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Renewable energy for data centers

Renewable energy certificates, power purchase agreements and beyond

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Sustainability is becoming a key issue for data center operators. Investors, customers and legislators are increasingly demanding carbon emissions reporting and 100% renewable energy use. Organizations risk charges of greenwashing if purchased renewable energy certificates are the main or only component of sustainability strategies; many are now using instruments such as power purchase agreements to procure renewable energy for their operations. Some industry leaders are also adding large-scale battery deployments for energy storage.

30-45 minutes to read

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This Uptime Institute Intelligence report includes:

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EXECUTIVE SUMMARY

Data center energy consumption and claims of 100% renewable energy use are receiving ever more attention from the media, legislators, and customers. The tech industry has made considerable effort to improve energy efficiency and is the largest purchaser of renewable energy. Even so, most data center sustainability strategies still focus on renewable energy certificates (RECs). RECs are now considered low quality products because they cannot credibly be used to back claims of 100% renewable energy use.

To avoid accusations of greenwashing, data center operators must consider investing in a portfolio of renewable energy products. RECs may play a part, but power purchase agreements (PPAs) are becoming more popular, even though there can be financial risks involved. Further, matching energy consumption with equivalent renewable energy purchasing on an annual basis is not enough to reach the goal of decarbonizing the electricity grid. In the long term, all data center demand — 100% — must be supplied by 100% renewable energy, 100% of the time. This will prove challenging.

KEY FINDINGS

- **Carbon emissions reporting is becoming more widespread. Reporting is voluntary in most jurisdictions, but mandatory international sustainability reporting standards are under discussion. Large corporations, such as Apple and Microsoft, now require carbon and sustainability reporting for all their suppliers. Organizations that are not tracking emissions may have to invest significant resources to catch up should reporting become required.**
- **Operators with the most sophisticated sustainability strategies have been expanding their renewable energy portfolios with large PPA contracts. Widely used RECs are likely to be dismissed as greenwashing if they are the main or only component of a renewable or low-carbon energy strategy. The low cost of RECs relative to the overall cost of electricity increases this risk.**
- **Operators should favor the purchase of direct PPAs (which guarantee physical delivery of electricity on the local grid) where possible, or virtual/financial PPAs (which do not provide physical delivery of electricity) if not. Purchasers should ensure they fully understand the contract terms, particularly with regard to pricing, to mitigate financial risk.**
- **As an alternative to PPAs, operators should consider retail or "green tariff" renewable energy contracts offered by energy services companies and utilities, sometimes in conjunction with a renewable energy developer. These contracts have a higher (financial) safety profile, because they have shorter terms and the renewable energy developer or energy retailer carries most of the financial risk.**
- **The 100% renewable energy use claim made by many data center and infrastructure operators can be misleading because it usually refers to the annual matching of renewable energy bought to equal the energy used. However, the power grid that they use carries electricity generated by many different fuels, the proportion of which shifts over time and with region. Over the coming years, operators should start planning to match electricity generated by renewable resources on an hourly basis, with detailed reporting of the electricity's source. Where this is not supported by energy suppliers, operators should pressure suppliers to provide the necessary data.**

(continued next page)

KEY FINDINGS *(continued)*

- **Although large-scale energy storage technology is still immature, new data center projects are starting to combine new renewable energy generation with large-scale battery storage. This allows the charging of batteries when renewable energy is available, then a switch to batteries when it is not. Large-scale, battery-based energy storage is being tested in some new data centers today; more widespread use may be an important component of future low-carbon/ sustainable data center designs.**

- **Customer demand for renewably powered data centers is increasing. Requests for proposals for new contracts may now include detailed questions about data center sustainability. Customers are also becoming more sophisticated (and demanding) about their understanding of offsets, RECs and PPAs.**

Introduction

In 2018, global electricity demand was almost 25,000 terawatt-hours.[1] Data centers are estimated to have been responsible for between 0.8% and 2% of the global consumption[2,3] and 2.7% of EU energy use.[4] This may seem small, but the energy requirements resulting from increasing IT demand are beginning to exceed the efficiency improvements made in the past decade.[5] There are indicators that data center energy efficiency is plateauing[6] and the Moore's Law expectation of regularly improving chip efficiency may no longer apply.[7] Meanwhile, mobile operators are rolling out 5G technology that is three times more energy intensive than 4G.[8] A 2020 EU report projects that by 2025, data center energy use will exceed 2018 levels by 21%.[4]

Increasing data center electricity demand is a concern because most electricity today is still generated using fuels with a high carbon intensity — coal, oil, and gas. Burning fossil fuels increases the carbon in the atmosphere (which contributes to climate change) and damages air quality (which has been linked to poor health and millions of deaths worldwide).[9,10] Although significant progress has been made in the transition to clean electricity (renewable energy accounted for almost 90% of the increase in global total power capacity in 2020),[11] overall the proportion of power generated via renewable sources is still small — just 5% of the total electricity mix.[12] Even if new efficiency opportunities are found, switching existing data centers to low-carbon energy sources is essential to combat climate, environmental and health effects.

This report will examine renewable energy in the context of data center energy use. It will consider how the grid mix operates, discuss clean sources for generating electricity, look at how the industry has approached renewable energy purchases through RECs and PPAs, and suggest where the industry needs to go next.

Generating electricity

The data center industry has paid considerable attention in recent years to overall energy use and efficiency. If climate goals are to be achieved, however, carbon emissions need to be measured, understood and driven down.

The overall carbon intensity of the electricity grid is measured on the basis of how much carbon is emitted for every unit of electricity generated, expressed in grams of carbon dioxide per kilowatt-hour (gCO2/kWh). Although progress has been made in the transition to renewable sources of electricity over the last decade, there is still much variation in carbon intensity among countries. For example, Norway's 2019 carbon intensity was just 13 gCO2/kWh, compared with 880 gCO2/kWh in South Africa.[13]

In 2010 The Green Grid developed a new metric, carbon usage effectiveness (CUE), specifically for the data center industry.[14] CUE is calculated by dividing the carbon dioxide emissions resulting from the facility's total energy use by the energy used by its IT equipment. Similar to Scope 1 (direct emissions) and Scope 2 (indirect emissions from electricity purchases) as defined by the Greenhouse Gas Protocol, the metric measures the operational — not life cycle — carbon emissions efficiency of a data center. (Life cycle emissions would include embodied emissions in equipment manufacture and building construction.) The end result is a value in kilograms of carbon dioxide equivalent per kilowatt-hour. The ideal CUE value is zero, indicating no carbon emissions. As discussed below, however, it is important to understand the reality behind the input values — which are primarily supplied by or calculated from data about carbon intensity from the grid supplier.

Although carbon intensity is generally reported on an annual basis, it actually varies minute by minute. This is because the electricity grid responds to demand, which changes depending on weather and time of day. Electricity must be generated to match demand; power plants start and stop as need dictates. Energy production is usually planned, using weather forecasts and historical trends, but power plants can sometimes be required to respond at a few minutes notice.

Each fuel type has a different ramp time. Nuclear power plants take days to start, so they tend to be used for baseline generation (because demand never drops to zero). In contrast, gas power plants can ramp up within seconds, so they provide quick response ("dispatchable") capabilities. Coal falls somewhere in between, requiring a few hours. The key characteristic of these fuels is the ability to control generation. Whether supply is suddenly required, or production is planned in advance, power must be available when needed.

This is not the case with renewable energy. It is possible to predict when the wind will blow and the sun will shine, but it cannot be controlled. Wind and solar generation vary with the weather and time of day, and sometimes there are periods of no wind and insufficient sunlight. Hydropower depends on water flow rate and so requires sufficient water to be available in rivers or reservoirs, which varies with weather. During these periods, renewable energy must be supplemented with alternatives in a process known as "firming."

"Firming" is the process of smoothing the variable and intermittent nature of renewable energy by supplying energy from other sources (which may or may not be renewable) to provide a committed level of output.

Pumped storage hydropower can provide only short bursts of supply, so other forms of energy storage (usually batteries) have been suggested as part of the longer-term solution, but rollout has been slow — only 2.9 gigawatts (GW) of storage capacity was added to global energy systems in 2019.[15] This is why even in countries such as Norway with a lot of hydroelectric power, or the UK with a lot of wind power, electricity is generated from a mix of sources. This is known as the grid mix, and it can be observed real time on sites such as electricityMap or Drax Electric Insights.

Countries may also import electricity via interconnectors with other countries. When this happens, they inherit the carbon intensity of the source. For example, the US has interconnections with Canada and Mexico; some US states, such as California and Virginia, are net importers of electricity, whereas Pennsylvania and Alabama are net exporters.[16] Similarly, the UK imports varying amounts of electricity from France, the Netherlands and Ireland.

The clean energy transition has been widely stimulated through government subsidy, but in many countries renewable energy is now simply cheaper than fossil fuels.[17] Wind energy in the UK has even started paying back its subsidy[18] and coal plants in the EU are being decommissioned because they are no longer economically viable.[19] Retail products that dynamically adjust pricing in near real time based on the grid mix already exist (see, for example, the plans offered by Octopus Energy in the UK).

Every component of the grid mix must be decarbonized to reach the climate goals agreed by the 195 signatory countries of the Paris Agreement. The future grid mix will include electricity from renewable sources (e.g., wind and solar), stable base capacity (likely from nuclear), and quick response (dispatchable) sources, such as pumped hydropower and other forms of energy storage. There are challenges to adding variable sources of generation to the grid, but they are not insurmountable.[20]

Sustainability portfolio components

Renewable energy certificates (RECs), **power purchase agreements (PPAs)** (either as wholesale or retail purchases) and carbon **offsets** work together as part of an overall sustainability portfolio, but only RECs and PPAs relate specifically to renewable energy.

For each unit of renewable energy generated, a unique **REC** is created. These certificates are traded separately from the energy that created them and may be purchased to enable a buyer to match their electricity consumption with an equivalent amount of renewable energy. In a portfolio of renewable energy products, RECS are considered low quality because they do not guarantee that the renewable energy was actually consumed or that new (or "additional") renewable energy capacity was built to match demand.

A **PPA** is a contract between a supplier and a customer whereby the customer agrees to buy (renewably generated) power from the supplier for a fixed period at a defined price. They are classified as either direct/physical PPAs or financial/virtual PPAs.

Direct/physical PPAs guarantee physical delivery of electricity to the grid at a fixed price. This protects the buyer against price increases, but if prices fall, the buyer may be stuck in a long-term contract at a price that is higher than the retail price. In a portfolio of renewable energy products, direct/physical PPAs are considered high quality because the buyer can point to the exact resources providing the power.

Financial/virtual PPAs do not physically deliver the energy to the buyer. The buyer agrees to a "strike price," which is the price they pay for each unit of energy. The generator then sells the power into the local wholesale market, which may be in a different location from the buyer. If the wholesale price is higher than the strike price, the supplier pays the buyer the difference. If the wholesale price is lower, though, the buyer must pay the difference to the supplier. A virtual PPA, therefore, usually involves undertaking some financial risk.

Carbon **offsets** mitigate emissions that have already occurred (from any source). Rather than reduce or remove emissions, such as by improving energy efficiency or switching to renewable power, offsets can be purchased to mitigate emissions elsewhere. Offsets are a good option where it is impossible to completely decarbonize or it is too late to reverse earlier emissions; they can be part of the journey toward decarbonization. However, use of offsets can be seen as an excuse to continue emitting.

Buying renewable energy

If the grid mix is regularly changing and no country has yet fully decarbonized, how is it possible for data center and cloud operators to claim 100% renewable energy use? There are several approaches to buying renewable energy, each differing in their perceived quality.

RECs are the most common product in renewable energy portfolios and are designed to match electricity use with renewable energy supply. They are commonly used in the data center industry (see Figure 1). Simplified, an organization calculates its total annual electricity consumption and buys a matching quantity of RECs — a practice referred to as "renewables matching." There are complexities to consider, however, such as correctly matching emissions factors across locations.

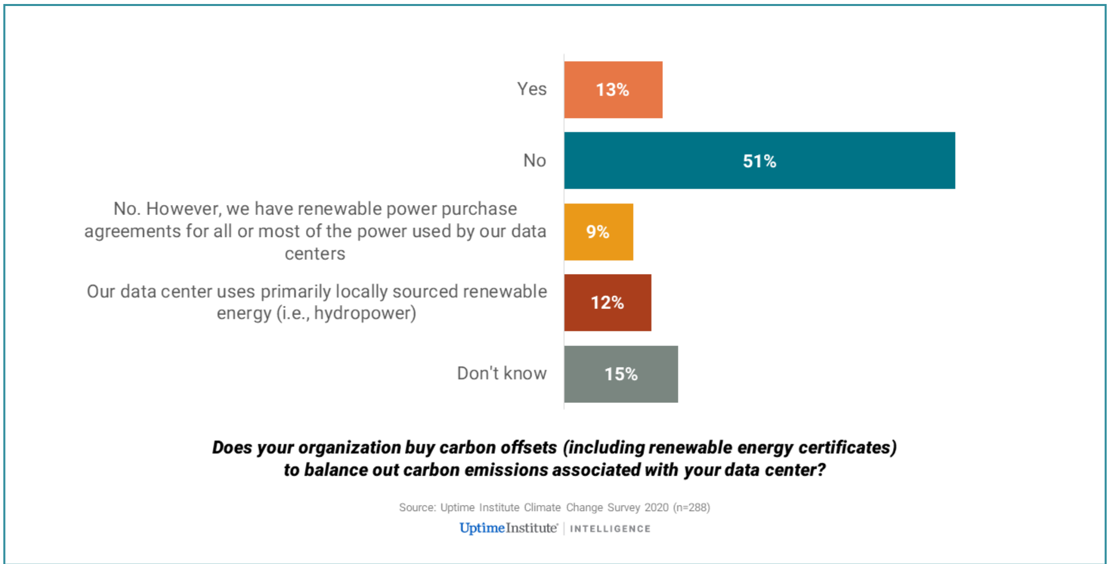


Figure 1. **Nearly a quarter of data center operators say they buy carbon offset products**

The operators with the most advanced sustainability programs have been progressing toward their renewable energy goals for over a decade, and some have already achieved 100% renewables matching — both Google[21] and Iron Mountain[22] achieved this in 2017, and Apple did in 2018.[23] Other providers have set public goals of 100% renewable energy use, such as Microsoft's and Amazon's commitments to 100% renewable energy use by 2025[24,25] and Equinix, which reported 92% renewable energy use for 2019 and is on a path to 100% (but without a public date to reach it).[26]

Renewables matching helps with the goal of decarbonizing the grid because it should, in theory, increase demand for renewable energy. However, it does not mean the electricity actually consumed was generated by renewable sources, just that the total consumption (of the buyer/holder of the certificates) is matched by renewable generation somewhere. Renewables matching does not, therefore, directly create new sources of renewable energy generation. This means that, while RECs represent a helpful step towards decarbonization, they are not sufficient; this is the reason why RECs are considered low quality instruments compared with PPAs.

Until the entire grid is fully decarbonized, the only way to guarantee that the electricity being supplied is 100% renewable is to install capacity that is either on-site at the data center or connected nearby on the local grid. Although on-site generation, such as installing rooftop solar panels, is good for public relations and may reduce overall carbon emissions slightly, the energy intensity of data centers means these projects can usually provide only a small proportion of overall demand — typically 5-10%. Large-scale projects must be constructed to generate sufficient electricity, and supply to a data center is often achieved through a direct/physical PPA. PPAs have been growing in popularity in recent years, and some new data center projects include the construction of large-scale renewable energy generation capacity as part of the plan.

These projects highlight the importance of data center site choices. Grid carbon intensity should be a factor, both in relation to the existing generation sources and to how easily new renewable energy resources can be added to the local grid. Some regions have more potential than others, and operators looking to expand should consider whether potential sites have renewable energy generation capabilities. Google's 490 megawatt (MW) solar farm in Texas,[27] Amazon's 115 MW wind farm in Ireland,[28] and EcoDataCenter in Sweden, located next to 700 MW of hydroelectric and 20 MW of wind power,[29] are all examples of operators choosing to build where the use of renewable energy was not only feasible, but also made good business sense.

Other regions face obstacles beyond the direct control of the data center operator. For example, in Northern Virginia (US), new data centers are being built by companies with strong renewable energy commitments (e.g., Amazon and Microsoft), but the area's largest electricity supplier, Dominion Energy, continues to build fossil-fuel power plants to meet the new demand.[30]

For existing data centers or those in urban areas, RECs and virtual/financial PPAs will be a key part of the sustainability strategy. The following section will consider RECs and PPAs in more detail and will explain why the final goal is not just matching renewable energy use annually but also ensuring the supply of 100% renewable energy 24/7.

Renewable energy certificates

For every unit of electricity generated from renewable sources, a unique REC is created. RECs are tradable commodities that can be bought and then retired/redeemed once that electricity is consumed. They exist independently of, and are often purchased entirely separately from, the electricity supplied.

For example, RECs tend to be purchased in units of one megawatt-hour (MWh), so a data center using 10,000 MWh (10 gigawatt-hours) of electricity in a year would need to purchase 10,000 RECs to match that usage. The electricity that was actually used might have been purchased in a region that is mostly supplied by coal but purchasing the RECs should guarantee that at least that amount of renewable energy was also generated somewhere else. It does not necessarily mean, however, that the carbon emissions were fully matched because of the differing carbon intensity at each location.

Renewable energy prices

- **Commercial retail electricity price:** $106/MWh* (2019 US average).
- **REC price:** Under $1/MWh (2015-2020 US average).
- **PPA price**: PPA pricing is negotiated in each contract so finding accurate, fully loaded pricing directly comparable to retail prices is difficult. For example, $22/MWh for wind and $35/MWh for solar was the 2016 US levelized average, but this excluded necessary grid services, such as transmission and distribution.

*MWh, megawatt-hour

Sources: https://www.nrel.gov/docs/fy21osti/77915.pdf, https://www.eia.gov/outlooks/steo/data/browser/#/?v=8, https://www.epa.gov/greenpower/green-power-pricing

In the US in 2019, 197,000 customers purchased 68.7 million MWh of electricity that was covered by RECs. REC prices were generally under $1/MWh between 2015 and 2020, although this increased to $1.50/MWh in summer 2020.[31] Contrast that with an average US commercial electricity price of $106/MWh in 2019[32] – the cost of RECs is insignificant relative to the overall spend on electricity, but can still be costly on an absolute basis.

This low cost makes RECs easy to criticize and leaves companies open to accusations of greenwashing if they are the only component of a renewable energy strategy.[33,34] RECs do help to increase demand for renewables overall but do nothing to encourage new renewable generation in response to specific demand.

Adding new renewable energy capacity in direct response to demand is known as "additionality," and it is a key concept in understanding the impact of products such as RECs and PPAs. If a new data center is being built, the electricity grid operator will be requested to add sufficient capacity to supply it with electricity, but RECs do not encourage or force that new supply to be renewable.

"Additionality" is adding new renewable energy generation capacity in direct response to demand. Understanding the concept of additionality is key to understanding the impact of different offset products on the decarbonization of the grid.

Double counting is also a risk. For example, if the data center owner purchases RECs to match its entire electricity consumption, an individual colocation customer can also purchase RECs to match their own calculated energy consumption. Or the opposite may occur, where one party believes the other is managing the certificates, but actually neither side is purchasing and retiring them appropriately. Avoiding this requires that the data center operator be specific and transparent with its customers about the type of electricity being supplied and the accounting associated with electricity from renewable sources.[35]

All RECs should be documented and properly tracked by the purchaser (e.g., the data center operator), and then customers (e.g., those with colocation leases) should be informed by the data center operator about how to account for their consumption: Do they hold the accounting responsibility, or is another party (e.g., the data center operator) managing it? In both cases, accurate reporting relies on proper attestation across the full supply chain, from generation through to consumption by the end user. It is the operator's responsibility to manage the reporting and retirement of RECs appropriately. Some operators, such as Iron Mountain,[36] offer a service that simplifies attestation and validation of renewable energy usage by transferring renewable energy ownership to the colocation customer for accounting purposes.

In the US, RECs are purchased in voluntary markets and may also be known as green tags, renewable energy credits or tradable renewable certificates. The European Energy Certificate System under Directive 2009/72/EC — which uses names such as green certificates, guarantees of origin or renewable energy guarantees of origin — operates a centralized registry to ensure double counting is avoided. These are all different products, but they are similar in how they operate.

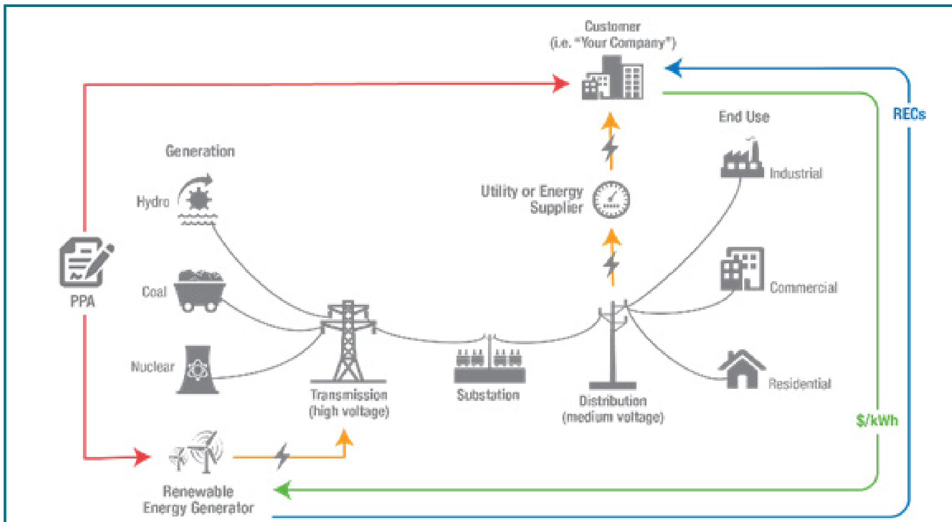
RECs are a part of decarbonizing the grid, but their role as a component of data center sustainability strategies should be reviewed by every operator. Many of the larger operators have already shifted their focus to more impactful options such as PPAs.

Power purchase agreements

To guarantee the electricity that enters a data center was generated from renewable sources, the generation must either happen on-site or nearby, and the power demand of the data center must be supplied from a renewable source 24/7. This is difficult because of how demand and supply fluctuate throughout the day and how the grid mix changes (see **Generating electricity**).

PPAs are the main tool being used to get closer to true 100% renewable energy use. A PPA is a contract between a supplier and a customer in which the customer agrees to buy electricity from the supplier for a fixed period at a defined price. They are classified as either direct/physical PPAs or financial/virtual PPAs.

Direct/physical PPAs guarantee physical delivery of electricity to the grid (see Figure 2). If the energy produced is from a renewable source and the new production capacity is added in direct response to demand, the buyer can claim additionality for the generated electricity. Effectively, that means the project went ahead only because of the PPA — that is, net new supply.



A diagram of a direct/physical power purchase agreement (PPA) showing the customer purchasing the PPA and associated renewable energy certificates (RECs), with the generated power physically delivered to the same electricity grid.

kWh, kilowatt-hour

Source: https://www.epa.gov/greenpower/physical-power-purchase-agreements-physical-ppas

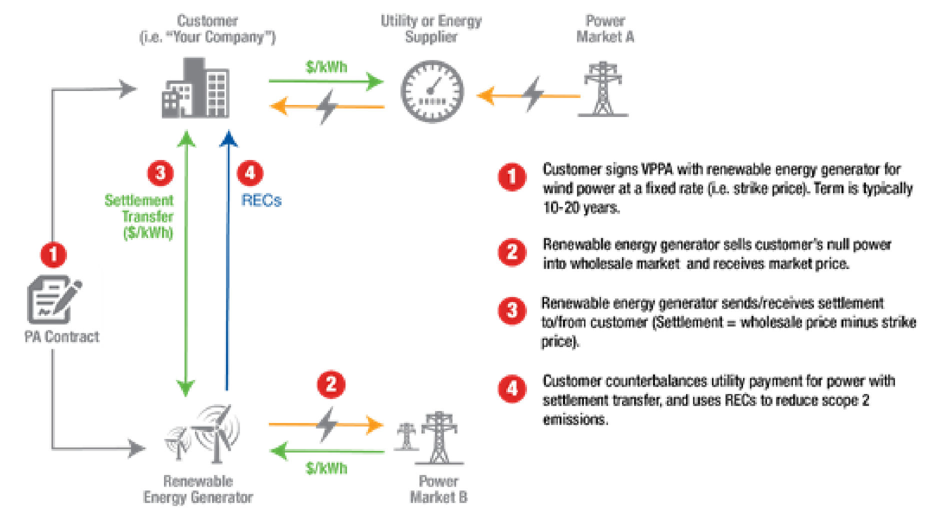
Figure 2. **Direct/physical power purchase agreement schema**

A direct PPA requires the buyer and the energy supplied to be in the same power market, and the market must allow retail access, so a data center operator can purchase power directly from the generator or a third party. The RECs generated from the power must also be a part of the contract and transferred to the buyer, otherwise they could be sold separately for someone else to claim their use.

Direct PPAs provide cost certainty because the price is usually fixed, but this is also a bet against future electricity prices. If prices increase, the buyer will benefit from their fixed price. If prices decrease, however, the buyer may be stuck with a long-term contract for a price that is higher than the retail price.

Direct/physical PPAs are the highest quality renewable product because the data center facility can point to the exact resources providing the power. However, such arrangements are not always possible due to the location of the data center. In these cases, operators can purchase financial/virtual PPAs, which allows them to point to the source of the RECs they receive, even if they operate in urban areas, in a power market where PPAs are not allowed, or in a region with a small amount of renewable generation in the grid mix.

Financial/virtual PPAs do not physically deliver the energy to the buyer (see Figure 3). The generator sells the power into the local wholesale market, which may be in a different location from the buyer. This arrangement may still have the benefit of additionality, but if the location is different the buyer cannot make any claim of buying renewable energy unless the PPA includes the RECs generated by the project.



A diagram of a financial/virtual power purchase agreement (VPPA) showing two separate markets – the renewable electricity being delivered to market B but the customer using power from market A – but with renewable energy certificates (RECs) still transferred to the customer as part of the contract.

kWh, kilowatt-hour

Source: https://www.epa.gov/greenpower/financial-power-purchase-agreements

Figure 3. **Financial/virtual power purchase agreement schema**

In a financial/virtual PPA, the buyer agrees to a “strike price” with the generator, which is a fixed price they pay for the energy and so acts as a partial hedge against unfavorable wholesale market price movement. If the wholesale price is higher than the strike price, the supplier pays the buyer the difference. If the wholesale price is lower, though, the buyer must pay the difference to the supplier.

For the many operators who cannot undertake such risks, there are other options. Retail, firm renewable energy or green tariff/supply contracts combine electricity generated from specified new or existing renewable generation projects, firming power from the spot market, and in-region RECs or certificates of origin to deliver 100% firm renewable energy. They are a combination of physical delivery of renewable energy and any matching RECs covering the firming generation sources (which may or may not be renewable) to provide a reliable power supply.

Contracts of this nature can be arranged through existing energy suppliers such as RWE (US, Europe, Asia),[37] EDF Energy (UK),[38] Constellation Energy (US), and StatKraft (Norway/EU). One such example is a supply agreement between Constellation Energy and Starbucks to supply electricity from renewable sources to more than 340 Starbucks stores in Illinois (US). Another example is the supply of renewable energy to Mercedes Benz factories in Germany: StatKraft combines electricity generated from specified wind, solar and hydroelectric projects to physically provide 100% renewable energy. These contracts typically have shorter terms than PPAs, the financial risks remain largely with the retailer or utility, and they provide the energy supply for a specific set of facilities. The contracts generally have a price premium, typically 1-5%, compared with conventional electricity purchases.

Google’s purchase of 48 MW of wind energy from the Grand River Dam Authority for its Oklahoma data center, and up to 407 MW of wind from MidAmerican Energy for its Iowa data center, are other examples of how a PPA may be structured. These are PPAs with a local utility, which then enters into agreement with the local wind farm, rather than Google contracting with the wind farm directly. Such arrangements allow Google to ensure additionality of the wind energy but mean the utility deals with the grid connection and power delivery.[39]

In the US, the use of PPAs is growing. Around 360 organizations purchased 42.3 million MWh of PPAs in 2019, an increase of 33% over 2018.[31] Tech firms made 42% of these purchases and telecommunications firms, 15%. The Renewable Energy Buyers Alliance, which facilitates and tracks corporate purchases of renewable energy, reports large purchases from data center operators such as Amazon, Facebook, Google, and Microsoft.[31] Deal terms are usually private but US national average levelized prices in 2016 reached $22/MWh for wind and $35/MWh for solar[40] — this excludes costs related with actually delivering power, so does not represent the fully loaded cost of the electricity to the end user.

PPAs can solve the problem of ensuring that new renewable supply is built in response to an increase in demand; however, it is still difficult to solve the 24/7 generation problem. Even if a data center operator buys, for example, a direct/physical wind and/or solar PPA, sometimes there is no wind or sunlight available. In these circumstances, the compute workload either needs to be moved elsewhere and equipment shut down to match the renewable energy shortfall or sufficient stored energy needs to be deployed to cover the gap.

Moving workloads between facilities is difficult to manage unless systems and policies have been carefully architected to support it. There are many theoretical technical frameworks to migrate IT load based on carbon intensity, but implementing them in practice requires access to multiple data center regions, real-time carbon intensity data, and workloads that can be easily migrated.[40] Even Google, with its distributed multi-site architecture, has only just recently begun to move some of its workloads based on carbon intensity.[41] This adds costs due to the need to deploy additional redundant equipment and either move data before going offline (with associated data transfer costs), or storing data in multiple locations. In reality, the entire data center is unlikely to be taken offline, so shifting off-grid to battery power or another local power source is the only viable option.

Energy storage is now starting to be deployed at large scale. Tesla is providing balancing and reliability services to the grid in Australia, where it has deployed 150 MW of batteries linked to a solar array that charge when the sun is shining. Tesla plans to expand to two more sites of 250 MW each.[41]

Data centers already use large amounts of battery power, of course, but generally only for seconds or minutes in emergencies when switching between grid and generator power. Google is now building new facilities with large-scale battery storage, such as a Las Vegas data center project that includes 350 MW of solar energy and 280 MW of batteries.[42] Google also announced a 3 MW live load test using batteries in Belgium at the end of 2020.[43] These are pilot projects, part of a plan to reach 100% renewable energy use 24/7 by 2030.[44]

The reality is that few data centers currently have sufficient battery storage to go off-grid for any meaningful amount of time, and most IT workloads are not architected to run on equipment that is ready to shut down entirely. This means that until the grid has been entirely decarbonized, offset products may be a short-term option to mitigate the environmental impact of being forced to consume nonrenewable energy.

Care must be taken to choose high-quality offset products — those that have been independently verified to have proven additionality and long-term management. Pricing varies depending on the standard(s) applied to assess quality, and there are several options for buyers to consider. The Carbon Offset Research and Education initiative of the Stockholm Environment Institute and Greenhouse Gas Management

Institute provides detailed information on the benefits and risks of carbon offsets and guidance on how to select a high-quality offset.

Next steps

Transitioning to renewable energy use is an important, but not easily achieved, goal. A stepwise approach will ease the process. There are four steps that data center operators need to take on the journey toward the use of sustainable, renewable energy.

1. Measure, report, offset

Electricity is just one component of the carbon footprint of an organization, but it is easy to measure because exact consumption is regularly reported for billing purposes. Every data center operator knows how much electricity is being used, but knowing the source is just as important. Tracking how much electricity comes from renewable and nonrenewable sources allows decisions to be made about offsets and renewables matching. This breakdown can be obtained from the electricity supplier, or grid-level emissions factors can be used. For example, in the US this is published annually by state by the Energy Information Administration; other countries provide similar resources. Multiplying the per unit emissions factor by the total consumption provides the total emissions from electricity. (A more formal methodology is explained in the Greenhouse Gas Protocol Scope 2 guidance.)

Once total emissions are known (that is, total emissions from electricity — the full organizational emissions also need to be calculated), the next step is to buy offset products to mitigate the existing impact. However, there are significant challenges with ensuring offset quality,[45] and offsetting is only a stopgap measure. Ideally, offsets must be reserved for emissions that cannot be reduced by other measures (e.g., switching to 100% renewable energy).

The operators with the most advanced sustainability programs, such as Equinix,[46] Iron Mountain[47] and Microsoft,[48] are using International Organization for Standardization (ISO) 14001 standards for the design and certification of environmental management systems, particularly in conjunction with net-zero emissions goals (whether already achieved or set for the future). Some companies are starting to require carbon reporting for their suppliers (for example, Apple and Microsoft, because of their own goals to be carbon-neutral/negative by 2030).

Measurement and reporting are crucial to understanding carbon footprint. Reporting is becoming a legal requirement for larger companies in some jurisdictions (e.g., the UK). This is also a key near-term goal for the US.[49] The EU is already engaged in a wider consultation about how green claims are substantiated.[50]

Many companies are, of course, reporting without being legally required to; for example, Digital Realty, Equinix, Google, Microsoft and others submit annual reports to the Climate Disclosure Project. The International Financial Reporting Standards Foundation, the organization responsible for mandatory accounting standards, has also launched an initiative about standardizing sustainability reporting.[51] Data center operators who are not tracking carbon emissions associated with electricity purchases may have to invest significant resources to catch up should reporting become required.

Key questions:

- Who is responsible for the sustainability strategy and who do they report to? Is sustainability being taken seriously as a part of core operations, reporting directly to the executive team or, ideally, the board?
- What are the sustainability goals, and what are the timelines and budget to achieve them?
- How much electricity is being consumed in total? Is it broken down by customer to allow individual reporting when requested?
- What is the source breakdown by renewable and nonrenewable?
- What is the emissions factor of each source? If renewables matching does not account for 100%, does the organization purchase high-quality offset products for the remaining amount? Is the organization developing a transition plan?
- What is the total carbon footprint? Will reporting be compliant with the Greenhouse Gas Protocol (which is voluntary now but may become compulsory in the near future)?

2. 100% renewables matching

Ideally, all electricity used should be 100% matched by renewable energy production. So far in the data center industry 100% renewables matching has generally been achieved through purchasing RECs, but PPAs (direct, financial, or through green supply arrangements) must now take over as the dominant approach. RECs can act as a stopgap between taking no action and using tools such as PPAs, but they should eventually be a small component in the overall data center sustainability strategy.

Those who have already achieved 100% renewables matching, or are on the path to it, started the process several years ago and have gradually been moving toward the goal of 100% renewable energy use or renewables matching. The leaders in sustainability planning have been investing in both physical and virtual PPAs for several years.

Key questions:

- What is the total nonrenewable consumption that needs to be matched? Can this be achieved using PPAs or, as a fallback, RECs?
- What documentation is in place? Does documentation from the commodity trade include key details such as certificate serial numbers, vintage, ownership, and retirement status?

- What granularity is being matched? Total annual electricity consumption is misleading, due to the minute-by-minute variations on the grid. Can hourly sourcing data be provided to get more accurate matching?

3. Power purchase agreements

Purchasing RECs is a reasonable first step in a sustainability strategy but is insufficient on its own. Establishing direct/physical PPAs combined with their associated RECs is the gold standard necessary to truly claim 100% renewable energy use. However, even this does not mean 100% renewable energy is actually being used by the data center — just that an amount of purchased renewable energy equivalent to the data center's energy use was added to the grid. Virtual/financial PPAs are an option where the power market does not allow direct retail PPAs.

Both types of PPA involve pricing risk and act as a hedge against wholesale price changes. For direct PPAs, the fixed price provides certainty but if wholesale prices fall, buyers may be stuck in a long-term contract paying more than the current market price. Virtual/financial PPAs introduce further complexity and financial risk: if the wholesale price falls below the agreed-upon strike price, the buyer must pay the supplier the difference, which may be significant.

Despite these risks, the use of PPAs is growing rapidly in the US, particularly in the tech and communications sector. Operators with advanced sustainability programs have been buying PPAs for several years, either directly, through financial/virtual PPAs, or using green supply agreements through a utility.

Understanding the grid mix and obtaining the appropriate documentation is crucial to be able to prove claims and provide assurance to customers. This may also include on-site generation, but the RECs generated must be used by the operator and not sold into the market.

Key questions:

- What is the total consumption that needs to be matched (either because the operator is replacing existing RECs or anticipates new demand)?
- Is it possible to purchase a direct/physical PPA? If so, what size project is necessary to meet demand? Will the PPA buyer purchase all the electricity the project generates, or is this a suitable project to work with other electricity users as a purchasing group or consortium?
- Will the RECs be transferred as part of the PPA?
- What is the organization's risk tolerance? PPAs are a hedge — there are benefits if wholesale prices rise above the strike price but if the wholesale/spot price falls below the strike price, the buyer must pay the provider the difference. Does the buyer have sufficient expertise to negotiate the strike price?
- If the hedging risk is too high or too complicated, what green supply options are available through utilities?

- What documentation is in place? Does it include key details such as certificate serial numbers, vintage, ownership, and retirement status?
- What granularity is being matched? Total annual electricity consumption is misleading, due to the minute-by-minute variations on the grid. Can hourly source data be provided to get more accurate matching?

4. 24/7 renewable energy use

Most matching happens on an annual basis but shifts in generation happen at a much lower granularity. Different sources of renewable energy can be combined to create blended PPAs, such as combining wind and solar energy production with storage capacity. This is useful because different sources generate at different times (for example, wind can generate energy at night when solar energy is unavailable).

In 2019, Microsoft and Vattenfall announced a new product to provide hourly renewables matching.[52] The pilot started at Microsoft's Sweden headquarters and will provide hourly matching to a new Azure cloud region in 2021.[53] No data center operator has achieved 24/7 matching for their entire global fleet, although some are almost there for individual sites (e.g., in 2019, Google achieved 96% renewable energy use in Oklahoma, and 61% on an hourly basis globally).[45]

This is the objective: 24/7 renewable energy use, 100% of the time. Matching on an annual basis is not enough to reach the goal of decarbonizing the electricity grid. All demand — 100% — must be supplied by 100% renewable energy, 100% of the time.

Key questions:

- What types of PPA does the existing renewable energy portfolio contain? Are they all one type of source, or are there multi-source, multi-technology blended PPAs?
- What is the strategy for improving the source and technology diversity of PPAs?
- Is the reporting sufficiently granular to support a move from annual to hourly matching?

Conclusions

Although most large corporations have a sustainability program, the range of tools and strategies employed may vary substantially. Buying RECs is common — almost standard practice, given how easy and cheap it is to purchase them. They also offer a marketing benefit: operators can claim to use 100% renewable energy with little of substance to back this up. However, more sophisticated buyers understand these limitations and, as a result, PPAs are now becoming much more common. Legislators and customers are also likely to understand the difference, which means relying exclusively on RECs risks allegations of greenwashing and customer/regulatory pushback.

Most data center operators continue to work on an annual matching basis, but operators with more advanced sustainability strategies are shifting their portfolios to include more PPAs and are experimenting with how to achieve matching on a more granular basis.

Data center operators mostly understand that using renewable energy is the right thing to do, but economic barriers have always been a concern. That is changing; in many regions, energy from wind and solar is now much cheaper than fossil-fuel alternatives. And pressure is increasing from multiple stakeholders — customers, regulators and investors alike all want more robust sustainability reporting.

Demand from operators is also starting to change. In the past, requirements for renewable energy were primarily driven by hyperscalers. However, several data center operators are reporting that questions about sustainability are showing up in requests for proposals. This is mostly appearing in new contracts, but existing customers are also asking questions at contract renewal.

Government regulation is inevitable and is driving the development of green finance products in the EU.[54] Climate risk disclosure looks to be a key near-term goal of financial regulators in the US as well.[50]

The data center industry has already made significant progress with its renewable energy goals; the sector is the largest purchaser of PPAs and of renewable energy generally. However, the composition of renewable energy portfolios needs to change — that means reducing reliance on RECs alone, buying PPAs and green supply contracts, and working toward 24/7 renewable energy use.

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