal servers and data centers alone account for approximately 6 billion kWh (10 percent) of this electricity use, for a total electricity cost of about $450 million annually.

https://www.energystar.gov/ia/partners/prod_development/downloads/EPA_Datacenter_Report_Congress_Final1.pdf

- **NextEra CEO John Ketchum says renewables are becoming a more attractive option to meet growing**
- **demand from data centers as the cost of building gas-fired generation triples due to a shortage of**
- **turbines. *(Politico Pro)***

John Ketchum's comments came after Energy Secretary Chris Wright downplayed the role renewable energy would have in new power generation.

BY: **BEN LEFEBVRE** | 03/10/2025 11:55 AM EDT

U.S. electricity demand is climbing as more data centers are built to power artificial intelligence and buildings and vehicles increasingly electrify. "To get your hands on a gas turbine right now and to actually get it to the market, you're looking at 2030 or later," Ketchum said on the CERAWeek stage. "The cost of gas-fired generation has gone up more than threefold." Factors for the cost increase include higher demand for turbines, which leads to higher labor costs as more workers in the gas turbine construction industry retire or leave for other careers, Ketchum said. Slow government permitting was also making natural gas projects more difficult.

…

https://subscriber.politicopro.com/article/2025/03/gas-turbine-shortage-boosts-renewable-energy-nextera-ceo-says-00220475?utm_campaign=Newsletter&utm_medium=email&_hsenc=p2ANqtz-_C0CfyKPlapndYHa8taltL0idePzjibbtyssWsqII_Z4JbHjcl4yIVATAWHM7_1TJW8n0JwJBBeN-haAe1zHjDEWD4mw&_hsmi=351165279

COMMENTARY – VIRGINIA MERCURY. For low-cost electricity, Virginia needs renewable energy — not gas plants

by IVY MAIN. JANUARY 20, 2025 5:10 AM

With data centers proliferating across Virginia unchecked, utility rates are under even more pressure now. The Joint Legislative and Audit Review Commission data center study, released last month, warns that ratepayer costs will inevitably rise under an "unrestrained growth" scenario that reflects current policy.

It's too early to tell whether any of the many bills to protect residential ratepayers and put guardrails on data center development will pass. For now, the governor and many Republicans seem to prefer to use the crisis to crush the transition to renewable energy.

State	Price cents/kWh	% generation from RE	Top Sources of RE
Utah	11.42	19	Solar, geothermal
Louisiana	11.84	4	Biomass, hydro, solar
Arkansas	11.88	9	Hydro, solar
North Dakota	12.08	36	Wind
Nebraska	12.13	32	Wind
Idaho	12.29	68	Hydro, wind
Washington	12.50	90	hydro
Missouri	12.58	14	Wind
Tennessee	12.92	14	Hydro, solar
Iowa	13.28	59	Wind
Kentucky	13.31	8	Hydro, biomass
Montana	13.35	50	Hydro, wind
Mississippi	13.78	3	Biomass, solar, wind
South Dakota	13.86	77	Wind, hydro
Georgia	14.00	13	Hydro, solar
Oklahoma	14.08	45	Wind
Wyoming	14.08	21	Wind
Florida	14.20	8	Solar, biomass
New Mexico	14.23	47	Wind, solar
Kansas	14.52	46	Wind
Nevada	14.61	39	Solar, hydro, geothermal
Arizona	15.02	17	Solar, wind, hydro
Virginia	**15.05**	**11**	**Solar, biomass, hydro**

Rates are for residential users as of October 2024. State numbers reflect generation, not consumption. Because Virginia imports so much of its electricity, and most of that is non-renewable, this data overstates how much renewable energy we actually use. According to EIA, less than 7% of our consumption is renewable.

LINK: HTTPS://VIRGINIAMERCURY.COM/2025/01/20/FOR-LOW-COST-ELECTRICITY-VIRGINIA-NEEDS-RENEWABLE-ENERGY-NOT-GAS-PLANTS/?EMCI=DD29FE68-B7D6-EF11-88D0-0022482A9D92&EMDI=111B7E14-26D7-EF11-88D0-0022482A9D92&CEID=342969

Big tech must stop passing the cost of its spiking energy needs onto the public

If left unaddressed, the unchecked growth of data centers will continue to threaten energy security and affordability for millions of Americans.

Utility Dive Published Jan. 6, 2025 By Julianne Malveaux

https://www.utilitydive.com/news/big-tech-data-centers-energy-needs-ai-consumers/736529/?utm_medium=email

The rapid expansion of data centers across the U.S. is not only reshaping the digital economy but also threatening to overwhelm our energy infrastructure. These data centers aren't just heavy on processing power — they're heavy on our shared energy infrastructure. For Americans, this could mean serious sticker shock when it comes to their energy bills. ....

Utilities may subsidize data center growth by shifting costs to other ratepayers: Harvard Law paper

"The public faces significant risks that utilities will … profit from new data centers by making major investments and then shifting costs to their captive ratepayers," the report's authors said.

Published March 10, 2025. Ethan Howland. Senior Reporter

Utilities may subsidize data center growth by shifting the costs of serving the facilities to residential and other ratepayers, according to a paper released March 5 by the Harvard Electricity Law Initiative.

The paper comes as American Electric Power, Dominion Energy, FirstEnergy and other utility companies are moving to serve data center developers such as Amazon, Google and Microsoft. Late last month, PPL subsidiaries Kentucky Utilities and Louisville Gas and Electric, for example, proposed a $3.7 billion plan to add power supplies for data centers.

The Harvard paper overlooks a December report from Virginia's Joint Legislative Audit and Review Commission that found that data centers in the state pay their cost of service, Fykes said in an email Monday. The report, however, also found that "data centers' increased demand will likely increase system costs for all customers, including non-data center customers … because current utility rate structures are not designed to account for sudden, large cost increases from the construction of new infrastructure to serve a relatively small number of very large customers."

Paper: https://eelp.law.harvard.edu/extracting-profits-from-the-public-how-utility-ratepayers-are-paying-for-big-techs-power/

https://www.utilitydive.com/news/utilities-subsidize-data-center-growth-ratepayer-cost-shif-harvard-peskoe/742001/?utm_source=Sailthru&utm_medium=email&utm_campaign=Issue:%202025-03-10%20Utility%20Dive%20Newsletter%20%5Bissue:71150%5D&utm_term=Utility%20Dive

REPORT: Solar Adds More New Capacity to the Grid in 2024 Than Any Energy Technology in the Past Two Decades

WASHINGTON, D.C. — March 11, 2025 -- The United States installed a record-breaking 50 gigawatts (GW) of new solar capacity in 2024, the largest single year of new capacity added to the grid by any energy technology in over two decades.

According to the U.S. Solar Market Insight 2024 Year in Review report released today by the Solar Energy Industries Association (SEIA) and Wood Mackenzie, solar and storage account for 84% of all new electric generating capacity added to the grid last year.

In addition to historic deployment, surging U.S. solar manufacturing emerged as a landmark economic story in 2024. Domestic solar module production tripled last year, and at full capacity, U.S. factories can now produce enough to meet nearly all demand for solar panels in the United States. Solar cell manufacturing also resumed in 2024, strengthening America's energy supply chain and cementing its place as a solar powerhouse.

Texas led all states for new solar capacity additions last year, replicating a record-setting 2023 with 11.6 GW of new installations. In total, 21 states set new annual installation records, and 13 states added over 1 GW of new solar capacity in 2024. The utility-scale segment saw historic gains in 2024, growing by 33% year-over-year with a record 41.4 GW of installed capacity. The community and commercial solar markets also set annual records, growing by 35% and 8%, respectively. The residential solar market experienced its lowest year of installations since 2021 due to state-level policy changes and elevated interest rates nationally. Forecasts show that the market is expected to rebound over the next decade.

https://seia.org/news/report-solar-adds-more-new-capacity-to-the-grid-in-2024-than-any-energy-technology-in-the-past-two-decades/

IEA Says Growth in Low-Emissions Sources is Sufficient to Cover Global Spike in Demand for Electricity Through 2027

ReNews.Biz, February 14, 2025
https://renews.biz/98799/renewables-to-meet-spike-in-demand-for-electricity
and
https://www.iea.org/news/growth-in-global-electricity-demand-is-set-to-accelerate-in-the-coming-years-as-power-hungry-sectors-expand
and
https://www.windpowermonthly.com/article/1906436/wind-meet-third-massive-electricity-demand-growth-2027-%E2%80%93-international-energy-agency
and
https://www.bloomberg.com/news/articles/2025-02-14/data-centers-evs-air-conditioning-and-industry-to-drive-grow

A new IEA report, “Electricity 2025,” forecasts global electricity consumption to rise by a whopping 3,500 terawatt-hours reflecting a strong annual rate of close to 4% through 2027, driven by industrial production, greater use of air conditioning, accelerating electrification, and the expansion of data centers. However, growth in low-emissions sources - primarily renewables and nuclear - is sufficient, in aggregate, to cover all the growth in global electricity demand over the next three years.

BloombergNEF says global solar installations could reach 700 GW in 2025, with additions rising to 753 GW in 2026 and 780 GW in 2027. March 13, 2025 **EMILIANO BELLINI**

The world may add about 698 GW of new PV capacity in 2025, BloombergNEF said in a new report.

That figure would compare to 599 GW in 2024, 444 GW in 2023, and 252 GW in 2022.

BloombergNEF said it expects China to remain the largest PV market this year, followed by the United States, India, Germany, Brazil, Pakistan, Turkey, and Italy.

The firm also projects global PV additions could reach 753 GW in 2026 and 780 GW in 2027.

The report's authors warned that many mature PV markets are now facing grid capacity constraints, falling spot market power prices, and declining homeowner interest in rooftop systems.

https://www.pv-magazine.com/2025/03/13/bloombergnef-expects-up-to-700-gw-of-new-solar-in-2025/?utm_source=USA+%7C+Newsletter&utm_campaign=1413008c49-dailynl_us&utm_medium=email&utm_term=0_80e0d17bb8-1413008c49-158716569&ct=t(dailynl_us)

TECHNOLOGY OPTIONS: DATA CENTER ENERGY

Utility energy efficiency investment hit record $8.8B in 2023: ACEEE

Published March 19, 2025, Robert Walton. Senior Reporter

Utilities are investing more than ever to reduce bills and cut emissions, but the increases are concentrated in just a few states, the American Council for an Energy-Efficient Economy concluded in its policy scorecard.

The total includes $6.9 billion for electric efficiency and $1.9 billion in gas efficiency investments. The total is an increase of approximately 16% compared with the recent low of 2020, ACEEE said, and 6% more than the previous high in 2019.

https://www.utilitydive.com/news/state-energy-efficiency-investment-hit-record-88-billion-2023-aceee/742963/?utm_source=Sailthru&utm_medium=email&utm_campaign=Issue:%202025-03-19%20Utility%20Dive%20Load%20Management%20%5Bissue:71463%5D&utm_term=Utility%20Dive:%20Load%20Management

Global Annual Revenue for Distributed Power Generation in Data Centers Expected to Reach $6.7 Billion in 2027:
Navigant Research, December 4, 2018

https://www.navigantresearch.com/news-and-views/global-annual-revenue-for-distributed-power-generation-in-data-centers-is-expected-to-reach-67-billi

According to a new report, "Sustainable and Renewable Power Generation for Global Data Centers," global annual revenue for distributed power generation in data centers is expected to grow from $3.9 billion in 2018 to $6.7 billion in 2027. Investment in cloud storage, colocation, and hyperscale data centers has resulted in the construction of a large volume of new data centers globally, thus increasing energy consumption. Consequently, the perceived benefits of distributed and renewable resources (like wind and solar PV) for both primary and critical power supply are gaining attention among data center operators. There is a compelling case for data centers to evaluate distributed generation along with demand response and grid interactivity. This strategy is likely to gain market acceptance in the next 3-5 years and offer rapid ROI across the globe.

Subsidiaries of Google and NV Energy have struck an agreement to power a $600 million data center in Henderson, Nev., using about 350 megawatts of solar photovoltaics and between 250 and 280 MW of battery storage, in what the tech company and public utility said is the world's largest battery-supported solar deal for a corporate customer. While project development deals are still under negotiation, the companies expect the solar-plus-storage resources to start operating in the second half of 2023.

(S&P Global Platts) ELECTRIC POWER
07 Jan 2020 | 21:51 UTC New York

https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/010720-google-nv-energy-propose-worlds-largest-corporate-solar-plus-storage-deal

Muscle Shoals Solar Project in Alabama Officially Online for Facebook Data Center: Solar Power World, by Kelly Pickerel, September 20, 2021

https://www.solarpowerworldonline.com/2021/09/muscle-shoals-solar-project-in-alabama-officially-online-for-facebook-data-center
and
https://renews.biz/72358/orsted-wraps-up-227mw-alabama-solar
and
https://www.nacleanenergy.com/solar/rsted-completes-muscle-shoals-solar-project-in-alabama

Ørsted has completed the 294-MWDC/227-MWAC Muscle Shoals solar PV project in Colbert County, Alabama. Located in the Tennessee Valley Authority service area, the project has a long-term PPA with TVA. This new project will support the sustainability goals of Facebook's data center in Huntsville, Alabama, that just started operations. Ørsted acquired Muscle Shoals in 2020 from Longroad Energy and has 1.4 GW of solar and storage capacity in operation and under construction.

160-MW Virginia Solar Project Will Support Facebook Data Centers:
Solar Power World, by Billy Ludt, October 25, 2021

https://www.solarpowerworldonline.com/2021/10/160-mw-virginia-solar-project-will-support-facebook-data-centers
and
https://renews.biz/73122/facebook-to-feast-on-virginia-solar
and
https://www.nacleanenergy.com/solar/d-e-shaw-renewable-investments-desri-announces-signing-of-a-160-mwac-solar-ppa-with-facebook-in-virginia

Facebook has signed a power purchase agreement on a 160-MWAC solar facility that will be built in Chesterfield County, Virginia. The Chester Solar project will support Facebook's data centers in the region, including the Henrico Data Center in Eastern Henrico County, helping the company maintain its commitment to support its global operations with 100% renewable energy. D.E. Shaw Renewable Investments (DESRI) and Torch Clean Energy are developing the project.

Data centers can benefit from clean energy, peaker plants

A new proposal from RMI would integrate clean energy with peaker plants to power data centers more efficiently, a strategy that could attract tech giants like Google and Microsoft aiming for 24/7 clean energy. Similar initiatives include Google and Intersect Power's $20 billion investment in renewable energy and data centers, but challenges remain, including regulatory hurdles and setting up contractual structures.

Full Story: Canary Media (3/18/2025) By **Jeff St. John**

People walk through the hallways at Equinix Data Center in Ashburn, Virginia, on May 9, 2024.

The biggest data centers now being planned across the country by
giants like Amazon, Google, Meta, and Microsoft can use hundreds
megawatts to gigawatts of electricity. In some of the country's bigge
data center hot spots, there simply isn't enough capacity left to conn
that much new load right now.

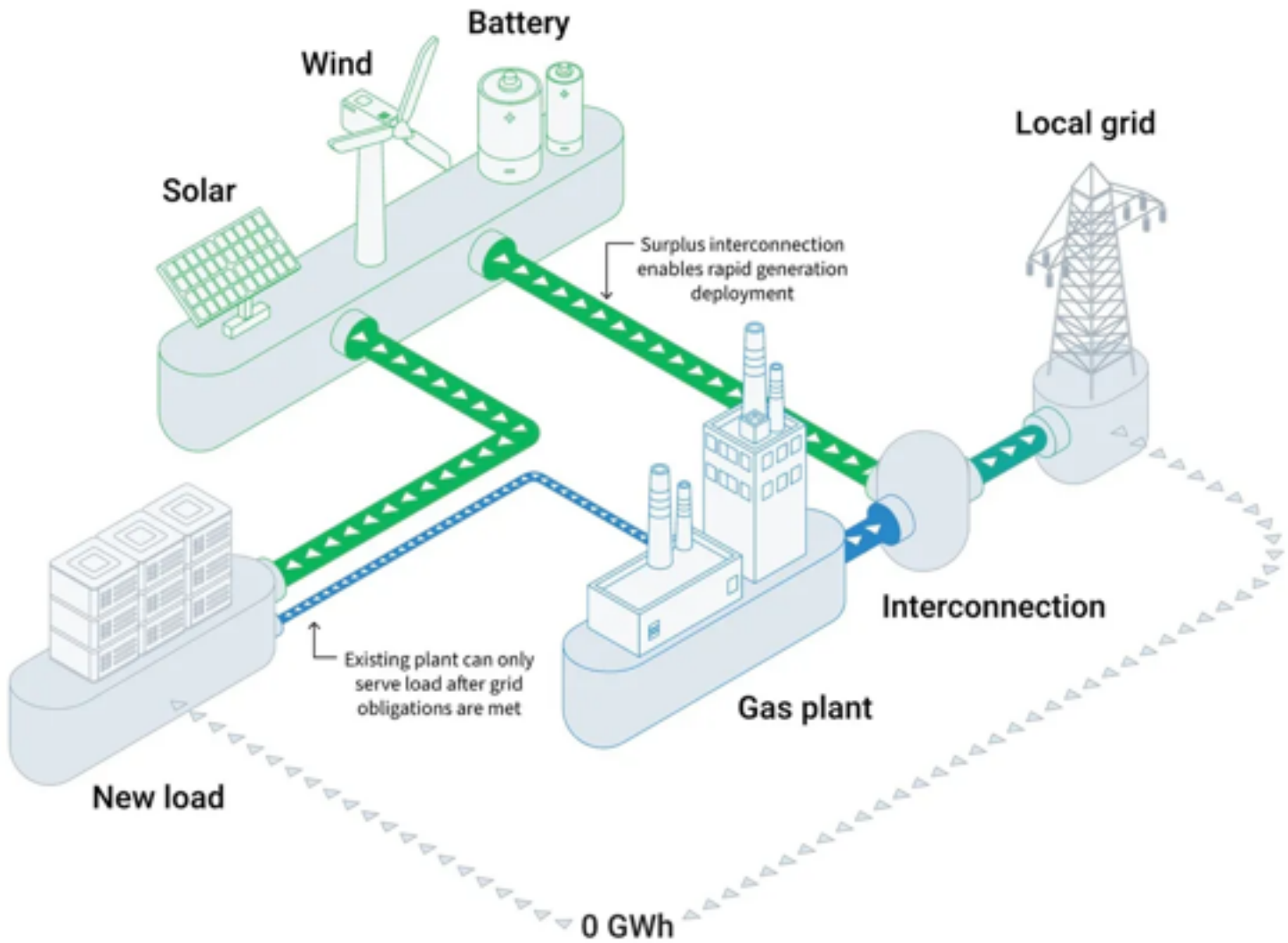
But in the "power couple" structure, those data centers wouldn't eve
draw from the grid, explained Uday Varadarajan, a senior principal a
RMI's carbon-free electricity program and co-author of the report.
Instead, they'd be connected to clean power behind the "point of int
connection" between peaker plants and the grid at large.

That could also allow new large-scale clean power projects to connect directly to the data center. Some of those solar, wind, and battery developments are already permitted and awaiting grid interconnection —
and all of them can be built much faster than new gas-fired power plants, according to industry experts. Allowing some of these projects to avoid the interconnection backlogs and grid upgrade costs would get clean power online much faster.

LINK: https://rmi.org/how-power-couples-can-help-the-united-states-win-the-global-ai-race/?__hstc=213470795.7a2373784efc80543846e38da876be54.1731802077390.1741295573865.1742424368978.27&__hssc=213470795.1.1742424368978&__hsfp=3092599220

https://www.canarymedia.com/articles/clean-energy/a-new-way-to-power-data-centers-pair-clean-energy-and-peaker-plants

Exhibit 1: Power Couple Co-location at Site of Existing Natural Gas Generator

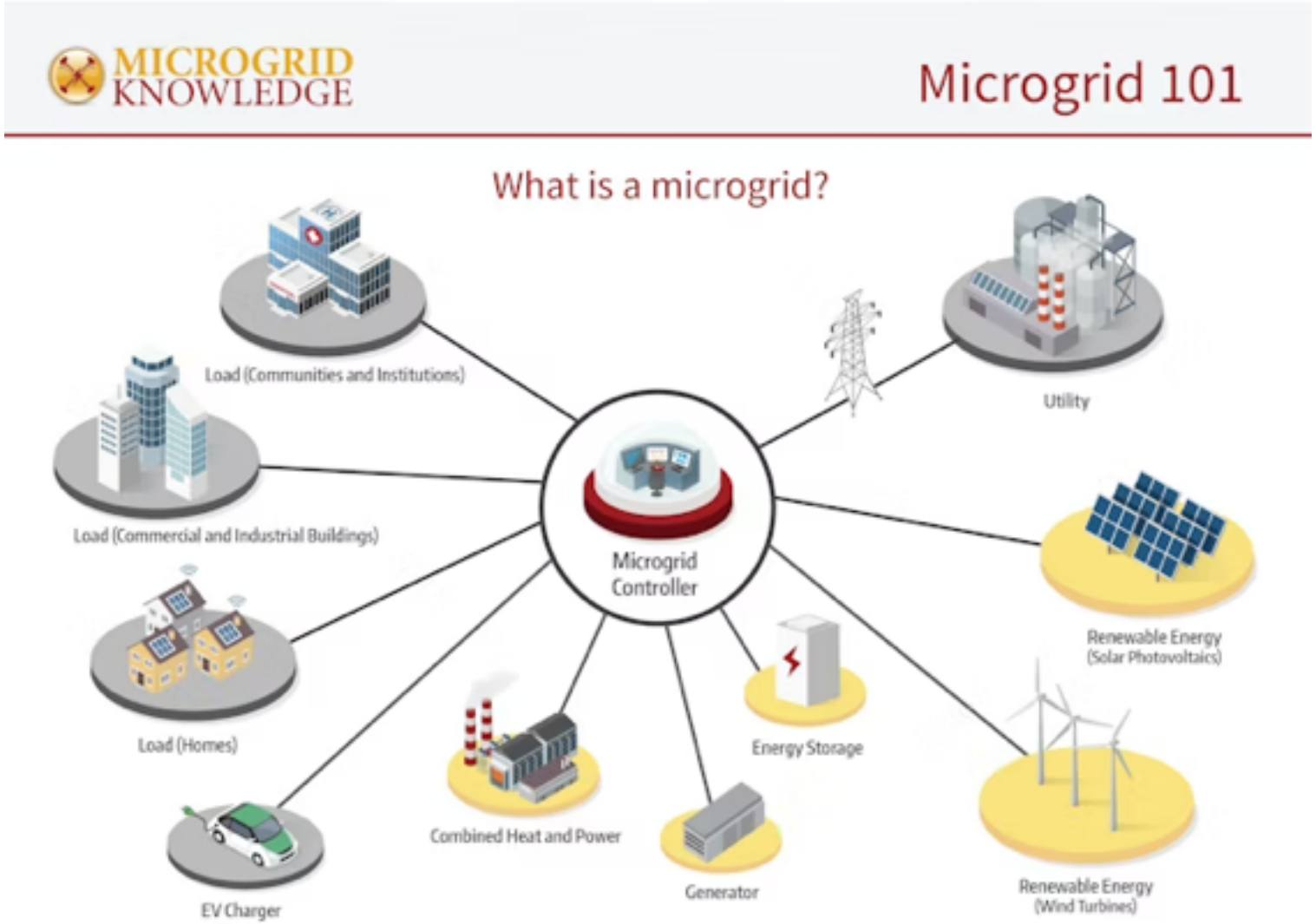


- continue from diagram –

In that sense, the peaker plants are more like gas-fired backups for a largely clean power mix. It's a natural fit: Peaker plants
are designed to fire up only when the grid really needs them, largely during summer heat waves or winter cold snaps when
demand for electricity peaks (hence their name).

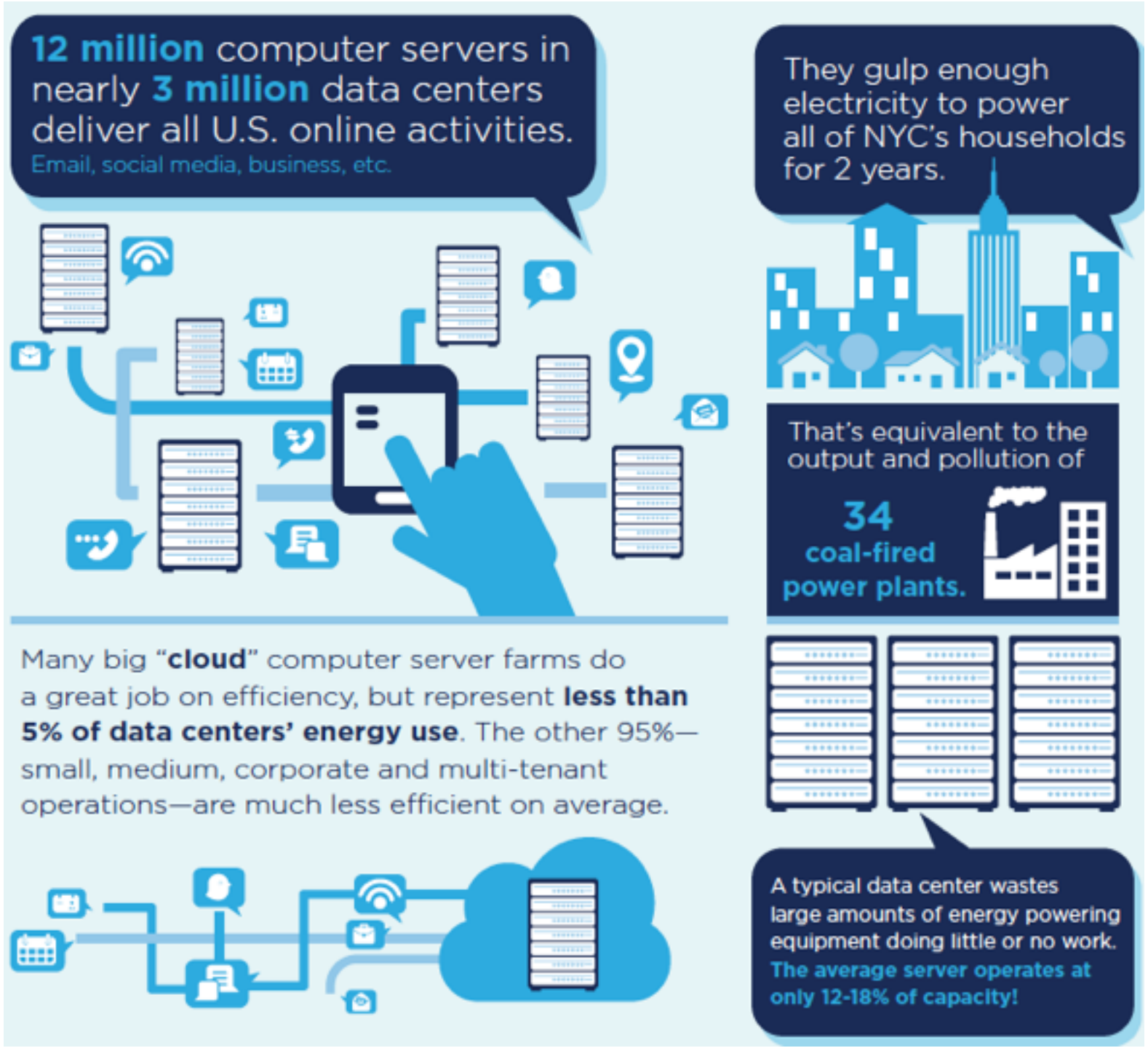
That leaves a lot of hours when those plants aren't using their connections to the grid at large — which creates an opening
for clean power to use them, Varadarajan said. Developers will probably want to "overbuild" the amount of dedicated solar,
wind, and batteries supplying data centers, so they can rely on those resources during more hours of the year. That means
the renewables will often generate more than the data center needs at a particular moment, but in the power couple arrange
ment that extra power wouldn't go to waste — it'd flow to the grid using the peaker plant's oft-idle grid connection.

Importantly, from the perspective of a utility or grid operator, this setup is potentially far less disruptive than adding a big new
load or trying to interconnect a brand-new source of generation, Varadarajan said. Many U.S. grid operators already have rules
to allow sites that have grid connections to add different types of generation capacity or to use a power plant's existing


MICROGRID KNOWLEDGE
Microgrid 101
What is a microgrid?
Load (Communities and Institutions)
Load (Commercial and Industrial Buildings)
Load (Homes)
EV Charger
Microgrid Controller
Combined Heat and Power
Generator
Energy Storage
Utility
Renewable Energy (Solar Photovoltaics)
Renewable Energy (Wind Turbines)

DEEPER INTO DATA CENTERS

Data Center Efficiency



DATA CENTER EFFICIENCY

Action is needed to accelerate adoption of energy efficiency best-practices.

Achieving just half of technologically feasible savings could cut electric use by 40% and save U.S. businesses $3.8 billion annually.

NRDC

Learn More at
nrdc.org/energy/data-center-efficiency-assessment.asp

ISSUE PAPER

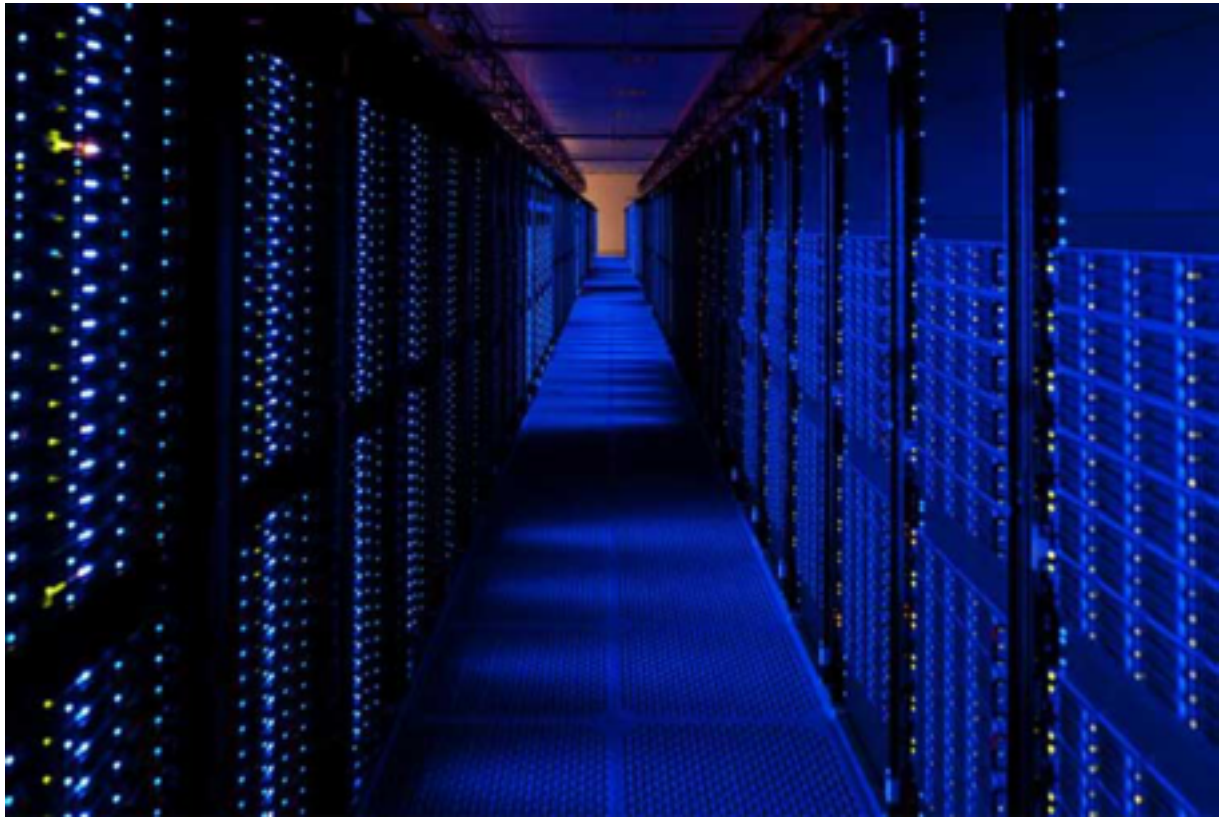
AUGUST 2014
IP:14:05:A

Data Center Efficiency Assessment

Scaling Up Energy Efficiency Across
the Data Center Industry:
Evaluating Key Drivers and Barriers

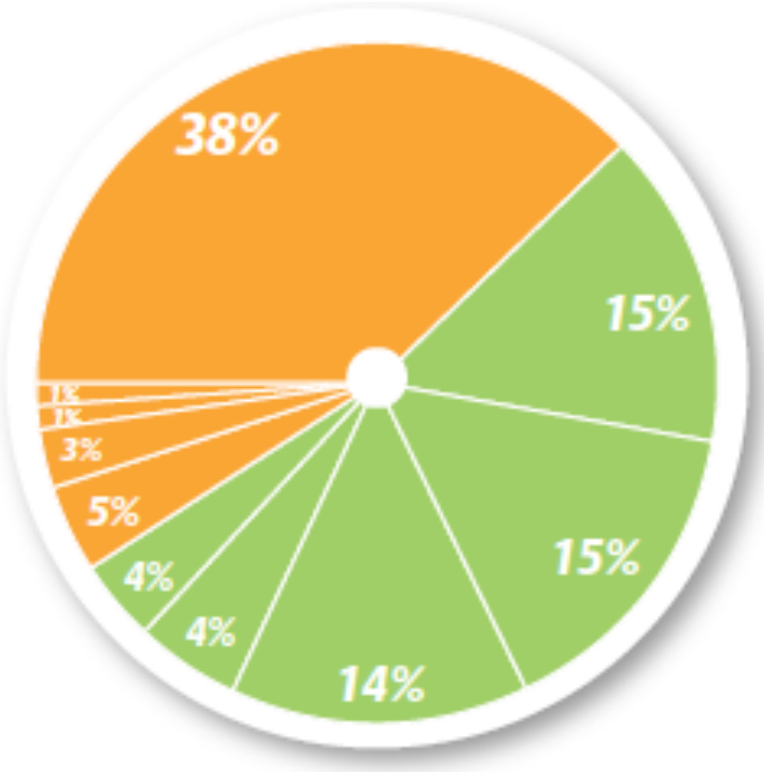
NRDC

Anthesis



As the largest player in public cloud computing, you'd expect Amazon to make our list. Indeed, Amazon has a large armada of cloud server farms, distributed in data center clusters . These clusters are spread across multiple smaller sites rather than a single huge campus, so Amazon doesn't rank as high as it otherwise might. This approach is driven by Amazon's use of Availability Zones, which allow customers to run instances in several locations to avoid a single point of failure. Availability Zones must reside in separate data centers that are isolated from one another, but close enough for low-latency network connections. The largest of these clusters is the US-East region, which spans more than 20 data centers in Northern Virginia, spread across Sterling, Manassas, Chantilly and Ashburn, where it has several multi-building campuses.

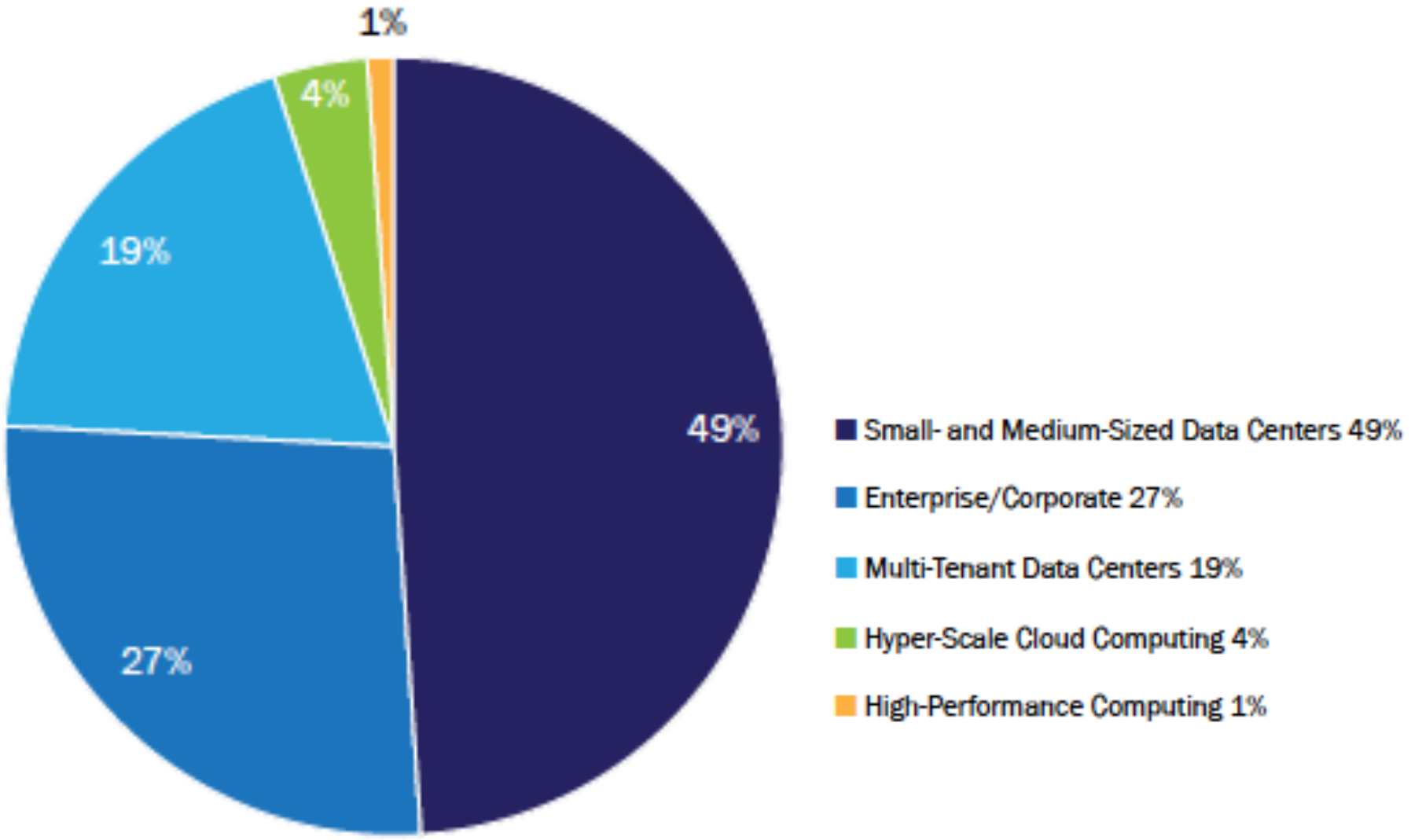
https://datacenterfrontier.com/top-10-cloud-campuses/



48% Power and Cooling	52% Computing Equipment
38% Cooling	15% Processor
5% UPS	15% Other Services
3% MV Transformer and Switchgear	14% Server Power Supply
1% Lighting	4% Storage
1% PDU	4% Communication Equipment

Category	Power Draw *
Processor	588 kW
Lighting	10kW
UPS and distribution losses	72kW
Cooling power draw for computing and UPS losses	429 kW
Building switchgear/MV transformer/other losses	28 kW
TOTAL	1,127 kW

Estimated U.S. data center electricity consumption by market segment (2011)



DATA CENTER ENERGY EFFICIENCY

Most data centers operate in a temperature range between 68 and 72 degrees Fahrenheit, and some are as cold as 55 degrees. Raising the baseline temperature inside the data center – known as a set point – can save money by reducing the amount of energy used for air conditioning. It's been estimated that data center managers can save 4 percent in energy costs for every degree of upward change in the set point. The list of companies singing the praises of savings through higher baseline temperature settings in the data center includes Google, Intel Sun and HP.

Analysis of a typical 5,000 square foot data center shows that demand-side computing equipment accounts for 52 percent of energy usage and supply-side systems account for 48 percent

https://www.datacenterknowledge.com/data-centers-that-recycle-waste-heat

NREL has the most energy efficient data center in the world and they reuse heat mostly for their office space. It's also connected to a district heating system if the local building demand isn't enough.

https://www.nrel.gov/computational-science/waste-heat-energy-reuse.html

NREL and LBNL are launching a new effort with FEMP in 2019, for new federal data center projects with liquid cooling, which can produce return water at 100+ deg F. There's also some recent projects with immersion cooling in DoD

(https://www.grcooling.com/wp-content/uploads/2018/09/grc-usaf-containerized-data-center-case-study.pdf).

Big Batteries at Data Centers Could Replace Power Plants:
Climatewire, by Benjamin Storrow, July 18, 2018

https://www.eenews.net/stories/1060089417

Can extensive battery systems installed at data centers like that of Microsoft Corp. southern Virginia be used to help grid operators smooth out the small spikes and drops in electric demand that occur throughout the day? If yes, power companies might not need to build new natural gas power plants. Directly powering data centers with the wind and sun becomes a real possibility. The stakes are potentially enormous. Technology companies are large buyers of electricity. Google estimates its global power consumption is equal to the city of San Francisco's. Researchers at the University of Washington studied a Microsoft data center and concluded the company could cut its annual electric bill by nearly 11 percent by reducing energy use at times of peak demand.

The home of the iCloud: The Apple data center campus in Maiden, North Carolina, featuring a massive 500,000 square foot building (at right) supported by a smaller “strategic” data center using modular data center technology. (Photo: Apple)

Apple was a latecomer to the cloud campus party, operating a relatively small data center footprint until 2009, when it announced plans to invest $1 billion in a data center in Maiden, a small town in western North Carolina. It has caught up in a hurry, and now has campuses under construction in Oregon, Nevada, Ireland and Denmark to provide the global infrastructure powering its iTunes and iCloud services. The original iDataCenter in Maiden spans 500,000 square feet, and is now supported by a smaller “strategic data center” using modular infrastructure. Apple’s North Carolina operation is distinctive for its on-site energy infrastructure, including two massive fields of photovoltaic solar power arrays, and a deployment of Bloom Energy Server fuel cells.

Almost four years after it began testing the idea of underwater data centers, Microsoft is sinking even more resources into the experiment. This time, it has submerged more than 864 computer servers (and all the related gear they need to run) about 117-foot deep on the seafloor off the coast of Scotland. They're crammed into 12 racks and housed in a 40-foot-long container that looks more like a submarine than a traditional data hall. The entire prototype runs off about 0.25 megawatt of renewable solar and wind electricity fed into it through a cable from the shore.The high-level aim of Project Natick is to test how reliably cool ocean water can keep the technology running when faced with rigorous workloads, such as running artificial intelligence computations or handling video streaming services. The experiment will run for one year before the data center is lifted back out of the water, collecting metrics such as power consumption, internal humidity and temperature

https://www.greenbiz.com/article/microsoft-facebook-take-plunge-novel-cloud-cooling-approaches?utm_source=newsletter&utm_medium=email&utm_term=newsletter-type-greenbuzz-daily&utm_content=2018-06-12&utm_campaign=newsletter-type-greenbuzz-daily-110646&mkt_tok=eyJpIjoiTVRjM1pETTROekZqT0dFeCIsInQiOiJVSWJTRDFSa25oXC9UUzN4TFIrWE5IbCs5QnAwZlR1OUdBTlZVQ0l3QkFnZW9valpRM0dGdlVybEQzSnpZaHg5eUdCVlhRU2ZPY2JZMkYwUDVJZGxJSG00U0NzdmdIc0E5bEEzdHdOalZlTGdhYWF3NGh5TXNBdEdURmt1dHhrN1UifQ%3D%3D

Engineers slide racks of Microsoft servers and associated cooling system infrastructure into Project Natick’s Northern Isles datacenter at a Naval Group facility in Brest, France. The data center has about the same dimensions as a 40-foot long ISO shipping container seen on ships, trains and trucks.

Google to power Virginia data centers with 24/7 clean energy from AES
Published May 4, 2021

Dive Brief:
AES announced on Tuesday a 10-year agreement to be the sole supplier of energy to three Google data centers in Virginia, providing clean power around the clock through a 500-MW portfolio of resources.

Through the partnership, AES will decarbonize Google's load in Virginia. The partnership "lays a blueprint for other companies looking to decarbonize their own operations," Michael Terrell, Google's director of energy, said in a statement. AES assembled a portfolio of its own projects and renewable generation by third-party developers, simplifying cost-efficient procurement for the tech company, it said. Part of the portfolio will be new renewable energy projects located in Virginia, according to Gail Chalef, global external relations senior manager at AES.

Dive Insight:
In 2018, Google announced its pursuit of 24/7 clean energy for its data centers and corporate campuses around the world, releasing statements last September about a two-pronged approach it was taking to sign additional power purchase agreements for renwable resources and to align its energy needs with the regional availability of clean energy. In a recent white paper, the tech giant outlined a path for ensuring, as part of its corporate sustainability goals, that the regional energy markets it participates in also have 100% clean energy available 24 hours a day.

Google is already working with M-RETS, a nonprofit that tracks and validates clean energy attribute certificates for hourly data, starting in the Southwest Power Pool and the Midcontinent Independent System Operator wholesale markets. The partnership with AES offers less complexity for the tech company, as a third party would manage its energy use.

https://www.utilitydive.com/news/google-to-power-virginia-data-centers-with-247-clean-energy-from-aes/599506/?utm_source=Sailthru&utm_medium=email&utm_campaign=Issue:%202021-05-06%20Utility%20Dive%20Renewable%20Energy%20%5Bissue:34104%5D&utm_term=Utility%20Dive:%20Renewable%20Energy

Google to Build 413-MW of Solar Plants in Tennessee and Alabama:
PV Magazine, January 18, 2019

https://www.pv-magazine.com/2019/01/18/google-to-build-large-solar-plants-in-tennessee-and-alabama

Google has announced plans to construct solar power plants in Tennessee and Alabama. The largest of the projects, in Hollywood, Alabama and in Yum Yum, Tennessee will each feature 150 MW of capacity. Additional smaller plants bring the total up to 413 MW. The electricity generated will ensure that the energy consumed by its data centers in Tennessee and Alabama will be sourced entirely from renewables. The projects are a part of the search engine titan's effort to supply its annual electricity consumption from renewable sources. A recent announcement by Facebook to develop 377 MW in the same states will result in the addition of 790 MW of new PV capacity.

NOTABLE RENEWABLE ENEGY DATA CENTER INSTALLATIONS BEGINNING 2019

Google Plans its Biggest Solar Farms in Alabama and Tennessee

January 17, 2019 by Emily Holbrook

Google announced this week that it is installing 1.6 million solar panels in Alabama and Tennessee for two of its new data center campuses. Hollywood, Alabama and Yum Yum, Tennessee will soon be home to the largest solar farms in their respective states, with each able to produce 150 megawatts of electricity. The solar power generated by these new farms will power Google's data centers in Tennessee and Alabama with 100% renewable energy. Google is partnering with NextEra Energy Resources and Invenergy on the solar farm implementation and operation. According to Amanda Corio, senior lead, Energy & Infrastructure at Google, to date, Google's more than 30 long-term contract commitments to purchase renewable energy have resulted in nearly $5 billion in investment worldwide.

https://www.energymanagertoday.com/google-plans-its-biggest-solar-farms-in-alabama-and-tennessee-0181111/

Emerson Network Power (Missouri)
Emerson looks to a Solar FutureA 100-kilowatt solar-panel array is located on the data center roof on Emerson's corporate campus in St. Louis, Missouri. Solar power has had difficulty gaining traction in the data center industry due to cost and capacity challenges, but Emerson took a forward-looking approach for its $50 million facility, and crafted a design that could demonstrate the potential for solar-generated power in the data center.

http://www.datacenterknowledge.com/solar-powered-data-centers/

Marine Corps Air Station Miramar and NREL: Allies in Energy Efficiency, Systems Integration, and Resilience. April 6, 2021

For Miramar's Latest Energy Management Mission, on-the-Ground Champions and Energy Experts Partnered To Build a New Efficient, Resilient, and Cost-Effective Data Center

Even before the latest data center project targeting efficiency and design, MCAS Miramar was an energy and water security leader within the Department of Defense. NREL has been a partner for over a decade in enhancing its resiliency, energy efficiency, and integration of renewable energy, and the laboratory was perfectly poised to assist MCAS Miramar in its new endeavor. NREL has experience designing, building, and operating its own high-performance data center, designed to be one of the most energy efficient data centers in the world, with an annual power usage effectiveness (PUE)—the ratio of a facility's total power use to the power used by its computing equipment—of less than 1.04. A "perfect" data center would have a PUE of 1.0. Across data centers overall, average PUE hovers around 1.8, and data centers focusing on efficiency typically seek to achieve PUE values of 1.2 or lower.

MCAS Miramar's new data center was commissioned in the summer of 2020. Advanced metering infrastructure system testing indicates the target PUE of 1.2 was achieved. https://www.nrel.gov/news/features/2021/marine-corps-air-station-miramar-and-nrel-allies-in-energy-efficiency-systems-integration-and-resilience.html?utm_source=NREL+News&utm_campaign=f6b0651700-EMAIL_CAMPAIGN_2019_10_23_10_59_COPY_01&utm_medium=email&utm_term=0_807f77e7f4-f6b0651700-282468141

Any questions ???

Need reports, contacts ???

Contact:

Scott Sklar
solarsklar@aol.com