EPRI

24/7 CARBON-FREE ENERGY: MATCHING CARBON-FREE ENERGY PROCUREMENT TO HOURLY ELECTRIC LOAD

Program on Technology Innovation



December 2022

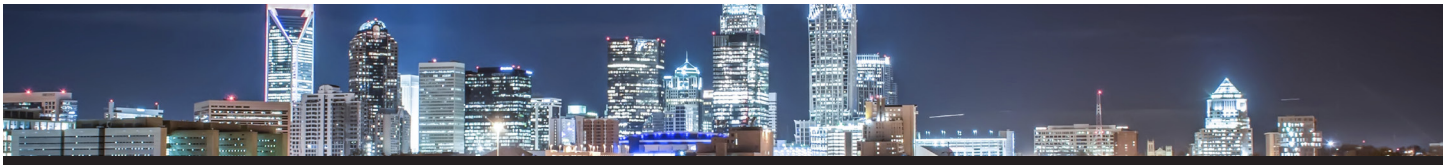


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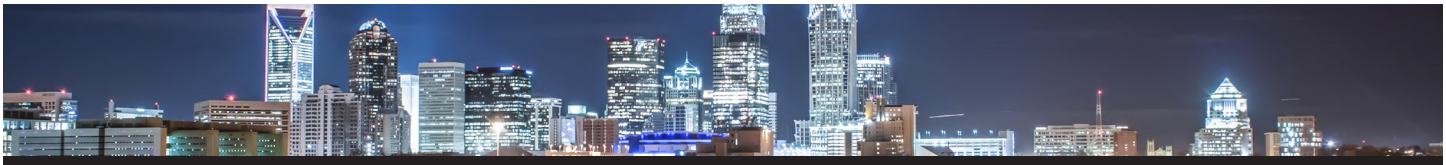
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EXECUTIVE SUMMARY

This EPRI white paper describes the evolution and growing interest of large electricity customers, electric companies, and others in procuring and supplying "carbon-free" energy 24 hours a day, seven days per week (24/7 CFE), and the opportunities and challenges facing electric companies considering developing products and services to meet this emerging need. Further, it explores the potential role of 24/7 CFE in future electric company and electric customer decarbonization activities, the current market status of 24/7 CFE products, services and suppliers, and provides information about existing commercial activities and recent 24/7 CFE agreements. This paper also addresses important related issues, including GHG emissions accounting related to procurement of 24/7 CFE, and the growing and controversial practice of procuring renewable energy (RE) and renewable energy credits (RECs) to achieve corporate carbon emission reduction goals. Development of this paper was supported by EPRI's Technology Innovation (TI) program.

The primary audience for this paper includes executives at electric utilities engaged in corporate strategy, company decarbonization and new product development. These individuals may find the information presented here to be useful as they consider engaging in early demonstration projects and/or partnership strategies related to 24/7 CFE. Electric companies can use the information presented here to develop potential strategies and customer power products to address growing large commercial and industrial (C&I) consumer demand for 24/7 carbon free energy. This paper also may assist electric companies and corporate electricity buyers with developing the terms and conditions for future 24/7 CFE power supply agreements, and provides information that may be of interest to state regulators and external stakeholders who want to learn more about this emerging issue and its current evolution.

Growing Interest in Procuring 24/7 Carbon-free Energy

In recent years, many large companies in the United States and internationally have focused on buying renewable electricity (e.g., wind and solar) to meet voluntary corporate sustainability goals, including reducing carbon dioxide (CO_2) other greenhouse gas (GHG) emissions. A large and growing group of leading sustainability-oriented companies procure enough renewable energy (RE) and/or renewable energy certificates (RECs) to equal 100 percent of the electricity (megawatt hours) they consume annually.

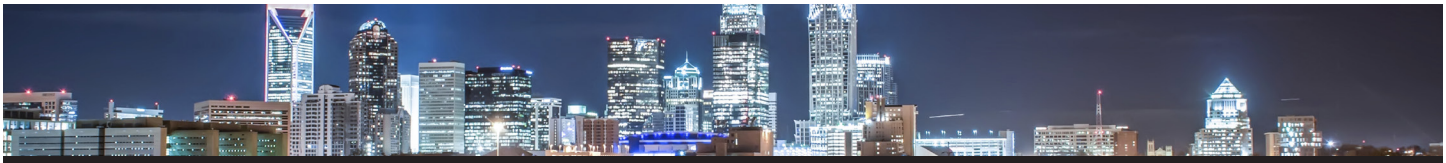
More recently, several large corporate C&I customers, such as Google, Microsoft, Iron Mountain and others have turned to procuring "*carbon-free energy*" that more closely matches their actual corporate hourly electricity load profile on a **24/7 hourly basis** every day of the year (aka 24/7 Carbon-free Energy). This shift from procuring 100% RE on an *annual* basis to procuring 24/7 CFE on an *hourly* basis marks a potentially important evolution of corporate efforts to promote clean energy and increase deployment of RE and a broader range of "carbon-free" generation technologies.

Recent 24/7 power contracts involve two basic components: (i) A portfolio of power supply resources that can generate high levels of CFE that matches a customer's hourly load, such as wind and solar combined with battery storage, and (ii) hourly tracking services that monitor and report how much of a customer's load in each hour is met with CFE. Typically, "qualifying" CFE resources are new, incremental resources located geographically within the same regional grid or balancing authority (BA) as the customer's load.

The United States federal government also is now gearing up to procure large amounts of 24/7 CFE by 2030 and beyond, as required by Executive Order 14057[1] (EO 14057) issued by President Biden in 2021. The federal government is the largest consumer of electric power in the U.S., and EO 14057 is designed to leverage this buying power to push development and deployment of 24/7 CFE by requiring all federal agencies to (i) purchase 100% carbon-free electricity on a net annual basis by 2030: and (ii) purchase 50% carbon-free electricity on a 24/7 basis by 2030. Although there is no generally agreed upon definition of "carbon-free energy," or "24/7 CFE," E.O. 14057 defines these terms for future federal agency electricity procurement and these definitions could become more widely accepted.

Electric power companies also have a growing interest in developing and supplying 24/7 CFE to meet emerging corporate demand and to collaborate directly with their customers to reduce their carbon emissions. The evolution of 24/7 CFE also may offer power companies opportunities to develop new power products and services to meet their current and future customers' needs and potentially increase their revenue. Additionally, electric companies that want to sell electricity to federal facilities in the future may want to consider developing strategies to provide 24/7 CFE products to these facilities.

1 Executive Order 14057 - Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, December 8, 2021.



In addition to growing demand in the U.S. for 24/7 CFE, there is growing international interest in 24/7 CFE. On September 21, 2021, the United Nations (UN) and a variety of other organizations around the world launched the *24/7 Carbon-Free Energy Compact*[2] and Eurelectric — the federation of the European electricity industry — has created a 24/7 CFE Task Force to explore and raise awareness about 24/7 matching and map out potential advantages, disadvantages and barriers, and to propose areas for further investigation and analysis. Several local governments in the U.S. and related entities also have joined the UN's Global 24/7 Compact and pledged to implement 24/7 CFE.

Using Renewables to Achieve Corporate Sustainability Goals

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 RECs to demonstrate RPS compliance. Typically, RECs record the generation of one megawatt hour (1 MWh) by a "renewable" resource (e.g., wind and solar), as defined by the specific RPS program.

Typically, corporate RE buyers count the RE and/or RECs they buy toward reducing their corporate GHG emissions, and existing voluntary GHG accounting practices allow these companies to reduce their reported "Scope 2" emissions in this way. However, critics of this approach point out that there is a critical difference between the content of power *purchased* by an end-use customer using a power purchase agreement (PPA) or other type of financial contract and the content of the electric power that is *dispatched* and consumed by the same customer. This distinction between the power *dispatched and used* by an electricity customer and the power resources *under contract* to deliver RE to the same customer can lead to confusing and disparate claims as to what extent a company has reduced its use of non-renewable, carbon-emitting power resources.

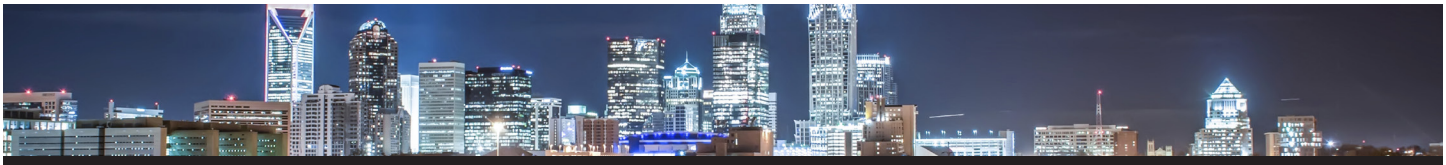
One factor that differentiates contracted from consumed electricity is that the energy output profile of contracted RE resources may not match a customers' hourly consumption on a 24/7 basis. Additionally, RE resources (or RECs) may be associated with RE generated in a BA or ISO that is geographically different from where the contacted electricity is consumed. In response to growing concerns about the potential mismatch between RE procurement and end-use energy consumption, some well-known, large corporate energy buyers recently have begun to procure "time-matched" RE and 24/7 CFE.

GHG Emissions Accounting for Renewable Energy Procurement

Existing GHG accounting protocols and practices provide a strong incentive to companies working to achieve sustainability goals to procure RE and RECs to reduce the "Scope 2" GHG emissions they report associated with the electricity they consume operating their businesses. Scope 2 emissions associated with purchased electricity often is a comparatively large source of GHG emissions for C&I customers, yet it can be challenging to reduce these emissions because they are not under their direct control. The only "direct" action these customers can take to reduce these emissions is to reduce their energy consumption (e.g., by installing energy efficiency upgrades) or install behind-the-meter renewable generation such as rooftop solar. In the absence of being able to take direct action to significantly reduce their Scope 2 emissions, many companies have focused on procuring RE and RECs to reduce their reported Scope 2 emissions, and more recently, a few leading sustainability-oriented technology companies have started to procure 24/7 CFE to reduce these reported emissions.

Under existing corporate voluntary GHG accounting standards, companies can report their electricity-related Scope 2 emissions using either a "locational" and/or a "market" approach and associated GHG emissions factors (EFs). This allows companies that purchase RE and RECs to report zero GHG emissions associated with the electricity they consume. In practice, the inclusion of the market approach has incentivized corporate electricity consumers to reduce their reported Scope 2 emissions by purchasing large amounts of RE and bundled and unbundled RECs while still physically consuming electricity from a grid that is partially supplied by fossil generation. This disconnect has motivated some consumers to seek out 24/7 supply agreements to better match their consumption with carbon free electricity supply.

2 United Nations, "24/7 Carbon-Free Energy Compact." https://www.un.org/en/energy-compacts/page/compact-247-carbon-free-energy (accessed Apr. 14, 2022)



Emissionality

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_2 emissions. While investing in (or building or buying power from) a new renewables 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 lower 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.

Anatomy of 24/7 CFE Power Supply Agreements

Today there are two evolving models for how companies have been procuring 24/7 CFE in the market. Some corporate buyers seek to procure a "turn-key" 24/7 CFE power product from a power supplier that includes both the 24/7 CFE resources and related back-end environmental reporting and attestations. Others plan to do it themselves by managing their own portfolio of electric supply agreements to achieve high-levels of CFE matched to their load.

In response to nascent customer demand for 24/7 CFE, several power companies have launched new power products to meet this need. To date, most of the 24/7 PPAs that have been publicly disclosed have involved power supplies being developed and delivered by independent power producers (IPPs). Recently, two investor-owned utilities (Nevada Energy and Georgia Power) received approval from state regulators to offer 24/7 CFE on a limited basis and two others (Duke Energy and Entergy) have announced plans to develop new 24/7 CFE products in the near future.

Some key elements to be considered when developing 24/7 supply agreements include: qualifying CFE generation sources; new versus existing power resources (also referred to as "additionality"); the percentage CFE target; measuring and ensuring performance of 24/7 CFE contracts; performance risk; and data tracking.

Challenges to Deploying 24/7 CFE

While there is growing interest and excitement surrounding 24/7 CFE, widespread deployment faces some significant challenges including: availability of CFE technologies to meet demand; regulatory considerations; transmission and distribution system infrastructure limitations; the mismatch between physical delivery of electricity and contracted power supplies; inaccurate and potential double counting of GHG emissions reduction and others.

Future deployment of 24/7 CFE also may be hampered by a lack of methods and infrastructure to track CFE resources and a range of data acquisition and management challenges, including accessing real-time grid data related to power generation and transmission and end-use customer load data, data interoperability across jurisdictions and entities, and data quality issues.

Potential Benefits and Challenges for Electric Companies

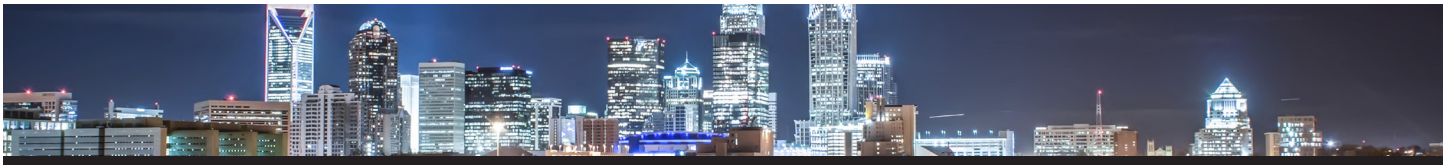
While the market for 24/7 CFE is small today and it is unclear how it may evolve, there are a variety of potential future benefits to electric companies that become engaged in supplying 24/7 CFE, including: new customer acquisition, maintaining existing customers, avoiding potential customer bypass and product and corporate differentiation.

Power companies considering engaging in 24/7 CFE also can anticipate facing some challenges that will need to overcome, including identifying 24/7 CFE generation technologies and projects, limited current C&I customer demand, the need to develop customized power supply agreements and the resources required to do this, market pricing or cost premiums for 24/7 CFE products, the potential need to build excess capacity to meet customer demand for 24/7 CFE, identifying suitable load-shapes, addressing asymmetric financial and operational risks, and the potential mismatch between existing electric company decarbonization strategies and developing and supplying 24/7 CFE products.

Key Insights and Opportunities

The following key insights and opportunities are based on the research and interviews completed to prepare this paper.

- 24/7 CFE represents a potentially significant evolution of corporate renewable energy procurement designed to better match RE procurement to real-time hourly customer load and further decarbonize the electricity supply.
- To date, there have been very few active corporate buyers of 24/7 CFE, and it is not clear when demand may grow significantly. Anecdotal information suggests corporate and municipal demands for these new power products may be growing.



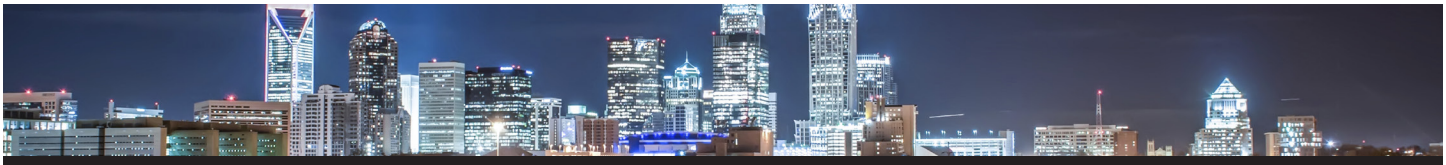
- The largest CFE buyer in the U.S. in the near term is likely to be the federal government as it implements Executive Order 14057. To serve this demand, or maintain existing power supply agreements with federal agencies, electric companies may want to consider developing 24/7 CFE power products, services, and tariffs.
- It is easier today to develop a 24/7 CFE product and transact it in deregulated power markets where IPPs are accustomed to supplying customized power products to corporate buyers than it is for regulated power companies to develop new 24/7 products and tariffs.
- Two regulated IOUs in the U.S. — Georgia Power Company and Nevada Energy — recently received state regulatory approval to develop and deliver 24/7 CFE products to corporate C&I customers located in their service territories. Two others — Duke Energy and Entergy — recently announced plans to develop 24/7 CFE products and services.
- Power suppliers that offer 24/7 CFE products face challenges, including product pricing, identifying suitable CFE projects, potential overbuilding of power generation resources, addressing asymmetric financial and operational risks, and developing new supply agreement and regulated tariffs to support 24/7 CFE.
- There is virtually no market infrastructure today to match customer load to unit specific CFE generation on an hourly basis. There is existing market infrastructure that supports RECs and RE procurement, but more limited infrastructure exists for CFE resources. The existing REC infrastructure is evolving rapidly to track hourly RE generation and provide time-stamped RECS and time-based environmental attribute certificates (T-EACs).
- Existing Scope 2 GHG accounting guidance provides a strong incentive for corporate RE buyers to continue to use bundled and unbundled RECs, renewable PPAs, and other mechanisms to reduce the GHG emissions factor they use to report their Scope 2 GHG emissions. Moreover, existing GHG accounting guidance provides little incentive for these C&I customers to procure 24/7 CFE as doing so will not reduce these customers' Scope 2 emissions more than simply procuring RE or RECs on an annual basis.
- For some corporate renewable and CFE buyers, *emissionality* and *location* are becoming important criteria for siting new facilities and PPAs. The move by some corporate, municipal, and institutional power buyers to make new renewable investments based on maximizing marginal GHG emissions impact or "emissionality" could reduce future demand for 24/7 CFE.
- There are a variety of data-related challenges that will need to be overcome to securely deploy 24/7 CFE, including ensuring data quality, access to real-time, unit specific grid generation data and end-use customer hourly load data. Deploying 24/7 CFE also will require managing larger data sets that includes specific generation attributes of qualifying CFE generation units on a 24/7 basis as well as end-use customer load data, and tracking and matching their use and retirement. It is also likely to be important and challenging to manage data interoperability across jurisdictions and to match load and CFE generation on an hourly basis.
- C&I customers who have procured 24/7 CFE to date have done so using two different approaches. Some corporate buyers have procured a "turn-key" 24/7 CFE power product from a power supplier while others are managing their own portfolio of electric supply agreements to achieve high-levels of CFE matched to their load.

Opportunities for Future R&D

A number of interesting topics and issues associated with 24/7 CFE could benefit from future research and development by EPRI and others.

Grid Benefits of 24/7 CFE

Proponents of 24/7 CFE claim procuring hourly RE may assist power grid operators to manage better the large and growing deployment of renewables by incentivizing increasing deployment of renewables and storage resources that better coincide with hourly loads. It is not clear if 24/7 CFE deployment will provide these grid benefits more cost effectively than other mechanisms, such as new market products or other changes to operations, and more research is needed to evaluate this.



Hourly Matching Impacts on Decarbonization

Another potential benefit of 24/7 CFE is that hourly load matching may increase the CO_2 displaced by renewable generation because it tends to incentivize renewable generation in hours of the day that typically are served by non-renewable resources. One recent study concluded that 24/7 CFE procurement drives significantly more retirement of natural gas generating capacity than 100% annual matching, but it will be important to confirm these initial findings and build on them.

24/7 CFE Contract Structures

Future R&D also could help to better understand existing and potential future 24/7 CFE power supply contract structures. It has been difficult to obtain specific information about existing 24/7 CFE supply agreements due to confidentiality concerns by both buyers and sellers. Key contract parameters include pricing, duration, supply technology mix, and performance agreements or guarantees. In addition to trying to better understand how existing agreements are structured, it may be important to consider how these structures may need to evolve to provide a foundation for 24/7 CFE resource development.

Impact of 24/7 CFE on Decarbonization

Another potential area of future research is to model regional power systems to explore and improve our understanding of the potential impacts of transitioning to 100% 24/7 CFE on GHG emissions and wholesale and retail electricity prices and other metrics. Energy systems modeling also could improve our understanding of the power system impacts of 24/7 CFE for different customer classes. For example, the impacts of procuring 24/7 CFE for data centers across the country may be different than doing so for large customers in the manufacturing or hospitality sectors. Quantitive modeling of these potential impacts could be done using EPRI's, proprietary United State Regional Greenhouse Gas and Energy simulation model (US-REGEN) of the U.S. economy and regional power systems.

Impact of 24/7 on Regional Power Systems and Reliability

Another key question related to large-scale deployment of 24/7 CFE is how deployment may impact regional power system reliability, including resource adequacy and climate resiliency. The transition to 100% 24/7 CFE potentially could have deleterious impacts on power system reliability and resiliency, unless properly planned for. Understanding how deployment of 24/7 CFE may impact system reliability and resiliency are important considerations that could be addressed by future research. This research potentially could be done using EPRI's new integrated generation, transmission and distribution planning modeling framework developed as part of EPRI's ongoing initiative on Integrated Strategic System Planning (ISSP) and as part of EPRI's ongoing Resource Adequacy and Climate READi Initiatives.

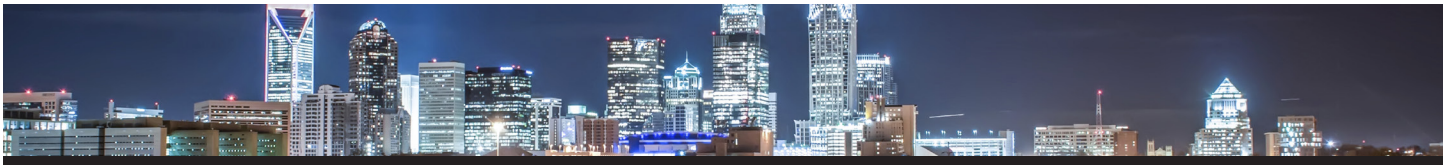
Relevant EPRI R&D Activities

In recent years, EPRI has published several research reports and other materials that explore topics related to 24/7 CFE. Below is a partial list of recent relevant EPRI resources:

- *Understanding Source-based and Load-based Greenhouse Gas Emissions Accounting.* EPRI, Palo Alto, CA: 2022. 3002024037.
- *Greenhouse Gas Emissions Accounting for Electric Companies: A Compendium of Technical Briefing Papers and Frequently Asked Questions.* EPRI, Palo Alto, CA: 2021. 3002022366.
- *EPRI Energy Systems and Climate Analysis Group Research on Greenhouse Gas Emissions Accounting.* EPRI. Palo Alto, CA: 2020. 3002018261.
- *Novel Power Purchase Agreements (PPAs) in Renewable Energy.* EPRI, Palo Alto, CA: 2020. 3002019434.

GLOSSARY

24/7 CFE	24/7 Carbon-free Energy
AEF	Average Emissions Factor
BA	Balancing Authority
BESS	Battery Energy Storage Systems
CARES	Georgia Power's Clean and Renewable Energy Subscription program
CES	Clean Energy Standard
CFE	Carbon-free Energy
CFE/ATC	Carbon-free Energy Around the Clock
C&I	Commercial and Industrial electric customers
EAC	Energy Attribute Certificate
EIA	The United States Energy Information Administration
EO	Executive Order
EPD	Environmental Product Declaration



ERCOT	Electric Reliability Council of Texas
EU	European Union
GO	Guarantee of Origin in the EU. Similar to a REC.
GPC	Georgia Power Company
IPP	Independent Power Producer
IRP	Integrated Resource Plan
ISO	Independent System Operator
ISO-NE	New England Independent System Operator
ISSP	EPRI's Initiative on Integrated Strategic System Planning
ISO	Independent System Operator (e.g., MISO and PJM)
JPM	JPMorgan Chase and Company
MEF	Marginal Emission Factor
MISO	Midcontinent Independent System Operator
M-RETS	Midwest Renewable Energy Tracking System
MWh	Megawatt-hour of electricity
NARR	North American Renewables Registry
NEPOOL-GIS	New England Power Pool Generation Information System
PJM	PJM Interconnection (ISO)
PPA	Power Purchase Agreement
PUCN	Public Utilities Commission of Nevada
REC	Renewable Energy Credit
RFI	Request for Information
RPS	Renewable Portfolio Standard
RTO	Regional Transmission Organization
T-EAC	Time-stamped Energy Attribute Certificate
WBCSD	World Business Council on Sustainable Development
WECC	Western Electricity Coordinating Council
WREGIS	Western Renewable Energy Generation Information System
WRI	World Resources Institute

1 INTRODUCTION

Purpose and Goals

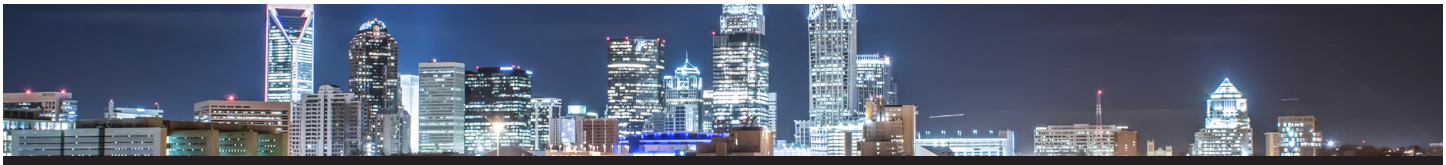
This EPRI white paper describes the evolution and growing interest of large electricity customers, electric companies, and others in procuring and supplying "carbon-free" energy 24 hours a day, seven days per week (24/7 CFE), and the opportunities and challenges facing electric companies who may consider developing products and services designed to meet this emerging need. Further, it explores the current market status of 24/7 CFE products, services and suppliers, describes existing commercial activities and recent 24/7 CFE agreements and explores the potential role of 24/7 CFE in future electric company and electric customer decarbonization activities. This paper also addresses important related issues, including GHG emissions accounting related to procurement of 24/7 CFE, and the growing and controversial practice of procuring renewable energy (RE) and renewable energy credits (RECs) to achieve corporate carbon emission reduction goals.

Development of this paper was supported by EPRI's Technology Innovation (TI) program. The information included here was developed by the EPRI project team by reviewing existing academic and corporate publications and presentations, interviewing representatives of large commercial electricity customers engaged in procuring 24/7 CFE and electric companies providing 24/7 CFE to customers. Additionally, the project team conducted interviews with staff of non-profit organizations and entrepreneurial startup ventures engaged in developing technical infrastructure that may provide the foundation for verifying and transacting 24/7 CFE.

Audience

The primary audience for this paper includes executives at electric utilities engaged in corporate strategy, company decarbonization and new product development. These individuals may find the information presented here to be useful as they consider engaging in early demonstration projects and/or partnership strategies related to 24/7 CFE.

Electric companies can use the information presented in this paper to develop potential strategies and customer power products to address growing large commercial and industrial (C&I) consumer demand for 24/7 carbon free energy. This paper also may assist electric companies and corporate electricity buyers with developing the terms and conditions contained in future 24/7 CFE power supply agreements.



This paper also can help electric power companies, electricity consumers, regulators, and other stakeholders to understand the challenges that have limited deployment of 24/7 CFE to date, and which will need to be addressed if 24/7 CFE is to be deployed more widely in the future and have a larger impact on achieving corporate decarbonization objectives.

In addition, this paper is designed to provide value to consumer and industrial (C&I) and other electricity customers who may be interested in reducing their GHG emissions; academic institutions and NGOs engaged in GHG emissions accounting, RECs, "green" power, and corporate decarbonization efforts; and staff of state public utility commissions and others.

Report Organization

Section 2 introduces the concept of 24/7 CFE and how it has evolved from prior corporate efforts to procure renewable energy (RE) and reduce GHG emissions. This section identifies and describes some of the key drivers of growing interest in 24/7 CFE deployment and highlights international, state, and local activities related to 24/7 CFE.

Section 3 explains how companies have procured RE and RECs to achieve their corporate sustainability and decarbonization goals. It highlights the important difference between the sources of electricity that are physically delivered to end-use customers and the electricity supplies these customers may have procured using financial contracts and power purchase agreements (PPAs).

Section 4 includes a brief overview of GHG emissions accounting and how companies today procure RE and RECs to reduce the GHG emissions they report associated with the electricity and other energy they purchase and consume in their operations (aka "Scope 2" emissions).

Section 5 describes 24/7 CFE energy products and some of the key elements that have been included in recent 24/7 power supply agreements. It explores different approaches C&I customers and others have used to procure 24/7 CFE, and concludes with brief overviews of some of the electric power companies engaged in developing and delivering 24/7 CFE products and services today.

Section 6 explores some key deployment challenges associated with 24/7 CFE that will need to be addressed if 24/7 CFE procurement is going to have a large-scale impact on future resource investments and grid decarbonization.

Section 7 highlights the potential benefits and challenges to electric companies that may consider developing 24/7 power supply products, services, and tariffs.

Section 8 highlights opportunities for potential research and development activities to further understand the potential for future deployment of 24/7 CFE and how it may help to achieve decarbonization goals.

Several appendices address important related topics, including tracking, trading, and retiring of renewable energy certificates (RECs), average and marginal GHG emissions factors, and service providers engaged in 24/7 CFE and a selected list of references.

2 DEMAND FOR 24/7 CARBON-FREE ENERGY

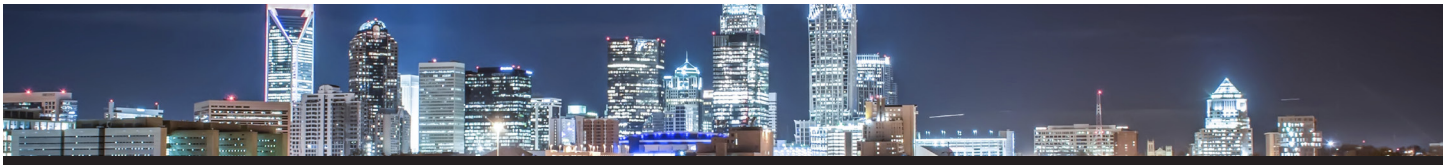
In recent years, many large companies in the United States and internationally have focused on buying renewable electricity to meet voluntary corporate sustainability goals, including reducing carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions associated with the electricity they consume. Today, hundreds of companies worldwide have committed voluntarily to procure 100% RE to meet corporate sustainability goals including reducing GHG emissions.[3] These efforts have focused on procuring renewable electricity resources – predominately wind and solar generation – and renewable energy credits (RECs), and typically have not included procuring other types of carbon-free generation resources such as geothermal, hydropower, nuclear, fossil-fired generation paired with carbon, capture and storage (CCS) and others. While pledges to purchase 100% RE largely have been led by high-tech companies such as Google and Microsoft, many companies in other sectors including retail, apparel, finance, insurance and manufacturing have made similar pledges.[4]

Having "matched" their annual power demand with RE generation, some companies claim to be "carbon free" or "100% renewable energy powered." For example, both Apple and Google announced in 2018 that their worldwide operations were powered using 100% RE resources.[5] In recent years, however, there has been growing recognition that companies that *procure* 100% RE nevertheless continue to *consume* electricity that is not carbon free and continue to

3 https://www.there100.org/re100-members.

4 Examples include retail (Walmart), apparel (Nike), finance (Citi and Barclays), insurance (Swiss Re), and manufacturing (3M and BMW). See *Advancing Corporate Procurement of Zero Carbon Electricity in the United States: Moving from RE100 to ZC100*, Columbia University GCEP, December 2021, pp. 9.

5 https://www.forbes.com/sites/energyinnovation/2018/04/12/google-and-apple-lead-the-corporate-charge-toward-100-renewable-energy/#714772371b23.



emit CO_2 and other GHGs. This is so for several reasons, including (i) electricity delivered in real-time through regional power grids is undifferentiated; (ii) corporate buyers often procure RE generation or RECs in different geographic region(s) from where they operate; and (iii) the generation profile of RE resources may not match most companies' actual hourly electricity demand or load profile.[6] These issues are discussed in more detail in section four.

24/7 Carbon Free Energy

In response to this growing awareness of the difference between buying and consuming 100% RE, several large corporate commercial and industrial (C&I) customers, such as Google, Microsoft,[7] Iron Mountain[8] and others recently have turned to procuring "*carbon-free energy*" that more closely matches their actual corporate hourly electricity load profile on a **24/7 hourly basis** every day of the year (aka 24/7 Carbon-free Energy). This shift from procuring 100% RE to procuring 24/7 CFE marks a potentially important evolution of corporate efforts to promote clean energy and increase deployment of RE and CFE resources.[9]

Recent 24/7 power contracts involve two basic components: (i) A portfolio of power supply resources that can generate high levels of CFE that matches a customer's hourly load, such as wind and solar combined with battery energy storage, and (ii) hourly tracking services that report how much of a customer's load in each hour is met with CFE. Typically, "qualifying" CFE resources are new, incremental resources and customer load is located geographically within the same regional grid or BA as the CFE resources.

In addition to helping companies to achieve decarbonization goals, proponents of 24/7 CFE have and recent analysis has suggested that procuring RE on an hourly basis may help achieve a variety of important societal objectives[10, 11] including:

- Assisting regional power grid operators to manage the large and growing deployment of RE by incentivizing deployment of RE and storage resources that better coincide with hourly loads.
- Hourly load matching may increase the amount of CO_2 displaced by renewable generation because it incentivizes renewable generation in hours that typically are served by non-renewable resources.
- 24/7 CFE procurement has the potential to enable much deeper reductions in CO_2 emissions from electricity consumption than 100% annual matching.
- By achieving 100% CFE, corporate power buyers may be able to leverage their capital investments to accelerate regional decarbonization efforts.
- 24/7 CFE could replicate the transformative impact voluntary RE procurement has had on wind and solar generation for a set of advanced, "clean firm" power generation and long-duration energy storage technologies enabling wider deployment.
- 24/7 CFE may help to hedge price volatility and risk for the electricity buyer by providing long-term fixed price contracts for electricity that matches the time and location of electricity consumption.

Large Corporate Customer Interest in 24/7 CFE

In recent years, a small, but growing list of large high technology companies have become interested in procuring 24/7 CFE to better align their RE procurement with their actual hourly electricity consumption and reduce the GHG emissions associated with the electricity they consume.[12] Some of these companies also have become interested in procuring electricity from a broader range of carbon-free generation technologies than traditional renewables like wind and solar.

For example, in 2020 Google increased its renewable and decarbonization ambitions by vowing to run its entire business on 24/7 CFE by 2030, including their data centers and offices worldwide. Since then, it has signed a power supply agreement with AES to supply its data centers in Virginia with at least 90 percent 24/7 CFE, and it has invested in CFE that can be generated around the clock, including entering into a power supply agreement with the geothermal startup Fervo.[13] Section 5 includes more details on Google's and other companies' 24/7 CFE power supply agreements.

6 Renewable credits may undercut climate targets — study, Energy Wire, June 10, 2022. https://subscriber.politicopro.com/article/eenews/2022/06/10/renewable-credits-may-undercut-climate-targets-study-00038468. Accessed online 6/10/22.

7 https://blogs.microsoft.com/blog/2021/07/14/made-to-measure-sustainability-commitment-progress-and-updates/, accessed 8/3/2022.

8 https://www.ironmountain.com/about-us/news-and-stories/stories/2022/january/powering-toward-leadership-in-clean-energy-a-look-at-our-data-centers, accessed 8/3/2022.

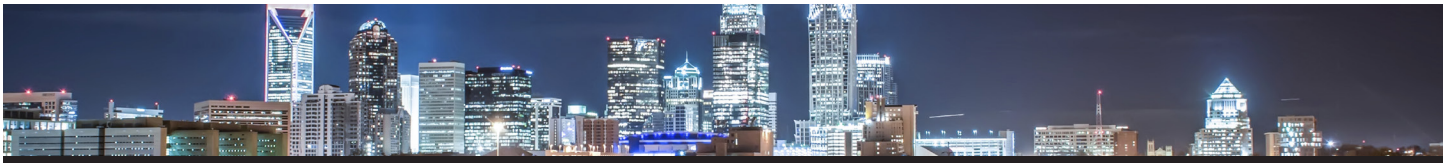
9 24/7 Carbon Free Energy Whitepaper, The AES Corporation, 2021. https://www.aes.com/sites/default/files/2021-05/AES-247-carbon-free-whitepaper.pdf (accessed April 19, 2022)

10 Ibid.

11 Xu, Q., Manocha, A., Patankar, N., and Jenkins, J.D., System-level Impacts of 24/7 Carbon-free Electricity Procurement, Zero-carbon Energy Systems Research and Optimization Laboratory, Princeton University, Princeton, NJ, 16 November 2021, p. 10.

12 These indirect GHG emissions are referred to as Scope 2 GHG emissions. Section two explains GHG emissions accounting and the various emissions scopes in more detail.

13 *A deeper dive into 24/7 carbon-free energy*, Canary Media, April 4, 2022. https://www.canarymedia.com/articles/energy-markets/a-deeper-dive-into-24-7-carbon-free-energy



Some corporate RE buyers believe aligning RE and CFE generation more closely to their actual hourly loads may help them achieve greater decarbonization of their electricity supply compared to buying RE on an annual basis. In theory, if a company is willing to pay to deploy new CFE resources that match their electricity usage in every hour in a regional power grid in which they operate, these companies may be able to accelerate the decarbonization of regional power grids. However, if these same customers are able to contract existing RE resources to meet their electricity needs this may have the unintended consequence of leaving the remaining higher GHG emitting resources to provide electricity to other consumers on the same grid without reducing overall GHG emissions.

Some large corporate customers in the high-tech sector also are engaged in 24/7 CFE to commercialize the underlying energy tracking and management software as a potential growth area for their cloud computing businesses. For example, Microsoft's recent 24/7 CFE supply deals with Engie, Constellation, and Vattenfall all include agreements to utilize region-specific tracking and 24/7 matching software hosted on Microsoft's Azure cloud platform.

Finally, procuring 24/7 CFE may help companies to address the ongoing controversy around the use of RE and RECs to reduce reported corporate Scope 2 GHG emissions. This controversy is discussed in more detail in section three.

Presidential Executive Order 14057

In addition to evolving corporate demand, the United States federal government now is gearing up to procure large amounts of 24/7 CFE by 2030 and beyond as required by Executive Order 14057[14] (EO 14057) signed by President Biden in 2021. The federal government is the largest consumer of electric power in the U.S., and EO 14057 is designed to leverage this buying power to push development and deployment of 24/7 CFE by requiring all federal agencies to (i) purchase 100% carbon-free electricity on a net annual basis by 2030: and (ii) purchase 50% carbon-free electricity on a 24/7 basis by 2030.

Although there is no generally agreed upon definition of "carbon-free energy," or "24/7 CFE," EO 14057 defines these terms for the purpose of future federal agency electricity procurement, and these definitions could become more widely adopted.

According to EO 14057, *carbon pollution-free electricity* means "… electrical energy produced from resources that generate no carbon emissions, including marine energy, solar, wind, hydrokinetic (including tidal wave, current, and thermal), geothermal, hydroelectric, nuclear, renewably sourced hydrogen and generated from fossil fuels that are accompanied by carbon capture and storage."

In addition, it defines *24/7 carbon pollution-free electricity* as "carbon pollution-free electricity procured to match actual electricity consumption on an hourly basis and produced within the same regional grid where the energy is consumed."

Electric Company Interest in 24/7 CFE

Electric power companies have a growing interest in developing and supplying 24/7 CFE to meet emerging corporate demand and to collaborate directly with their customers to reduce their GHG emissions. For example, two regulated IOUs in the U.S. — Georgia Power Company and Nevada Energy — recently received state regulatory approval to develop and deliver 24/7 CFE products to corporate C&I customers located in their service territories. Two others — Duke Energy and Entergy — recently announced plans to develop new 24/7 CFE product and services. These innovative IOU efforts to deploy 24/7 CFE are described in section four.

The evolution of 24/7 CFE also may offer power companies opportunities to develop new power products and services to meet their current and future customers' needs and potentially increase their revenue. Also, electric companies that want to continue to sell electricity to federal facilities now and in the future likely will need to consider developing strategies to provide 24/7 CFE products to these facilities.

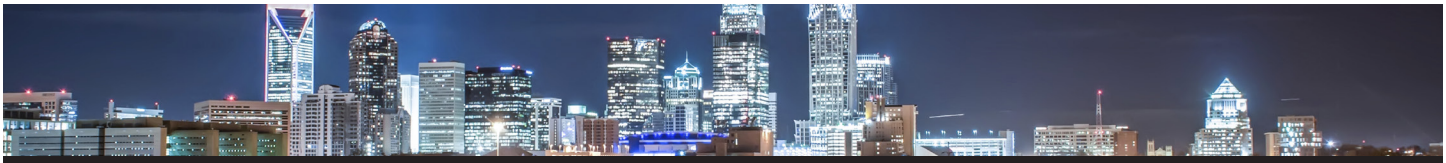
Recently, corporate power customers also have begun to consider access to 24/7 CFE when they are making their future facility siting decisions. Power companies and public officials may be interested in local deployment of 24/7 CFE as an important lever to maintain and improve regional competitiveness and economic development.

International Activity

Interest in 24/7 CFE also has been growing fast internationally. On September 21, 2021, the United Nations (UN) and a variety of other organizations around the world announced the creation and launch of the *24/7 Carbon-Free Energy Compact*[15] (see accompanying text box). This UN Compact brings together a group of energy buyers, energy suppliers, governments, system operators, solutions providers, investors and other organizations to "*…transform global electricity grids to "absolute zero" - or full decarbonization - by adopt-*

14 Executive Order 14057 - *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, December 8, 2021.

15 United Nations, "24/7 Carbon-Free Energy Compact." https://www.un.org/en/energy-compacts/page/compact-247-carbon-free-energy (accessed Apr. 14, 2022)



ing, enabling, and advancing 24/7 Carbon-free Energy (CFE). 24/7 CFE means that every kilowatt-hour of electricity consumption is met with carbon-free electricity sources, every hour of every day, everywhere…"[16]

In addition, Eurelectric — the federation of the European electricity industry — has created a 24/7 CFE Task Force[17] comprised of corporate energy buyers, energy suppliers, industry associations, technology start-ups, traders, and others to explore and raise awareness about 24/7 matching and map out potential advantages, disadvantages and barriers to its deployment, and to propose areas for further investigation and analysis.

Several existing 24/7 CFE agreements also have been consummated in the European Union (EU), including a recent agreement between Electricite´ de France (EDF) and JPMorgan Chase and Company in the United Kingdom. These agreements are described in more detail in section four.

State Legislative Activity

We are not aware of any state legislation that specifically requires electricity consumers to purchase CFE resources or 24/7 CFE. Several states in recent years have adopted clean energy standards (CES) that typically require electric utilities to deliver increasing levels of CES to their customers in the future but do not impose requirements to purchase CFE or renewable resources on an hourly matching basis.[18]

In 2018, California enacted SB 100 which increased the state RPS target to the current level of 60% by 2030. In addition, this new law requires all the state's electricity to come from carbon-free resources by 2045. In 2021, state legislators in California also considered SB 67, the *Clean Energy: California 24/7 Clean Energy Standard Program*[19] which would expand California's existing RPS program to establish interim targets and hourly accounting for an expanded set of clean energy resources.

Also, Google has been clear it plans to be engaged actively in promoting state and federal policies to increase deployment of clean energy resources and 24/7 CFE. Google's ability to impact the trajectory of public policy in this area was highlighted by the company in its 2022 Policy Roadmap for 24/7 CFE.[20]

16 https://www.un.org/en/energy-compacts/page/compact-247-carbon-free-energy. Accessed 7/25/22.

17 List of members of Eurelectric's 24/7 CFE Task Force. https://247.eurelectric.org/about/ (accessed 7/12/22).

18 *A Policy Roadmap for 24/7 Carbon-Free Energy*, Google, April 2022. https://cloud.google.com/blog/topics/sustainability/a-policy-roadmap-for-achieving-247-carbon-free-energy

19 https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB67 (accessed April 19, 2022).

20 Op. Cit., Google, 2022, p.2.

"Finally, we will develop partnerships and advocate for policies that accelerate electricity decarbonization across the globe… To achieve carbon-free electricity grids, we must do more than just purchase clean energy. We can multiply our impact by working to create and advance the tools, partnerships, and policy frameworks that allow all energy consumers to achieve 24/7 CFE. As one initial step in September 2021 at the United Nations High-level Dialogue on Energy, we and our partners launched the global 24/7 Carbon-free Energy Compact—a set of commitments and actions from energy buyers, energy suppliers, governments, system operators, solutions providers, investors, and other organizations to advance 24/7 CFE."

Local Government Activities

Several local governments and related entities have joined the UN's Global 24/7 Compact and pledged to implement 24/7 CFE and are taking other actions that may help to drive increased demand for 24/7 CFE:

- **Des Moines, IA** – On January 2021, the city council adopted a resolution committing to a community-wide goal of 100% 24/7 CFE by 2035.[21]
- **South Lake Tahoe, CA** – On December 7, 2021, the city council adopted a community-wide goal of 100% 24/7 CFE by 2030.[22]
- **Ithaca, NY**, is working towards 100% decarbonization of its buildings, and, along with the previous two cities, joined the United Nations 24/7 Carbon-free Energy Compact.[23]
- **Sacramento Municipal Utility District (SMUD)** plans to reach zero carbon emissions by 2030, using hourly greenhouse gas accounting.[24]
- Peninsula Clean Energy (PCE) – In 2017, the community choice aggregator in San Mateo County, CA, set a goal to deliver 100% RE by 2025, matching demand on an hourly basis.[25]

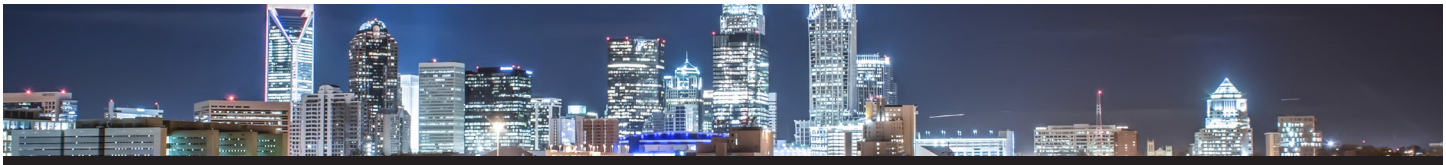
21 City Council of Des Moines, *Resolution: Establishing New Greenhouse Gas Emissions Reduction Goals and a Community 24x7 Carbon Free Electricity Goal for the City of Des Moines*, Jan. 11, 2021. https://councildocs.dsm.city/Resolutions/20210111/32.pdf .

22 *A milestone: South Lake Tahoe adopts ambitious energy plan*, Dec. 08, 2021. https://www.tahoedailytribune.com/news/a-milestone-south-lake-tahoe-adopts-ambitious-energy-plan/ (accessed Apr. 14, 2022).

23 E. Rosenbaum, *Ithaca, New York becomes first U.S. city to begin 100% decarbonization of buildings, an urban climate change milestone*, Nov. 04, 2021. https://www.cnbc.com/2021/11/04/ithaca-is-first-us-city-to-begin-100percent-decarbonization-of-buildings.html (accessed Apr. 14, 2022)

24 *2030 Zero Carbon Plan*, Sacramento Municipal Utility District, pp 62 of SMUD. 2030-Zero-Carbon-Plan-Technical-Report.ashx. Accessed on 8/9/22.

25 Peninsula Clean Energy, "Our path to 24/7 renewable power by 2025," Dec. 01, 2021. https://www.peninsulacleanenergy.com/our-path-to-24-7-renewable-power-by-2025/ (accessed Apr. 18, 2022).



United Nations 24/7 Carbon-Free Energy Compact

"...Due to the remarkable ongoing progress in clean energy and enabling technologies, the transition to a fully decarbonized electricity sector is possible. But it is not inevitable. It will require a concerted and targeted effort by all stakeholders to develop and scale the energy policies, technologies, procurement practices, and solutions to transform the broader energy ecosystem to enable rapid and cost-effective achievement of 24/7 CFE for all.

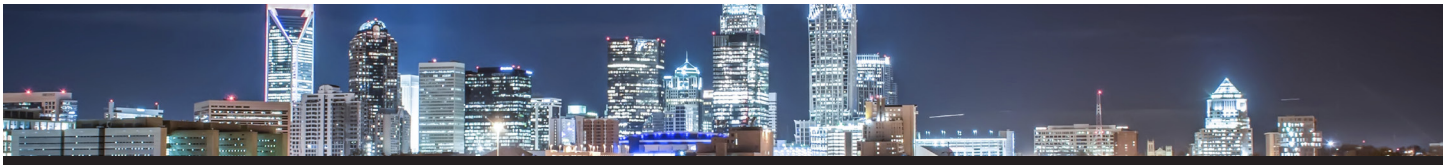
In service of accelerating this transformation, we commit to the following principles and actions:

- ***Procurement:*** Energy buyers commit to moving beyond 100% renewable energy annual matching goals and adopting, over time, 24/7 CFE procurement approaches that lead to new clean electricity generation to match hourly electricity demand on local/regional electricity grids where their consumption occurs, in line with the 24/7 CFE principles.
- ***Market Mechanisms:*** Suppliers and solutions providers commit to provide offerings that enable increasing access to 24/7 CFE, including by developing contractual arrangements, market products, or other innovations that enable the delivery of round-the-clock clean electricity.
- ***Policy:*** Signatories commit to publicly advocate and support energy policies that accelerate the decarbonization of electricity grids. This can include policies that help develop, commercialize, and deploy CFE generation and demand optimization technologies; policies that expand and interconnect electricity grids to integrate CFE; policies that expand and enhance electricity markets; and policies that provide direct access to purchases of CFE, among others.
- ***Technology:*** Signatories commit to supporting the advancement of CFE technology to decarbonize electricity grids, including by any one or a combination of the following actions: enabling the deployment of commercialized CFE generation and demand optimization technologies; enabling the commercialization of next-generation CFE generation and demand optimization technologies; developing or enabling supporting electricity grid infrastructure or technology that integrates carbon-free energy; developing or adopting software solutions that advance decarbonization of the electricity sector.
- ***Data and Transparency:*** Signatories commit to advocate and support widespread access to the energy data required to enable all consumers to set and measure 24/7 CFE goals, support the optimization of CFE technologies to demand, and maximize the decarbonization impact of consumer actions.

Not all commitments listed above will be equally relevant for all signatories, but all signatories commit to the broader principles behind 24/7 CFE. Further, each signatory agrees to submit a UN Energy Compact to capture the organization's specific commitments and actions between now and 2030 to move towards 24/7 CFE, in line with the commitments above and their core functions within the broader energy ecosystem. As part of the Energy Compact process, they will also develop and submit core metrics and measure their progress against these metrics on an annual basis.

Each signatory is also encouraged to include within the Energy Compact additional commitments and actions to support the achievement of SDG7 to help ensure everyone has access to affordable and clean energy by 2030." For a list of signatories and relevant commitments, see https://www.un.org/en/energycompacts/page/registry.

Source: https://www.un.org/sites/un2.un.org/files/2021/10/24-7cfe_compact_-_v2_updated.pdf.



3 USING RENEWABLES TO ACHIEVE CORPORATE SUSTAINABILITY AND DECARBONIZATION GOALS

Growing C&I customer demand for 24/7 CFE is part of the ongoing evolution of corporate RE procurement that began more than two decades ago. Many companies have become increasingly involved in RE procurement both domestically and internationally to achieve corporate sustainability goals and reduce their GHG emissions footprints.

By the end of 2020, more than 1,500 business had pledged to meet a "net-zero" GHG emission goal, and some of these entities now are leading a new wave of private investments focused on procuring zero-emission RE to offset carbon emissions attributable to their energy use.[26] In 2021 alone, according to BloombergNEF, approximately 31.2 GW of corporate clean energy contracts were signed globally, up 480% from 2017, and up 23% from the previous year 2021 (Figure 1).

Since 2020, some leading sustainability-oriented companies (e.g., Google, Microsoft), however, have begun to transition away from procuring 100% RE on an annual basis toward procuring 24/7 CFE to meet their corporate sustainability and decarbonization goals, marking what may be a potentially important evolution of both of these long-term trends.[27]

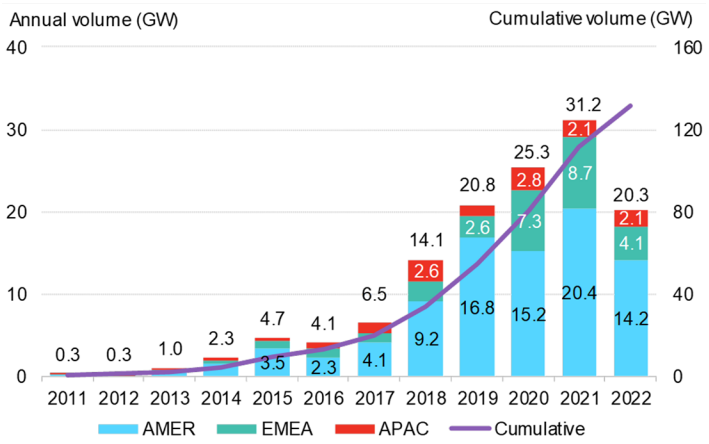


Figure 1. Global Corporate PPA Volume
Notes: AMER = North, Central, and South America region; EMEA = Europe, Middle East and Africa region; APAC = Asia Pacific region. Chart is for offsite PPAs only. APAC capacity is estimated. Pre-market reform Mexico PPAs excluded.
Source: Fernandez, J. Corporate PPA Deal Tracker: August-September 2022. BloombergNEF. October 2022.

For example, as shown in Figure 2, the evolution of Google's clean energy journey started in 2007 when the company adopted the goal of achieving "*carbon neutrality*" by buying GHG emissions offsets and procuring RE. In 2017, Google adopted a new goal of matching its global annual electricity use with procurement of 100% RE from wind and solar resources.[28] And, in 2020 Google adopted its current goal to match its operational electricity use with 24/7 CFE for "every hour of every day of the year" by 2030.

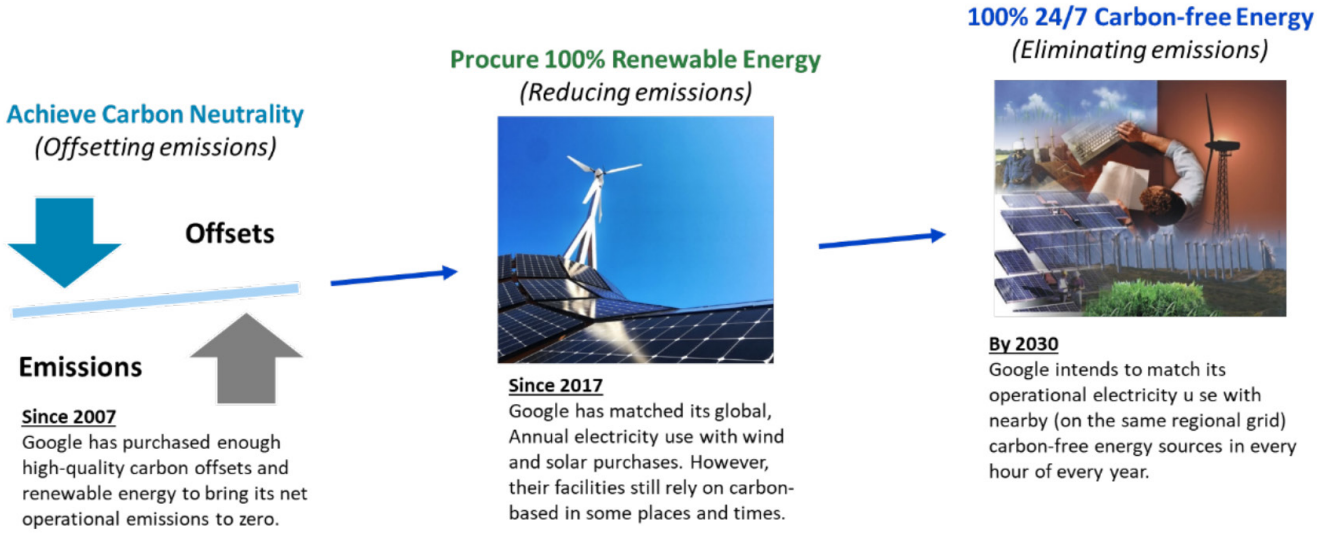
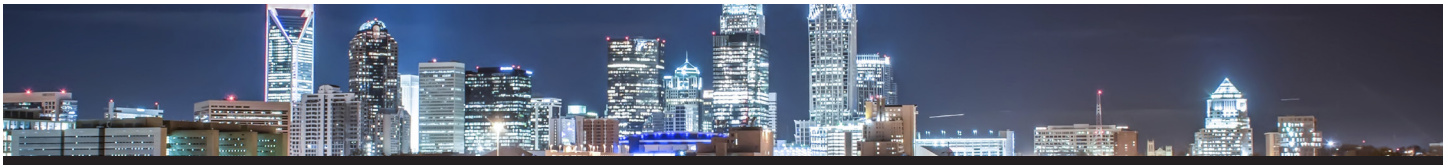


Figure 2. Google's Energy Journey 2007–2030
Source: Graphic by EPRI. Based on 24/7 by 2030, Realizing a Carbon-free Future, Google, September 2020. https://www.gstatic.com/gumdrop/sustainability/247-carbon-free-energy.pdf (accessed 10/17/22).

26 He. H., Rudkevich, A., Xindi, L., et. al., Using marginal emissions rates to optimize investments in carbon dioxide displacement technologies, *The Electricity Journal* 34 (2021) 107028, p1.

27 Supra, AES 2021.

28 https://sustainability.google/progress/projects/announcement-100/. Accessed 8/9/22.



Renewable Portfolio Standards (RPS)

To drive rapid deployment of RE and decarbonization, many states have adopted renewable portfolio standards (RPS), clean energy standards (CES) and other regulatory programs requiring electric companies to procure and track RE generation and other types of "clean energy."

An RPS typically requires a specified percentage of electricity delivered to end-use customers in a state to be generated by qualified "renewable resources"[29, 30] by a certain date. CES mandates are similar, but typically include a broader array of clean energy technologies such as hydropower, nuclear, fossil-fired generation combined with CCS, and other low-carbon generation resources.

Renewable Energy Certificates (RECs)

Most RPS programs allow electric utilities and other power generators to create and trade RECs to demonstrate RPS compliance. Typically, RECs record the generation of one megawatt hour (1 MWh) by a "renewable" resource (e.g., wind and solar), as defined by the specific RPS program.

Originally RECs were intended to be used as a tradable instrument solely for tracking electric company compliance with state RPS procurement targets. The use of RECs in regulatory compliance schemes enables accounting for the procurement of wholesale RE without the need to track the underlying electricity or verify the underlying renewable PPAs.

Over time, however, the use of RECs has expanded significantly, and today RECs are used widely as a proxy for reducing GHG emissions associated with the electricity that companies purchase and consume (aka "Scope 2" emissions).[31] Large C&I customers now routinely purchase and retire "bundled" and "unbundled" RECs to demonstrate progress toward achieving their renewable procurement and decarbonization goals.[32]

Historically, REC tracking systems have issued RECs in monthly or quarterly batches and REC markets typically transact RECs in monthly batches. Importantly, the individual RECs within each batch are not tied to a specific time of day or week. Recently, several REC tracking and issuance organizations, including M-RETS in the U.S. and EnergyTAG in the EU, have begun to develop time-stamped energy attribute certificates (T-EACS) that can be used to match hourly and sub-hourly RE and CFE power generation with end-use load. The tracking, trading and retirement of RECs are discussed in more detail in Appendix A.

Appropriate emissions accounting for purchases of RE (MWhs) and RECs is complex and depends on the context and purpose for the accounting. Electric companies may seek to account for their own wholesale RE purchases as part of demonstrating RPS regulatory compliance,[33] and to facilitate RE purchasing goals of their end-use customers.

In recent years, corporate consumers have used a variety of 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) reportedly have been actively reducing their reported Scope 2 GHG emissions by generating RE onsite, procuring RE via 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 PPAs, a RE generator sells both electricity and RECs directly to a corporate energy buyer bypassing the local utility.[34] Alternatively, a *retail access* customer can buy a 100% RE from a competitive retail supplier, who in turn 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 particular customer, rather than to all of the utility's customers. In each of these examples, large corporate buyers enter into an agreement with renewable energy generators (directly or indirectly) to purchase some or all their facilities' output.

29 Existing state RPS goals range from 10% by 2015 (Wisconsin) to 60% by 2030 (California) to 100% by 2045 (Hawaii). As of September 2020, 30 states had an RPS, and another and five had adopted a CES. A number of states also have adopted voluntary renewable energy goals. Source: http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx.

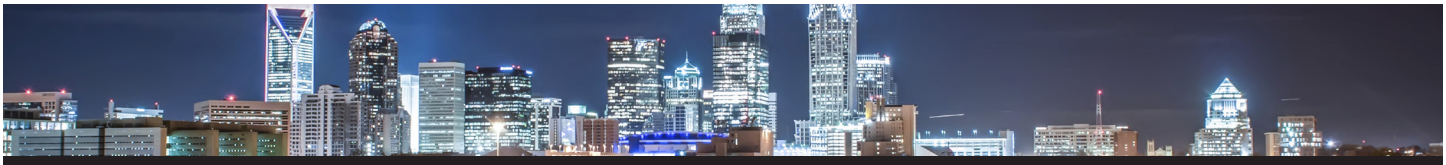
30 RPS qualifying RE resources may include hydropower, wind, solar and other resources based on the jurisdiction.

31 Gillenwater (2008). "Redefining RECs (Part 1): Untangling attributes and offsets." *Energy Policy*.

32 RECs that are traded along with the underling renewable energy generation are referred to as 'bundled" RECs while RECS that are traded separately from the underlying RE generation are referred to as "unbundled."

33 Typically, an RPS requires an LSE deliver a percentage (e.g., 50%) of specified RE resources to end-use consumers by a specified date (e.g., 2030).

34 For more information on some of the types of contractual mechanisms used by corporate end-use consumers to purchase RE, see "*Achieving our 100% Renewable Energy Purchasing Goal and Going Beyond*," Google, December 2016 (available online here: https://static.googleusercontent.com/media/www.google.com/en//green/pdf/achieving-100-renewable-energy-purchasing-goal.pdf



Typically, corporate renewable energy buyers count the RE and/or the RECs they buy toward reducing their corporate GHG emissions by reporting zero CO_2 emissions associated with their electricity consumption. Existing voluntary GHG accounting practices allow these companies to reduce their reported Scope 2 emissions in this way. This is discussed in more detail in section four.

In recent years, there has been growing recognition that this approach to reducing a company's Scope 2 emissions may lead to inaccurate attribution of GHG emissions. In 2020, Google highlighted this difference 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 to 82 percent depending on its location and corresponding demand profile.[35] 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."*

A more recent systematic quantitative modeling and analysis of the mismatch between RE generation and the load profiles of different 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."*[36]

Buying Versus Consuming 100% Renewable Energy

The difference between claiming GHG emissions reductions based on purchasing RE or RECS and achieving actual GHG emissions reductions associated with customer energy use is rooted in different perspectives on the environmental impacts of buying and using RE resources, particularly CO_2 and GHG emissions. Critics long have pointed out that 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 actually dispatched and consumed by the same customer.

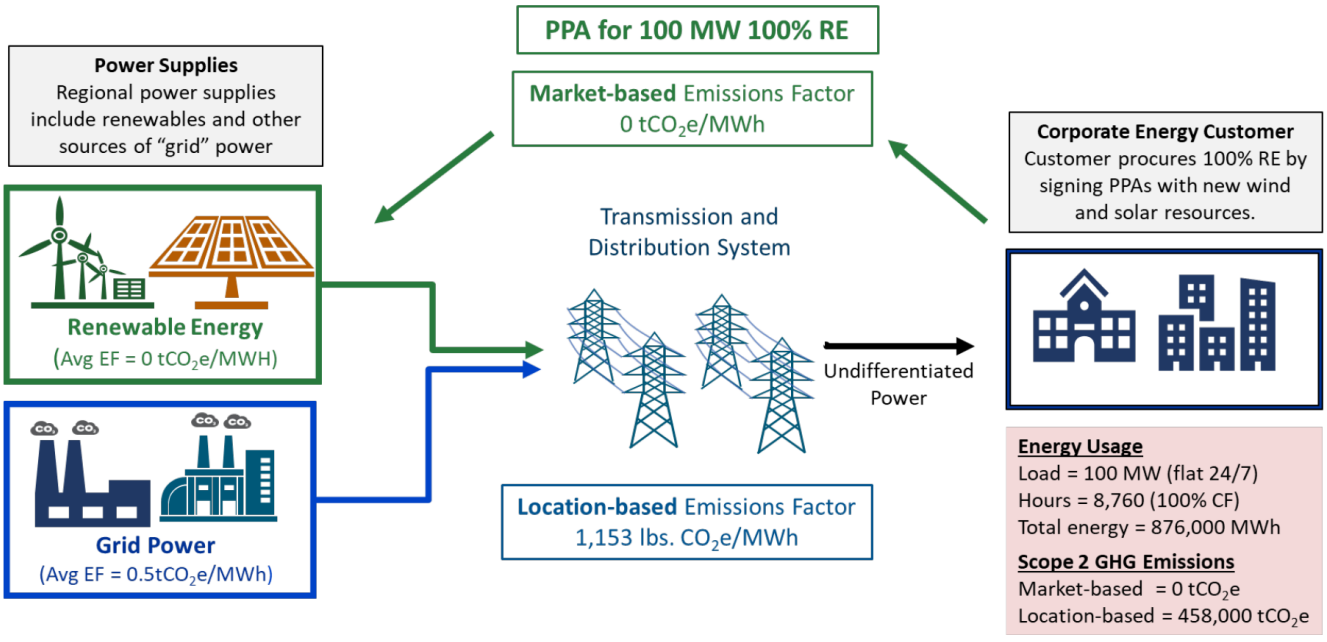
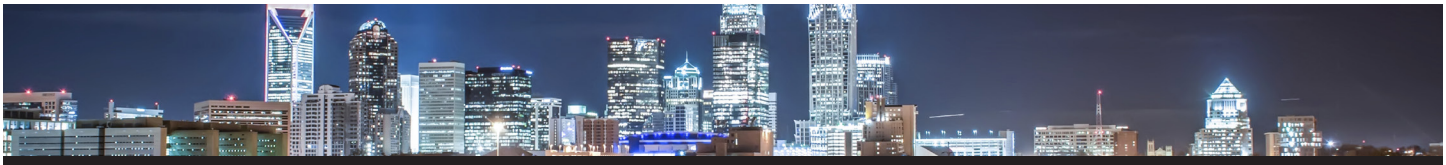


Figure 3. Buying versus Consuming 100% Renewable Energy
Source: EPRI

35 "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.

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



To better understand how buying and consuming 100% renewable energy are not the same thing, consider the example shown in Figure 3 of a hypothetical commercial facility that has a "flat" around-the-clock electric load of 100 MW (such as a computer data center). As shown, the company has entered into a PPA for the output from a nearby 346 MW solar farm. Over the course of one year, the solar farm expects to generate 876,000 MWh of RE (100 MW x 8,760 hours) and an equal number of RECs. This output exactly matches the facility's annual load of 876,000 MWh (100MW x 8,760 hours/year).

Typically, a company like the one in Figure 3 will claim to consume 100% RE and may report zero Scope 2 emissions associated with their annual power consumption. This is the case because the solar plant with whom they executed a PPA is expected to generate enough RE annually to equal the total amount of electricity the company expects to consumer. However, this claim is not based on the actual physical flow of electricity but rather a "contract path." The electricity that actually would be delivered to the facility is undifferentiated by source and would include both RE and other power resources operating on the grid simultaneously.

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 as shown in Figure 3. Even if an electric customer could purchase a 100% 24/7 CFE power product by contract, the customer may continue to consume undifferentiated "grid" power in real time. 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.[37, 38]

Time Synchronicity

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 isn't blowing, or the sun isn't shining).[39]

Locational Mismatch

Another key factor that differentiates the environmental impact of contracted RE (or RECs) and dispatched power is that RE resources (or RECs) may be generated in a BA or ISO that is in a location far from where the contracted electricity is consumed. In the US (and the EU), companies are allowed to acquire and retire RECs created by renewable energy generated virtually anywhere in the US (or the EU) 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. The potential GHG impact of making new RE investments in different locations (i.e., emissionality) is discussed in more detail in the section four.

Time-Matched Renewable Energy Procurement and 24x7 CFE

In response to growing concerns about the potential mismatch between RE procurement and end-use energy consumption, some well-known, large corporate energy buyers have decided to focus on procuring "time-matched" RE and 24/7 CFE. In addition, corporate energy buyers, energy suppliers and others engaged in the UN's 24/7 CFE Compact recently adopted a set of key principles and methods for developing 24/7 CFE agreements (see accompanying text box).

24/7 CFE Aligns Hourly Load with Contracted Power Supply[40]

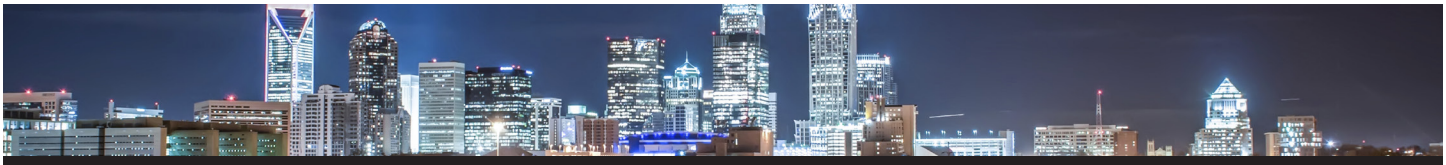
How does 24/7 CFE better align RE procurement with a company's actual load? Let's return to the example commercial facility shown in Figure 3 that has a "flat" around-the-clock electric load of 100 MW that is being supplied by a 346 MW capacity solar farm. Over the course of one year, the solar farm is expected to generate 876,000 MWh of RE and an equal number of RECs. This matches the 876,000 MWh of energy consumed by the facility. While this facility would have procured enough total solar energy (MWh) to meet 100% of its annual load, only about 40% of the facility's actual hourly electricity needs would be met with contracted CFE.

37 *Renewable credits may undercut climate targets — study*, Energy Wire, June 10, 2022. https://subscriber.politicopro.com/article/eenews/2022/06/10/renewable-credits-may-undercut-climate-targets-study-00038468. Accessed online 6/10/22.

38 International Energy Agency, *Advancing Decarbonisation Through Clean Electricity Procurement*, November 2022, p, 21. https://www.iea.org/reports/advancing-decarbonisation-through-clean-electricity-procurement. Accessed 12/5/22.

39 Op. Cit., IEA 2022, p 22.

40 Supra, AES, 2021.



Principles and Methods for Developing 24/7 CFE

24/7 Carbon-Free Energy means that every kilowatt-hour of electricity consumption is met with carbon-free electricity sources at every hour of every day, everywhere. It is based on the following 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: 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 Carbon-Free Energy technologies can play a role in creating this future.

Enabling new generation: Focusing on delivering additional Carbon-Free Energy to drive the rapid decarbonization of electricity systems.

Maximizing system impact: Addressing the dirtiest hours of electricity consumption where the most fossil fuel is used in generation.

Source: 24/7 Carbon Free Energy Compact https://gocarbonfree247.com/about/. Accessed 7/12/22.

As shown in Figure 4, the facility's hourly electric demand does not perfectly match the hourly output of the solar generator. For example, during hours 7–17, the solar plant is expected to generate more RE than needed by the facility and this "excess" power would need to be exported to the grid or stored. In hours 0–5 and 19–23, the facility's load would exceed the output from the solar farm. The balance of the facility's load during these hours would need to be met by other grid resources, including GHG emitting sources.

Figure 5 illustrates how different portfolios of renewable energy resources and CFE percentages of supply impact expected GHG emissions associated with a specific end-use load. As shown,

Figure 5 compares the hourly level of CFE associated with an illustrative set of different portfolios of RE resources (solar and wind) that could be used to provide energy to supply a 100 MW flat load.[41]

Each portfolio is shown on the left and the percentage CFE and CO_2 emissions reductions associated with each is shown on the right. The hourly CO_2 emission "heat map illustrates the percentage of CFE in each portfolio used to meet the 100 MW load for each of the 8,760 hours in a year.[42] These heat maps illustrate how 24/7 CFE can help electricity customers increase the amount of CFE used to match their load and provides estimates of potential CO_2 emissions reductions associated with each portfolio.

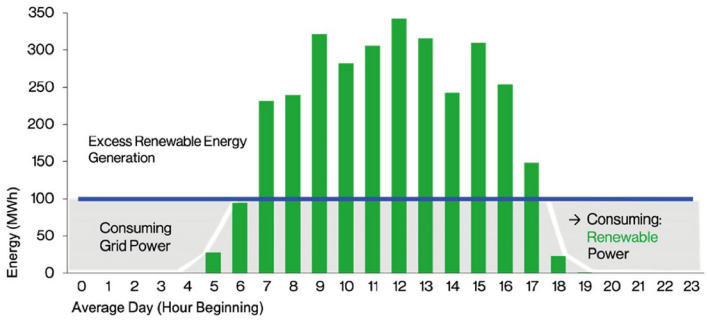


Figure 4. Customer Load versus Renewable Power Generation
Source: 24/7 Carbon Free Energy Whitepaper, The AES Corporation 2021. Updated October 2022

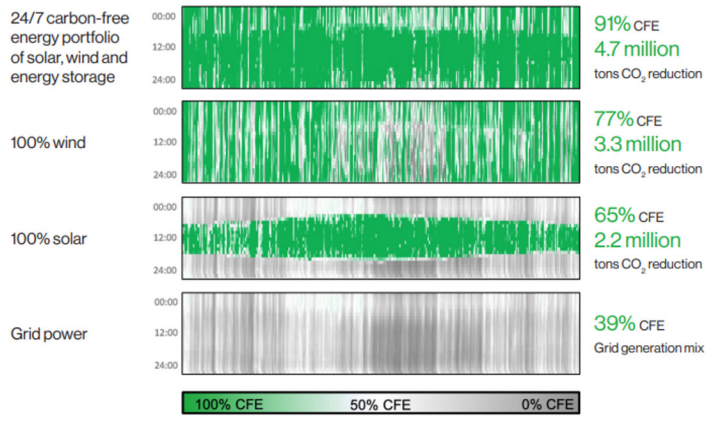
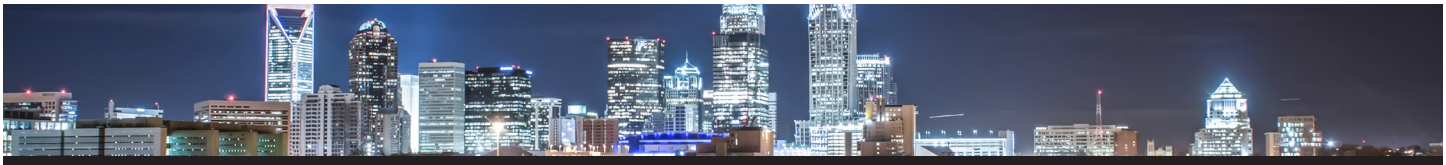


Figure 5. Comparing 24/7 CFE with 100% Renewable Energy Sources
Source: 24/7 Carbon Free Energy Whitepaper, The AES Corporation 2021

41 The X-axis in this figure represents each of the 365 days in a year and the Y-axis represents each of the 24 hours in each day. The green / grey color represents a "heat map" showing (high / low) percentages of CFE delivered for each hour of each day.

42 The x-axis on Figure 5 represents the day of the year and the y-axis represents the hour of the day.



For example, if this customer relied solely on PJM's grid power to meet their hourly 100 MW load they would receive 39% CFE over the course of a year based on the existing PJM grid resources. Developing a portfolio of new 100% wind or solar resources to meet 100% of this customer's annual electricity needs would dramatically increase the amount of CFE used by this customer, but the customer would continue to receive 23% of their power from grid-based carbon-emitting sources for the 100% wind portfolio (100%-77%) and 35% for the 100% solar portfolio (100%-65%). However, when solar, wind and storage resources are combined to provide 24/7 CFE, the load is expected to be met with CFE in 90% of the hours in a year. Additionally, the 100% wind portfolio would reduce 2.2 million tCO_2e as compared the reference grid power mix and the 100% solar portfolio would reduce 3.3 million tCO_2e.

GHG Emissions Accounting for Renewable Energy Procurement

Existing GHG accounting protocols and practices provide a strong incentive to companies working to achieve sustainability goals to procure RE and RECs to reduce the GHG emissions they report associated with the electricity they consume. Currently, there is a growing interest and confusion about how RE procurement, RECs, and other market-based instruments may translate into reduced corporate CO_2 and GHG emissions.

What is a Corporate GHG Inventory?

A GHG inventory is an assessment of the GHG emissions and removals attributed to a company's operations over a year. Several standards and guidelines exist that can provide guidance to electric companies on doing credible GHG accounting, including The Greenhouse Gas Protocol developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WRI/WBCSD) and The Climate Registry General Reporting Protocol.[43, 44] These existing standards typically require entities like electric and natural gas companies to report their GHG emissions disaggregated into "scopes" that include direct and indirect emissions.

Direct emissions — referred to as scope 1 — result from company activities that physically release (or remove) GHGs to (from) the atmosphere, such as burning coal or natural gas to generate power.

Indirect emissions can be either Scope 2 or scope 3, and result from indirect activities that are essential to a company's operations (e.g., fuel extraction and transport to a power generation facility), but which are not directly emitted by the company.

43 See WRI/WBCSD Revised Corporate Standard (2004) and WRI/WBCSD GHG Protocol Scope 2 Guidance (2015).

44 See The Climate Registry (TCR) General Reporting Protocol (GRP) v3 (2019) and TCR Electric Power Sector Protocol (2009).

Scope 2 Emissions Associated with Purchased Electricity[45]

More specifically, Scope 2 emissions refer to indirect emissions associated with electricity, heat, steam or cooling purchased by an entity for its own use. A large component of many electricity customers' total GHG emissions are Scope 2 emissions associated with their electricity consumption.[46] Scope 3 emissions refer to all other indirect emissions outside of Scope 2 that occur in a company's value chain.

Many corporations, including electric and non-electric companies, voluntarily report the Scope 2 emissions associated with the electricity they consume, unless they supply 100% of their electricity from carbon-free energy resources they own and operate and do not purchase any electricity from others.

Scope 2 emissions often are a comparatively large source of GHG emissions for C&I customers; yet, it can be challenging for them to reduce these emissions, in part because they are not under their direct control. Entities that want to reduce their Scope 2 emissions have limited options to do so, including: (i) reducing energy consumption (e.g., by installing energy efficiency upgrades); improving load management so as to operate during hours when the grid is supplied with low-carbon resources; and, (iii) deploy on-site or "behind-the-meter" (BTM) renewable generation. Each of these options has significant limitations for many end-use customers, and each is limited in its ability to reduce GHG emissions.

In the absence of being able to take more powerful direct action to reduce their Scope 2 emissions, many companies with corporate sustainability and decarbonization goals have focused on procuring RE and RECs. More recently, a few leading sustainability-oriented technology companies have begun to procure 24/7 CFE to reduce these reported emissions.

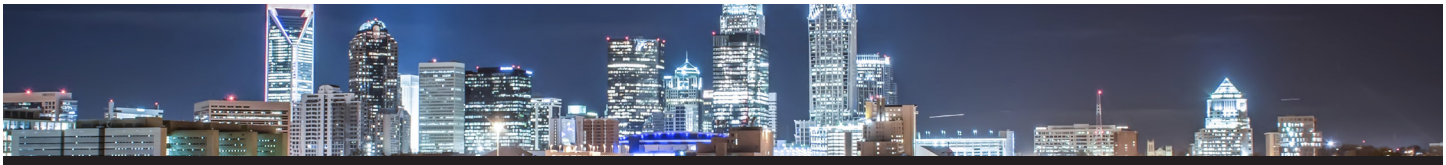
Locational and Market-Based Emissions Factors

Under existing corporate voluntary GHG accounting standards, companies can report their electricity-related Scope 2 emissions using either a "*locational*" and/or a "*market*" approach and associated GHG emissions factors (EFs).[47] Typically, EFs are expressed as the mass of a pollutant per unit of the emission producing activity, such as lbs. of CO_2 emitted per MWh of power generated (lbs CO_2/MWh). To estimate emissions, an EF is multiplied by corresponding

45 *Greenhouse Gas Emissions Accounting for Electric Companies: A Compendium of Technical Briefing Papers and Frequently Asked Questions.* EPRI Palo Alto, CA 2021. 3002022366.

46 Scope 2 emissions for some electric companies, particularly transmission and distribution (i.e., "wires-only") companies, also includes emissions associated with "line losses" from transmitting electricity from generators to load-serving entities (LSEs). Electric companies that generate power and deliver it via transmission lines account for these Scope 2 line-loss emissions as part of their direct scope 1 emissions as they generate power to cover these line losses.

47 GHG Protocol, Scope 2 Guidance, Executive Summary, World Resources Institute , p. 3. https://ghgprotocol.org/sites/default/files/Scope2_ExecSum_Final.pdf. Accessed online.8/9/22.



activity data such as the hours a piece of machinery operated, or the mass of coal combusted, or electricity consumed.

The *location-based* method reflects the average GHG emissions intensity of power generation on a power grid where energy consumption occurs, using mostly grid-average emissions data. This is an EF that reflects the physical flow of electricity in the regional grid. The *market* method reflects the GHG emissions associated with electricity that end-use customers have *procured* using PPAs and other types of financial arrangements.[48] In practice, the inclusion of the market approach in the WRI/WBCSD GHG Protocol has incentivized corporate electricity consumers to reduce their reported Scope 2 emissions by purchasing RE and bundled and unbundled RECs while still physically consuming electricity from a grid that is partially supplied by fossil generation. This disconnect has motivated some consumers to seek out 24/7 supply agreements to better match their hourly consumption with carbon free electricity supply.

Choosing whether to use a location or market-based EF can have a significant impact on a company's reported Scope 2 GHG emissions. As shown in Figure 6, a company operating in Michigan in 2020 that bought 100% RE could report its 2020 Scope 2 emissions using a market-based EF of zero lbs. CO_2/MWh, while the same company using a locational EF would report 1,153.1 lbs. CO_2/MWh, based on the EPA's 2020 eGrid regional CO_2 EF for the RFC Michigan subregion including Minnesota.[49]

Returning to the example in Figure 3, a hypothetical commercial facility that has a "flat" electric load (e.g., a computer data center) of 100 MW may be supplied power via a PPA with a 346 MW capacity solar farm. Over one year, the solar farm will generate 876,000 MWh and an equal number of RECs. This matches the facility's 876,000 MWh of load (100MW x 8,760 hours / year).

While this customer may claim to use 100% RE based on applying a market-based EF of 0 tCO_2e/MWh associated with the solar resources, the customer physically would receive 100% of their electricity from *undifferentiated* power resources that includes fossil-fired generation resources. If we assume this facility is in the RFC Michigan subregion, the company would have calculated much higher Scope 2 emissions of ~458,000 tCO_2e based on using the location-based EF 1,153 lbs. CO_2/MWh,[50] as shown in Figure 6. Obviously, this is a large difference in estimated Scope 2 emissions and illustrates part of the conundrum facing companies that are trying to reduce their Scope 2 GHG emissions.

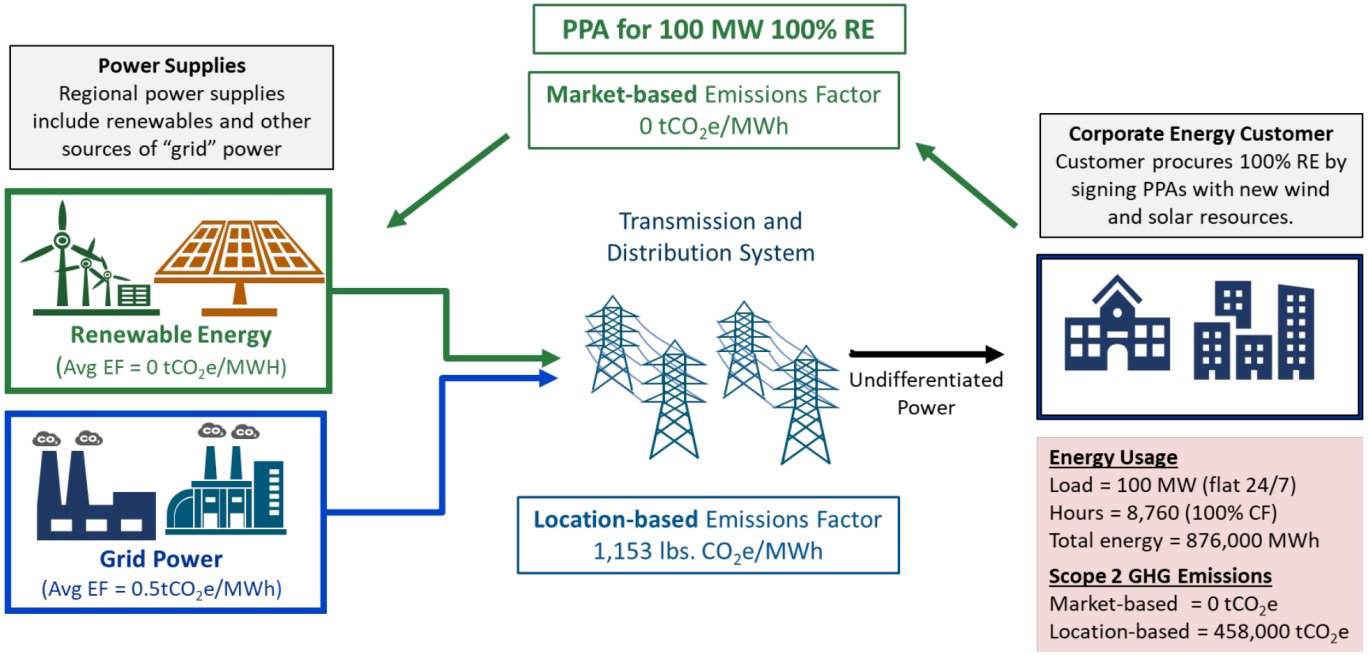
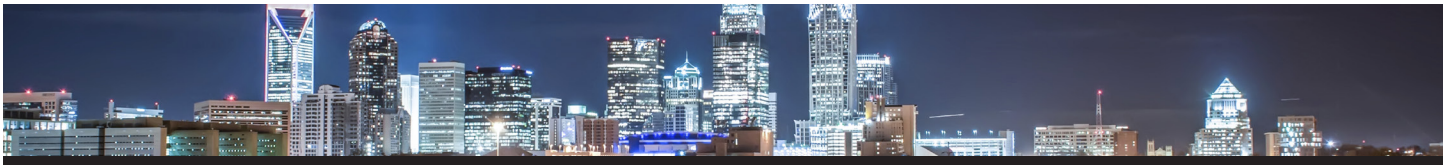


Figure 6. Using Locational and Market-based Emissions Factors
Source: EPRI

48 Ibid., p4.

49 https://www.epa.gov/system/files/documents/2022-01/egrid2020_summary_tables.pdf. Accessed 7/26/22.

50 In theory, the location-based EF used in this example might be adjusted slightly to account for the new RE resources added to the regional grid. However, in practice the addition of 100 MW of new renewable energy resources into a large regional grid is not likely to significantly alter the regional grid's CO_2 EF.



Using Market-Based GHG Emissions Factors is Controversial

The widespread use of market-based EFs for corporate GHG accounting and reporting purposes has caused confusion in recent years about the efficacy of using RE and RECs to reduce reported corporate GHG emissions. This confusion stems from WRI's Corporate GHG Protocol allowing companies to use a market approach as an alternative to the locational approach to report their Scope 2 emissions.[51] By doing this, the GHG Protocol blurred the lines between *attributional* accounting of the physical flows of GHG emissions and *consequential* accounting of the potential GHG emissions impact of interventions like investing in new RE development to reduce GHG emissions.

A fundamental principle of attributional environmental accounting is that emissions should be allocated based on physical processes (e.g., combustion of a fuel) and physical matter or energy transfers (e.g., purchase and use of steel).[52] The use of RE contracts and RECs by retail electricity consumers, in all but special circumstances, do not reflect this principle.[53, 54] RECs and some other RE contractual arrangements often are used as a proxy for the physical transaction of energy between an RE supplier and an end-use consumer. Implicitly or explicitly, RECs and other contractual arrangements often are then used as the basis to claim and use a "zero" EF for the RE included in these arrangements, as allowed by existing GHG accounting protocols.

In recent years, environmental accounting experts have challenged corporate GHG emission reduction claims based on RE and REC procurement and found them to be highly problematic when made on an attributional accounting basis.[55] Further, some experts have demonstrated in the peer-review scientific literature that voluntary REC markets do not influence RE investment or generation, thereby also rejecting consequential accounting claims associated with most kinds of contractual arrangements.[56, 57]

While it is appropriate for electric utilities to use bundled and unbundled RECs to demonstrate RPS compliance, it remains controversial for companies to use the GHG Protocol's market-based approach to track their progress toward achieving corporate Scope 2 emissions reductions.

Emissionality and 24/7 CFE

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_2 emissions. While investing in (or building or buying power from) a new renewables 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 lower than enabling a clean energy project to be built in a regional grid with a higher GHG emissions rate. For example, building a new wind farm in a region already saturated with wind resources may not reduce total electricity related GHG emissions as much as developing a new solar farm where its output may displace coal fired electricity.

"Emissionality" refers to the impact of new renewable or CFE power generation resource to reduce *marginal* GHG emissions in a regional power grid. Appendix B discusses the differences between average and *marginal* EF's and their use in GHG emissions reporting.

Among large technology companies and some clean-energy advocates, there is a difference of opinion about the relative merits of pursuing a 24/7 CFE strategy to reduce reported Scope 2 emissions versus siting new RE resources where these investments may have the largest marginal impact on reducing GHG emissions (i.e., the greatest "emissionality").

For some corporate renewable and CFE buyers, emissionality and location are becoming important criteria for siting new facilities and PPAs, and could blunt future enthusiasm to deploy 24/7 CFE. For example, emissionality reportedly was a driving force behind Boston University's large wind power purchase announcement in September 2018.[58] The university looked beyond the New England region and signed a contract for a project located in South Dakota because BU's 2017 Climate Action Plan included a focus on buying wind and solar energy with a focus on seeking out projects that would reduce GHG emissions as much as possible. BU didn't just want to procure RE or 24/7 CFE, but rather it wanted to develop renewable energy that would have the largest impact on reducing marginal GHG emissions.

51 On March 31, 2022, WRI announced the GHG Protocol is starting a process to determine the need and scope for additional guidance for Scope 1, Scope 2, and Scope 3 emissions. https://ghgprotocol.org/blog/ghg-protocol-assess-need-additional-guidance-building-existing-corporate-standards. Accessed April 21, 2022.

52 If the principle of physical connection is relaxed, then the attribution of emissions to entities in attributional accounting can become arbitrary and meaningless, representing immaterial reallocation of emissions and leading to GHG accounting that does not reflect physical emissions to the atmosphere that result from an entity's activities.

53 The University of Edinburgh Centre for Business, Climate Change and Sustainability compiles a webpage of research on this topic.

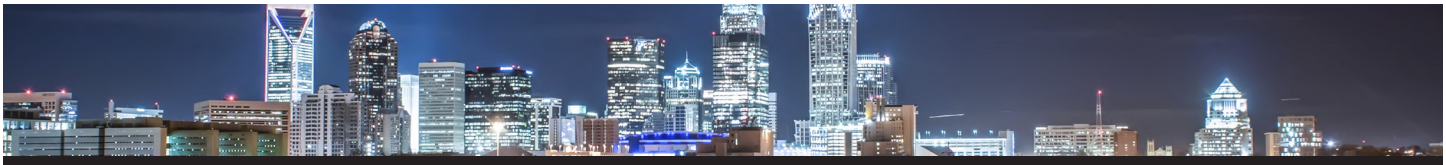
54 Some consumers use RE contractual arrangements to make consequential emission reduction claims, akin to those associated with GHG emission offset credits. Such claims are also problematic due to overlapping policy interventions such as the production tax credit (PTC). For example, if a RE generation facility accessed a PTC incentive and generates RECs, it is not clear whether the REC or PPA, and not the PTC, caused the additional renewable capacity investment.

55 https://scope2openletter.wordpress.com/

56 Gillenwater, Lu, and Fischlein (2014). "Additionality of wind energy investments in the U.S. voluntary green power market." *Renewable Energy*.

57 Gillenwater (2013). "Probabilistic decision model of wind power investment and influence of green power market." *Energy Policy*.

58 https://www.bu.edu/articles/2018/boston-university-announces-wind-power-purchase/



Large energy buyers who purchase RE and RECs to reduce their reported Scope 2 emissions typically focus their GHG emissions reduction efforts on acquiring RE or CFE measured in mega-watt hours (MWhs). For other entities who may be primarily interested in achieving the largest GHG emissions reductions possible based on their incremental investment in new RE, their efforts typically are focused on making investments that reduce tons of GHGs emitted based on an emissionality metric.

The debate between advocates for 24/7 CFE and those who favor emissionality is confusing in part because these two concepts are based on different GHG accounting methods (i.e., attributional versus consequential) that are used for different purposes. Attributional accounting seeks to allocate GHG emissions among the responsible emitters, while consequential accounting attempts to estimate the marginal GHG emissions impact of new investments.

4 24/7 CARBON-FREE ENERGY PRODUCTS

Anatomy of 24/7 Power Supply Agreements

In the past 18 months, a number of 24/7 CFE power supply agreements have been executed in the US and internationally. And, more recently, several IOUs have move forward to offer 24/7 CFE products and tariffs to their customers. This section describes some of these 24/7 CFE energy products and highlights some of the key elements that have been included in recent 24/7 power supply agreements. It explores different approaches C&I customers and others have used to procure 24/7 CFE and provides brief overviews of some of the electric power companies engaged developing and delivering 24/7 CFE products and services today.

Some of the key elements that need to be considered when developing 24/7 power supply agreements are described below and include: qualifying CFE generation sources, new versus existing power resources, percentage CFE, measuring performance of 24/7 CFE contracts, performance risk and tracking data. Figure 7 illustrates some key elements of a 24/7 power supply transaction.

As shown, an electricity customer could partner with a power supplier to develop the terms of a 24/7 CFE agreement (24/7 PPA). The power supplier then would develop and/or designate a set of CFE resources to supply the customer. The agreement sets the deal's terms, including those related to price and payment, resource performance, the performance level of 24/7 CFE (e.g., 90%), and the involvement of other parties.

Following execution of 24/7 power supply agreement, it is important to understand the 24/7 CFE customer still will receive undifferentiated grid electricity through the regional transmission and distribution systems. The service provider providing 24/7 CFE hourly tracking often is responsible for collecting and aggregating

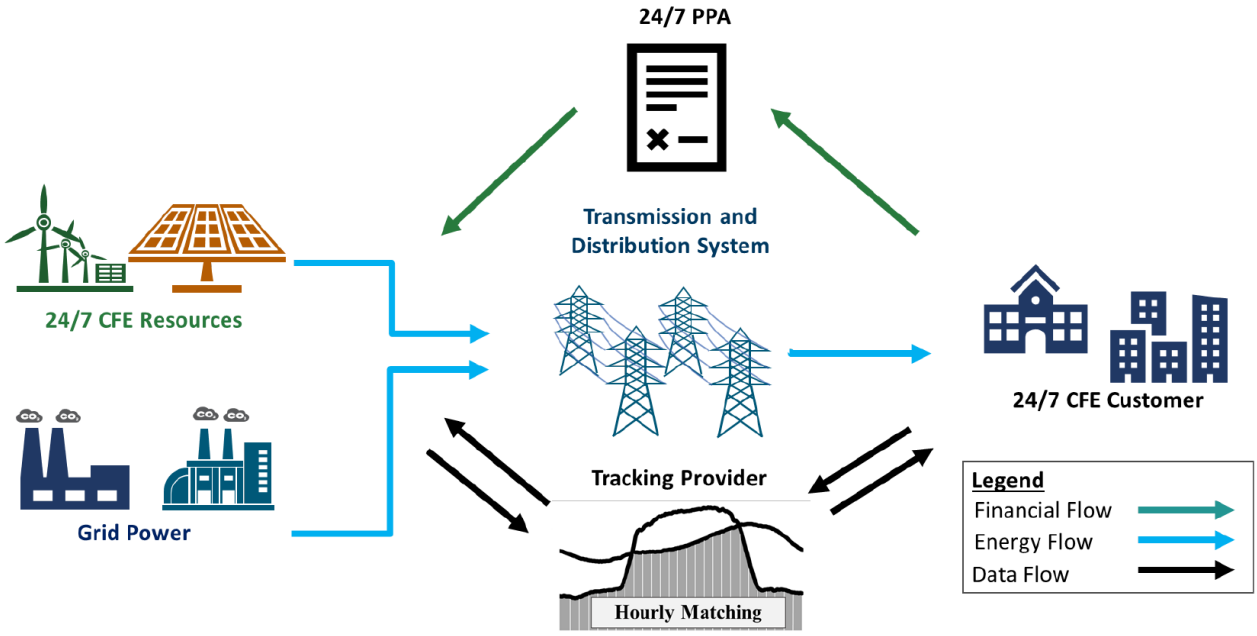
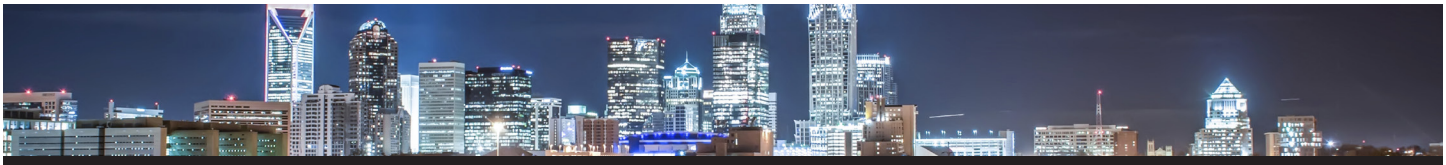


Figure 7. Anatomy of a 24/7 CFE Contract
Source: EPRI



data from the customer, the 24/7 CFE supplier, and the broader grid (e.g., ISO or BA) to verify the level of hourly CFE matching that occurs. Based on discussions with staff of companies involved in recent 24/7 CFE supply agreements, some 24/7 PPA contractual terms differ from how these terms may be addressed in more traditional renewable PPA's for wind and solar power.

Qualifying CFE Generation

Today, there is no standard definition of CFE, so the preferences of corporate buyers typically determine this important contract parameter. For example, some buyers prefer to procure only wind, solar or other RE, while other buyers are interested in other CFE resources, including power generation with CCS, nuclear, hydropower. Interestingly, some buyers will accept energy storage as CFE while others will not because they are concerned storage may increase fossil-fired power generation. Today, the specific generation and storage resources that support 24/7 PPAs typically are a mix of wind, solar, and grid-scale lithium-ion batteries. Some agreements also include hydropower or nuclear resources, depending on the region and the customer and power supplier.

New Versus Existing Power Resources

The electricity supply resources underlying a 24/7 PPA potentially may include *new* and/or *existing* RE and CFE resources. There is an ongoing debate among 24/7 CFE advocates and others about whether 24/7 PPAs should be executed only with new and incremental qualifying generation resources (also referred to as "*additionality*"), or if these agreements may also include existing CFE resources and renewable PPAs.[59]

Corporate power buyers engaged in 100RE and 24/7 CFE are predominately focused on bringing new RE and CFE resources onto the grid and this is highlighted in the UN 24/7 CFE Compact's Principles and Methods for Developing 24/7 CFE. Several high-technology companies we interviewed also reported that their ability to influence the development of new RE resources is a key aspect of their decisions on where to site new data centers and other facilities.

Those who favor including only new resources as eligible to be 24/7 CFE point out that only new resources can achieve the objective of increasing decarbonization of the grid and argue existing renewable resources should not benefit by being counted as 24/7 CFE. Also, some advocates point out that existing resources could have been developed in response to state-mandated RPS requirements and so should not now be considered 24/7 CFE.

Another concern about the use of existing resources is that if energy buyers are allowed to buy existing resources in 24/7 CFE supply agreements made with IOUs, it may be possible for a buyer to take credit for the clean energy and/or GHG reductions associated with CFE resources that already were providing clean electricity to the grid and which were paid for (at least partially) by the utilities' exiting customers.

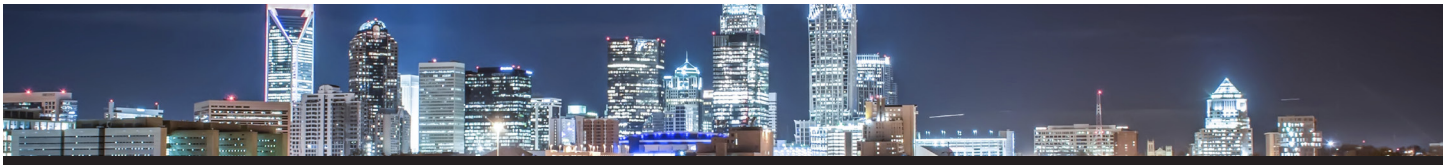
Furthermore, if existing clean energy resources are claimed by a new 24/7 CFE customer, the renewable or carbon-free attributes associated with the existing resources included in the 24/7 PPA no longer would be available to provide RE or clean energy benefits to the other customers on the same power grid. This could result in the shuffling around of environmental claims related to existing CFE resources and make the "residual" power system more GHG intensive for non-24/7 CFE customers. Otherwise, these environmental attributes may be double counted inadvertently by both the 24/7 CFE customer and others who consume power on the same grid.

Finally, if existing RE resources can be redeployed to specific customers under new 24/7 power supply agreements, operating the power system at times may require increased ramping and generation of fossil-based resources to meet the electricity load of the remaining consumers on the same power grid.

Others counter that existing renewable resources should be counted towards achieving 24/7 CFE goals because these resources are carbon-free and help to meet buyer's end-use electricity demand. These advocates also point out that it may be very difficult or impossible to scale up development of 24/7 CFE resources to meet a significant portion of total power demand if existing resources are excluded. Supporters of incorporating existing resources also point out that buyers should not be "penalized" for making early investments in RE that continues to generate carbon-free energy. A recent survey of leading large energy buyers reportedly found that these customers strongly prefer a CFE solution that uses all existing CFE grid resources that could match a higher percentage of hours over a solution using only new grid resources that matched a much lower percentage of hours.[60]

59 Op. Cit., IEA 2022, p33.

60 The Edison Foundation Institute for Electric Innovation, *Issue Brief — Designing 100 percent Carbon-free Energy Solutions: Preferences, Challenges and Pathways Forward*, December 2022, p. 8.



Percentage CFE Target

Another key contract element of 24/7 PPAs is the specified percentage of the 8,760 hours total in each year that must meet a specified percentage of CFE. There are several different ways this CFE threshold may be defined. For example, some buyers may want to achieve a specified average percentage level of hourly CFE annually, such as 80%. Others may prefer to incorporate a minimum floor on the percentage CFE that can be delivered in any single hour of the year.

Although companies are making commitments to purchase 24/7 CFE 100% of the time in the future, today's 24/7 PPAs typically do not guarantee delivery of 24/7 CFE on a 100% hourly basis. Today, CFE buyers and suppliers seem to agree it is not possible or cost-effective yet to deliver 24/7 CFE on a 100% basis and so have settled for using a minimum threshold (often 80% or higher) for the number of hours that must be 100% CFE.

For example, Google's 24/7 PPAs with ENGIE and AES include commitments to supply their data centers with 80-90% carbon free energy on an hourly basis.[61, 62] While some large electricity consumers have goals to achieve 100% CFE on a 24/7 basis, no contracts today have yet achieved that level. We understand that combinations of commercial wind, solar, and short duration storage can provide very high levels of CFE, but not on a 24/7 basis. Achieving the last 10–20% of hourly CFE may require a form of carbon-free dispatchable generation or long-duration storage that is not yet widely available.[63]

Measuring and Ensuring Performance of 24/7 CFE Contracts

Understanding how the CFE "performance" will be measured by both the buyer and seller and how performance will be monitored are key elements of any 24/7 CFE supply agreements. There is no single, widely agreed-upon methodology or metrics used today to measure the degree to which an end-use customer's load is matched hourly to CFE supplies.

One methodology, developed by Google,[64] uses two primary metrics to measure progress towards achieving 24/7 CFE. The first is the CFE Score which measures the degree to which Google's load in a given regional grid is matched with CFE on an hourly basis. This metric includes counting both the CFE under contract by Google and the CFE included in the regional power mix.[65] To calculate its ***Annual CFE Score*** (%), Google calculates a load-weighted average of all individual CFE Scores during the year.

The second metric, ***Avoided Emissions*** (tCO_2e), is designed to measure the impact of Google's procurement decisions on carbon emissions in the regional grid (i.e., emissionality). This metric is used to help prioritize its procurement activities across both geography and time.

Performance Risk

Another important aspect of 24/7 agreements is how they address performance risk. Existing 24/7 CFE agreements reportedly largely place much or all of the performance risk on the power supplier. If the supplier is not able to deliver the CFE resources required in the agreement or does not meet the agreed-upon CFE performance goals, they are financially liable for purchasing alternative qualifying resources in the wholesale power market. In addition, contracts may include performance guarantees that may penalize suppliers financially if they are not able to meet the CFE performance targets or thresholds in a 24/7 PPA.

Tracking Data

Another key aspect of 24/7 CFE power supply agreements relates to how hourly CFE power generation and customer hourly load data are to be tracked and matched. There are various ways these types of data have been incorporated into existing 24/7 PPAs, but today there is no standard way to track, report and verify matching hourly CFE generation to customer load.

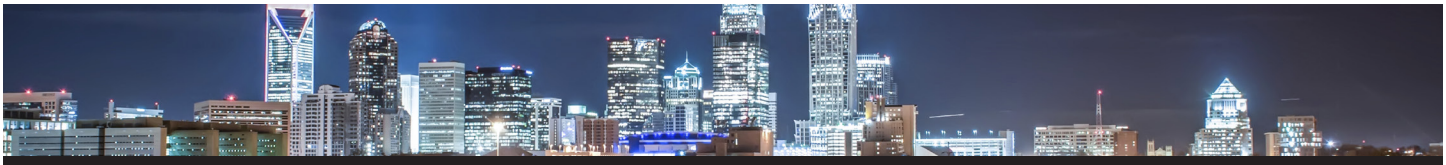
61 *NGIE and Google Sign 24/7 Carbon-Free Energy Supply Agreement in Germany and Strengthen Existing Collaboration*, Engie.com. https://www.engie.com/en/journalists/press-releases/engie-and-google-sign-24-7-carbon-free-energy-supply-agreement-in-germany-and-strengthen-existing-collaboration (4/14/2022).

62 *AES Announces First-of-Its-Kind Agreement to Supply 24/7 Carbon-Free Energy for Google Data Centers in Virginia*, May 04, 2021. https://aescorp2020cr.q4web.com/press-releases/news-details/2021/AES-Announces-First-of-Its-Kind-Agreement-to-Supply-247-Carbon-Free-Energy-for-Google-Data-Centers-in-Virginia/default.aspx (accessed 4/18/2022).

63 While we are not aware of a 100% CFE contract, it is conceivable that certain idiosyncratic grids could enable such an agreement today. For example, most of the dispatchable electricity in Iceland comes from hydro and geothermal sources.

64 *24/7 Carbon-Free Energy: Methodologies and Metrics*, Google, February 2021.

65 Importantly, Google caps its CFE Score at 100 so in any hours when Google's CFE generation exceeds its load, the CFE consumed by the company and its CFE Score are capped at 100.



Several key types of data are needed to develop and execute 24/7 CFE supply agreements,[66] including:

- Customers' current and projected hourly electricity consumption and load
- Current and projected hourly CFE generated in the electric company's resource mix and the associated GHG emissions profile of the delivered electricity
- Data on the hourly generation mix and GHG emissions profile of a specific 24/7 CFE product delivered to customers to meet their demand

Today there are a number of startup firms and non-profit organizations that are developing solutions to gathering and using customer and power supplier data to support 24/7 CFE contracts. For example, ClearTrace is a third-party vendor collaborating with JPMorgan Chase (JPM) in the UK to monitor JPM's energy usage using a patented blockchain-based energy-tracking technology. This technology is designed to match JPM's electricity consumption digitally, in real-time, to renewable generation as part of the 24/7 PPA JPM recently executed with Electricite' de France UK (EDF-UK). Other firms, including FlexiDAO and Granular Energy have developed software platform for their electric utilities and large customers to manage 24/7 power supplies and match them to related end-use customer loads.[67]

M-RETS, one of the most active REC registries engaged in 24/7 CFE, has developed a database approach to hourly REC tracking which it recently tested with Google. And earlier this year, M-RETS launched an hourly tracking system to provide hourly tracking of renewable power generation.

While information about RECs and hourly REC tracking can be obtained and used in the US, and similar information is available in the EU and elsewhere, it can be very difficult for electricity consumers to obtain information about their actual hourly power demand from their electricity supplier or local utility. In the absence of this information being available, some large corporate power buyers have installed their own power consumption meters at their facilities to monitor their real-time energy usage.

66 Op. Cit., Institute for Electric Innovation, 2022, p. 10.

67 Granular - Building a 24/7 clean energy market (granular-energy.com).

Corporate Procurement of 24/7 CFE

Today there are two evolving models for how companies are procuring 24/7 CFE in the market: "Turn-key" procurement and the "do-it-yourself" approach. Both of these are discussed briefly below.

"Turn-key" Acquisition of 24/7 CFE

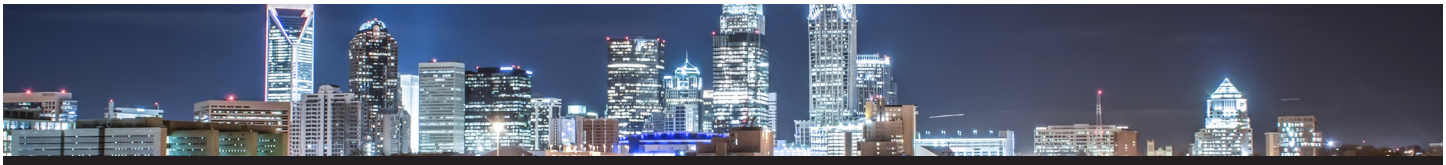
Some 24/7 CFE buyers want to procure 24/7 CFE seek to do so from a power company that can provide both the 24/7 CFE resources and related back-end tracking and environmental reporting and attestations in a one-stop "turn-key" solution. These buyers are potential customers for power providers who may be interested in developing and offering customers 24/7 CFE power supplies and related services. To meet the needs of these customers, 24/7 CFE power suppliers to date have developed power supply portfolios that include wind, solar and battery storage technologies.

Do-it-Yourself 24/7 CFE Procurement

Other companies, however, plan to manage their own portfolio of electric supply agreements to achieve high-levels of CFE matched to their load. Companies who want to pursue this approach will need to develop a portfolio of renewable PPAs and other supply agreements for CFE resources. This DIY approach is illustrated by the journey Iron Mountain has taken from procuring 100% RE toward procuring 100% CFE. Today, Iron Mountain actively manages a legacy portfolio of renewable PPAs and RECs and additional electricity resources it has acquired under contract both to meet the energy demands of its data centers and to achieve higher CFE levels than would be possible focusing solely on procuring 100% RE.

Power Companies Supplying 24/7 CFE

In response to nascent customer demand for 24/7 CFE, several power companies have launched new power products to meet this need. To date, most of the 24/7 PPAs that have been publicly disclosed have involved power supplies being procured and delivered by independent power providers (IPPs). Recently, however, two IOUs have received approval from state regulators to offer 24/7 CFE on a limited basis and two other IOUs have announced their plans to offer 24/7 CFE products in the future. These activities are described further below.



Independent Power Providers (IPPs)

AES Corporation

In April 2021, AES and Google partnered to launch a 24/7 CFE solution designed to ensure Google's Virginia data centers will be 90% powered by CFE on an hourly basis. AES reached a 10-year agreement to supply energy to three Google data centers from a mix of RE and energy storage projects, with the goal of making the data centers 90% carbon-free on an hourly basis. AES intends to source the energy supply from a $600 million, 500-MW portfolio of wind, solar, hydro, and battery storage that includes both its own projects and RE generation developed by third-party developers. New RE projects in Virginia reportedly will be part of the portfolio.[68, 69]

Constellation[70]

In March 2022, Microsoft and Constellation announced they are collaborating to develop a 24/7/365 energy software product, and Microsoft will become one of its first customers to match and report emissions data on an hourly basis. Microsoft agreed to purchase a portion of its clean energy supply from Constellation, and in turn, Constellation has agreed to use Microsoft's Azure cloud platform to develop clean energy solutions with better analytics.

Engie[71]

In September 2019, Microsoft and Engie announced long-term solar and wind PPAs that are designed to provide 24/7 CFE supply to Microsoft's operations in the United States. Microsoft agreed to purchase 230 MW from two projects in TX operated by Engie, expected to be online in Jan 2021. The PPAs include a volume firming agreement (VFA) that will provide a 24/7 power solution aligned with Microsoft's energy needs. The deal also involves implementation of Darwin on the Azure cloud. Darwin is software to optimize performance of Engie's wind, solar, and hybrid renewable assets worldwide.

In August 2021, Engie and Google signed a 3-year supply agreement in Germany.[72, 73] Under this agreement, Engie will assemble and negotiate an energy portfolio with renewable power to ensure its German operations are 80% carbon free by 2022 on a 24/7 basis. th The energy portfolio reportedly includes 140 MW of renewable electricity plus ENGIE providing "comprehensive" energy management services, including sourcing of residual supply, balancing pool management, grid management, and more.

Investor-owned Utilities

Duke Energy[74]

In October 2022, Duke Energy announced it had proposed to the South Carolina Public Service Commission the creation of new customer renewable programs and an expansion of an existing one to allow large C&I customers the option to supplement their power usage with 100% renewable power.

Duke's proposed Renewable Choice program would allow large-load customers to contract with either of Duke Energy's South Carolina utilities to provide locally sourced environmental attributes, including renewable energy certificates (REC), generated from both utility-owned generation assets as well as third-party owned generation assets and could include energy-storage options. If approved, South Carolina would have one of the first tariffed programs for time-aligned clean energy in the country.

Changes are also being requested for an existing program – Green Source Advantage – an option that allows large customers to offset their power purchases by securing renewable energy from projects connected to the Duke Energy grid. The customer may count the renewable energy generated to satisfy sustainability or carbon-free goals. Proposed changes include the ability for customers to contract for up to 100% of their energy use compared to the current approximately 30%, as well as expanding the number of available solar resources. As with Renewable Choice, customers can also combine energy storage with their project – allowing them to align the production of renewable energy with their energy load.

68 *AES Announces First-of-Its-Kind Agreement to Supply 24/7 Carbon-Free Energy for Google Data Centers in Virginia*, May 04, 2021. https://aescorp2020cr.q4web.com/press-releases/news-details/2021/AES-Announces-First-of-Its-Kind-Agreement-to-Supply-247-Carbon-Free-Energy-for-Google-Data-Centers-in-Virginia/default.aspx (accessed 4/18/2022).

69 *Google to power Virginia data centers with 24/7 clean energy from AES*, Utility Dive. https://www.utilitydive.com/news/google-to-power-virginia-data-centers-with-247-clean-energy-from-aes/599506/ (accessed 4/14/2022.)

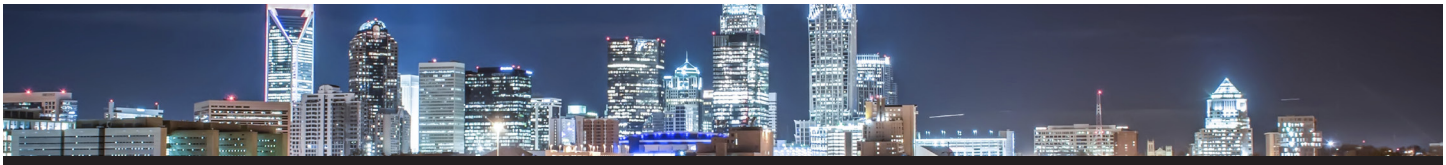
70 *Constellation Launches Sustainability Partnership with Microsoft featuring 24/7/365 Real-Time Carbon-Free Energy Matching Solution*, Mar. 07, 2022. https://www.constellationenergy.com/newsroom/2022/constellation-launches-sustainability-partnership-with-microsoft-featuring-24-7-365-real-time-carbon-free-energy-matching-solution.html (accessed 4/14/2022).

71 *Microsoft and ENGIE announce innovative renewable initiatives*, Stories, Sep. 24, 2019. https://news.microsoft.com/2019/09/24/microsoft-and-engie-announce-innovative-renewable-initiatives/ (accessed 4/15/2022).

72 *ENGIE and Google Sign 24/7 Carbon-Free Energy Supply Agreement in Germany and Strengthen Existing Collaboration | ENGIE*, Engie.com. https://www.engie.com/en/journalists/press-releases/engie-and-google-sign-24-7-carbon-free-energy-supply-agreement-in-germany-and-strengthen-existing-collaboration (accessed Apr. 14, 2022).

73 H. Devarasetti, *Google signs agreement with Engie for renewable power*, Power Technology, Sep. 01, 2021. https://www.power-technology.com/news/google-engie-renewable/ (accessed Apr. 18, 2022).

74 https://news.duke-energy.com/releases/duke-energy-proposes-new-programs-to-help-grow-south-carolina-economy-by-helping-customers-use-100-renewable-energy. Accessed 10/11/22.



To meet the load created by these programs, Duke is planning to use new solar generation resources currently going through the companies' competitive procurement processes. If approved, current customers and customers in the process of locating their business to South Carolina can sign up for these programs in advance.

Entergy

On November 15, 2022, at the 2022 United Nations Climate Change Conference, the Biden Administration announced the U.S. federal government's first Memorandum of Understanding (MOU) with a utility to work toward achieving the CFE procurement goals in E.O. 14057.[75] The MOU between the U.S. General Services Administration (GSA) and Entergy Arkansas, LLC will help federal agencies in Arkansas to source 100% of the federal government's electricity from CFE sources by 2030, including 50 percent 24/7 CFE.

Under the MOU, Entergy Arkansas, one of the top 10 suppliers of electricity to the federal government, will allow its public and private sector customers to utilize regionally-sourced nuclear and renewables, including solar, hydro, or wind. This new program is interesting in part because it allows for blending existing and new CFE resources to meet the federal government's procurement goals. Once fully developed and approved, Entergy anticipates customers in both the public and private sector will have a cost-competitive and reliable option for CFE that matches their electricity consumption for all hours of the day. Reportedly, Entergy will rely upon existing nuclear power generation along with new carbon-free renewable resources to supply its 24/7 CFE .

Georgia Power Company[76]

Earlier this year, Georgia Power received state regulatory approval of its proposed 2022 Integrated Resources Plan (IRP) which included approval to launch a new 24/7 CFE subscription service for large retail power customers called "Carbon Free Energy Around the Clock (CFE/ATC) as part of the company's Clean and Renewable Energy Subscription (CARES) program.

Although the CFE/ATC program was approved in July 2022, Georgia Power expects it will take about five years to fully develop the program, and the company plans to begin offering this subscription service in 2028 to eligible large C&I customers, including municipalities, universities, schools and healthcare customers. To support CFE/ATC, Georgia Power plans to procure 650 MW of new solar generation capacity using PPAs. See the accompanying text box for more information about the CFE/ATC program.

Nevada Power Company

In December 2020, the Public Utilities Commission of Nevada (PUCN) approved an energy supply agreement between NV Energy and Google to power a new $600 million Google data center located in Henderson, NV with renewable energy. Nevada Power Company (a subsidiary of NV Energy) 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 Large Customer Market Price Energy Tariff.

Initially, Google approached NV Power to purchase RE to offset the data center's annual CO_2 emissions and to closely align the RE generation with the data center's hourly consumption. This led to an initial filing with the PUCN in 2019 and Commission approval in late 2020.[77] The agreement includes a capacity-sharing mechanism to share the cost of battery storage facilities between NV Energy and Google. Reportedly, NV Power will retain the ability to dispatch the battery during summer peak periods (i.e., evening hours in June, July, and August between 4 p.m. and 9 p.m.) for the benefit of all of NV Power's customers.[78] For the rest of the year, the solar and storage supply will be dispatched to track the data center's load to support Google's 24/7 CFE objective.

Reportedly, 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.[79] NV Power also has stated the agreement includes an option to extend supply after an initial "long-term period." The RE facilities are expected to achieve commercial operation in late 2023.

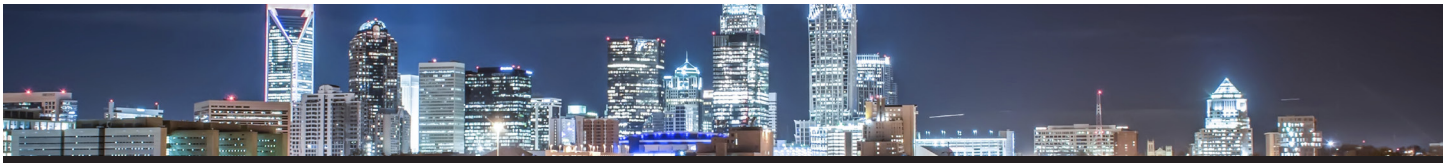
75 Federal government, Entergy Arkansas partner for 24/7 carbon-free energy deal, S&P Capital IQ, November 15, 2022. Accessed 12/1/22.

76 *World Resources Institute Webinar 24/7 CFE Customer Opportunities*, presentation by Georgia Power Company, 07/28/2022.

77 PUCN docket 19-12017.

78 PUCN Approves NV Energy, Google Solar-Plus-Storage Agreement, California Energy Markets, December 24, 2020. Accessed 8/30/2022.

79 Google and NV Energy Invent a New Genre: The Corporate Solar-Plus-Storage Deal, Greentech Media, January 23, 2020. Accessed 8/30/22.



Georgia Power's CFE Around the Clock Program

Starting in 2028, Georgia Power plans to offer eligible customers the option to subscribe to "carbon-free energy around the clock" (CFE/ATC). Currently, Georgia Power plans to offer a total of 100 MW of CFE/ATC capacity for subscription by C&I customers. The generation to supply this new capacity is expected to come from 650 MW of new renewable resources (primarily solar) and battery energy storage systems. The CFE/ATC S program plans to provide subscribers with carbon-free renewable power 75% - 90% of all hours in the year on either a "fixed" or "optimal" dispatch schedule.1

The CFE/ATC program will be available to existing or new C&I customers with a minimum annual peak demand of 25 MW. The CFE/ATC subscription is limited to 100% of the customer's preceding year's or projected total annual energy consumption. Also, the subscription cannot include load already participating in any other Georgia Power renewable subscription program. Once established, the customer's subscription level will be fixed for the term of the agreement.

The CFE/ATC program includes a Fixed Program Portfolio Charge per kWh which includes PPA supply cost, administrative fee and a potential capacity charge. The subscription includes a minimum contract term length and incorporates levelized pricing over the entire term of a customer's agreement. In addition, the program includes an hourly credit per kW that includes hourly operating cost of incremental generation and potential capacity credit. All RECs associated with the CFE/ATC program will be retired on behalf of programs subscribers using an attestation approach.

Although GPC obtained regulatory approval in 2022 to launch the CFE/ATC program, GPC anticipates the program will start accepting subscribers in Q1, 2028. This five-year development period includes key milestones, such as filing tariffs and program documents with regulators, opening a Notice of Intent (NOI) to assess potential customers interest, and executing a request for proposals process to acquire new renewable resources to support the program.

Source: *World Resources Institute Webinar 24/7 CFE Customer Opportunities*, presentation by Georgia Power Company, July 28, 2022.

Notes: 1. Under the fixed program option, a customer would receive dispatch of CFE/ATC on a fixed schedule, and the associated BESS would operate until it becomes expended and is recharged. Under the optimal dispatch approach, a customer would receive dispatch of CFE/ATC on a schedule that is optimized for the overall power system, and the associated BESS would be operated to optimize its dispatch to benefit the entire power system.

Vattenfall [80, 81]

In November 2020, Swedish utility Vattenfall AB agreed to match demand at Microsoft's three data centers in Sweden with around-the-clock renewable energy. The two parties reportedly have piloted "24/7 matching solution" software in 2019 and are now intensifying their partnership. The 24/7 matching solution will be used in Microsoft's new datacenters located in Sweden to measure renewable energy consumption per hour. Vattenfall has agreed to deliver Environmental Product Declaration (EPD) labelled hydro and wind power 24/7 to the three datacenters in 2021.

80 *Vattenfall to deliver renewable energy 24/7 to Microsoft's Swedish datacenters*, 11/24/2022. https://group.vattenfall.com/press-and-media/pressreleases/2020/vattenfall-to-deliver-renewable-energy-247-to-microsofts-swedish-datacenters (accessed 4/18/2022).

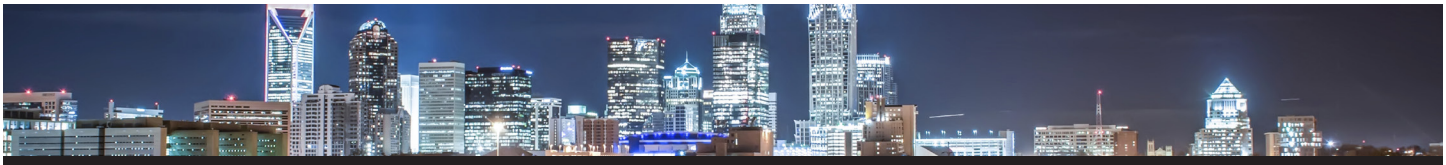
81 Achieving 100 percent renewable energy with 24/7 monitoring in Microsoft Sweden, Nov. 24, 2020. https://azure.microsoft.com/en-us/blog/achieving-100-percent-renewable-energy-with-247-monitoring-in-microsoft-sweden/ (accessed 4/18/2022).

5 CHALLENGES TO DEPLOYING 24/7 CFE

While there is growing interest and excitement around 24/7 CFE, widespread deployment of 24/7 CFE faces some significant challenge described below.

Available CFE Technologies

Executive Order 14057 defines the terms "CFE" and "24/7 CFE" for the purpose of future power procurement by federal government agencies as discussed in section one and provides an indication of the types of technologies that are likely to fit into this evolving construct. However, other parties engaged in buying and supplying 24/7 CFE may have different perspectives about what specific power supply resources may qualify to generate CFE.



Among potential CFE generation technologies, only solar, wind, hydropower and nuclear are commercially deployed today at a large scale globally. In addition, one or more of these existing CFE technologies are neither readily available, nor can they be developed, in every region of the US or internationally due to constraints on resource availability and/or local regulations. Even in regions where sufficient capacity of these resources is available or can be developed, the generation profiles of these resources may not match the load profiles of potential 24/7 CFE power buyers.

Finally, the specific types of power generation resources that may "qualify" to generate 24/7 CFE and the potential scale of future CFE deployment depends in part on the resolution of the ongoing debate regarding whether new, incremental and/or existing resources may qualify.

Regulatory Considerations

Regulated investor-owned electric utilities (IOUs) and independent power providers (IPPs) face different opportunities and challenges related to 24/7 CFE based on important differences in the regulatory environments in which they operate. Most of the existing 24/7 power supply agreements that have been publicly disclosed to date involve IPPs supplying 24/7 CFE to corporate power buyers operating in deregulated power markets. IPPs predominately operate in deregulated, competitive power markets and have operational flexibility to build new power generation projects and develop customized bilateral power supply agreements with corporate customers. IPPs also are focused on maximizing their financial profits which may drive them to develop innovative and potentially risky power supply agreements.

In contrast, regulated IOUs predominately are focused on providing customers with least-cost electric service in a manner prescribed by their state public utility commission (PUC). Regulated IOUs must obtain state PUC approval to build new power plants and are bound by PUC rules and the retail "obligation to serve," and so have less flexibility than IPPs to build new generation facilities and develop customized power supply agreements with corporate customers. The regulatory approval process involves balancing interests from a larger set of stakeholders and typically takes significantly longer than developing a PPA in a deregulated wholesale market. A regulated utility seeking to acquire new generation, such as the resources to provide 24/7 CFE, typically needs to obtain PUC approval for its IRP and subsequently obtain a Certificate of Need to construct new facilities.[82] These proceedings can last multiple years, involve a wide range of stakeholders, and entail extensive litigation expense.

For example, Georgia Power, a regulated electric utility, recently received approval from state regulators to launch a new 24/7 CFE power supply subscription product to serve eligible retail C&I customers. Although this new program was approved as part of Georgia Power's 2022 IRP, the company anticipates the program will not begin to accept subscribers until Q1, 2028.

The time, expense, and risk involved in regulatory proceedings present challenges for customers seeking to differentiate their energy supply. Thus, large C&I consumers that want to procure clean energy tend to prefer executing PPAs with IPPs in deregulated regions and areas with competitive markets.[83]

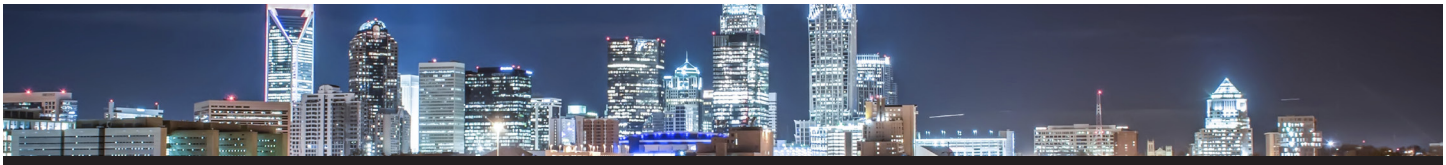
Notwithstanding these challenges, regulated utilities with the backing of state authority have the scale and ability to move entire markets and grids towards clean energy. Many large IOUs with commitments to decarbonize also are the BA that physically schedules real time supply and demand of electricity in their service territories.[84] This scale of coordination can be more difficult to achieve in deregulated markets where states have limited authority to conduct centralized electric resource planning and market operators in deregulated regions do not have authority over electric supply investments.

State officials also may look favorably on opportunities like 24/7 CFE that promote clean energy combined with new economic development. This appears to have been one of the drivers for the PUCN to approve the recent Nevada Energy power supply agreement with Google. Competition is fierce among utilities to attract new data centers, manufacturing, and warehousing facilities. For example, many utilities, with support from their state government, offer discounted economic development rates to large C&I customers that relocate or expand operations in their service territory. These discounts can be combined with voluntary clean energy programs to attract particular companies. Finally, a regulated 24/7 CFE program could streamline participation for all qualifying entities, lowering access barriers for less sophisticated consumers.

82 The specific names and scope of these proceedings vary by state, while generally accomplishing a similar purpose.

83 For example, Google writes "as a major electricity buyer across dozens of regions worldwide, our experience has taught us that regional and competitive wholesale electricity markets are key vehicles to accelerate clean energy adoption and lower costs for electricity consumers." A policy roadmap for 24/7 carbon free energy (2022) https://cloud.google.com/blog/topics/sustainability/a-policy-roadmap-for-achieving-247-carbon-free-energy.

84 For example: Xcel Energy 80% CO_2 reduction by 2030; PacifiCorp 60% CO_2 reduction by 2030. Source: https://sepapower.org/utility-transformation-challenge/utility-carbon-reduction-tracker/, accessed 04/26/2022.



Transmission and Distribution Infrastructure Limitations

The development of new 24/7 CFE resources may require development of new transmissions lines to deliver new, incremental power generation to regional loads, including the corporate power buyer(s) that owns any associated PPAs. The design, approval and development of new transmission infrastructure are very complex and can take many years to complete. Rapid development of new 24/7 CFE resources may be easier in regions with available transmission capacity located near to where new power supply resources may be located or where new transmission infrastructure already is planned for development.

Mismatch Between Physical Delivery of Electricity and Contracted Power Supplies

Future deployment of 24/7 CFE could be hampered by the ongoing controversy regarding how to account for efforts by companies to reduce their reported Scope 2 GHG emissions by purchasing RE, RECs or 24/7 CFE. Because it is not possible to differentiate in a physical sense the electricity resources used to meet a customer's load in real-time, 24/7 CFE agreements may face ongoing criticism from some stakeholder since these arrangements do not fundamentally mitigate the problem of attributing zero GHG emissions to "market" acquisitions of CFE resources.

GHG Emissions Accounting

As described in section three, there is an ongoing debate about how to incorporate RE and REC procurement into corporate scope 2 GHG emissions accounting.[85] In addition to this debate, existing voluntary corporate GHG emissions reporting protocols do not include methods for companies to determine and report how procurement of 24/7 CFE or T-EACs may reduce their reported Scope 2 GHG emissions. Both of these issues are likely to be addressed as part of WRI's review of its Corporate GHG Protocol which recently began and is expected to be completed in 2023.

Inaccurate and Potential Double Counting of GHG Reductions

Similarly, if a corporate CFE buyer arranges to take delivery of 24/7 CFE resources that are operating today in a regulated electric utility's service territory, this could lead to incorrect accounting for the GHG emission reductions associated with this CFE generation. For example, this could occur if the CFE buyer reports their Scope 2 emissions as zero (based on a market EF of 0 lbs./MWh EF) while at the same time the CFE generated by the facility(ies) underlying the 24/7 CFE contract are being dispatched into the regional grid reducing the average location-based EF used by other energy consumers as the basis to report their Scope 2 emissions. Another way double counting may occur is if both a buyer of unbundled RECs and A buyer of the remaining "null power" both claim the same GHG emission reductions.[86]

Methods and Infrastructure to Track CFE Resources Are Evolving

While there are existing REC credit registries that track and retire RECs (e.g., M-RETS), we are not aware of other corresponding registries that track generation from other types of carbon-free resources, such as CCS, nuclear power, hydropower, and others in a comprehensive way. Although the definition of qualifying "renewable" resources varies in each state, REC registries have evolved to track RECs and facilitate REC trading and ensure against double counting or double-use of RECs. Similarly, in states that have adopted a CES, existing tracking systems track CES power generation and retirement of CES credits by regulated electric companies.

Today, however, there is no analog to these types of registries that can track and report hourly CFE generation in a transparent, verifiable manner that ensures against double-counting and claiming, and which can provide the infrastructure needed to verify that 24/7 CFE generation matches hourly customer load. Currently, several nonprofit organizations, including M-RETS in the US and EnergyTAG in the EU, as well as private organizations are working on creating infrastructure to issue and track and certify hourly RECs and hourly CFE generation in both the U.S. and internationally.

Data Acquisition and Management

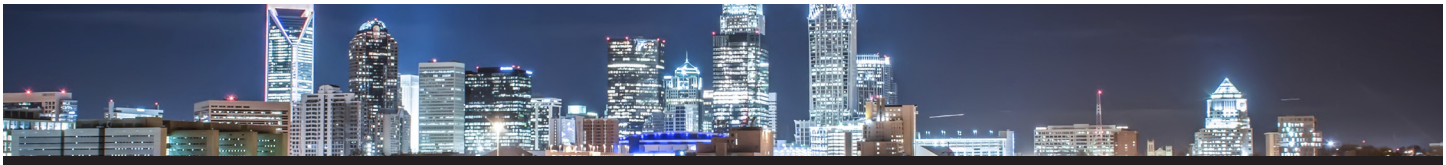
Real-Time Grid Data

Real time grid data is foundational for an electricity consumer to understand its 24/7 carbon profile. A variety of technology companies and startups exist today that scrape data from original sources and provide it in an actionable format to consumers.[87] This grid data ultimately originates from the BAs and RTOs that dispatch electricity supply in real time. In the US, RTOs/ISOs are sophisticated BAs which cover roughly two-thirds of U.S. electricity supply. The RTOs/ISOs publish real-time generation data by fuel category on

85 For more information, see *Modernizing How Electricity Buyers Account and are Recognized for Decarbonization Impact and Climate Leadership*, Clean Air Task Force, August 2022.

86 Op. Cit.., IEA 2022, p. 36

87 See Appendix C for several examples of these service providers.



their public websites.[88] While this RTOs/ISOs is quite robust, one potential drawback is the large geographic size of their territories. For example, the multi-state RTOs each span all or parts of 13–15 states. An electricity user in Minnesota may not want to utilize MISO's grid mix data that includes generation sources as far away as Louisiana, due to both the geographic distance and limited direct transmission connections.

In the remaining areas of the U.S. not covered by an RTO/ISO, balancing authority responsibility typically is shared with vertically integrated utilities who also own electric supply. Our understanding is most of these companies do not routinely provide the public with access to hourly or sub-hourly real-time power generation and other grid-related data.[89]

While the aggregated hourly generation by fuel type data provided by the RTO/ISOs is a useful starting place, robust tracking and verification of 24/7 CFE will involve tracking unit-level generation data. Grid operators often classify unit-level data as commercially sensitive and confidential. Some grid operators have made this data available to interested parties on an ad-hoc basis via bilateral non-disclosure agreements. However, others have denied, or not responded to, requests by emerging 24/7 tracking entities to obtain hourly generation data. Currently, there is no standardized process for data access nor assurance that a 24/7 CFE tracking entity will be able to access the data needed to perform their service.

The data discussed above characterizes the grid's fuel mix, from which average CO_2 EFs can be derived. BAs utilizing unit commitment and dispatch algorithms to optimize scheduling typically can also identify the marginal unit(s) operating at each zone or node across their system. This data is not publicly available in real time. Only a few BAs provide public marginal fuel data on a historical basis.[90] Thus, marginal grid data is more difficult to obtain.

Access to End Use Customer Load Data

Data availability and standardization are two important considerations for corporate customers considering procuring 24/7 CFE. Customers reportedly want access to granular, high-quality, standardized, secure, near real-time load and generation mix data.[91]

In many cases it can be difficult if not impossible for energy customers to access information about their own electricity demand or hourly load profile.[92] Even in cases where hourly consumption is tracked by an electric utility, many customers do not own and cannot access the data produced by their electricity meter. Without access to hourly load information, it will be difficult for electricity consumers and power suppliers to develop 24/7 CFE power supply agreements or to verify the matching of consumption and CFE generation on an hourly basis.

In addition, it is also very difficult for these companies to obtain real-time, or even quasi real-time, GHG emissions factors associated with the electricity they consume from their local electric utility supplier. And in some cases, local electric companies may not even have this information to provide to end-use customers, and typically it is not available from ISOs/ RTOs or states.

To address these data challenges, some corporate consumers and power producers have been developing their own approaches with the help of third-party software companies. For example, ClearTrace – a startup carbon data provider – reportedly has installed meters on company office buildings to monitor real-time electricity demand to match it on an hourly basis to real-time renewable power generation at the facility(ies) included in a 24/7 PPA agreement.

Data Interoperability Across Jurisdictions and Entities

Some large customers consume energy in many locations around the world, each with its own grid operator and local electric utility, with varying levels of data quality, format, and access. As discussed above, obtaining access to confidential hourly supply data for a single power system can be difficult, and multiplying that effort across many different jurisdictions increases the challenge. Once a customer obtains data access across the jurisdictions in which they operate, it will require additional resources to aggregate the data so it can be useful. Some power providers will use file transfer protocol (FTP) sites to share data, while others utilize application programming interfaces (APIs) of varying functionality and quality, and the formatting of related datasets is often inconsistent.

The lack of standardization for reporting generation data and aggregating that data and information across the many local jurisdictions in which a multi-national company may operate can be a formidable technical effort for any organization to undertake.

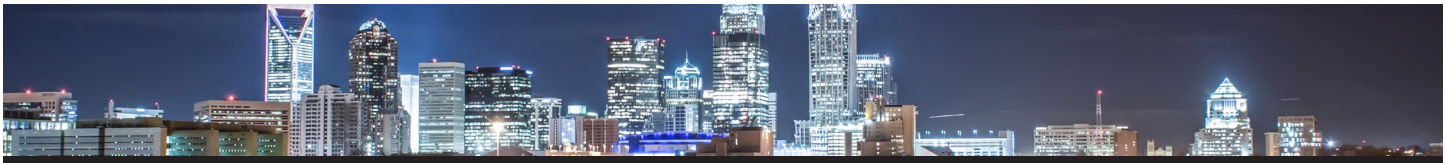
88 For example: CAISO https://www.caiso.com/todaysoutlook/Pages/supply.html ; PJM https://www.pjm.com/markets-and-operations.aspx; MISO https://www.misoenergy.org/markets-and-operations/real-time--market-data/operations-displays/.

89 Exceptions include the Bonneville Power Authority (https://transmission.bpa.gov/business/operations/Wind/baltwg.txt) and Oahu (https://www.islandpulse.org/)

90 PJM, for example: http://www.monitoringanalytics.com/data/marginal_fuel.shtml

91 Op. Cit, Institute for Electricity Innovation 2022, p 10.

92 In some cases, electric companies may make this hourly load data available to corporate customers and may charge a fee to provide it. Some state regulatory commissions reportedly also want customers to pay for access to more detailed hourly load data.



Data Quality

To the extent generation data is available, data quality issues exist and can be a challenge for 24/7 CFE tracking applications. Errors frequently pop up in electric supply data. In cases where real time data is missing or of suspect quality, 24/7 tracking entities may need to resort to utilizing historic trends and machine learning methods to estimate real-time generation.

The U.S. Energy Information Administration (EIA) collects on a mandatory basis and publishes hourly grid data from all balancing authorities, but typically the data is delayed by at least one day for non-RTO/ISO regions. Furthermore, quality issues exist within their data collection. The EIA acknowledges "anomalous values of some data elements" and "advise[s] caution when using these data."[93]

Figure 8 shows several examples of these data quality issues based on EIA's hourly generation data for a set of anonymous balancing authorities. The two BAs shown on the left had full days for which data was unreported. The two BAs on the right show short-term spikes and drops in hourly generation that appear unrealistic, and may not reflect actual system operations.

The four BAs associated with these data errors are among the largest and most sophisticated US electric system operators. One is an RTO, one is a municipal utility serving a large metropolitan area, and two are vertically integrated regulated IOUs. Data issues like these are not isolated to these four examples but are relatively common among BAs reporting to EIA. Data issues like these can stem from human and/or software errors and can cause large costs and incorrect money transfers.[94]

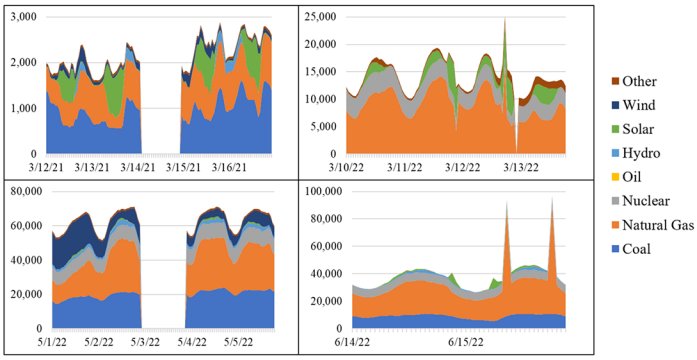


Figure 8. Examples of recent data quality issues observed in hourly generation data (MWh). Source: EPRI

93 See EIA's Hourly Electric Grid Monitor: https://www.eia.gov/electricity/gridmonitor/dashboard/electric_overview/US48/US48

94 For example: https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/natural-gas/022521-spp-recalculates-prices-after-winter-storm-led-to-gas-power-record-highs.

There are provisions in the November 2021 Infrastructure Investment and Jobs Act which aim to improve the availability and quality of real-time grid data in the U.S. via an expansion of the U.S. Energy Information Administration's (EIA) responsibilities.[95] This includes publishing a dataset within one year that includes, "*where available, the average and marginal greenhouse gas emissions by megawatt hour of electricity generated within the metered boundaries of each balancing authority.*" This data is to be disseminated to the maximum extent practicable on a real-time basis and through a publicly accessible API. However, there are no explicit provisions that acknowledge nor mandate any changes designed to address data quality issues.

6 POTENTIAL BENEFITS AND CHALLENGES FOR ELECTRIC COMPANIES

As electric companies consider becoming engaged in providing 24/7 CFE solutions, they may want to consider the key potential benefits and challenges described below.

Potential Benefits

New Customer Acquisition

The evolution of 24/7 CFE provides electric companies an opportunity to develop new power products to meet growing demand from large, sustainability-oriented power customers, such as Google, Microsoft and others.

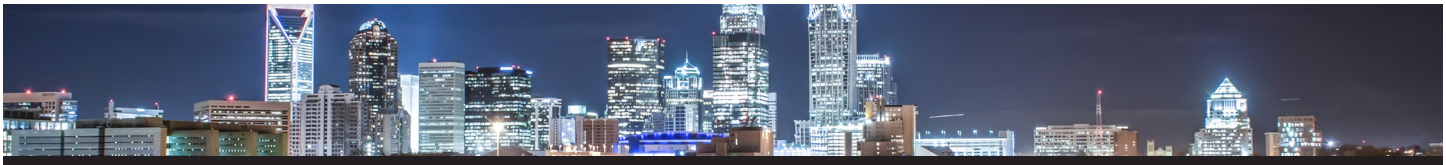
In recent years large corporate energy buyers have begun to consider the availability of locally sourced RE and 24/7 CFE when selecting locations for new facilities and this interest increasingly is being recognized by electricity suppliers.

For example, Georgia Power pursued development of its CFE/ATC service based on initial inquiries from several existing and potential customers that operate data centers in Georgia or who are potentially interested in siting new facilities there. Similarly, Duke Energy recently identified customer access to new renewable generation services as a "…a critical need for many businesses seeking to relocate or expand operations in the Palmetto State."[96] Furthermore, Mike Callahan, Duke Energy's South Carolina state president recently noted:

> *"A majority of South Carolina's leading employers have explicit decarbonization goals, and the carbon intensity of electricity suppliers is top-of-mind for economic development prospects too.*

95 H.R.3684 – Infrastructure Investment and Jobs Act, Title IV – Enabling Energy Infrastructure Investment and Data Collection, Subtitle B – Energy Information Administration.

96 Duke Energy proposes new programs to help grow South Carolina economy by helping customers use 100% renewable energy. Accessed 10/11/22.



Recruiting the next big employer to South Carolina may hinge on helping achieve their corporate sustainability goals. We believe these programs and the stakeholder feedback that helped create them will be critical in attracting and retaining companies in the 21st century."

Maintaining Existing Customers

Given the goals and requirements set out in EO 14057 for federal agencies to procure 24/7 CFE in the coming years, it is important for electric companies that supply electricity to federally owned facilities to consider developing new 24/7 CFE power products so they may continue to supply these facilities. This appears to be one of the key drivers for Entergy's plans to develop 24/7 CFE products as described in section four. In addition, growing demand for 24/7 CFE by the federal government provides another opportunity for electric companies to develop new power 24/7 CFE products knowing in advance there is likely to be growing federal demand for these resources.

Avoiding Customer Bypass

Large corporate buyers interested in 24/7 CFE may seek to "bypass" their local electric utility to match their power consumption with CFE-based generation sources. For example, large energy buyers may try to develop their own new, on-site CFE power generation resources to power facilities such as data centers and others or may try to develop new power generation resources within existing utility service territories.

In recent years, a number of local governments have created Community Choice Aggregation (CCA) programs to bypass their local electric utility to provide electric service to local residents.[96] In California in 2021, there were 24 CCAs serving more than 11 million customers in 201 towns, cities and counties. These CCAs served about 28% of the total load in the service territories of the state's three main investor-owned utilities and this percentage is expected to continue to rise in the future.[98]

By developing 24/7 CFE power products, regulated IOUs may reduce the desire of large corporate buyers and local governments to bypass their local electric utility and instead partner with them to achieve decarbonization goals. For example, in 2019 the Tennessee Valley Authority (TVA) announced a novel hybrid PPA structure in partnership with Google and generation developers Invenergy and Bellefonte Solar. A similar agreement between TVA and Facebook was announced in March 2019 using the same type of novel PPA structure.[99]

Challenges for Small Commercial and Residential Customers

Electric companies may face particular challenges engaging smaller commercial and residential customers with procuring 24/7 CFE. Multiple barriers constrain participation of smaller corporate entities in clean energy procurement. These challenges include lack of creditworthiness, high up-front investment needs, and lack of internal capacity to deal with the complexity of frameworks and negotiations leading to PPAs. Some companies also lack understanding of energy markets, which is challenging when corporate procurement options rely on wholesale market prices.[100]

Corporate and Product Differentiation

Power companies that move early and aggressively to develop new 24/7 CFE power products may be able to differentiate both their companies and their power products from their competitors. This differentiation may become more important as the new clean energy economy unfolds in the coming years.

Ongoing Challenges

Today, there are a variety of challenges that will need to be addressed by both corporate power buyers and electric to increase future deployment of 24/7 CFE. These challenges are discussed below.

Identifying 24/7 CFE Generation Technologies and Projects

Currently, there are few power generation technologies and approaches that can generate and dispatch 24/7 CFE to end-use customers. While a variety of new power generation technologies are being developed that may provide 24/7 CFE in the future (e.g., natural gas power generation combined with CCS, hydrogen-based resources, small modular nuclear reactors, and others), today the large-scale power generation technologies that can provide 24/7 CFE are limited and include RE (predominately wind and solar PV), nuclear, hydropower, biomass, and geothermal energy resources.

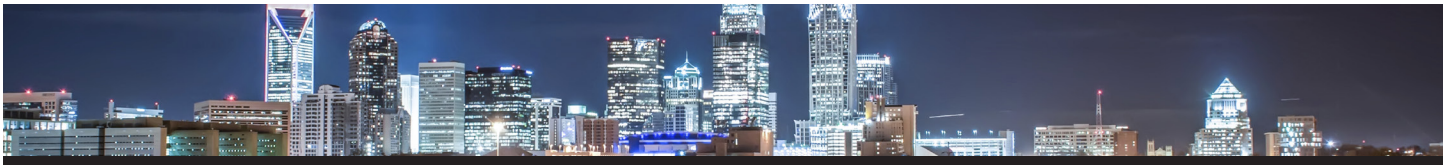
Another key challenge is identifying and acquiring new CFE resources and projects that match potential corporate buyers'

97 Examples include Marin Clean Energy and Peninsula Clean Energy.

98 "California CCA membership surpasses 200 communities, 28% of utility load," Electric Power. 15 Apr 2021. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/041521-california-cca-membership-surpasses-200-communities-28-of-utility-load. Accessed 7/28/22.

99 *Novel Power Purchase Agreements (PPAs) in Renewable Energy.* EPRI. Palo Alto, CA. 2020: 3002019434. pp. 11.

100 Op. Cit., IEA 2022, p. 40.



preferences. For example, in parts of the EU the existing demand for RE projects is so great today that there are few high-quality new RE projects available to build to meet demand from buyers interested in 24/7 CFE. In part this is due to existing EU policies that provide revenue streams, such as feed-in tariffs and capacity payments, that have driven rapid RE deployment in recent years.

In addition, many corporate RE buyers today are focused on purchasing RE and CFE resources that are generated in the same regional ISO or BA where their corporate facilities are located. This desire to match the location where RE/CFE is procured and consumed is important to some corporate buyers who want to claim that their electricity procurement reduces GHG emissions where they operate.

Limited C&I Customer Demand for 24/7 CFE

In recent years, corporate RE procurement has boomed as prices for wind and solar resources have declined. However, today we are aware of only a small number of large, well-funded U.S-based corporations that have engaged in procuring 24/7 CFE and only a few 24/7 PPAs have been executed.

Google and Microsoft are two of the first commercial energy users to contract 24/7 CFE, and they have both done so to meet the energy demand of large computer data centers which typically have a "flat" electricity demand profile. In addition, Iron Mountain Inc. announced an agreement in April 2021 to match power demand at more than 60 of its buildings in Pennsylvania and New Jersey with renewable energy on an hourly basis.[101] Also in 2021, Iron Mountain developed a power supply agreement with NRG focused on matching Iron Mountain's hourly load with existing renewable resources it has procured. (See text box for more information.)

In addition, based on interviews with existing 24/7 power suppliers, we understand many corporate power buyers in the EU support government action to decarbonize EU electricity supplies and so may be less interested in purchasing 24/7 CFE or paying a price premium for these resources.

Bespoke Power Supply Contracts

One of the principal challenges facing electric companies interested in supplying 24/7 CFE is the bespoke, customized nature of existing 24/7 CFE power supply agreements. Today, there are no standard 24/7 CFE power supply contracts that have been developed by power suppliers and are available to share with prospective buyers. Based on interviews conducted for this project, we understand power suppliers willing to supply 24/7 CFE today will do so only based on non-standard, customized energy supply agreements. The development of the Georgia Power's CFE/ATC subscription-based power product is the first effort by an electric utility to develop a standardized approach.

Time Required to Develop 24/7 CFE Power Supply Agreements

Along with the need to develop non-standard, customized power supply agreements to meet corporate buyers' interest in 24/7 CFE, it can take months and potentially years of negotiation between buyers and sellers to reach agreement on key terms and execute an agreement. For example, although Georgia Power's CFE/ATC program was approved by the PUCN in July 2022, the company plans to take up to five years to fully develop the program to begin offering this subscription service to eligible customers.

Market Pricing of 24/7 CFE

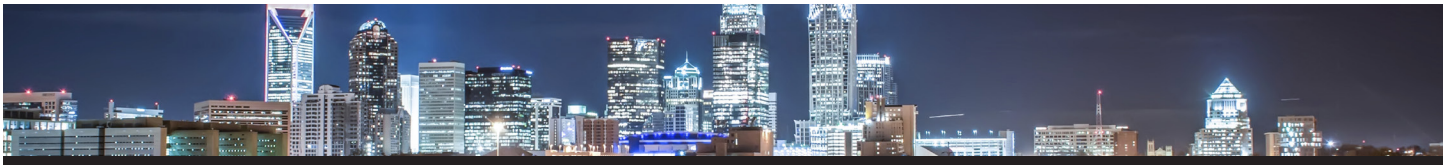
Electric companies that successfully develop and market 24/7 CFE power products may increase their revenues from the sale of 24/7 CFE. Based on discussions with power companies involved in providing 24/7 CFE in both the EU and the US, we understand that most corporate power buyers today are reluctant to pay a premium over existing market prices for RE and RECs. In addition, the Institute for Electricity Innovation recently reported that C&I customers who participated in a series of workshops and a survey of their attitudes about 24/7 CFE reported that cost was identified as the most significant concern for customers, followed by the ability of the CFE offering to cost effectively meet the corporate customer's goals and ease of participating in the CFE offering. The potential inability to charge a price premium for 24/7 CFE may present a significant barrier to future development of 24/7 CFE.[102]

Excess Capacity Buildout

Another challenge related to identifying suitable projects to supply 24/7 CFE is the potential need to overbuild new resources to meet contractual requirements to supply 24/7 CFE. Based on discussions with existing suppliers of 24/7 CFE, we understand project developers may need to develop two or three times the capacity needed to

101 *Iron Mountain Data Centers Among the First to Track Renewable Energy by the Hour*, 4/14/2021. https://www.ironmountain.com/about-us/newsroom/press-releases/2021/april/iron-mountain-data-centers-among-the-first-to-track-renewable-energy-by-the-hour (accessed 4/18/22).

102 Op. Cit., Institute for Electric Innovation, 2022, p. 2.



Iron Mountain and 24/7 CFE

In 2021, Iron Mountain Inc. announced an agreement with green energy marketer RPD Energy and retailer Direct Energy to match power demand at more than 60 of its buildings in Pennsylvania and New Jersey with renewable energy on an hourly basis. Also in 2021, Iron Mountain developed a power supply agreement with NRG that is focused on matching Iron Mountain's hourly load with existing renewable resources it has procured.

There are several interesting features related to Iron Mountain's engagement in 24/7 CFE. Not only is the company procuring RE and CFE to achieve its own corporate goal of becoming 100% 24/7 CFE worldwide by 2040, but a core part of the company's strategy is to act as "pass-through" power supplier of low-cost, 24/7 CFE to the high-technology companies that lease computer server "co-location" space and services from Iron Mountain.

As a co-location service provider, Iron Mountain leases conditioned space and related infrastructure such as electricity, lighting and HVAC to high-technology companies that co-locate their computer data servers and other IT infrastructure inside Iron Mountain's own facilities. By doing this, Iron Mountain can provide CFE to their co-location tenants at no additional cost to what Iron Mountain pays to obtain electricity for the entire facility. Iron Mountain acts simply as a "pass through" of both the costs borne by Iron Mountain to acquire CFE on behalf of their tenants but also of the RECs and associated environmental attributes.

According to BloombergNEF, "Iron Mountain's arrangement could offer a blueprint for companies that want to use more renewable energy but have struggled to sign PPAs, which can be daunting for smaller companies that lack expertise in energy markets." Iron Mountain considers their ability to provide their lessees with increasing levels of CFE to power their businesses as a competitive advantage and corporate differentiator. In a recent presentation by Iron Mountain, the company pointed out that "...We buy the power clients would choose to buy for themselves in support of their environmental goals."

Source: "Supply Products for 24/7 CFE," presentation by Iron Mountain as part of a webcast hosted by WRI, July 28, 2022

meet the instantaneous electricity demand included in a 24/7 CFE agreement. Also, it is likely that batteries and other energy storage technologies likely will need to be developed and deployed to ensure new RE and CFE generation can be dispatched when it is needed. For example, one power supplier reported, 'If we need to supply 100 MWs of 100% renewable power on a 24/7 hourly basis, we need to build 200-300 MW or more of renewable resources to do this." This need to overbuild in part reflects buyer preferences to include or exclude certain potential types of power resources from a 24/7 CFE supply agreement and reflects the inherent uncertainty and variability of the power generation output from renewable facilities.

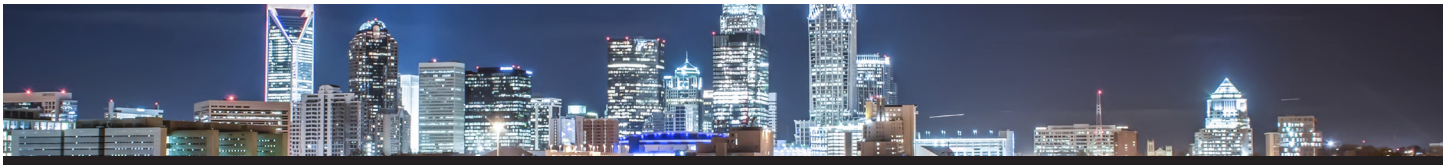
Load Shapes

All the 24/7 CFE deals explored in this study are designed to provide power to meet a relatively "flat" block of demand. To date, most of the 24/7 agreements have been made to supply electricity to large computer datacenters that have a flat and stable load profile. It is likely to be more challenging to develop 24/7 CFE power products that are capable of meeting customer demand on an hourly basis as it fluctuates between periods of low and high demand (i.e., "load following"). A related challenge is designing 24/7 CFE solutions for multiple customers with different hourly load profiles. One idea that has been suggested to address this to develop 24/7 CFE products for specific types of customers with similar load profiles (e.g., a product for hotels, data centers, retail stores). However, it may be difficult for electric companies to gain regulatory approval for these targeted 24/7 products, and it may be difficult for companies to develop and manage multiple product offerings.[103]

Financial and Operational Risks

Another challenge today for power providers considering engaging in 24/7 CFE is that existing contractual mechanisms typically place most of the financial risk associated with entering a 24/7 CFE power supply arrangement on the power supplier and is not shared with the corporate buyer. In addition, it is reportedly very difficult for power suppliers to financially hedge these new types of PPAs. Given the extended time periods covered by typical PPA arrangements (10-20 years), the added risk to the power supplier of guaranteeing delivery of 24/7 CFE is challenging for suppliers to accept, particularly if they are not able to charge a price premium for providing 24/7 CFE.

103 Op. Cit., Institute for Electric Innovation, 2022, p. 6.



Mismatch with Electric Utility Decarbonization Goals

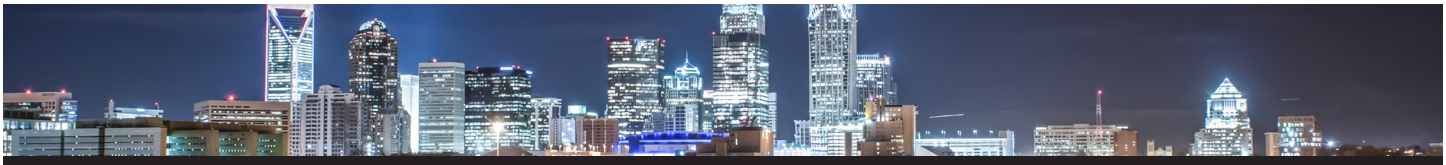
Many electric companies in the U.S. have adopted aggressive decarbonization and "net-zero" GHG reduction goals. These companies have been rapidly developing resource plans and working with their state regulators and local stakeholders to realign regional power systems to meet these aggressive goals while maintaining power system reliability and resource adequacy. This requires a careful balancing of power supplies and demand on an hourly basis. Going forward, it may be difficult for these regulated electric companies to move more quickly to decarbonize their power supply and simultaneously provide 24/7 CFE to large corporate buyers. If 100% 24/7 CFE is going to be deployed widely, it will be important to demonstrate how this deployment will assist with ongoing regional decarbonization efforts that are already underway and that widespread deployment will not endanger regional resource adequacy or electric system reliability.

7 KEY INSIGHTS AND OPPORTUNITIES

The following key insights and opportunities are based on the research and interviews completed to prepare this paper.

Key Insights

- 24/7 CFE represents a potentially significant evolution of corporate renewable power procurement designed to better match RE procurement to real-time hourly customer load and further decarbonize the electricity supply.
- To date, there have been very few active buyers of 24/7 CFE, and it is not clear when demand may grow significantly. Anecdotal information suggests corporate and municipal demands for these new power products may be growing both in the US and internationally, particularly in the EU.
- The largest CFE buyer in the U.S. in the near term is likely to be the federal government as it implements E.O. 14057. To serve this demand or maintain existing power supply agreements with federal agencies, electric companies may want to consider developing 24/7 CFE power products.
- It is easier today to develop a 24/7 CFE product and transact it in deregulated power markets where IPPs are accustomed to providing customized power products to corporate buyers than for regulated power companies to develop new 24/7 products and tariffs.
- Two regulated IOUs in the U.S. — Georgia Power Company and Nevada Energy — recently received state regulatory approval to develop and deliver 24/7 CFE to corporate C&I customers located in their service territories. A third IOU, Duke Energy, recently requested approval from South Carolina state regulators to offer a 24/7 CFE service.
- Power suppliers who may wish to offer 24/7 CFE products face challenges, including product pricing, identifying suitable CFE projects, potential overbuilding of power generation resources, addressing asymmetric financial and operational risks, and developing new supply agreement and regulated tariffs to support 24/7 CFE.
- There is virtually no market infrastructure today to match customer load to unit-specific CFE generation on an hourly basis. There is existing market infrastructure that supports RECs and RE procurement, but more limited infrastructure exists to track CFE resources. However, the existing REC infrastructure is evolving rapidly to track hourly RE generation and provide time-stamped RECs.
- The move by some corporate, municipal and institutional power buyers to make new renewable investments on the basis of maximizing the marginal GHG emissions impact or "emissionality" could reduce future demand for 24/7 CFE.
- While investing in (or building or buying) a renewables project located within the regional power grid serving a corporate load may help reduce a company's reported Scope 2 emissions, that same emissions reduction may be far lower than enabling a clean energy project to be built in a regional grid with a higher GHG emissions rate. For some corporate renewable and CFE buyers, *emissionality* and *location* are becoming important criteria for siting new facilities and PPAs.
- Existing Scope 2 GHG accounting guidance provides a strong incentive for corporate RE buyers to continue to procure bundled and unbundled RECs, renewable PPAs, and other mechanisms to reduce the GHG emissions factor they use to report their Scope 2 GHG emissions. Moreover, existing GHG accounting guidance provides little incentive for these C&I customers to procure 24/7 CFE as doing so will not reduce these customers' Scope 2 emissions more than simply procuring RE or RECs.



- There are a variety of data-related challenges that will need to be overcome to securely deploy 24/7 CFE, including ensuring data quality, access to real-time, unit specific grid generation data and end-use customer hourly load data. In addition, deploying 24/7 CFE may require managing larger data sets that includes specific generation attributes of qualifying CFE generation units on a 24/7 basis as well as end-use customer load data, and tracking and matching their use and retirement. It is also likely to be important and challenging to manage data interoperability across jurisdictions and entities that can match load and CFE generation on an hourly basis.
- C&I customers who have procured 24/7 CFE to date have done so using two different approaches. Some corporate buyers have procured "turn-key" 24/7 CFE power products from a power supplier while others plan to manage their own portfolio of electric supply agreements to achieve high-levels of CFE matched to their load.

Opportunities for Future Research

Based on the research conducted to develop this white paper, a number of interesting topics and issues associated with 24/7 CFE could benefit from future research and development by EPRI and others. These are described briefly below.

Grid Benefits of 24/7 CFE

Proponents of 24/7 CFE claim procuring hourly RE may assist power grid operators to manage better the large and growing deployment of renewables by incentivizing increasing deployment of renewables and storage resources that better coincide with hourly loads. It is not clear if 24/7 CFE deployment will provide these grid benefits more cost effectively than other mechanisms, such as new market products or other changes to operations, and more research is needed to determine if this claim has merit.

Hourly Matching Impacts on Decarbonization

Another potential benefit of 24/7 CFE is that hourly load matching may increase the CO_2 displaced by renewable generation because it tends to incentivize renewable generation in hours of the day that typically are served by non-renewable resources. One recent study appears to confirm this and concluded that 24/7 CFE procurement "better matches participating demand during periods of limited supply and thus drives significantly more retirement of natural gas generating capacity than 100% annual matching."[104]

24/7 CFE Contract Structures

Future R&D also could help to better understand existing and potential future 24/7 CFE power supply contract structures. To date, it has been difficult to obtain specific information about existing 24/7 CFE supply agreements due to confidentiality concerns by both buyers and sellers. Key contract parameters include pricing, duration, supply technology mix, and performance agreements or guarantees. In addition to trying to better understand how existing agreements are structured, it may be important to consider how these structures may need to evolve to provide a foundation for 24/7 CFE resource development.

Impact of 24/7 CFE on Decarbonization

Another potential area of future research is to model the nation's power system to explore and improve our understanding of the potential impacts of transitioning to 100% 24/7 CFE on GHG emissions and wholesale and retail electricity prices and other metrics. Energy systems modeling also could improve our understanding of the power system impacts of 24/7 CFE for different customer classes. For example, the impacts of procuring 24/7 CFE for data centers across the country may be different than doing so for large customers in the manufacturing or hospitality sectors.

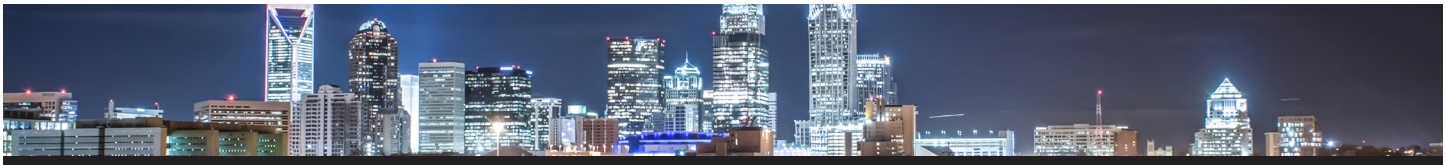
Research in this area has just begun and a recent, first-of-its-kind study of electricity system-level impacts of 24/7 CFE procurement concluded:[105]

> *"…24/7 carbon-free electricity enables deeper emissions reductions and deeper transformation of the electricity sector than 100% annual matching by driving early deployment of advanced clean firm and long-duration energy storage technologies. But it does so at a potentially significant cost premium for early leaders, a premium paid to accelerate innovation, maturity, financeability, and widespread availability of clean firm resources that can make it much easier for broader society to follow on the path to a 100% carbon-free grid. Just as 100% annual matching helped transform wind and solar PV from expensive "alternative energy sources" to mainstream, affordable options for the world, 24/7 procurement is likely to have similar transformative impacts on clean firm resources."*

While these modeling results appear to confirm many of the potential benefits of 24/7 CFE, additional modeling would help to confirm these findings and could further elaborate on them. Quantitively modeling of these potential impacts in the U.S. could be done

104 Op. Cit., Xu et. al., 2021. p17.

105 Op. Cit., Xu et. al., 2021, p19.



using EPRI's, proprietary simulation model of the U.S. economy and regional power systems called the United State Regional Greenhouse Gas and Energy model (US-REGEN).

Impact of 24/7 on Regional Power Systems and Reliability

Another key question related to large-scale deployment of 24/7 CFE is how deployment may impact regional power system reliability, including resource adequacy and climate resiliency. The transition to 100% 24/7 CFE potentially could have deleterious impacts on power system reliability and resiliency, unless properly planned for. Understanding how deployment of 24/7 CFE may impact system reliability and resiliency are important considerations that could be addressed by future research. This research potentially could be done using EPRI's new integrated generation, transmission and distribution planning modeling framework developed as part of EPRI's ongoing initiative on Integrated Strategic System Planning (ISSP) and as part of EPRI's ongoing Resource Adequacy and Climate READi Initiatives.

A TRACKING, TRADING AND RETIREMENT OF RENEWABLE ENERGY CERTIFICATES (RECS)

REC Tracking

The creation of RECs by metered RE generation, as well as REC transfers and retirements for RPS regulatory compliance, are recorded in designated tracking systems, such as the Midwest Renewable Energy Tracking System (M-RETS). The use of RECs in regulatory compliance schemes enables accounting for the procurement of wholesale RE without the need to track the underlying electricity or verify the underlying renewable Power Purchase Agreements (PPAs).

The use of REC accounting as a compliance instrument is complicated by RPS compliance rules that vary by state. Multiple tracking systems have arisen to accommodate different definitions of RPS-qualified renewable energy for each state law. Currently, there are 10 REC tracking systems in North America.[106] There is a close link between the REC tracking systems and electric balancing authorities and ISOs that are the primary data source for renewable energy generation.

For example, ERCOT and PJM directly provide REC tracking for the states in their RTO regions, as opposed to a stand-alone tracking system. The M-RETS and New England Power Pool Generation Information System (NEPOOL-GIS), on the other hand, are separate entities that receive generation data directly from MISO and ISO-NE, respectively, and the tracking system's geography largely overlaps with the ISO. In the west, the Western Renewable Energy Generation Information System (WREGIS) collects data from individual balancing authority utilities under the governance of the Western Electricity Coordinating Council (WECC).

In addition to regulated power companies that may be required to procure RE, corporate sustainability and decarbonization efforts among large corporate power buyers has resulted in these market players purchasing and retiring RECs to demonstrate achievement of their sustainability goals.

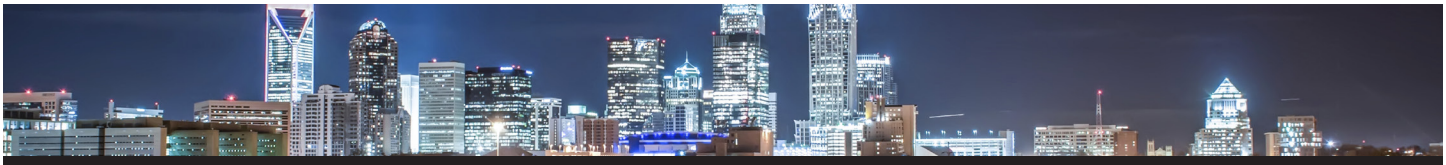
The tracking entities provide a system of accounts through which RECs are issued to primary RE power producers, and which can then be traded and retired to provide the basis for corporate RE consumption claims and RPS compliance. In this way, REC tracking has facilitated development of a large voluntary market through which participants buy and sell RECs representing RE above what is mandated in RPS laws to individual entities who want to make RE purchasing claims.

Bundled and Unbundled RECs

RECs often are described as being "*bundled*" when they are transferred in conjunction with the underlying renewable energy (MWh) generated to create the REC, and "*unbundled*" when the RECs are separated and sold or transferred separately from the underlying renewable energy.

Using a financial arrangement called a "virtual" renewable PPA, companies can buy *unbundled* RECs without purchasing or consuming the underlying electricity (MWhs) that created the RECs. This approach is problematic in part because unbundled RECs may or may not be registered to a specific generation resource actually serving load in the same power grid where the end-use consumer is physically connected. In addition, the renewable resources may or may not be reducing GHG emissions depending on the composition of the regional grid in which they operate, and the emissions associated with the marginal operating unit.

106 Among the largest include the Midwest Renewable Energy Tracking System (M-RETS), Western Renewable Energy Generation Information System (WREGIS), New England Power Pool Generation Information System (NEPOOL-GIS), and the North American Renewables Registry (NAR) by APX. A map of the REC tracking systems with acronym definitions is available from the Center for Resource Solutions: https://resource-solutions.org/wp-content/uploads/2018/02/Tracking-System-Map.pdf



Corporations and other retail electricity customers also purchase unbundled RECs to claim progress toward achieving voluntary RE procurement goals. These REC transactions often are tracked in a similar fashion to those for RPS compliance, but such "consumer" commitments are not subject to any regulatory oversight. And importantly, even when these claims are based on *bundled* RECs, the RECs themselves do not represent the physical delivery or consumption of electricity as discussed further below.

Voluntary REC transactions are not bound by the geographic restrictions imposed in state RPS laws, and corporate consumers theoretically can source RECs from anywhere. The proliferation of the voluntary REC market has accelerated the need for global standards and certification to provide consumers with confidence and information regarding the quality of RECs.[107]

Monthly and Annual REC Tracking

Historically, REC tracking systems have issued RECs in batches on a monthly or quarterly basis and REC markets include REC transactions in monthly batches. Individual RECs within each batch are not tied directly to a specific time of day or week. In these tracking systems, RECs from a particular vintage are the same commodity regardless of what time of day or which day of the month they were produced.

Evolution of Hourly REC Tracking

A monthly batch of RECs with no time stamps is not sufficient for a corporate power buyer to use to claim a particular level of RE matched to their hourly consumption. Today, REC tracking has begun to evolve towards increased accounting granularity. To meet the growing interest of corporate electricity buyers to understand on a more granular level the GHG emissions impacts of their energy consumption and investment decisions in more granular time-differentiated RECs, existing REC tracking systems in the U.S. and the EU are evolving to develop time-based energy attribute certificates (T-EACs) and hourly REC tracking services.

M-RETS, for example, has begun to integrate hourly generation data into its platform, and in 2021 facilitated an hourly REC retirement in conjunction with Google.[108] Google has also worked with the North American Renewables Registry, another REC tracking system maintained by the software company APX, to develop hourly REC trading on their platform.[109] Global standards that are specific to hourly energy certificates also are being developed, with an early and large collaborative effort being led by the UK-based non-profit EnergyTag. Hourly REC markets could facilitate trade at this level of granularity, enabling market participants to purchase RECs differentiated by time of day and create price divergence across time. In such a market, RECs produced during peak demand hours or periods of low renewable output could be more valuable to consumers interested in hourly matching and command a higher price.

Fractionalization

One challenges that existing REC tracking programs will need to address to move toward an hourly approach relates to the potential "fractionalization" of RECs. For example, a REC usually is defined legally and traded as a whole mega-watt hour MWh). Historically, there has not been any need to subdivide RECs into smaller increments. If a renewable generator produces 100.5 MWh in a month in the existing REC tracking systems, the portion of the REC from the last 0.5 MWh would be rolled over to the following month and becomes part of the first whole REC in the next month's new batch. Taking a fraction of a REC and moving it to the following month's batch works sufficiently if a timestamp is not part of the commodity. However, this existing shifting of fractional RECs across time cannot be used to support hourly tracking because it must remain tied to the hour it was produced.

Cherry Picking

Any transition to hourly REC trading may lead to concerns about "cherry-picking" high-value hourly RECs. An entity who owns hourly RECS may find it profitable to sell hourly RECs associated with high-value periods (e.g., peak periods such as 2-7 pm), while selling RECs from the remaining low-value hours into the "legacy" market. This could lead to unintended consequences and create a bifurcated REC market with entities transacting a mix of hourly and legacy RECs. The bifurcation could lead to changes in the characteristics and the value of non-hourly RECs in the legacy market once hourly transactions become possible. This could occur if market participants convert hourly RECs during high-demand periods at a larger rate, leaving RECs from the remaining time periods in the non-hourly, legacy batches.[110]

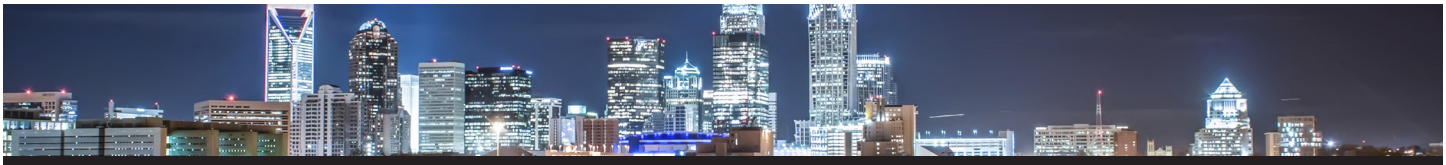
One way to potentially mitigate this issue is to have REC markets require a full monthly batch of RECs to be converted together to hourly RECs, and not allow conversion of selected hours. This

107 Green-e is a leading certifier of voluntary REC programs that has been used for decades. https://www.green-e.org/

108 https://www.mrets.org/hourlydata/

109 https://cloud.google.com/blog/topics/sustainability/t-eacs-help-drive-around-the-clock-carbon-free-energy

110 For more technical information on the REC fractionalization and cherry-picking topics, see "A Path to Solving the Complexity of Fractional RECs," https://www.mrets.org/resources/publications/.



approach would keep the intraday characteristics of non-hourly REC batches roughly aligned with how they were prior to the conversion to hourly-tracking.

B GREENHOUSE GAS EMISSIONS FACTORS

The U.S. Environmental Protection Agency (US EPA) defines "emissions factors" as "a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant."[111] Typically, EFs are expressed as the mass of GHG pollutant per unit of the emission producing activity, such as pounds (lbs.) carbon dioxide (CO_2) emitted megawatt hour of power generation. To estimate emissions, an EF is multiplied by corresponding activity data such as the hours a piece of machinery operated, or the mass of coal combusted, or electricity consumed.

Average Grid Emissions Factors (AEF)

There are different types of electric grid EFs. The most commonly used is an *annual grid-averaged EF*.[112] This type of EF is a generation-weighted EF averaging all GHG emissions (or CO_2 only) associated with all power generation resources in a defined grid region for a calendar year. This type of EF can blur significant seasonal and/or intra-day (peak/off-peak) differences in the emission intensity of system power (i.e., *undifferentiated* electric power taken from the grid). Grid average EFs typically overestimate the emission intensity of the system mix during periods of high renewable generation and underestimate the emission intensity during peak load periods with little or no available renewable power.

Marginal Emissions Factors (MEF)

A ***marginal EF*** represents the emission rate of the marginal generating resource dispatched on the power system to meet real-time electric demand. Marginal EFs are continually changing as the marginal power resource at any given point in time depends on load and grid conditions.

111 https://www.epa.gov/air-emissions-factors-and-quantification/basic-information-air-emissions-factors-and-quantification

112 Some RTOs and ISOs publish GHG intensity data for their operating footprint. The US EPA's eGRID program also publishes emission intensities for grid sub-regions throughout the U.S. One challenge using grid EFs databases like eGRID is that publishing typically lags one or more years behind the current reporting period. This lag is particularly problematic for recent years, as the overall power generation mix has been changing rapidly in certain regions of the country.

Grid-averages often are used for attributional GHG accounting, which includes preparing corporate GHG emissions inventories. The purpose of attributional environmental accounting frameworks is to allocate responsibility for aggregate emissions across a population (e.g., countries or organizations). For instance, a grid-average EF often is used to calculate the allocation of corporate Scope 2 emissions associated with electricity consumption to each company consuming electricity from a regional power grid.

In contrast, marginal EFs are used for *consequential* GHG accounting, where the goal is to estimate *changes in emissions or removals* caused by specific interventions. Consider an energy efficiency project that potentially reduces emissions by reducing demand for electricity. In evaluating the emission reductions caused by this example, a marginal EF would be appropriate to apply to estimate the emissions expected to be avoided through reduced output from the last-to-be-dispatched generator(s) corresponding to the reduced electrical load. However, a marginal factor is not appropriate to use for attributional environmental accounting, such as corporate GHG inventories, in part because emissions from marginal generation units cannot be allocated and claimed by all companies simultaneously.

Average CO_2 and marginal CO_2 EFs differ significantly from one another as shown below for the PJM Interconnection (Figure 3), and average and marginal EFs can vary significantly across time (e.g., daily, monthly and annually). For example, the average CO_2 EF in November 2019 was ~800 lbs. CO_2/MWh, while the marginal "on peak" EF across the same month was almost 40% higher at ~1,100 lbs. CO_2/MWh.

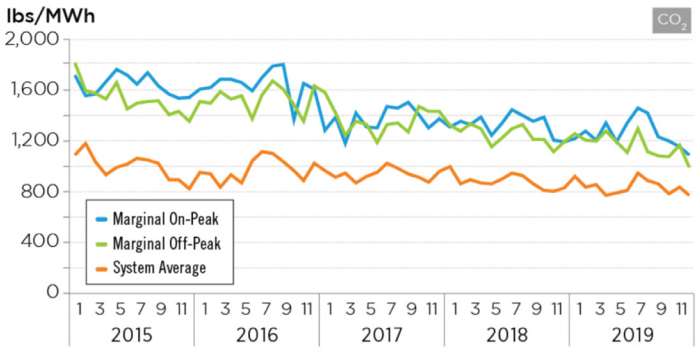
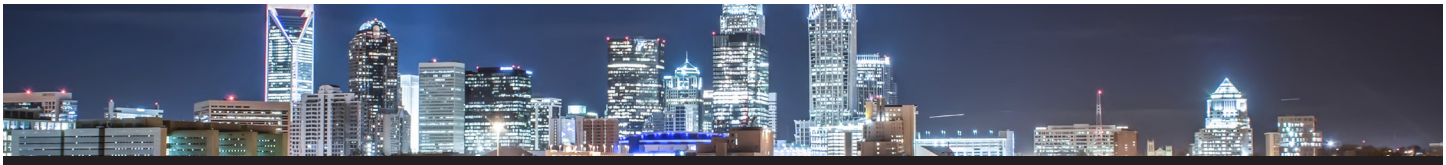


Figure B1. Marginal and average CO_2 emissions rates in PJM Interconnect (2015–2019). *Source: 2015–2019 CO_2, SO_2 and NOx Emissions Rates, PJM Interconnection, April 9, 2022.*



C ADDITONAL SERVICE PROVIDERS ENGAGED IN 24/7 CFE

This appendix provides brief summaries of some of the organizations engaged in developing 24/7 CFE. This appendix does not include power suppliers currently engaged in 24/7 CFE transactions and companies that have purchased 24/7 CFE as these entities are described elsewhere in this paper.

Other Independent Power Providers

Brookfield Renewables

In March 2022, Brookfield Renewables announced a power supply agreement with Brookfield Properties, an affiliated real estate development company. This agreement will supply 100% of the electricity needs of One Manhattan West, the 18th tallest skyscraper in New York City that was completed in 2019. The building's energy supply will come from Brookfield Renewable's hydropower facilities in upstate New York. The agreement involves using ClearTrace and its blockchain-based platform to digitally match the building's electric consumption with energy and RECs from Brookfield Renewable's hydropower resources on an hourly basis.[113]

Broad Reach Power

Broad Reach Power is a U.S.-based IPP with a focus on utility-scale battery storage. In March 2022, Broad announced a partnership with REsurety (see below) to analyze in a granular manner the carbon impact of their storage projects. REsurety's Locational Marginal Emissions (LME) data incorporates grid congestion, topology, generation, and load and publishes at thousands of locations on an hourly basis. The LME data allows Broad Reach Power to (i) measure the emissions impact of each project on an hourly basis, (ii) enable carbon-based dispatch of storage resources, and (iii) incorporate incremental carbon impact in their siting decisions for new projects.[114]

Software and Service Providers

ClearTrace

ClearTrace's system tracks electricity metering data from where power is generated to where it's consumed and makes the information available to clients via dashboards. ClearTrace focuses on providing a single source of energy and carbon information based on streaming data – primarily hourly data – drawn directly from its sources and fed into granular carbon footprinting calculations. ClearTrace also uses blockchain technology to create an immutable ledger, minimizing data corruption risks or an incomplete data warehouse and providing permissions-accessible audit trails so companies can truly prove their impact. In July 2022, ClearTrace announced a $20M strategic equity raise this week to expand its emissions tracking and traceability platform.[115]

FlexiDAO

FlexiDAO is a software company that helps companies trace their electricity consumption and CO_2 emissions on an hourly basis. They offer blockchain-based certification and hourly tracking of electricity production and consumption. FlexiDAO recently completed two pilot projects with Microsoft and power supplier Eneco to demonstrate the issuance, transfer, and claims of hourly certificates associated with Microsoft's data center consumption in the Netherlands with offshore wind generation by Eneco.[116]

Granular Energy

Granular Energy is a startup company in the based in France that is developing a software platform for their electric utility customers to use to manage 24/7 power supplies and match them to related end-use customer loads.[117] Granular Energy offers a complete software solution for utilities, traders and large energy buyers to manage their portfolio of energy certificates around the world, at a (sub-)hourly level. Their software platform automates the allocation of certificates and optimizes a company's portfolio's matching level. Features include monitoring of key metrics such as carbon free energy coverage, visibility into hours of excess or shortfall, portfolio management, risk dashboards, and monthly auditable reports.

REsurety

REsurety has been providing Microsoft, Hannon Armstrong, Quinbrook Infrastructure Partners and other major clean-energy investors with a "locational marginal emissions" product that uses grid and emissions data to determine the emissions impacts of grid congestion and renewable energy curtailment.

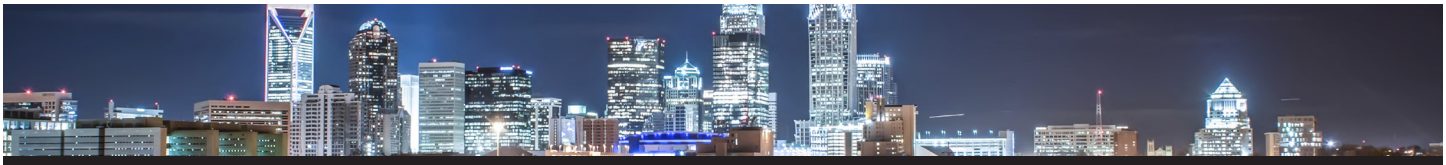
113 https://cleartrace.io/press-releases/brookfield-properties-one-manhattan-west-to-be-powered-by-100-per-cent-renewable-energy/#:~:text=Brookfield%20Properties%20will%20use%20ClearTrace,an%20hourly%20basis%20and%20create

114 https://resurety.com/resurety-enables-broad-reach-powers-grid-decarbonization/

115 https://workweek.com/2022/07/06/a-clear-path-to-decarbonization/

116 https://www.flexidao.com/news/hourly-certification-of-renewable-electricity-a-step-closer

117 Granular - Building a 24/7 clean energy market (granular-energy.com).



Singularity

Singularity offers a software platform that provides time- and location-based granular grid emissions data, plus analysis and decision support tools around carbon emissions for entities across the electricity value chain, including utilities, grid operators, and end-users. In May 2022, Singularity closed a seed round of funding. Singularity's customers currently include Eversource, Harvard University, and M-RETS, among others. Singularity also is a participant in EPRI's IncubateEnergy Labs and is working on implementing demonstration projects with several EPRI member electric companies.

WattTime

WattTime is a nonprofit technology provider that correlates emissions data from power plants and energy markets to the time and place where energy is consumed. That data has been used to inform the operations of residential batteries in California, electric-vehicle charging and Google Nest thermostats.

Renewable Energy Certificate Registries and Service Providers

EnergyTAG Initiative

EnergyTAG is in international NGO leading the collaborative development of international standards for tracking hourly RE and CFE certificates. A variety of organizations are supporting EnergyTAG and are involved in their standards development process, including some of large energy buyers, energy suppliers, and other NGO such as Google, Microsoft, Engie, Iberdrola, Vattenfall, M-RETS, and the Clean Air Task Force (CATF).

Midwest Renewable Energy Tracking System (M-RETS)

M-RETS is a non-profit renewable energy tracking system. Their system is used by load-serving entities (LSEs) and others to demonstrate RPS compliance in many states across the Midwestern U.S., and they provide voluntary REC tracking services for entities across North America. M-RETS recently began integrating hourly generation data into its platform, and in early 2021 worked with Google to pilot an hourly REC retirement.

Elia

Elia, the Belgian grid operator, in 2021 implemented a proof-of-concept tracking service to provide granular Guarantees of Origin (GOs) to support their consumer market design with peer-to-peer energy trading on a 15-minute basis. Elia has partnered with technology provider Energy Web to provide the blockchain-based certification system and digital market platform.[118]

Other Entities

APX

APX provides REC tracking solutions in both the voluntary and compliance markets in every region of the United States. APX operates two separate REC tracking platforms to offer complete worldwide REC portfolio coverage: the North American Renewables Registry (NAR) covers REC tracking across all North America, and the Tradable Instrument for Global Renewables (TIGR) covers the rest of the world. Google has worked with APX and SPP to trade hourly RECs in the SPP.

Clean Air Task Force (CATF)

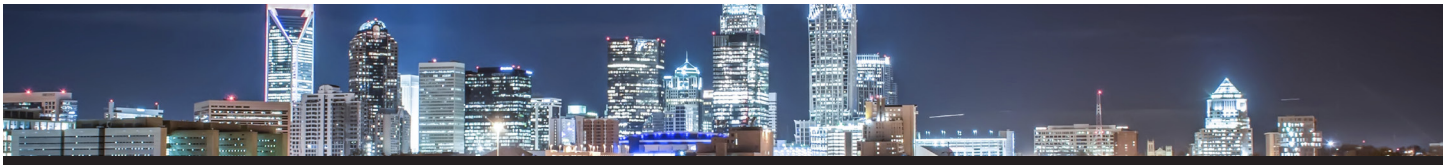
CATF is a global NGO working to safeguard against the worst impacts of climate change by catalyzing the rapid development and deployment of low-carbon energy and other climate-protecting technologies. CATF recently requested the Biden administration to push harder on 24/7 clean energy as part of its broader goal of moving the entire U.S. power grid to 100% clean energy by 2035.

Clean Energy Buyers Association (CEBA)

CEBA is a membership association for energy customers seeking to procure clean energy across the U.S. Today, its membership of nearly 300 entities includes stakeholders from across the commercial and industrial sector, non-profit organizations, as well as energy providers and service providers. CEBA's goal is to achieve a 90% carbon-free U.S. electricity system by 2030 and to cultivate a global community of energy customers driving clean energy.[119]

118 https://medium.com/elia-group-engineering-blog/truly-green-energy-trades-with-blockchain-based-certificates-a-proof-of-concept-to-embed-a-232479d14c39

119 https://cebuyers.org, accessed April 20, 2022.



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