CEAP | CLEAN ENERGY ACCOUNTING PROJECT

HOURLY UTILITY PRODUCT DESIGN

Background Report | March 2025

CRS

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I. Introduction

Electricity providers are exploring product options to meet increasing demand for "hourly matched" carbon-free energy (CFE), in which CFE generation is matched to customer load in each hour. This background report summarizes current hourly product offerings; previous initiatives to facilitate or provide guidance, tools, or standards related to hourly CFE procurement; outcomes from previous technical assistance projects done with Center for Resource Solutions (CRS) related to hourly procurement, sales, or accounting; as well as relevant research. The goal is to inform working group sessions for the Hourly Utility Product Design CEAP initiative and subsequent guidance.

A. Summary of Current Hourly Products

While hourly products are relatively novel, there are many that already exist or have been offered in the energy marketplace. These products encompass customized individual corporate deals with Electric Service Providers (ESPs) and product offerings from utilities, Community Choice Aggregators (CCAs), and competitive suppliers. Below, we have summarized publicly available information relevant to deal structure and product design. However, in some cases, public information regarding supply/projects, matching level and method, generation and load data, REC/attribute ownership, reporting, and other elements of product design is very limited.

A.1. Customized Individual Corporate Deals with ESPs

Customized individual corporate deals with ESPs are made to meet the specific needs of one buyer. Many of these deals are with large technology companies pursuing hourly CFE for their data centers and other operations. Some examples of corporations entering into deals include Iron Mountain, Google, and Microsoft.

Iron Mountain

Iron Mountain, an information management services company, entered into a deal with RPD Energy and Direct Energy to source 100% renewable energy to match the hourly energy usage of Iron Mountain's two data centers and more than 60 buildings in Pennsylvania and New Jersey. RDP Energy would identify the optimal generation portfolio and retail supplier, collaborating with Axpo US to design a wholesale transaction that suited renewable developer EDP Renewables North America.

RPD Energy collaborated with multiple industry partners to identify the optimal generation mix, including a wind farm and small hydro facilities in the Northeast, to provide locally sourced power and renewable energy certificates (RECs) and match Iron Mountain's hourly consumption.[1] RPD Energy worked with Direct Energy, which sells energy in NJ and PA, to provide Iron Mountain with a monthly report to document the match of average hourly generation with Iron Mountain's actual hourly offtake from the grid. The environmental claims were substantiated through

[1] See RPD Energy. Finally, A Renewable Energy Solution That Matches Your Usage Every Hour. https://www.rpdenergy.com/finally-a-renewable-energy-solution-that-matches-your-usage-every-hour/

RECs provided by EDP Renewables North America and "sourced from the same renewable developer." [2] [3] [4]

Google [5]

Google has contracted with multiple entities in various regions to meet their goal of 24/7 CFE for all operations by 2030, including AES in Virginia, Silicon Valley Clean Energy in California, and NV Energy in Nevada.

AES [6] [7]

Google's deal with AES in Virginia will allow AES to supply Google's data centers with at least 90% 24/7 CFE under a 10-year supply contract. To meet this goal, AES built a portfolio optimization tool and assumed responsibility for every aspect of Google's energy management process in Virginia. They will be the sole supplier of the data centers' CFE needs on an annual basis, bearing the risk of under and over generation by purchasing and selling into the electricity market on an hourly basis. For this deal, AES developed or contracted a 500 MW portfolio consisting of wind, solar, hydro, and battery storage resources and selected the resources based on numerous criteria including cost efficiency, additionality, and CFE profile.

[2] See Renewables Now. Iron Mountain flags hourly renewable energy matching for data centres. (2021). https://renewablesnow.com/news/iron-mountain-flags-hourly-renewable-energy-matching-for-data-centres-738082/

[3] See Data Center Frontier. Iron Mountain Adds Hourly Renewable Energy Tracking for its Data Centers. (2021). https://www.datacenterfrontier.com/sustainability/article/11428268/iron-mountain-adds-hourly-renewable-energy-tracking-for-its-data-centers

[4] See Iron Mountain. Iron Mountain Data Centers Among the First to Track Renewable Energy by the Hour. (2021). https://investors.ironmountain.com/news-and-events/press-releases/press-release-details/2021/Iron-Mountain-Data-Centers-Among-the-First-to-Track-Renewable-Energy-by-the-Hour/default.aspx

[5] See Google. 24/7 by 2030: Realizing a Carbon-free Future. (2020). https://www.gstatic.com/gumdrop/sustainability/247-carbon-free-energy.pdf

[6] See PR Newswire. AES Announces First-of-Its-King Agreement to Supply 24/7 Carbon-Free Energy for Google Data Centers in Virginia. (2021). https://www.prnewswire.com/news-releases/aes-announces-first-of-its-kind-agreement-to-supply-247-carbon-free-energy-for-google-data-centers-in-virginia-301282750.html

[7] See The AES Corporation. Google and AES innovate the next frontier in clean energy with first-of-its-kind 24/7 carbon-free energy solution. (2021). https://www.aes.com/sites/default/files/2021-05/AES-Google-Case-Story_0.pdf

Silicon Valley Clean Energy (SVCE) [8] [9]

Google's deal with SVCE established a standard retail product where renewable and CFE energy is matched hourly with demand. Under their 10-year agreement, SVCE will match Google's demand for at least 92% of all hours in the year. The agreement establishes and utilizes a CFE measure — a 24/7 "CFE Score" which is incorporated into a commercial energy service for Google. The measure allows SVCE to build and manage an optimized portfolio of resources including wind, solar, geothermal, demand-side management, and long-duration energy storage. Google would also support this deal with its all-electric building design, including thermal and electric storage, and electric vehicle charging infrastructure, which can be flexed to use energy from the cleanest hours.

NV Energy

NV Energy and Google partnered on a grid-scale solar and storage solution to provide Google's data center with 350 MWs of solar and up to 280 MWs of battery storage for a minimum of 70% of hours annually. The agreement included a capacity-sharing mechanism where the battery cost is shared between both parties and NV Energy can dispatch the battery power during peak times.[10] Google would pay a "fixed, blended price" for the clean power from the solar-battery plant.[11]

NV Energy and Google are seeking a new tariff, the "Clean Transition Tariff" (CTT), that would provide existing customers the ability to remain retail NV Energy customers while transitioning to an energy supply agreement (ESA) to achieve specific corporate energy goals. The CTT would allow eligible non-residential customers, with a demonstrated average annual load of five MW or more, the option to receive retail electric service from NV Energy that reflects a price within an ESA for energy associated with a new energy resource.[12]

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[8] See Silicon Valley Clean Energy, & Google. Silicon Valley Clean Energy and Google's innovative 24/7 carbon-free energy agreement embraces electrification and community collaboration in advancing a clean energy future. (2022). https://www.svcleanenergy.org/wp-content/uploads/SVCEGoogle-24x7-CFE-Case-Study_FINAL_061422.pdf

[9] See Solar Builder. Google and SVCE devise a carbon-free energy plan. (2022). https://solarbuildermag.com/news/google-and-svce-devise-a-carbon-free-energy-plan/

[10] See Institute for Electric Innovation. Designing 100 Percent Carbon-free Energy Solutions: Preferences, Challenges, and Pathways Forward. (2022). https://www.edisonfoundation.net/-/media/Files/IEI/publications/IEI_Designing-100-Carbon-Free-Energy-Solutions_December-2022.pdf

[11] See Greentech Media. Google and NV Energy Invent a New Genre: The Corporate Solar-Plus-Storage Deal. (2020). https://www.greentechmedia.com/squared/storage-plus/anatomy-of-a-deal-google-and-nv-energy-make-corporate-energy-storage-happen

[12] See EPRI. Deploying 24/7 Carbon-Free Energy: Power Generation Technologies, Tariff Design, and Data Tracking. (2025). https://www.epri.com/research/products/000000003002031693

> The CTT would supply Google's Storey County data centers with 24/7 power from the Fervo geothermal plant. The tariff could speed up the facility's deployment process. The tariff stipulates that Google would pay the difference between the cost of the geothermal energy from the Fervo project and the lower-cost resource — typically solar or natural gas — that NV Energy would have deployed. In exchange for the fixed rate, Google would be credited for the energy and generation capacity on its electric bills. This deal arose because Google noticed that NV Energy had some interesting opportunities for CFE on its Integrated Resource Plan (IRP) that it did not include due to cost, so they worked with the Public Utilities Commission of Nevada and NV Energy to create this tariff.[13]

Microsoft

Microsoft contracted with AES [14] and Constellation in Virginia to receive hourly-matched CFE for their data centers. The agreement with Constellation[15] combines the environmental attributes of up to 35% nuclear power with hourly CFE matching to help the data center operate on nearly 100% clean power. Microsoft and Constellation spent several years pioneering their Azure-based hourly matching CFE platform which will allow Microsoft and Constellation to track the energy used and match it with energy produced in another location.[16] The platform provides accurate accounting and transparency, allowing Microsoft to demonstrate environmental results.[17] Additionally, the corresponding timestamped, sub-MWh Environmental Attributes Credits (EACs) were retired in PJM GATS.[18] Constellation has leveraged its Microsoft Azure-based hourly matching CFE platform and retail structuring

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[13] See Utility Dive. NV Energy seeks new tariff to supply Google with 24/7 power from Fervo geothermal plant. (2024). https://www.utilitydive.com/news/google-fervo-nv-energy-nevada-puc-clean-energy-tariff/719472/

[14] See PR Newswire. AES Announces First of-Its-Kind Agreement to Supply 24/7 Carbon-Free Energy for Google Data Centers in Virginia. (2021). https://www.prnewswire.com/news-releases/aes-announces-first-of-its-kind-agreement-to-supply-247-carbon-free-energy-for-google-data-centers-in-virginia-301282750.html

[15] See Constellation. Constellation Signs Hourly Carbon-Free Energy Matching Agreement with Microsoft to Support a Clean-Powered Data Center. (2023). https://www.constellationenergy.com/newsroom/2023/Constellation-signs-hourly-carbon-free-energy-matching-agreement-with-Microsoft-to-support-a-clean-powered-data-center.html

[16] See Data Center Dynamics. Microsoft signs 24/7 nuclear power deal with constellation for Boydton data center. (2023). https://www.datacenterdynamics.com/en/news/microsoft-signs-247-nuclear-power-deal-with-constellation-for-boydton-data-center/

[17] See Environment Energy Leader. Constellation, Microsoft to Reduce Carbon Footprint of Virginia Data Center. (2023). https://www.environmentenergyleader.com/stories/constellation-microsoft-to-reduce-carbon-footprint-of-virginia-data-center,4271

[18] See EnergyTag. Constellation's Hourly Carbon-Free Energy Agreement with Microsoft. https://energytag.org/projects/constellations_hourly_cfe_agreement_with_microsoft/

knowledge to design flexible and comprehensive solutions for customers looking to match CFE around the clock.

A.2. Utility Products

Utility products are developed by utilities looking to offer additional options to their customers. The 24/7 CFE product offerings for three regulated utilities are described below.

Entergy Arkansas

In November 2022, the Federal government announced a Memorandum of Understanding (MOU) with Entergy Arkansas for a 24/7 CFE deal. The deal stipulates that federal agencies will receive 100% CFE resources with 50% on a 24/7 basis, in line with the Biden Administration's 2030 goal for federal agencies. The MOU stipulates that public and private sector customers can utilize the regionally-sourced nuclear and renewable — solar, hydro, or wind — resources. The electricity utility tariff would support 24/7 hourly matching of CFE with consumers' electricity needs. Once the program is developed and approved, Entergy Arkansas public and private sector customers will have the option for CFE to match their electricity consumption for all hours of the day, blending both existing and new CFE resources.[19]

In 2023, Entergy Arkansas received approval for their Go ZERO offering for commercial and industrial customers. As announced via the MOU above, the Federal government worked with Entergy Arkansas in the development of Go Zero as a means to meet their 2030 goals. Go Zero provides three options to customers:

1. Option 1: a subscription to RECs retired on their behalf,
2. Option 2: a subscription for zero-emission Alternative Energy Certificates (AECs) for the customer's existing share of nuclear and hydro, with AECs retired on their behalf
3. Option 3: 24/7 Time-Match Reporting of the customer's Scope 2 emissions associated with their retail electricity purchases.[20]

The initial term for option three is one year, with automatic extensions for successive periods of one year. Option three, Time-Match Reporting, will allow customers to receive a report matching the customer's actual hourly load with the actual hourly output of solar, nuclear, and/or hydro on a 24/7 basis to which the customer is

[19] See Entergy News Room. Entergy Arkansas, U.S. government sign first MOU to work toward 24/7 carbon-free electricity. (2022). https://www.entergynewsroom.com/news/entergy-arkansas-u-s-government-sign-first-mou-work-toward-24-7-carbon-pollution-free-electric/

[20] See Entergy News Room. Entergy Arkansas gets green light for commercial customers to Go Zero. (2023). https://www.entergynewsroom.com/news/entergy-arkansas-gets-green-light-for-commercial-customers-go-zero/

otherwise subscribed. Option three is only available to customers participating in any of Entergy Arkansas' offerings where AECs and/or RECs are retired on their behalf.[21] Time-matched reporting will be available on an hourly basis for renewable energy and/or legacy nuclear and hydro resources during those hours when it was produced. Customers may select renewable matching, nuclear and hydro matching, or combined output matching, with preliminary Time-Match reporting available each quarter. Under the options above, the RECs and AECs will be third-party certified annually.[22]

The Go Zero offering allowed customers to select one of three monthly billing options: "(i) A fixed price per kWh with an annual escalator applied to the KWh produced by the customer's subscription in the corresponding designated resource(s); (ii) A fixed price per kW based on the expected output applied to the kW subscription of the designated resource(s); or (iii) A floating price per kWh tied to the actual locational marginal price of power in the MISO's wholesale power market and applied to the kWh produced by the subscribed designated resource(s)." [23]

Georgia Power Company

In 2022, Georgia Power Company (GPC) received regulatory approval to create an hourly CFE subscription service for corporate customers.[24] As described in the Institute for Electric Innovation's *Designing 100 Percent Carbon-free Energy Solutions: Preferences, Challenges, and Pathways Forward*[25], the Around the Clock (ATC) CFE subscription program is a tariff-based regulated offering for corporate customers. Georgia Power Company will procure 2100 MW of new CFE resources, including solar energy and storage. Subscribers could get 75-90% of all hours in the year. Customers must meet a minimum annual peak of 25 MW to subscribe.

Georgia Power Company will provide hourly credits for kWh of energy and capacity credits for battery storage retired on their behalf. The ATC program allows customers to subscribe to a fixed (dispatching on a set daily schedule) or optimal (using the

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[21] See Entergy. Choose your impact. https://renew-arkansas.entergy.com/go-zero/go-zero-plans
[22] See Arkansas Public Service Commission. Go Zero. (2023). https://cdn.entergy-arkansas.com/userfiles/content/price/tariffs/eal_gz.pdf
[23] See EPRI. Deploying 24/7 Carbon-Free Energy: Power Generation Technologies, Tariff Design, and Data Tracking. (2025). https://www.epri.com/research/products/000000003002031693
[24] See Georgia Power. Clean And Renewable Energy Subscription. https://www.georgiapower.com/business/products-programs/business-solutions/commercial-solar-solutions/clean-and-renewable-energy-subscription.html

[25] See Institute for Electric Innovation. Designing 100 Percent Carbon-free Energy Solutions: Preferences, Challenges, and Pathways Forward. (2022). https://www.edisonfoundation.net/-/media/Files/IEI/publications/IEI_Designing-100-Carbon-Free-Energy-Solutions_December-2022.pdf

battery for both customer and system needs) dispatch schedule for battery storage (Institute for Electric Innovation, 2022).

The 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 GPC renewable subscription program. Once established, the customer's subscription level will be fixed for the term of the agreement. The 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. [26]

Duke Energy

In 2022, Duke Energy proposed a 24/7 renewable energy expansion offering for its Green Source Advantage (GSA) program, known as GSA Choice, which has since been approved. Duke Energy's expansions to the GSA program allows a path to hourly renewable energy, with the option of a storage component. With the GSA Choice program, existing and new large business customers can contract directly with Duke Energy to provide local Clean Energy Environmental Attributes (CEEAs), generated from utility-owned and third-party-owned generation in which the company was purchased power agreements (PPAs) in place or through a three-party agreement (customer, Duke Energy, and renewable developer). Duke is increasing their capacity for CEEAs to 4,000 MW of capacity — up to 2,200 MWs of utility owned and 1,800 MWs of third-party owned assets that have entered into a two-party or three-party PPA — which will allow contracts for up to 100% of a customer's energy use.

The initial capacity for the GSA Choice program will come from ~~Duke's~~ solar resources but may include other renewable technologies in the future, with the capacity coming online beginning in 2026 and then annually into the early 2030s.. This product allows customers to work with Duke Energy and/or independent developers for their long-term purchases, has the option to combine energy storage with the project, and proposes a 10-year avoided cost bill credit option (along with the hourly 2-year and 5-year options already available). These changes and program

[26] See EPRI. Deploying 24/7 Carbon-Free Energy: Power Generation Technologies, Tariff Design, and Data Tracking. (2025). https://www.epri.com/research/products/000000003002031693

expansions will, according to Duke Energy, create a path for hourly renewable energy. More information on their GSA program is available in their filing with the North Carolina Utilities Commission.[27] [28] [29]

Duke Energy also has similar approved tariffs in South Carolina known as Renewable Choice and GSA. They also include a new proposal to let large corporate big tech customers fund technologies like advanced nuclear and long-duration storage that Duke needs to provide 24/7 clean energy options. Duke Energy has worked with Amazon, Google, Microsoft and Nucor on a plan to allow these corporations to essentially bankroll Duke's development of advanced clean energy technologies to deliver on the customers' 24/7 goals. The proposal includes new tariffs for on-site generation at customer facilities, buying power from dedicated renewables and battery storage, and a Clean Transition Tariff that would pay for emerging technologies needed for 24/7 clean energy. To help gain regulatory approval in the future, Duke would need to make it clear that regular customers would not see a cost increase.[31]

A.3. CCA Products

CCAs are qualifying government entities within an investor-owned utility service area that are permitted to procure and/or generate electricity for their residents and businesses. [27]

Peninsula Clean Energy

California CCA Peninsula Clean Energy (PCE)[28] has a pointed goal to provide all their 310,000 residential, commercial, and industrial customers with 24/7 renewable energy matched on an hourly basis. Their paper describes their procurement modeling tool, MATCH (Matching Around the Clock Hourly Energy), that they built and tested to answer critical questions about the ideal 24/7 portfolio, costs, emissions reductions, and system impacts.

MATCH is based on an existing open-source power system planning model called SWITCH and was substantially redesigned to meet PCE's time-coincident portfolio

[27] See California Public Utilities Commission. Community Choice Aggregation--Consumer Information. https://www.cpuc.ca.gov/consumer-support/consumer-programs-and-services/electrical-energy-and-energy-efficiency/community-choice-aggregation-and-direct-access-/consumer-information-on-ccas---frequently-asked-questions#:~:text=Community%20Choice%20Aggregation%20(CCA)%20is,for%20their%20residents%20and%20businesses.

[28] See Peninsula Clean Energy. Achieving 24/7 Renewable Energy by 2025. (2023) https://www.peninsulacleanenergy.com/wp-content/uploads/2023/01/24-7-white-paper-2023.pdf

modeling needs. The portfolio and dispatch optimization model identifies the cheapest portfolio to meet specified targets. The model included: resource contract cost, market revenue for generation, market cost of serving load, resource adequacy costs, REC costs, and cost premium for hedge contracts for any load not matched by bundled renewable energy contracts. In addition to MATCH, PCE used MATCH's outputs as inputs into the Ascend Analytics' PowerSimm software to analyze portfolio uncertainty in the face of future prices, weather patterns, and the associated impacts on load and supply.

MATCH suggested procuring hourly clean energy is cost effective for PCE when matched on a 99% hourly matching of renewable energy rate. Matching the final 1% to achieve 100% hourly matching of renewable energy would increase cost by 10% and would likely not have a zero-carbon intensity due to trace emissions from geothermal supply.

PCE argues that demand-side resources and storage are expected to play a role in hourly renewable portfolios but are not mature enough yet. By 2025, PCE aims to be 71% matched on an hourly basis.

Silicon Valley Clean Energy

Silicon Valley Clean Energy (SVCE) has had a carbon-free portfolio since its founding in 2016, measured on an annual basis. They have committed $1.8 billion to renewable energy facilities that would be able to meet 24/7 demand, including battery plus storage plants, long-duration storage contracts, and geothermal. Additionally, SVCE is partnering with Google to launch a service that provides customers like Google the ability to plan, commit, and track hourly delivery of carbon-free energy. The service established a standard retail product where renewable and CFE is matched hourly with electric demand and is described in the subsection on Google under customized individual corporate deals above.[29]

A.4. Application to vertically integrated utility products

Vertically integrated utilities can look to the case studies above when designing their products. Utilities can enter various long term supply deals with large corporations seeking to meet 24/7 CFE deals. Some applicable product design features include sourcing from owned and contracted resources to ensure enough capacity to meet

[29] See Silicon Valley Clean Energy, & Google. Silicon Valley Clean Energy and Google's innovative 24/7 carbon-free energy agreement embraces electrification and community collaboration in advancing a clean energy future. (2022). https://www.svcleanenergy.org/wp-content/uploads/SVCEGoogle-24x7-CFE-Case-Study_FINAL_061422.pdf

the corporation's goals, integrating demand-side management and long-duration storage, and utilizing hourly matching platforms and portfolio optimization tools.

Google and NV Energy's partnerships illustrate two key product design takeaways. The first is building a capacity-sharing mechanism to allow both the utility and the consumer to share in the costs and benefits of a solar and storage facility. The second is creating a CTT that would allow a consumer to provide necessary capital to facilitate the deployment of new CFE resources required for 24/7 CFE, without increasing prices for non-participating customers, which the utility may not have been able to afford otherwise.

Entergy Arkansas Go Zero offering shows how long-term buy-in from the Federal government can incentivize products for both public and private sector customers. With options for RECs, AECs, and Time-Match Reporting of a customer's actual hourly load and hourly output. This product was designed as a subscription and gave customers multiple choices for billing, subscribing, and matching. Another subscription offering, Georgia Power Company's ATC program is a tariff-based offering that allows subscribers to receive up to 75-90% of all hours in the year. They designed multiple restrictions to reduce risk including minimum contract lengths, a customer minimum annual peak of 25 MW, and restrictions limiting subscriptions to 100% of the customer's preceding year's projected total annual energy consumption.

Duke Energy is another interesting example for multiple proposed green tariffs. Their GSA program illustrated how expansions to existing programs can pave a path for 24/7 CFE (e.g., increased program MW capacity and adding energy storage). Along with the GSA expansion, Duke has proposed green tariffs for their South Carolina commercial customers and various other new tariffs designed to work with large corporate customers to help them meet their goals and Duke develop advanced clean energy technologies.

It is important to note that regulated utilities may have less flexibility as they must go through the regulatory approval process for their products. Duke Energy's case highlights that it is important to ensure the costs of the 24/7 CFE products do not generalize to non-participating customers. Additionally, the NV Energy and Google case show how collaborating with a corporate entity, along with the local PUC, can help develop a green tariff offering.

Publicly available information about these products and deals generally does not include details regarding REC sourcing and ownership where hourly RECs are not available, hourly customer load data acquisition (particularly for residential customers), aggregated vs. individual customer load matching where there are multiple customers participating, matching method, hourly matching reporting periods and disclosure, etc.

B. Summary of Previous 24/7 Initiatives

Increased market interest has propelled governmental bodies, non-governmental organizations (NGOs), and other varied groups to explore topics related to hourly matching, with some specifically targeting hourly utility product design. Each of the five initiatives described below can provide insight into the scope, direction, and necessity of the guidance that will be created from the Hourly Utility Product Design CEAP initiative.

B.1. Regulatory Assistance Project (RAP) [30]

In 2023, the Regulatory Assistance Project (RAP) launched an initiative to, "define the optimal design of 24/7 transition tariffs and contracts for participants and broader electricity systems." The goal was to standardize tariffs to accelerate offerings and adoption. For eight months, RAP hosted monthly meetings with a variety of stakeholders (utilities, end users, federal and state governments, and nonprofits) with an average of 60 attendees per meeting and 140 stakeholders on the distribution list, collecting significant feedback on drafts and presentations. To ensure the right questions were prioritized, stakeholders were organized into three specialized working groups and joined by subject matter experts. The findings and recommendations of the working groups, along with the research undertaken by RAP staff, are detailed in the four appendixes of the report:

1. Appendix A: Resource Planning Requirements — for integrating 24/7 CFE portfolios into utility and system planning.
2. Appendix B: Emissions tracking and Verification — best practices to ensure 24/7 CFE portfolios have the intended emissions outcomes.
3. Appendix C: Rate-Making, Pricing and Resource Compensation — best practices and near-term recommendations.
4. Appendix D: Operational Requirements — to implement integrated 24/7 CFE portfolios in distribution and bulk system operations.

The research and working group guidance resulted in the identification of fundamental design recommendations to help regulators, utilities, and customers develop 24/7 transition tariff offerings. The five fundamentals for creating a 24/7 transition tariff offering outlined by the RAP project are:

1. Integrate transition tariff investments with ongoing utility planning
2. Ensure accurate hourly emissions tracking and verification
3. Design transition tariffs to accelerate complementary investments
4. Employ rate design to ensure fairness and to align carbon-free electricity grid needs with pricing and compensation

5. Integrate operating systems to implement hourly matching

For Fundamental No. 2, to ensure accurate hourly emissions tracking and verification, the RAP project identified five key recommendations. These included recommending that load serving entities (LSEs) provide hourly customer load data in a standardized format, employ consequential and attributional accounting, rely on publicly available emissions data or best available calculated emissions and energy data, define geographic market boundaries based on energy delivered (or capable of being delivered) and treat participating and non-participating customers fairly in the allocation of existing CFE resource mixes. For Fundamental No. 3, to design transition tariffs to accelerate complementary investments, the RAP project identified one key recommendation: that customers should receive clear information on existing investments and the impact of their customer-driven investments. For Fundamental No. 5, integrating operating systems, the RAP project identified three key recommendations. These included consulting the latest standards when developing products, implementing products based on actual data first, and implementing products based on forecast data second.

The RAP project suggests that the above Fundamentals would help 24/7 CFE transition tariffs be designed in a fair way and can be tailored to specific markets or customers to help increase their effectiveness.

B.2. United Nations Carbon Free Energy Compact [31]

The 24/7 Carbon Free Energy Compact (UN Energy, 2021) is comprised of an international group of market actors (energy buyers, energy suppliers, governments, system operators, solutions providers, investors, and others) on a mission to fully decarbonize electricity grids through hourly CFE. The Compact defines 24/7 CFE as meeting every kWh of electricity consumption with CFE sources, every hour of every day, everywhere. And the goal of the compact is to spur action towards net-zero goals through voluntary, trackable commitments submitted by governments, corporations, international organizations, philanthropies, and other stakeholders towards achieving the clean energy transition.[32]

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[30] See Regulatory Assistance Project. 24/7 Carbon-free electricity transition tariffs: A regulatory tool for accelerating decarbonization. (2024). https://www.raponline.org/wp-content/uploads/2024/03/rap-linvill-enterline-farnsworth-kadoch-lebel-seidman-24-7-carbon-free-electricity-transition-tariffs-summary-2024-march.pdf

[31] See United Nations. The 24/7 Carbon Free Energy Compact. (2021)https://www.un.org/sites/un2.un.org/files/2021/10/24-7cfe_compact_-_v2_updated.pdf

[32] See United Nations. Energy Compacts. https://www.un.org/en/energycompacts/page/about

The Compact outlines a set of five principles and actions that stakeholders across the energy sector can take to drive change:

1. Procurement that moves beyond annual matching goals to 24/7 CFE procurement and matches local generation to where the consumption occurs.
2. Market Mechanisms driven by suppliers and solutions providers' commitment to increasing access to 24/7 CFE.
3. Policy that accelerates grid decarbonization.
4. Technology that advances grid infrastructure, software solutions, demand optimization, and commercialized CFE generation.
5. Data and Transparency advocacy and support for widespread access to data required to enable consumers to set and measure 24/7 CFE goals.

The Compact is supplemented by a 24/7 CFE procurement principles document which outlines five key procurement principles:

1. Time-matched procurement on an hourly basis
2. Local procurement on the local/regional electricity grids where consumption occurs
3. Technology-inclusive for all carbon-free technologies
4. Enable new generation to support rapid decarbonization
5. Maximize system impact by focusing on emissions reductions and solving the dirtiest hours.[33]

The Compact encourages all stakeholders to sign and commit to the principles and actions laid out above in order to achieve hourly CFE.

B.3. Clean Energy Buyers Institute (CEBI) Next Generation CFE Procurement Guide [34]

The Clean Energy Buyers Institute (CEBI) organized a workshop series with over 100 organizations to create the Next Generation Carbon-Free Electricity Procurement Guide. The guide seeks to encourage the market to improve procurement options and empower customers to play a greater role in decarbonizing the grid and reaching hourly CFE. The guide provides a "customer-oriented, market system stakeholder-specific roadmap for specific updates that EAC issuing bodies and

[33] United Nations. Call To Action: 24/7 Carbon-free Energy Compact to Accelerate the Decarbonization of Electricity Grids. (2021). https://www.un.org/sites/un2.un.org/files/2021/09/principles_-_updated.pdf

[34] See Clen Energy Buyers Institute (CEBI). The Next Generation Carbon-Free Electricity Procurement Activation Guide. (2022). https://cebi.org/wp-content/uploads/2022/10/Community-Guide_Oct31st_v1.pdf

registries, data providers, customer leadership programs, and greenhouse gas (GHG) accounting standards bodies must make to activate new CFE procurement solutions." The initiative found eight customer-identified objectives for procurement:

1. Procurement of demand-side, complementary, and/or CFE resources
2. 24/7 matching of energy consumption with local CFE
3. CFE procurement to cover the most carbon-intensive times of day
4. CFE procurement to cover the most carbon-intensive locations
5. CFE procurement to cover electricity use across the value chain
6. Over-procurement of CFE applied to regions without procurement options
7. Motivate systemic grid decarbonization beyond the organization's operations
8. Social and community benefits that promote further grid decarbonization.

To enable the customer-identified procurement options, the guide identifies four key updates needed to for these expanded CFE procurement options:

1. New EAC attributes, including "hourly or sub-hourly timestamps, tags for all CFE resources, tags for complementary resources, snapshot of grid carbon intensity, and tags for social and community credentials – with underlying data"
2. Access to more granular and consistent data
3. New customer leadership programs
4. Clarifications and gap-filling (using a subset of data to estimate missing data) in greenhouse gas accounting

The purpose of the guide was to provide practical recommendations on how four specific types of market stakeholders — EAC issuing bodies and registries, data providers, customer leadership programs, and GHG accounting standards bodies — can make updates to enable expanded CFE procurement options.

B.4. EnergyTag

EnergyTag is an independent industry-led initiative working to accelerate the shift to 24/7 clean energy.[35] The non-profit is "defining and promoting net-zero aligned electricity carbon accounting, enabled by real-time tracking with Granular Certificates." [36] To serve its mission, EnergyTag is engaging in three pillars: standards development for granular certificates (GCs) and hourly matching, enabling markets and projects, and encouraging policy that uses granular accounting.[37]

[35] See EnergyTag. EnergyTag Whitepaper: Accelerating the transition to 24/7 clean power. (2023). https://energytag.org/wp-content/uploads/2023/09/EnergyTag-Whitepaper.pdf
[36] See EnergyTag. Carbon accounting & tracking for 24/7 clean grids. https://energytag.org/
[37] See EnergyTag. Carbon accounting & tracking for 24/7 clean grids. https://energytag.org/

EnergyTag is working with over 100 organizations to develop a mechanism or framework to 'tag' EACs with a timestamp. They are committed to providing guidelines for market participants and service providers to increase time granularity of existing EACs and coordinating demonstrator projects around the world to grow the global voluntary hourly certificate market. One such project is French energy retailer ekWateur that is using the Powerledger platform to provide retail customers with the choice to pick their own energy mix. They tracked 1.67 GWh on a 30-minute temporal matching for up to 22,000 customers in 2024.[38]

EnergyTag's Granular Certificate Scheme Standard[39] outlines the requirements to create an EnergyTag compliant Granular Certificate (GC) Scheme. This Scheme Standard is intended to supplement or replace an EAC and complement the evolution of an existing scheme for electricity tracking. The Standard states that GCs could help track and verify hourly matching of clean energy. It outlines key market participants including GC issuers, producers, consumers, registries, and measurement bodies who would play a role in the GC scheme. The Standard defines three different configurations for the relationship between GC and EAC schemes:

1. GC schemes evolve out of EAC schemes, such that the current EAC issuer becomes a GC issuer,
2. GC scheme supplements EAC scheme and is managed by verified third-parties,
3. GC scheme is based on canceled EACs where the GC Issuer ensures the EACs are canceled before issuing GCs.

Each of these models is intended to prevent double counting of the environmental attributes and help enable hourly energy matching. EnergyTag's GC Scheme Standard could be used by suppliers to make verified 24/7 CFE claims to customers. It also includes storage provisions to have storage records include charge and discharge timestamps to ensure accurate time-based matching and discusses how to properly account for storage.

Along with the GC Scheme Standard, EnergyTag put out an accompanying GC Matching Standard[40] to provide guidance on matching GCs to consumption. The GC Matching Standard identifies key stakeholder roles for the matching process including producers, GC issuers, matchers, independent claim verifiers checking the GCs are matched correctly, consumers/suppliers, and measurement bodies ensuring accurate reporting. The Standard outlines three main types of matching:

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[38] See EnergyTag. 24/7 CFE – The Retailer's Role. https://energytag.org/projects/24-7-cfe-the-retailers-role/

[39] See EnergyTag. Granular Certificate Scheme Standard. Version 2. (2024). https://energytag.org/wp-content/uploads/2024/12/EnergyTag_Granular-Certificate-Scheme-Standard-V2.pdf

[40] See EnergyTag. Granular Certificate Matching Standard. Version 1. (2024). https://energytag.org/wp-content/uploads/2024/03/Granular-Certificate-Matching-Standard_V1.pdf

1. Temporal matching where GCs must be matched in the same hour
2. Geographic matching where GCs must be sourced from the same or interconnected grid region
3. Attribute matching of additional criteria

To match GCs properly, hourly or sub-hourly energy consumption data should be used when possible. If (sub)hourly data is unavailable, hourly data from sub-metering systems and monthly billing should be acceptable. If not available, load profiles to estimate the distribution of (monthly or annually measured) consumption over specific (sub)hourly periods can be used during a temporary transition period.

B.5. Institute for Electric Innovation: Designing 100 Percent Carbon-free Energy Solutions: Preferences, Challenges, and Pathways Forward [41]

The Institute for Electrical Innovation (IEI) and World Resources Institute (WRI) co-hosted the 100% CFE workshop series, which was attended by seven regulated electric utilities and six corporate customers. The workshops aimed to explore how to "scale 24/7 CFE offerings by electric companies, beyond the one-on-one transactions seen to date." The goal was to understand customer demand for hourly 100% CFE, challenges of scaling offerings to a broader customer base, possible offering designs, data needs, and which attributes matter most to customers (cost, whether the resources are new or existing, resource types, and demand-side resources).

The workshop hosts sent a questionnaire to customers asking about their preferences for differentiated CFE products. Customers preferred CFE options that matched a lower percentage of hours at no cost premium versus a higher percentage of hours at a cost, suggesting concerns over price outweigh interest in being fully carbon-free. Customers also preferred CFE options with a higher percentage of hours using all CFE resources over matching a lower percentage of hours with only new resources, suggesting customer interest in additionality is low. Customers showed preference for options that increase the amount of CFE on the grid. Customers asked for easy access to real-time hourly load data, hourly grid resource mixes and associated carbon emissions data, and access to electric companies' annual energy mix forecasts. To ease offering development and

[41] See Institute for Electric Innovation. Designing 100 Percent Carbon-free Energy Solutions: Preferences, Challenges, and Pathways Forward. (2022). https://www.edisonfoundation.net/-/media/Files/IEI/publications/IEI_Designing-100-Carbon-Free-Energy-Solutions_December-2022.pdf

customer interaction, customers demonstrated an interest in shared solutions, demand-side resources, and verification.

The report also highlighted some important product design considerations. For example, when designing a product, certain restrictive qualifying criteria such as quantity of load required, load shape, new versus existing loads, and subscription length, caused some concern for customers. They stated their desire for flexibility in their participation commitments, like short-term contracts and subscription options at different load percentages. Ultimately, the report highlights that offerings should gather customer input for product design to ensure program success. However, electric companies claim aligning on "subscription length and terms is necessary to balance risks inherent in long-term ownership of new resources", suggesting flexibility isn't always possible.

Additionally, regulatory considerations surrounding the length of the regulatory process for green tariffs were explored. The report highlighted a need to accelerate regulatory approval by making a set of minimum criteria that a CFE offering must satisfy and establishing a stakeholder review process. Developing an agreed upon set of criteria could reduce regulatory approval time, enable companies to design products that meet regulator expectations, and allow more flexible offerings.

B.6. Application to vertically integrated utility products

Vertically integrated utilities can learn from the RAP, UN, CEBI, EnergyTag, and IEI initiatives described above. The RAP initiative identified five fundamentals that vertically integrated utilities could follow when creating 24/7 transition tariff offerings. These fundamentals include integrating transition tariff investments with ongoing utility planning, accurate emission tracking, designing tariffs that accelerate investments, ensuring fairness, and integrating operating systems. Each of these fundamentals can be tailored to specific markets and customers.

While the UN Compact didn't discuss tariff design, it did provide five key principles for 24/7 CFE procurement which utilities can incorporate. The principals for procurement are time-matched, local, technology-inclusive, enable new generation, and maximize system impact by focusing on the dirtiest hours. Utilities may want to consider these attributes in their program design. Some of these attributes align with CEBI's customer-identified objectives. These objectives include demand-side and complementary resources, local matching, procurement to cover the most carbon-intensive hours and locations, apply over-procurement to cover areas without procurement options, and social and community benefits.

The EnergyTag initiative provides a different scope of product design considerations. EnergyTag's focus on establishing Standards — GC Scheme Standard and GC Matching Standard — provides utilities with an outline for how to use, track, verify, and match GCs for hourly matching. EnergyTag encourages the use of granular certificates to account for hourly CFE products and prevent double counting of environmental attributes. It provides suggestions for how GCs should be created and used and how utilities can match GCs to load. Utilities may use hourly RECs, incorporate storage, and match generation to load in line with EnergyTag guidance.

In addition to CEBI's workshops, the IEI workshop series highlighted a different set of customer preferences for designing offerings. They stated that customers preferred CFE options that matched a lower percentage of hours at no cost premium versus a higher percentage of hours at a cost, suggesting concerns over price outweigh interest in being fully carbon-free. Customers preferred more use of all CFE resources than less use of only new resources. Additionally, customers wanted flexibility in subscription length commitments, options for different load profiles, and less restrictive qualifying criteria.

C. Summary of Outcomes from CRS Technical Assistance Projects

Center for Resource Solutions (CRS) provides mission-driven advisory services to help organizations navigate their clean energy transitions and achieve impactful decarbonization goals. Through these services, CRS provides market research and policy recommendations, verification and audit protocol development, best practices and guidance documents, reviews and guidance on organizational standards and materials, and more, for a variety of clients in the US and internationally, including electricity consumers, utilities, government agencies, tracking systems and other functional support entities. CRS has completed three CRS technical assistance projects related to hourly procurement, sales, and/or accounting. They are summarized below.

C.1. Utility X

CRS assisted Utility X, a vertically integrated utility outside of the US, with hourly product design specifications and developed a verification protocol for the product. As part of the process, CRS proposed product design options for how the product could be sold. The product offering options, which could be selected by the utility or provided as options to customers, included:

1. Purchasing the maximum percentage available to match hourly RECs to the customer's overall hourly electric load (averaged over the course of each month); or
2. Enrolling by MW of capacity of the dedicated facility/facilities and receive the associated hourly RECs; or
3. Enrolling to receive a specified percentage (e.g., up to 80%) of the customer's overall hourly electric load, averaged over the course of each month; or
4. Purchasing the maximum percentage available to match hourly RECs to specific windows of the customer's electric load (for example, to match the electricity consumed to manufacture a specific product in a factory)

In addition to the product options, CRS provided suggestions for how to design the offering. This included allowing customers to choose different term lengths (3-year, 5-year, or 10-year), specifying whether priority for hourly delivery goes to customers on a first-come, first-served basis, and highlighting the importance of providing customers with detailed information of what they received. This information could be presented in the form of a Prospective Product Content Label (PPCL) delivered upon sign up or before the reporting year and a Historical Product Content Label (HPCL) provided within three months after delivery. The PPCL and HPCLs would detail the resource type, location, "New Date" of the facilities, and other pertinent

information. CRS also specified the type of information that should be presented on the digital Real Time REC including the name of the customer, the name of the facility, resource type, amount of electricity purchased, percentage of load that was matched, direct CO2e emissions associated with the electricity production, unique digital REC number, and issue date of the REC.

The project noted that matching would be done at about 90% hourly matching of CFE. Even though the project sourced from one large facility, guaranteeing a higher rate did not seem feasible at the time. The 90% limitation was due to the way they designed their supply. Portfolio diversification could have allowed the utility to match at a higher percentage, but this was not the primary goal for Utility X.

C.2. Utility Y

CRS assisted Utility Y, a vertically integrated utility in the US, with the development of a verifiable resource mix and emission rate. For both their general and green tariff customers, they planned to match hourly CFE for load aggregated on annual timeframes. CRS reviewed and analyzed the Utility's products and facilitated an audit process.

The general and green tariff product review consisted of a review of the product structure (generation facilities, market purchases, retail sales), energy accounting system design and hourly tracking approach (customer load data, emissions accounting for non-renewables), resource allocation approach (stacking methodology for allocating resources at the lowest variable cost), emissions allocation to grid purchases (transparent disclosures for purchases), and Scope 2 emissions calculation.

CRS analyzed Utility Y's product types and relayed best practices for energy accounting and customer disclosures. This consisted of a verification protocol which could be used by a third-party auditor to verify the delivery of resources to customers.

Due to the difficulty of procuring at a 100% hourly matching of renewable energy, this project heavily focused on emissions accounting for the non-renewable piece of the products sold by the regulated Utility Y.

C.3. Readiness for Hourly: U.S. Renewable Energy Tracking Systems (add footnote)

The Readiness for Hourly: U.S. Renewable Energy Tracking System report evaluated the capabilities and potential plans of U.S. renewable energy tracking systems to track data on a more granular level. The U.S. has nine REC Tracking Systems which track quarterly and monthly EACs. They play an essential role in verifying the delivery

and/or use of renewable electricity in the U.S and are a key source of data for Renewable Portfolio Standards (RPS), voluntary transactions, and renewable utility product design.

The Readiness for Hourly report identified that most of the U.S. REC tracking systems could phase-in hourly tracking in about one to two years after the decision to implement hourly tracking is made, except for WREGIS which had an estimated phase-in of three to five years. At the time of publication, three systems (M-RETS, NAR, and PJM-GATS) had some level of hourly tracking functionality. Manual processes and monthly/quarterly tracking system reports could be used in place of hourly system tracking, where hourly tracking functionality is unavailable.

For those hoping to incentivize the development of hourly tracking the Readiness for Hourly report identifies key challenges and obstacles including costs, interactions with state RPS compliance programs, low demand, lengthy stakeholder engagement processes, and data availability.

C.4. Application to vertically integrated utility products

Vertically integrated utilities can find many key takeaways from the CRS Technical Assistance projects described above, including specific product design options for vertically integrated utilities, and related emissions accounting information. Design options for utilities include:

1. Purchasing the maximum percentage available to match hourly RECs to the customer's overall hourly electric load (averaged over the course of each month); or
2. Enrolling by MW of capacity of the dedicated facility/facilities and receive the associated hourly RECs; or
3. Enrolling to receive a specified percentage (e.g., up to 80%) of the customer's overall hourly electric load, averaged over the course of each month; or
4. Purchasing the maximum percentage available to match hourly RECs to specific windows of the customer's electric load (for example, to match the electricity consumed to manufacture a specific product in a factory)

Additional considerations for product design include contract term lengths, establishing a priority for hourly delivery, highlighting the importance of detailed information provided to customers, establishing criteria for the age of a facility and clarifying the percentage of matching a customer can receive.

The readiness for hourly report includes information related to data and tracking information that may be available to utilities. Utilities should also be mindful of where they are located and the types of data availability in their region. If they would

like to encourage better data availability and incentivize hourly CFE, utilities can engage with regional tracking systems, state regulators, and state PUCs.

D. Summary of Research

In recent years, academic and stakeholder research on hourly matching has increased. Five such publicly available research papers with application to hourly utility product design have been summarized below. This section does not encompass all relevant papers but can provide insight into the scope and direction of research papers on this topic. This report summarizes key findings in selected resources and does not evaluate the validity of such findings.

D.1. 24/7 Clean Power Purchase Agreements [42]

The Long Duration Energy Storage (LDES) council and McKinsey & Co., in *A path towards full grid decarbonization with 24/7 clean Power Purchase Agreements*, argue for a new form of PPA — a 24/7 clean PPA. They cite that current PPAs are either pay-as-produced or match demand annually and can only achieve 40-70% decarbonization of an off-taker's electricity consumption, and that traditional PPAs enable new generation but not full system decarbonization due to a mismatch between renewable supply and off-taker demand. However, they claim achieving 100% decarbonization with PPAs is possible with novel energy storage technologies such as LDES. The paper defines LDES as a technology that can deploy competitively, store energy for long time periods, can be scaled economically, and can contribute to decarbonization.

The LDES Council argue that the 24/7 Clean PPA addresses decarbonization challenges because it is available now and only relies on a contract between a buyer and a PPA provider. One barrier to the 24/7 Clean PPA is that lithium-ion storage has high-cost premiums. LDES could address that barrier by reducing the costs of a 24/7 Clean PPA, if more widespread deployment occurs to drive down prices. The report lists four potential standards based on ambition levels: entry level, silver, gold, and platinum — with varying criteria like matching at 80% versus 98%, whether it supports new capacity deployment, and support of flexible capacity.

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[42] See LDES Council. A path towards full grid decarbonization with 24/7 clean Power Purchase Agreements. https://www.ldescouncil.com/assets/2205_ldes-report_247-ppas.pdf

D.2. Zero Lab: System-level Impacts of 24/7 Carbon-free Electricity Procurement[43]

This Princeton Zero Lab study analyzed the electricity system-level impacts of 24/7 CFE procurement. With modeled impacts in California and PJM Interconnection and comparison models of either no voluntary procurement or 100% annual matching of renewable energy procurement. This is an impact analysis and does not go into depth on matching, trading, or other product design factors. Results suggest that 24/7 procurement can lower emissions rates for participating C&I customers and help transform electricity systems by accelerating the deployment of clean firm resources, such as geothermal, nuclear, natural gas with carbon capture and storage, gas with zero-emissions fuels, and LDES. However, such deployment and 24/7 matching comes at a potentially significant cost premium. Additionally, the report suggests that reaching 100% CFE appears to have much higher costs in the PJM Interconnection than in California. This is due to current resource maturities in the regions, including lower levels of wind and solar resources in PJM and gas-fired generators are the marginal supply during more hours of the year.

D.3. Pathways to Integrating Customer Clean Energy Demand in Utility Planning[44]

This paper from WRI explores the potential for utilities and customers to have greater alignment between utility resource planning and large customer decarbonization goals through a more collaborative Integrated Resource Plan (IRP) process. IRPs are the most common form of long-term resource plans for vertically integrated utilities, and they prioritize the delivery of reliable resources at the lowest system-wide cost. Utilities have begun incorporating customer demand for clean energy into their IRP process, and some large corporate customers have begun tracking and getting involved in utility IRP processes. The paper argues for the benefits of stakeholders' input in driving innovation in resource planning practices.

This paper breaks down the steps and elements of IRPs as a starting point for customers looking to become engaged with their utilities' IRP process and reflects on improvements that could be made to increase collaboration in the future. The authors outline the following steps in:

[43] See Princeton University Zero Lab. System-level Impacts of 24/7 Carbon-free Electricity Procurement. (2021). http://www.raabassociates.org/Articles/Jenkins-Princeton%20Carbon-Free-Electricity%20Study.pdf

[44] See Ratz, H.B., & Bird, L.Pathways to Integrating Customer Clean Energy Demand in Utility Planning. (2019) https://wriorg.s3.amazonaws.com/s3fs-public/uploads/pathways-integrating-customer-clean-energy-demand-utility-planning.pdf

1. Develop demand forecast and review existing resources
2. Identify goals and regulatory requirements
3. Develop candidate resource portfolios using investment modeling
4. Compare how portfolios perform under a variety of futures using production cost modeling
5. Select preferred portfolio
6. Utility files plan and supporting documents with commission.

Ultimately, the paper argues that collaboration between utilities and customers is mutually beneficial. Collaborating early in the IRP process and having a robust stakeholder process, that allows for continued collaboration, helps utilities and customers meet their clean energy goals. Collaboration can lead to help from customers in integrating new resources. However, innovation will be needed to help align layered goals and IRP process improvement to further collaboration.

D.4. 24/7 Carbon-free Energy: Matching Carbon-free Energy Procurement to Hourly Electric Load [45]

In 2022, the Electric Power Research Institute (EPRI) released a whitepaper on *24/7 Carbon-Free Energy: Matching Carbon-Free Energy Procurement to Hourly Electric Load*. The whitepaper aimed to describe the growing interest in 24/7 CFE and the opportunities and challenges facing electric companies in creating 24/7 products and services. The paper identified several challenges and benefits to 24/7 CFE. The benefits included customer retention, customer acquisition, and product differentiation. The challenges included deployment of CFE technology, regulatory considerations, transmission infrastructure, data needs, mismatch between physical delivery of electricity and contracted supply, limited commercial and industrial customer demand, need for customized power supply agreements, market pricing and cost premiums for 24/7 CFE, suitable load-shapes, addressing asymmetric financial and operational risks, and potential required excess capacity needed to meet 24/7 CFE demand.

Key takeaways from research and interviews conducted by EPRI included that demand for 24/7 CFE has consisted of very few active CFE buyers (the largest in the U.S. being the Federal Government per implementing Executive Order 14057, which has been rescinded) and that future demand for 24/7 CFE could be reduced by

[45] See EPRI. 24/7 Carbon-free Energy: Matching Carbon-free Energy Procurement to Hourly Electric Load. (2022). https://www.epri.com/research/products/000000003002025290

corporate buyers looking to maximize marginal GHG emissions impact. Additionally, power suppliers face many challenges to 24/7 CFE products including:

1. Pricing — which can be difficult if customers do not want to pay a premium for 24/7 CFE projects.
2. Identifying suitable projects — from limited large-scale resources that can provide 24/7 (wind, solar, nuclear, hydro, biomass, and geothermal) and matching available resources with buyer preferences, especially if there are location-based preferences.
3. Potential overbuilding of resources — to meet contractual supply requirements, with some suppliers suggesting they need to develop two or three times the capacity to meet instantaneous electricity demand.
4. Load shapes — if the load is not flat, it can be difficult to design an offering for multiple customers. A potential solution is to create product types for customers with similar load profiles (e.g. retail stores).
5. Addressing asymmetric financial and operational risks — associated with these new types of PPAs.
6. Developing new supply agreements and regulated tariffs — a time intensive process taking months or years.
7. The lack of infrastructure needed to match customer load to unit specific CFE on an hourly basis.
8. Variety of data-related challenges.

D.5. Deploying 24/7 Carbon-Free energy: Power Generation Technologies, Tariff Design, and Data tracking [46]

This report from EPRI summarizes findings from EPRI's 24/7 Carbon-free Energy Buyers Forums, a collaborative project that convened interested buyers and sellers of 24/7 CFE offerings to uncover key barriers to product deployment. The resulting report addresses three key questions relating to- identified barriers:

1. What generation resources may qualify to be 24/7 CFE and what are their costs and performance?
2. How can energy supply agreements (ESAs) and utility tariffs be designed to facilitate deployment?
3. How can power generators and end-use customers track, and report 24/7 CFE data and information?

[46] See EPRI. Deploying 24/7 Carbon-Free Energy: Power Generation Technologies, Tariff Design, and Data Tracking. (2025). https://www.epri.com/research/products/000000003002031693

The conclusions drawn can help electric companies potentially interested in developing new 24/7 CFE products and related services to better define the generation technologies that may underpin a 24/7 CFE offering, develop commercial terms and arrangements to deploy 24/7 CFE, and gain a more thorough understanding of the types of data and information that customers will expect to obtain from their electric company related to purchasing 24/7 CFE products. The information and insights presented in this report can help C&I buyers of 24/7 CFE to better define the generation technologies they might consider accepting as 24/7 CFE, understand different elements of energy supply agreements and tariffs related to 24/7 CFE and current and potential future approaches to track and report data and information related to 24/7 CFE.

D.6. Application to vertically integrated utility products

Vertically integrated utilities can take many lessons from the research and papers available today, particularly related to supply options and deal structure or agreement type. The 24/7 Clean PPA argues for the benefits of hourly PPAs and their ability to incentivize flexible capacity like LDES storage. The LDES storage technology could be helpful for utilities to explore as widespread adoption will help reduce cost. The Zero Lab report illustrated that 24/7 portfolios typically have non-renewable clean resources including geothermal, nuclear, natural gas with carbon capture and storage, gas with zero-emissions fuels, and LDES, while annual matching had only renewable resources (wind and solar). Utilities may want to consider which technologies they want to include or prioritize and whether they want to offer hourly renewable products and/or hourly clean products. Additionally, the Zero Lab report model demonstrated higher costs of 100% CFE in the PJM Interconnection as compared to California. Utilities should consider geographic boundaries when modeling resources.

Additionally, according to the WRI report, when designing new product options, utilities may want to engage with customers who have the potential for flexible load, consider their grids when designing procurement strategies, and create a collaborative environment during the IRP process. According to EPRI's 2022 research, utilities should understand the challenges and benefits to 24/7 CFE. The benefits identified in the research included customer retention, customer acquisition, and product differentiation while the challenges included pricing, identifying suitable projects, potential overbuilding of resources, load shapes, financial and operational risks, and more. These benefits and challenges could be helpful when considering product objectives.

Another avenue for utilities is to consider the varied and complex structures of current 24/7 tariff options. EPRI's 2025 report suggests the importance of restricting any impacts on non-participating customers, especially avoiding any cost increases. EPRI also described the three types of agreements — PPAs, ESAs, and utility tariffs — for 24/7 products. These agreements can be used by utilities to create offerings tailored to specific customers or more general subscription-based offerings. Though regulated utilities may have less flexibility, EPRI outlines multiple types of offerings that can be referenced.

II. Conclusion

This background report summarizes public information about current hourly products, previous initiatives, outputs of CRS technical assistance projects, and selected relevant papers and research. The intent of this report was to reflect on each of these subcategories to inform future guidance on hourly utility product design for vertically integrated utilities in regulated markets. Although there has been a lot of research and examples of hourly product design, many questions and challenges remain. Some of the challenges identified in this background report include:

1. Few and varied real-world deals and products to-date, limited to a small number of customers.
2. Prevalence of existing resources essential to hourly matching (demand-side resources and flexible capacity storage).
3. Difficulties in creating “off-the-shelf" products that can be used by a broader set of customers with different load profiles.
4. Designing products that offer customers flexibility (e.g., contract terms and load minimums) while also reducing risk for utilities in procuring new resources.
5. Clear and transparent data.
6. Regulatory challenges (green tariff approval process, interaction with state regulators, and PUC interaction).

Additionally, some key takeaways and guidance identified above include:

1. Customized individual deals can be designed in a manner that allows utilities to develop new CFE resources at an accelerated rate, extend benefits of the new technology to other customers, and avoid cost increases to non-participating customers.
2. New Green Tariffs and expanded existing tariffs can help incentivize emissions reductions in the dirtiest locations and hours through design principles that prioritize customer objectives relating to 24/7 matching, deployments of new CFE technologies, fixed pricing schemes, specific resource types, new deployments, and 24/7 matching.
3. Customer objectives align with creating a carbon-free grid and providing hourly renewable energy, though cost may be a significant concern.
4. Utilities can look to EnergyTag’s demonstrator projects and frameworks for timestamped EACs to learn more about how the product can be designed and what tools are available.
5. Utilities can look to the preferences, challenges, and guidance outlined by IEI to offer a broader set of customers with 100% hourly CFE products.

6. If they would like to encourage better data availability and incentivize hourly CFE, utilities can engage with regional tracking systems, state regulators, and state PUCs.
7. Utilities may want to engage with customers who have the potential for flexible load, consider their grids when designing procurement strategies, and create a collaborative environment during the IRP process.

The CEAP Hourly Utility Product Design working group will collaborate to create a guidance document that will help vertically integrated utilities in regulated markets understand the types of specifications and considerations that must be evaluated when designing an hourly utility product offering.

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