



2024 White Paper

# Understanding Impacts of Data Centers on Greenhouse Gas Emissions in the United States



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## GLOSSARY

ABBREVIATION	MEANING
24/7 CFE	Carbon-free energy 24 hours a day, 7 days per week
AI	Artificial Intelligence
CEMS	Continuous Emissions Monitoring Systems
CFE	Carbon-free energy
CO <sub>2</sub> e	Carbon Dioxide Equivalent
CTT	Clean Transition Tariff
EACs	Environmental Attribute Certificates
EF	Emission Factor
EGU	Electricity Generation Unit
GHG	Greenhouse Gas. GHGs include carbon dioxide (CO <sub>2</sub> ), methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O); sulfur hexafluoride (SF <sub>6</sub> ), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Nitrogen trifluoride (NF <sub>3</sub> ).
GHGP	GHG Protocol The WRI-WBCSD Corporate Standard and related guidance.
ISOs	Independent System Operators
KWh	Kilowatt hour (equals 1,000 watts)
LCMPE	Large Customer Market Price Energy
MWh	Megawatt hour (equals 1000 KWh or one million watt-hours)
PPA	Power Purchase Agreement
PUCN	Public Utilities Commission of Nevada
PV	Photovoltaic
RE	Renewable Energy
RECs	Renewable Energy Certificates
RTOs	Regional Transmission Organizations

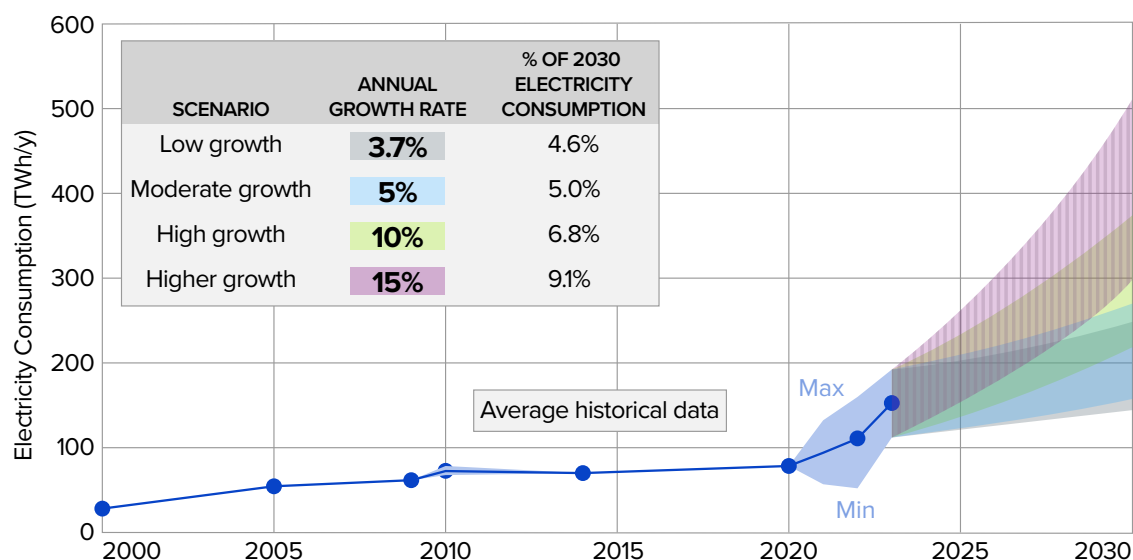


Figure 1. Historic and future projected electricity consumption by computer data centers. Source: EPRI, 2024

## INTRODUCTION

Computer data centers (DCs) are one of the fastest growing consumers of electricity worldwide. Between 2017 and 2021, electricity used by four large DC companies who are the main providers of commercially available cloud computing and digital services globally (i.e., Meta, Amazon, Microsoft, and Google) more than doubled. Artificial Intelligence (AI) models typically are much more energy-intensive than the data retrieval, streaming, and communications applications that have driven DC growth over the past two decades. At 2.9 watt-hours per ChatGPT request,<sup>1</sup> AI queries are estimated to require 10x the electricity of traditional Google queries, which use about 0.3 watt-hours each; and emerging, computation-intensive capabilities such as image, audio, and video generation are unprecedented.<sup>2</sup>

In recent years, end-use electricity load growth accelerated, driven by emerging AI applications and COVID-era increases in demand for services like streaming and video conferencing. Figure 1 highlights historic and future projected electricity consumption by computer DCs in the United States. The light blue area highlights uncertainty in a range of DC electricity consumption estimates for 2021 to 2030. Colored bands in Figure 1 show four different projections for future DC load growth, which combine estimates of increased data processing needs with assumptions about efficiency gains.

These estimates assume all other loads increase at 1% per year. As shown, the DC's future share of total U.S. electricity consumption in 2030 is expected to grow considerably from a low of 4.6% annually to a high of 9.1% annually. Data centers accounted for approximately 4% of the total U.S. electricity load in 2023.

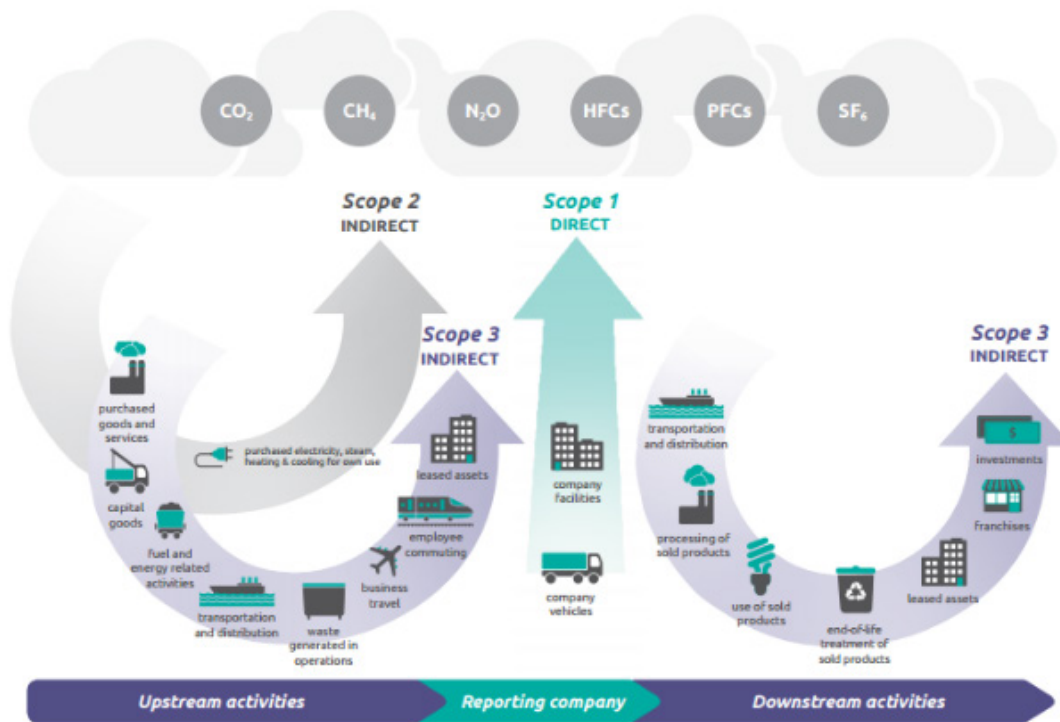
Many DC owners and operators, like many other corporations around the world, calculate and report the amount of greenhouse gas<sup>3</sup> (GHG) they emit annually. These GHG emissions "inventories" typically account for the company's direct and indirect emissions from operating their business. The largest source of GHG emissions for DCs are the scope 2 emissions associated with the electricity these entities purchase and consume.

To reduce the GHG emissions associated with their purchased electricity usage, some data center owners and operators set corporate decarbonization goals that include procurement of "carbon-free" electricity (CFE) and/or renewable energy (RE) resources such as wind and solar power generation. For example, Google and Microsoft seek to procure CFE produced within the same regional grid and match the hourly consumption of their data centers (aka 24/7 CFE). Meta and Amazon have established goals that focus more on "emissionality," to identify the geographic locations where deployment of new CFE and RE resources

1 [Powering Data Centers: U.S. Energy System and Emissions Impacts of Growing Loads](#), EPRI, Palo Alto, CA, 2024.

2 *ibid.*

3 Greenhouse gases include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O); sulfur hexafluoride (SF<sub>6</sub>), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Nitrogen trifluoride (NF<sub>3</sub>).



**Figure 2.** Greenhouse gas emissions sources by scope

Source: Greenhouse Gas Protocol, Corporate Value Chain (Scope 3) Accounting and Reporting Standard, 2013)

may have the largest potential impact on avoiding GHG emissions. Corporate goals which include procurement of 24/7 CFE, RE, and emissionality strategies are all efforts DC owners and operators are taking now to decrease the scope 2 GHG emissions associated with their purchased electricity.

## BASICS OF CORPORATE GREENHOUSE GAS EMISSIONS ACCOUNTING<sup>4</sup>

A GHG emissions inventory is an assessment of the GHG emissions and removals attributed to a company’s operations over the course of a year. Several standards and guidelines exist today that provide guidance to electric companies for doing credible GHG accounting. The most widely used standard in the United States and internationally is the [GHG Protocol Corporate Standard](https://www.epri.com/research/products/000000003002028297)<sup>5</sup>. Many electric companies also use [The Climate Registry’s Electric Power Sector Reporting Protocol](https://theclimateregistry.org/registries-resources/protocols/)<sup>6</sup> to guide their GHG accounting and reporting.

4 For more information about GHG accounting for electric companies, see <https://www.epri.com/research/products/000000003002028297>

5 <https://ghgprotocol.org/corporate-standard>

6 <https://theclimateregistry.org/registries-resources/protocols/>

Corporate GHG inventories typically include accounting and reporting of CO<sub>2</sub> and other GHG emissions.<sup>7</sup> Typically, companies report their annual GHG emissions in terms of metric tonnes of “carbon dioxide equivalent (tCO<sub>2</sub>e)” emissions. This metric accounts for the different global warming impacts of each of the individual GHGs being emitted.<sup>8</sup>

Corporate activities may cause *direct* and *indirect* GHG emissions which are categorized under different “scopes” as shown in Figure 2.

### Scope 1 Emissions

Direct emissions, referred to as “scope 1,” are emissions from equipment and facilities owned or controlled by a reporting company and operational activities that physically release (or remove) GHGs into (from) the atmosphere.

7 Greenhouse Gas Protocol, 2013. Required Greenhouse Gases in Inventories: Accounting and Reporting Standard Amendment. [https://ghgprotocol.org/sites/default/files/standards\\_supporting/Required%20gases%20and%20GWP%20values\\_0.pdf](https://ghgprotocol.org/sites/default/files/standards_supporting/Required%20gases%20and%20GWP%20values_0.pdf)

8 The United Nations Intergovernmental Panel on Climate Change (IPCC) assesses the global warming potential (GWP) values of each GHG, accounting for their different atmospheric lifespan and warming effect. By definition, CO<sub>2</sub> has a GWP equal to 1. According to the IPCC Assessment Report 5: CH<sub>4</sub> has a GWP of 28 and N<sub>2</sub>O has a GWP of 265. These GWPs can be used to convert emissions of each GHG into universal units called “carbon dioxide equivalents (CO<sub>2</sub>e).” For example, 1 metric ton (“tonne”) of CH<sub>4</sub> emissions has an equivalent warming effect of 28 tonnes CO<sub>2</sub>e.

These scope 1 emissions fall into four distinct categories:

- **Stationary combustion:** Emissions from the burning of fossil fuels to power heat sources or stationary combustion engines. For example, emissions from a natural gas-fired electricity generating unit (EGU).
- **Mobile combustion:** Emissions from vehicles owned or controlled by a company that run on fossil fuels. For example, cars, vans, and trucks.
- **Fugitive emissions:** Leakage of GHGs to the atmosphere, such as natural gas emissions from pipelines and compressor stations, SF<sub>6</sub> emissions from transmission system transformers, and GHGs associated with refrigeration, air conditioning units, or fire suppression systems.
- **Process emissions:** Emissions released during industrial processes and on-site manufacturing. For example, the production of CO<sub>2</sub> during cement manufacturing.

## Scope 2 Emissions

Indirect emissions are classified either as scope 2 or scope 3, and result from emission sources that are not owned or operated by the company but are essential to its operations. Scope 2 emissions refers specifically to emissions associated with *electricity, heating, cooling, and steam* purchased by an entity for its own use. A large component of many electricity customers’ total GHG emissions is scope 2 emissions associated with buying and using electricity to operate their businesses.<sup>9</sup>

## Scope 3 Emissions

Scope 3 emissions refer to all other indirect emissions not included in scope 2. For many corporations not engaged

in energy production or fossil fuel combustion, the majority of their GHG emissions are likely to be indirect to their operations and be associated with their scope 3 “value chain” activities. The GHGP standard guides companies on how to prepare and report 15 categories of “upstream” and “downstream” scope 3 emissions resulting from value chain activities.<sup>10</sup>

## DATA CENTER GREENHOUSE GAS EMISSIONS SOURCES

Table 1 identifies some common GHG emissions associated with DC operations. These include scope 1 emissions associated with (i) fuel-combustion in backup generators and (ii) fugitive emissions of refrigerants used to cool the DCs; scope 2 emissions associate with electricity purchased to operate DCs; and scope 3 emission sources may include a range of “value chain” emission including emissions associated with purchased goods and services, capital goods, fuel and energy-related emissions and other categories.

**The largest sources of GHG emissions associated with DCs include scope 2 emissions related to purchased electricity and scope 3 emissions associated with different components of a company’s “value chain.”** In some cases, scope 3 emissions will appear as the largest scope of emissions for information technology and DC-related firms. However, these indirect emissions sources can be very difficult for a company to reduce since they are outside of the company’s direct operational control.

For example, scope 3 emissions reportedly represented more than 96% of Microsoft’s annual emissions in 2023. Microsoft’s scope 3 emissions come primarily from the

**Table 1.** Some Common Sources of GHG Emissions for Data Centers

SCOPE 1	SCOPE 2	SCOPE 3
<ul style="list-style-type: none"> <li>• Back-up generator fuel</li> <li>• Refrigerant leakages</li> </ul>	<ul style="list-style-type: none"> <li>• Purchased electricity</li> </ul>	<ul style="list-style-type: none"> <li>• Purchased Goods and Services (Category 1)</li> <li>• Capital Goods (Category 2)</li> <li>• Fuel and Energy-related Activities (Category 3)</li> <li>• Transportation and Distribution (Category 4)</li> <li>• Leased Assets (Categories 8 and 10)</li> <li>• Other scope 3 categories, including: Business Travel (Category 6), Employee Commuting (Category 7)</li> </ul>

<sup>9</sup> Scope 2 also includes GHG emissions associated with electricity transmission and distribution systems (T&D) line losses associated with transmitting electricity from where it is generated to load-serving entities (LSEs) and end-use customers.

<sup>10</sup> Additional guidance on defining and calculating emissions from the 15 scope 3 categories can be found in the Scope 3 Standard supplement, *Technical Guidance for Calculating Scope 3 Emissions*. [https://ghgprotocol.org/sites/default/files/standards/Scope3\\_Calculation\\_Guidance\\_0.pdf](https://ghgprotocol.org/sites/default/files/standards/Scope3_Calculation_Guidance_0.pdf)

operations of their tens of thousands of “upstream” suppliers and the “downstream” use of their computer products across millions of their customers.<sup>11</sup>

## Calculating Greenhouse Gas Emissions

Each GHG source included in a GHG inventory must be estimated using accurate and credible methods. Many scope 1 GHG emissions can be quantified by direct measurement or estimation, but scope 2 and 3 indirect emissions typically must be estimated, often using proxy data. For example, it is common for electric companies to measure directly the CO<sub>2</sub> emissions from large EGUs using Continuous Emissions Monitoring Systems (CEMs). Alternatively, to estimate GHG emissions for power generation and many other types of emissions, one can calculate emissions by multiplying “activity data” (e.g., fuel combusted, kWh used, output from a process, hours of equipment operation) by an appropriate GHG emission factor (EF).

An EF relates a unit of activity (e.g., a kilowatt hour (KWh) of electricity consumed) to GHG emissions within a specific context (e.g., the emissions intensity of the electricity generated in a regional grid region). Annual grid average EFs for the entire U.S. disaggregated into 25 sub-regions are available in the Emissions & Generation Resource Integrated Database (eGRID) maintained by the U.S. Environmental Protection Agency.<sup>12</sup> Table 2 shows example 2022 emission factors for CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub> for the Virginia and North Carolina and the California subregion.

**Table 2.** Example 2022 Annual Emission Factors from EPA’s eGRID database for the Virginia—North Carolina region (SRVC region) and California (CAMX region). Source: eGRID 2022 database: <https://www.epa.gov/egrid>

eGrid Subregion	CO <sub>2</sub> (lbs. per MWh)	SO <sub>2</sub> (lbs. per MWh)	NO <sub>x</sub> (lbs. per MWh)
SRVC (VA and NC)	623.0	0.157	0.308
CAMX (CA only)	497.4	0.03	0.467

## Data Center Perspective

The GHG emissions “impacts” associated with new DC deployment depends on one’s perspective. From the perspec-

tive of a DC owner like Google, the GHG emissions impact of building new DCs likely would be a substantial increase in the company’s scope 2 emissions as the amount of electricity the company would consume can be expected to increase with the deployment of new DCs.<sup>13</sup>

Equation 1 shows how a DC owner could calculate the increase in a DC company’s scope 2 emissions associated with deployment of a new DC supplied by grid electricity. As shown, the DC operator would multiply the number of additional MWh’s expected to be consumed by a new DC by the appropriate regional average grid EF provided in eGRID.

**Equation 1.** Calculating Scope 2 Emissions using Regional Grid Average Emissions Factors

$$\text{MWh}_{(i,j)} \times \text{Avg EF}_{(i,j)} (\text{CO}_2/\text{MWh}) = \text{CO}_2 \text{ emissions}_{(i,j)}$$

Where: i = data center; j = location

For example, a new DC located in Virginia that is expected to consume 1,000 MWh of electricity, would be expected to emit 623,000 lbs. of CO<sub>2</sub> or 283 MT of CO<sub>2</sub>; while a new DC consuming 1,000 MWh in California would emit 497,400 lbs. of CO<sub>2</sub> or 226 MT of CO<sub>2</sub>. Because of regional differences in the average grid EFs, a new DC built in California can be expected to increase the DC owner’s scope 2 emissions by 21% fewer lbs. of CO<sub>2</sub> than if the company deployed the same DC in Virginia.

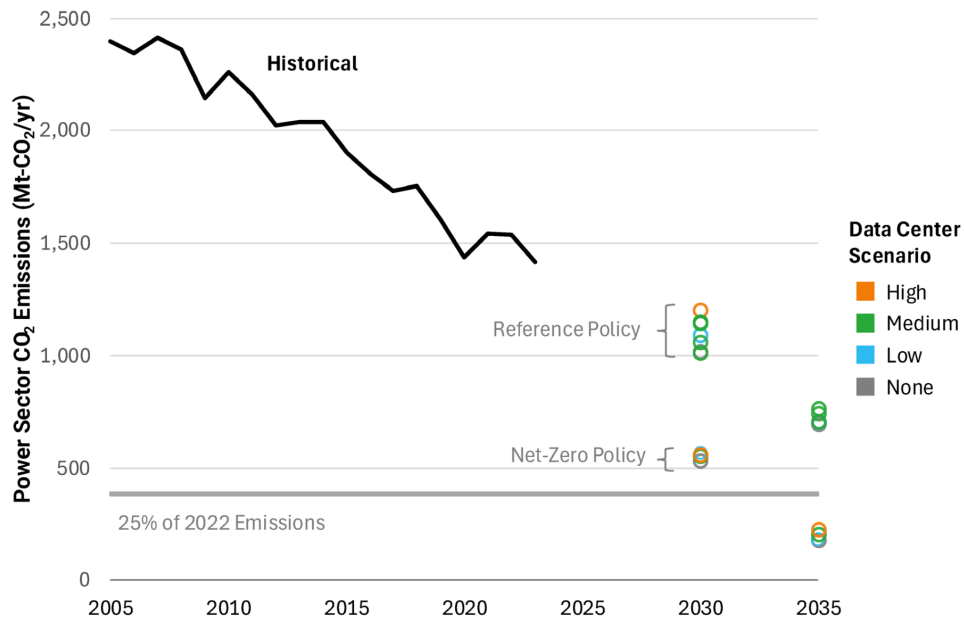
## Electric Company Perspective

From the perspective of an electric company providing the electricity to meet new DC electricity demand, the expected increase in GHG emissions would equal the increase in the electric company’s scope 1 direct emissions from stationary combustion associated with meeting the new DC power demand. The increase in the electric company’s GHG emissions also may include increases in specific categories of scope 3 emissions, including scope 3, category 3 (fuel and energy-related emissions, including purchased electricity for resale to end-use customers). However, the electric company greenhouse gas emissions impacts are determined by the extent the new load can be met with RE or other carbon-free energy sources. This is because RE or other carbon free resources have an associated EF of 0

11 2024 Environmental Sustainability Report, Microsoft, 2024, <https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RW1IMjE>.

12 <https://www.epa.gov/egrid>

13 An alternative and more refined calculation approach would use the expected increase hourly demand for electricity multiplied by the marginal CO<sub>2</sub> emissions rate (MER) for each hour.



**Figure 3.** Power sector CO<sub>2</sub> emissions over time by scenario. Source: EPRI 2024.

Note: Projected values show scenarios across data center load assumptions. Historical emissions are based on U.S. EPA’s “Inventory of U.S. Greenhouse Gas Emissions and Sinks.” The 25% of 2022 emissions line is the threshold where power sector Inflation Reduction Act tax credits begin to expire.

tCO<sub>2</sub>e, thus, mitigating an electric company’s scope 1 emissions associated with meeting increased load.

## National System-wide Perspective

Finally, we might consider the system-wide impact of expected future DC-related load growth on U.S. national CO<sub>2</sub> emissions. Recently, EPRI completed a comprehensive quantitative analysis of potential DC growth in the U.S. from now through 2030 using EPRI’s proprietary United States Regional Greenhouse Gas Emissions and Energy model (US-REGEN)<sup>14</sup>. This analysis provides updated projections for future regional load growth from new DCs; estimates of load growth from other sources including domestic manufacturing, end-use electrification, and electrolytic hydrogen; and analyses of how these loads could alter electric sector investment decisions CO<sub>2</sub> emissions under a range of future policies (including current policy and economy-wide net-zero by 2050 cases). Some of the key conclusions from this analysis, include:

- In all scenarios, CO<sub>2</sub> emissions decline significantly over time as coal capacity retires and new low-emitting capacity is added; however, near-term DC load growth may induce more near-term CO<sub>2</sub> emissions from in-

creased utilization of existing coal- and gas-fired capacity (Figure 3). Overall, emissions impacts of DC loads are more limited than the effects of other factors such as state and federal policy.<sup>15</sup>

- The marginal emissions intensity of generation to serve incremental DC load declines over time and is 61–84% lower than the average intensity of the current generation mix by 2035. However, in the near term, the marginal CO<sub>2</sub> intensity of generation to meet incremental DC load is higher than the current grid due to increased utilization of existing coal and gas capacity.
- CFE demand can significantly lower the emissions impacts of higher DC loads, especially with an hourly matching commitment.

Based on the analysis, increasing DC loads can be expected to drive additions of new generation capacity, especially natural gas-fired EGUs to meet firm capacity requirements of higher peak loads, as well as solar PV in some regions. In the short run, increasing DC loads also could lead to higher utilization of existing fossil resources under current policies. In the longer run, data center load growth could be serviced by new, lower-emitting resources after 2030, with increasing deployment of solar, energy storage, wind, and natural gas regardless of the data center load scenario.

14 For more information about US-REGEN, please refer to <https://us-regen-docs.epri.com/>.

15 EPRI 2024, p24.

Although the scale of future DC load is highly uncertain, the scenarios explored in the analysis suggest that DC load growth is just one driver of change. There are other emerging electric loads, such as transport electrification, and trends in policy, technology, and markets that are also expected to shape power sector outcomes. Overall, this EPRI analysis concludes that DCs can be expected to have more limited emissions impact than other factors such as state and federal policy.

## DATA CENTER ACTIONS TO REDUCE SCOPE 2 EMISSIONS

Scope 2 emissions associated with purchased electricity often is a comparatively large source of GHG emissions for large C&I electricity customers including DCs, yet it can be challenging for these entities to reduce these emissions because they are not under their direct control. This is particularly the case for companies engaged in certain activities, such as finance, high-technology, and service-oriented companies, because these types of entities have comparatively low scope 1 emissions.

### Direct Action to Reduce Scope 2 Emissions

The only direct action most electricity customers can take to reduce their scope 2 electricity-related emissions is to reduce their energy consumption (e.g., by installing energy efficiency upgrades), or by installing behind-the-meter RE resources such as rooftop solar photovoltaic (PV) panels. These approaches often can be optimized to reduce some of a company's scope 2 emissions, but many companies, including DC, will continue to purchase large amounts of electricity—along with the associated scope 2 emissions.

In the absence of being able to take direct action to reduce their scope 2 emissions more significantly, many companies have focused on working with their electricity providers to purchase cleaner power and/or buying market instruments such as RECs reduce their reported scope 2 emissions.

### Buying Renewable Energy and Renewable Energy Certificates

To drive rapid deployment of RE and decarbonization, many states have adopted regulatory programs establishing renewable portfolio standards (RPS), clean energy standards

(CES) and other programs requiring electric companies to procure and track RE generation and other types of “clean energy.” Most RPS programs allow electric utilities and other power generators to create and trade renewable energy credits (RECs) to demonstrate RPS compliance. Typically, RECs record the generation of one MWh of electricity by a specified “renewable” resource (e.g., wind and solar), as defined by the specific RPS program.

### Procuring Renewable Energy to Reduce Reported Scope 2 Emissions

In recent years, many companies in the U.S. and internationally have focused on buying renewable energy (RE) and RECs to reduce their reported scope 2 emissions and to meet their voluntary corporate sustainability goals. A large and growing group of leading sustainability-oriented companies procure enough RE and/or RECs to equal 100 percent of the megawatt hours (MWh) of electricity they consume annually.<sup>16</sup>

### Scope 2 Location – Versus Market-Based Emissions Accounting

Existing GHG accounting protocols and practices provide a strong incentive and a way for companies to procure RE and RECs to reduce the scope 2 GHG emissions they report associated with the electricity they buy and consume. Under existing corporate voluntary GHG accounting standards, companies can report their electricity-related scope 2 emissions using either a “locational” and/or a “market-based” approach and associated GHG EFs. This allows companies that purchase RE and RECs to report zero GHG emissions (i.e., 0 tCO<sub>2</sub>e/MWh consumed) associated with the electricity they buy even though they still use electricity from a regional power grid that may be supplied by fossil-fired power generation. This disconnect has motivated some electricity customers to seek out 24/7 CFE supply agreements to better match their hourly power consumption with carbon free electricity supply.

In recent years, corporate consumers have used different approaches to acquire RE and provide the basis for making environmental sustainability claims. Several large commercial customers particularly in high technology (e.g., Apple, Google, Microsoft) have reduced their reported scope 2

<sup>16</sup> For a list of companies who have taken a pledge to use 100 % RE annually, see <https://www.there100.org/>

GHG emissions by generating RE onsite, procuring RE using power purchase agreements (PPAs), and buying and retiring RECs.

For example, in deregulated power markets an electricity buyer can purchase either all or a portion of the electricity output from a new wind or solar facility for a fixed length of time using a PPA. Using this type of “physical” renewable PPA, a RE generator sells both electricity and RECs directly to a corporate energy buyer, bypassing the local utility. Alternatively, a retail access customer can buy 100% RE from a competitive retail supplier, who may contract with renewable power developers or purchase and retire RECs.

In some regulated markets, a corporate electricity buyer can indirectly purchase all or a portion of the electricity output from a new wind or solar facility for a fixed length of time by participating in an electric utility-sponsored “green” tariff program, where the RE is designated for that customer, rather than to all of the utility’s customers. In each of these examples, large corporate buyers enter into an agreement with RE generators (directly or indirectly) to purchase some or all their facilities’ output.

The GHG Protocol’s (GHGP) Scope 2 Guidance (2015) defines two approaches to account and report scope 2 emissions associated with purchased electricity. The Scope 2 Guidance also requires entities to report using both location- and market-based methods if an entity operates in a region in which market-based energy procurement contracts (e.g., PPAs) and/or environmental attribute certificates (EACs) are used, such as in the United States where markets for RECs are widely used today.

**The location-based approach applies grid average EFs to estimate and report scope 2 emissions associated with purchased electricity.** This approach is not based on tracking electricity from a specific power plant to the end-user, but rather it applies a power grid-level average to estimate indirect emissions associated with electricity consumption. Some regional transmission operators (RTOs) and independent service operators (ISOs) publish GHG intensity data for their operating footprint. The US EPA’s eGRID program also publishes emission intensities for grid sub-regions of the U.S. One challenge with using eGRID and other EF databases is that publishing typically lags one or more years behind the current reporting period.

**The market-based method is a mechanism designed to reflect the GHG emissions associated with electricity that end-use customers have procured using power purchase agreements (PPAs) and other types of contractual instruments.** In practice, the inclusion of the market-based approach in the GHG Protocol has incentivized corporate electricity consumers to procure RE, and to buy bundled and unbundled RECs to reduce their reported scope 2 emissions and claim scope 2 emission reductions, despite physically consuming electricity from the grid that is (partially) supplied by fossil generation. “Bundled” RECs refer to RECs that are sold in conjunction with the underlying renewable energy (MWhs). Unbundled RECs are RECs that are sold separately from the underlying renewable energy.

### EXAMPLE: LOCATION-BASED VERSUS MARKET-BASED ACCOUNTING

In 2023, using a location-based approach, Google reported a total of 9.3 million tons CO<sub>2</sub>e (MtCO<sub>2</sub>e) of scope 2 emissions associated with the electricity they purchased in that year. However, using a market-based approach, Google reported their total corporate scope 2 as 3.4 MtCO<sub>2</sub>e, based on their procurement of renewable energy with PPAs and associated RECs.

(Source: 2024 Environmental Report, Google, July 2024, <https://www.gstatic.com/gumdrop/sustainability/google-2024-environmental-report.pdf>)

### Procuring Renewable Energy to Reduce Scope 2 Emissions is Controversial

In recent years, there has been growing recognition this approach to reducing a company’s reported scope 2 emissions may lead to inaccurate attribution of GHG emissions. In 2020, Google highlighted this issue when it reported that despite having contracted for 100% RE to meet the annual electricity consumption of the company’s worldwide data centers, the data centers continued to rely on undifferentiated regional “grid power” to meet a significant portion of their electricity consumption, ranging from six (6) to 82 percent depending on its location and corresponding demand profile. Globally, Google reported:

*“Although we matched 100% of our global, annual electricity consumption with renewable energy in 2019,*

*on an hourly basis 61% of all the electricity we used was matched with regional, carbon-free sources.... Without Google's purchases of renewable energy this figure would have only been 39%, equivalent to the existing "grid mix" in regions where we operate."<sup>17</sup>*

A more recent systematic quantitative modeling and analysis of the mismatch between RE generation and the load profiles of diverse types of large C&I customer types concluded:

*"For buyers, the results of this analysis showed that current corporate procurement practices will not typically provide energy that is sufficient to meet all of a company's load for significant portions of the year. This gap means that, in reality, buyers continue to rely heavily on electricity from their regional electric grid, which often has a significant fossil fuel component and corresponding carbon footprint. Even with the addition of battery storage, the mismatch between variable renewable energy supplies and customer load is only reduced, not eliminated."<sup>18</sup>*

## Buying Versus Consuming 100% Renewable Energy

Critics of scope 2 market-based GHG accounting long have pointed out there is a critical difference between the content of power **purchased** by an end-use customer using a PPA or other type of financial contract and the content of the electric power dispatched and consumed by the same customer. This distinction can lead to confusing and disparate claims as to what extent a company has reduced its use of non-renewable, carbon-emitting power resources.

## Electricity Delivered to Customers is Undifferentiated

The electric energy dispatched in real-time to end-use customers typically is undifferentiated and is a mix of the power generation resources operating on the grid.

Even if an electric customer could purchase a 100% RE or 24/7 CFE by contract, the customer may continue to consume undifferentiated "grid" power in real time.

<sup>17</sup> 24/7 by 2030: Realizing a Carbon-free Future," Google, September 2020, <https://www.gstatic.com/gumdrop/sustainability/247-carbon-free-energy.pdf>, accessed April 20, 2022.

<sup>18</sup> Columbia University, *Advancing Corporate Procurement of Zero Carbon Electricity I the United States: Moving from RE100 to ZC100*, 2021, p. 16.

One factor that differentiates contracted and consumed electricity is that the energy output profile of contracted RE resources may not match a customers' hourly load on a 24/7 basis. C&I customers may purchase enough RE and/or RECs to equal their electricity consumption on an annual basis, but their real-time electric load typically does not match this annual average load. This means a customer that procures 100% RE still will receive undifferentiated "grid" power that often includes fossil-fired power resources that emit GHGs during some hours of the day and year—particularly when contracted RE do not operate (e.g., when the wind is not blowing, or the sun is not shining).

Additionally, RE resources (or RECs) may be associated with RE generated in a balancing area (BA) or ISOs/RTOs that are geographically different from where the contacted electricity is consumed. In the U.S. (and the European Union), companies are allowed to acquire and retire RECs created by RE generated virtually anywhere in the U.S. as the basis for reporting reduced scope 2 emissions. This locational mismatch is another reason RE procurement does not translate directly into reduced GHG emissions.

## Other Approaches to Reduce Reported Scope 2 GHG Emissions

There are other approaches that companies can use to reduce the scope 2 emissions they report associated with buying electricity. First, companies in deregulated markets can choose to buy electricity that has a lower GHG emissions content than the electricity supplied by their incumbent power provider. This approach has led some companies to develop renewable and 24/7 CFE PPA agreements as described above.

Companies also have developed and/or used GHG emission offset credits to reduce their reported GHG emissions. In simple terms, GHG offsets provide a way for a company to substitute "external" GHG emission reductions that may be less expensive to achieve than reducing its own direct or indirect emissions.<sup>19</sup> To date, most companies that develop or purchase GHG offsets do so to reduce their reported direct scope 1 emissions, but there is no explicit reason companies cannot use issued GHG offset credits to reduce their reported scope 2 and/or scope 3 emissions. While many

<sup>19</sup> For more information about GHG emissions offsets and associated EPRI research products, see <https://esca.epri.com/GHG-Accounting-Markets-and-Offsets.html#GHG-Accounting>

entities purchase and use GHG offset credits to reduce their GHG emissions, this approach is not recognized by the GHG Protocol to reduce reported GHG emissions. Rather, the GHG Protocol encourages reporters to record a “memo item” identifying and describing any GHG offsets and other emissions mitigation approaches a company may have used during a reporting year and to report an organization’s net GHG emissions taking into consideration these additional measures.

According to recent EPRI analytics, increasing DC loads drive new additions of generation capacity, especially natural gas-fired units to meet firm capacity requirements of higher peak loads, as well as solar photovoltaics in some regions. It is also likely that increasing DC loads could lead to higher utilization of existing fossil resources.<sup>20</sup> If fossil fuel generation is used to supply data center electricity consumption, the scope 2 emissions of the data center owners and operators would increase.

However, given longstanding corporate sustainability commitments, many of the data center owners and operators have instituted policies regarding clean energy procurement to decrease their scope 2 emissions. Of these corporate policies, the two most common are common include “24/7 CFE” and “emissionality” approaches.

## 24/7 Carbon Free Energy

24/7 CFE means that every kilowatt-hour of electricity consumption is met with carbon free electricity sources at every hour of every day. While there is no universal agreement on what exactly constitutes 24/7 CFE, many parties in the United States and internationally that are engaged in procuring 24/7 CFE are doing so based on the following key principles:

- **Time-matched procurement:** matching hourly electricity consumption with carbon-free electricity generation. Hourly matching helps connect clean energy purchasing to underlying electricity consumption.
- **Local procurement (or deliverability):** purchasing clean energy on the local/regional electricity grids where electricity consumption occurs. This is the only way to drive the electricity-related emissions that a consumer is directly responsible for to zero.
- **Technology-inclusive:** recognizing the need to create zero-carbon electricity systems as quickly as possible. All CFE technologies can play a role in creating this future.
- **Incrementality (or additionality):** enabling new generation by focusing on delivering additional CFE to drive the rapid decarbonization of electricity systems. Technically “additional” implies generation resources that would not have been added without CFE demand, although this is difficult to define in practice.

**Among the large DC owners and operators, Google and Microsoft have adopted aggressive goals to procure 24/7 CFE to reduce their corporate scope 2 emissions.**

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<sup>20</sup> [Powering Data Centers: U.S. Energy System and Emissions Impacts of Growing Loads](#), EPRI, Palo Alto, CA, 2024.

## EXAMPLE – GOOGLE HELPS TO DEVELOP NEW 24/7 CFE TARIFF IN NEVADA

To meet their 24/7 CFE goals, Google supported the development of the Nevada Energy Large Customer Market Price Energy Tariff (LCMPE) and Clean Transition Tariff (CTT).

In December 2020, the Public Utilities Commission of Nevada (PUCN) approved an energy supply agreement (ESA) between Nevada Energy (NVE) and Google to supply RE to a new \$600 million Google data center located in Henderson, NV. Under this agreement, Nevada Power Company agreed to provide Google with 350 MW of solar generation capacity combined with up to 280 MW of battery storage capacity under the utility’s regulated LCMPE Tariff.<sup>21</sup>

The deal is structured to deliver CFE to Google for every hour of every day “to the greatest extent possible,” and requires that at least 70 percent of hours in the year must come from CFE. The exact way that the battery operations will be aligned with Google’s hourly consumption is confidential as is the length of the supply contract and the pricing terms, although it has been reported that Google will pay “a fixed, blended price” for dispatchable energy from the hybrid solar-battery facility.

21 [24/7 Carbon-free Energy: Matching Carbon-free Energy Procurement to Hourly Electric Load: A Technology Innovation Program White Paper](#). EPRI, Palo Alto, CA: 2022. 3002025290. P4–6 and 4–7.

In May 2024, NVE and Google submitted a proposed new 24/7 CFE CTT to the PUCN for approval.<sup>22</sup> The CTT provides a path for existing customers to remain retail NVE customers while transitioning to an ESA to achieve specific corporate energy goals. The proposed CTT would be applicable to all non-residential customers who can demonstrate they will have an average annual hourly load of 5 MW or more.

The CTT is a new tariff intended to provide eligible customers the option to receive retail electric service from NVE that reflects a price within an ESA for energy associated with a new clean energy resource proposed concurrently in an Integrated Resource Plan. The CTT and the associated ESA were built from the general structure of the LCMPE but simplified to serve the unique needs of existing customers.

The CTT is structured so that each customer will execute an individual ESA with the utility, which will utilize a new clean generation resource. The ESA will be filed for PUCN approval contemporaneously with the new clean resource submitted to the PUCN for approval.

22 This new CTT tariff was proposed in two separate dockets to cover both NVE’s northern and southern utility service territories. PUCN docket # [24-05023](#) relates to NVE operating company Sierra Pacific and covers NVE’s northern Nevada utility service territory. Docket [24-05022](#) relates to NVE’s operating company Nevada Power and covers NVE’s southern Nevada service territory.

## EXAMPLE – MICROSOFT PARTNERS WITH CONSTELLATION TO PROVIDE 24/7 CFE

In an endeavor to meet their rising DC load, Microsoft recently signed a long-term PPA with Constellation Energy for the output of existing nuclear generation. This agreement reportedly involves a premium payment of \$110–\$115 per MWh. This agreement is part of an effort to restart Unit 1 of the Three Mile Island nuclear plant in Pennsylvania, which was shut down in 2019 for economic reasons. The rising demand for clean energy to power DCs has driven renewed interest in nuclear energy. This deal is notable in part because to date no U.S. nuclear reactor has been reopened after closure.

## Emissionality

Emissionality is the strategy of identifying the best locations for new renewable and CFE energy generation based on where these new units may have the greatest potential impact to reduce GHG emissions by displacing fossil-fired power generation assets. For example, new solar capacity deployed in California likely would displace pre-existing RE capacity having little impact on GHG emissions, while building a new wind farm in Indiana could displace a fossil-fueled generation source leading to larger scale GHG reductions. Siting a new RE resource based on its project “emissionality” and not proximity to the load, the asset likely will not directly serve the associated hourly load. Consequently, these RE investments may reduce a company’s reported market-based scope 2 emissions but is not likely the scope 2 emissions it reports using a location-based approach.

Although RE and CFE are both carbon-emissions free sources of energy, *where* these projects are built can have a significant differential impact on overall grid-related CO<sub>2</sub> emissions. While investing in (or building or buying power from) a new RE project located within the regional power grid serving a company's load may help a company reduce its reported Scope 2 emissions, that same emissions reduction may be far smaller than enabling a clean energy project to be built in a regional grid with a higher GHG emissions rate. "Emissionality" refers to the impact of new renewable or CFE power generation resource to reduce *marginal* GHG emissions in a regional power grid. For some corporate renewable and CFE buyers, *emissionality* and *location* are becoming important criteria for siting new facilities and PPAs.

**Of the large data center owners and operators, Meta and Amazon have emphasized using "emissionality" as a strategy to decrease their corporate scope 2 emissions.**

### **EXAMPLE – META EXPANSION OF GEOTHERMAL POWER BASED ON EMISSIONALITY**

Meta Platforms and Sage Geosystems have announced a partnership to expand the use of advanced geothermal energy in the U.S. This collaboration reportedly will utilize Sage's advanced Geopressured Geothermal System (GGS) to provide up to 150 MW of carbon-free power for Meta's DCs, marking the first use of next-gen geothermal energy east of the Rocky Mountains. The project, slated for 2027, highlights the potential of geothermal energy as a scalable, reliable renewable source. This project follows Google's announcement in 2024 of its plans to deploy advanced geothermal energy in NV to provide existing Google DCs in NV with 24/7 CFE in conjunction with NVE and FERVO.

## **CONCLUSION**

Between 2017–2021, the energy consumption of major cloud computing providers—Meta, Amazon, Microsoft, and Google—more than doubled and by 2030 DC energy consumption could account for up to 9% of U.S. electricity load by 2030. This growth reflects the increased energy demands of AI models, which are more power-intensive than traditional DC operations. The substantial electricity consumption of both existing DC and expected from the anticipated future build out of DCs could lead to substantial increases in the scope 2 emissions attributed to these companies. Managing these growing scope 2 emissions has become an important consideration for these companies as they consider where and when to build new DCs. Despite their commitments to reduce GHG emissions, the leading tech companies have experienced significant increases in their overall CO<sub>2</sub> emissions in recent years, partly due to business expansion efforts to maintain market leadership.

In response to the challenges of reducing their scope 2 emissions, many of these companies have made large-scale investments to procure RE and increasingly 24/7 CFE to provide carbon-free electricity for their DCs. These companies also are exploring new approaches to reducing their future energy usage, such as investing in waste heat management and novel cooling methods. While these efforts aim to reduce their reported scope 2 and 3 emissions, it remains a complex challenge for these companies to balance and manage their growing GHG emissions as their DC operations continue to grow at an exponential pace.

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Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together...shaping the future of energy.

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