CEAP | CLEAN ENERGY ACCOUNTING PROJECT

Accounting for Transacted Timestamped Information

Background Report | March 2025

CRS

Table of Contents

Introduction

U.S. clean energy markets are increasingly moving toward more granular, time-based accounting of clean electricity generation and consumption, driven by evolving policy frameworks and corporate sustainability goals that emphasize sub-monthly (including hourly) carbon-free electricity (CFE). However, the market infrastructure needed to support this level of temporal alignment is still developing.

Historically, most energy attribute certificates (EACs) have been issued with monthly or quarterly vintages and traded on an annual basis. These instruments have played an important role in supporting compliance with state Renewable Portfolio Standards (RPS), providing financing streams for renewable energy projects, and enabling voluntary clean energy procurement by corporate buyers. But their temporal resolution makes it difficult to align clean electricity generation with load at a sub-monthly level.

Hourly EACs address this by incorporating a timestamp that specifies not only the month, but also the day and hour of generation, enabling more precise matching between electricity produced by a particular resource and its ultimate consumption. These certificates are not yet available at scale in North America, however, leaving market participants to either over- or under-procure monthly or quarterly certificates to meet their hourly matching targets. To bridge this gap, a growing number of participants are transacting not just certificates, but the underlying hourly generation information itself — exchanging generation profiles or "shapes" through interim solutions such as splicing EACs into hourly components and adapting legacy power purchase agreements (PPAs). These mechanisms help market participants balance over- and under-procurement, fill hourly gaps, and optimize procurement strategies, while maintaining the credibility and transparency central to clean energy accounting and the liquidity necessary for well-functioning markets.

This Report provides a background overview of the evolving policy landscape, the current market for hourly EACs, and how these certificates and associated information are being traded and transacted today.

Policy and Market Context

Evolving Standards

The shift toward more granular matching is being driven by several developments in power system operations, policy design, and carbon accounting. Growing concern about renewable energy intermittency and system reliability has focused attention to where and when clean energy is being generated. Policymakers and market participants are also placing greater emphasis on deliverability and grid impacts, including marginal emissions, hourly price signals, and incentives for clean energy deployment. All of this was reinforced by federal policy; the Inflation Reduction Act passed in 2022 required hourly-based matching for tax credit eligibility for low-

carbon fuels, though few projects will now qualify under the One Big Beautiful Bill Act.[1]

Global greenhouse gas (GHG) accounting and reporting frameworks are currently being updated with increasing focus on temporal alignment. The Greenhouse Gas Protocol (GHGP) Corporate Standard, which serves as the basis for most corporate emissions reporting, is undergoing revisions from 2023 through at least 2027. As of January 2026, proposed revisions to the Scope 2 Guidance would require companies[2] reporting market-based emissions to source certificates that are issued and retired within the same hour as the electricity consumption they represent.[3] These provisions have not yet been finalized.

The Science-Based Targets initiative (SBTi) draft Corporate Net-Zero Standard recommends the use of spatially and temporally aligned certificates wherever possible.[4] Similarly, RE100's 24/7 Technical Criteria require that, for RE100 members to make a credible CFE usage claim, the vintage of the clean energy attributes must fall within the same hour as the electricity consumption to which they are applied.[5]

Taken together, these policy and framework developments represent a significant shift in carbon accounting; hourly matching is becoming an emerging expectation for some stakeholders for credible Scope 2 reporting and net-zero target validation.

Corporate Demand and Utility and Tracking System Response

Corporate commitments are a major driver of the adoption of hourly matching practices and supporting market infrastructure. Leading companies have set ambitious 24/7 CFE goals that require clean energy to be matched with consumption in every hour. Google has committed to operating entirely on CFE every hour of every day by 2030 and is working with utilities and registry operators to pilot hourly certificates and time-matched procurement programs.[6] Similar strategies are being pursued by Microsoft, which has also committed to 100% 24/7 CFE by 2030 by diversifying its renewable energy portfolio, and Iron Mountain, which aims to achieve 24/7 CFE across all its global operations by 2040 through collaboration with Engie.[7]

Utilities and load-serving entities are increasingly responding to customer demand for more granular, time-matched clean energy options. Peninsula Clean Energy has established a goal of matching all customers with 100% renewable energy on a 99%

---

[1] Latham & Watkins. "One Big Beautiful Bill: New Law Disrupts Clean Energy Investment." Latham & Watkins Insights. https://www.lw.com/en/insights/one-big-beautiful-bill-new-law-disrupts-clean-energy-investment

[2] "Organizations under a certain threshold may be exempt from hourly matching requirements. https://ghgprotocol.org/blog/upcoming-scope-2-public-consultation-hourly-matching-and-deliverability

[3] GHG Protocol. 2025. "GHGP Public Consultation Draft – Scope 2." https://ghgprotocol.org/sites/default/files/2025-10/GHG-Protocol-Scope2-Public-Consultation.pdf

[4] Science Based Targets Initiative. "Draft Corporate Net-Zero Standard V2 Explained: Scopes 1, 2 and 3." March 18, 2025. https://sciencebasedtargets.org/blog/draft-corporate-net-zero-standard-v2-explained-scopes-1-2-and-3

[5] The Climate Group. "247 Technical Criteria May 2025." May 2025. https://www.theclimategroup.org/sites/default/files/2026-02/24_7%20CFE%20technical%20criteria%20and%20appendices%20-%20v1.02%20-%20PUBLIC%20VERSION.pdf

[6] Golin, Caroline, and Devon Swezey. "A Policy Roadmap for 24/7 Carbon-Free Energy." Google Cloud Blog, April 14, 2022. https://cloud.google.com/blog/topics/sustainability/a-policy-roadmap-for-achieving-247-carbon-free-energy
Hallie Cramer and Savannah Goodman, "T-EACs Show Promise for Helping Decarbonize the Grid," Google Cloud Blog, November 15, 2023, https://cloud.google.com/blog/topics/sustainability/t-eacs-show-promise-for-helping-decarbonize-the-grid

[7] Eurelectric, "Exploring the 24/7 Carbon-Free Energy (CFE) Ecosystem: The Future of Corporate Procurement," November 2024, https://www.eurelectric.org/in-detail/exploring-the-24-7-carbon-free-energy-cfe-ecosystem-the-future-of-corporate-procurement/

coincident hourly basis.[8] Duke Energy's Green Source Advantage program allows large customers to offset their power purchases by procuring renewable energy from projects interconnected to Duke Energy's grid, providing a pathway toward 24/7 clean energy.[9] Entergy Arkansas has signed a memorandum of understanding (MOU) with the U.S. government to achieve 100% clean energy, with at least 50% delivered on a 24/7 basis, and Xcel Energy has partnered with the U.S. Department of Energy through an MOU to supply federal facilities in Colorado with at least 50% clean energy on a daily basis.[10] Georgia Power has also pursued a 24/7 clean energy subscription service for corporate customers within its service territory.[11]

In response, tracking and registry infrastructure is adapting. Several North American tracking systems, including NAR, PJM-GATS, CleanCounts, and NEPOOL-GIS, have implemented or are piloting the functionality needed to support more granular accounting and transactions.

Barriers to Uptake

Despite this momentum, a key challenge in delivering 24/7 CFE is that mature, cost-effective renewable technologies such as wind and solar are intermittent, with their output at any given hour dependent on weather conditions (solar generation typically peaks mid-day, while wind production is often highest overnight).[12] Because these generation profiles rarely align perfectly with a buyer's load, relying solely on variable renewables creates persistent imbalances in a procurement portfolio, with some hours having excess clean generation while others fall short.[13]

This challenge underscores the need for mechanisms that can effectively balance hourly supply and demand. Several solutions are already being deployed, including time-of-use (TOU) tariffs and energy storage. TOU tariffs signal system conditions through time-varying prices, typically with higher afternoon peak prices and lower off-peak rates. This approach reflects the dynamic nature of electricity availability and costs, encouraging customers to shift or reduce consumption to better align with electricity production[14] Energy storage further enables this flexibility by allowing excess renewable power to be shifted to the hours (and, in some cases, days) when it is most needed. While these tools provide partial solutions, transactions of hourly certificates or hourly information are also important in credibly and feasibly addressing these granular supply and demand mismatches, scaling 24/7 CFE procurement, and creating robust granular renewable energy markets.

---

[8] Peninsula Clean Energy. "24/7 Carbon-Free Energy White Paper." 2023.
https://www.peninsulacleanenergy.com/wp-content/uploads/2023/01/24-7-white-paper-2023.pdf
[9] Duke Energy. "Duke Energy to Help Customers Go 100% Renewable."
https://news.duke-energy.com/releases/duke-energy-to-help-customers-go-100-renewable
[10] Entergy. "Entergy Arkansas and U.S. Government Sign First MOU to Work Toward 24/7 Carbon-Pollution-Free Electricity."
https://www.entergy.com/news/entergy-arkansas-u-s-government-sign-first-mou-work-toward-24-7-carbon-pollution-free-electric
World Resources Institute. "24/7 Carbon-Free Energy: Progress."
https://www.wri.org/insights/247-carbon-free-energy-progress
[11] World Resources Institute. "24/7 Carbon-Free Energy: Progress."
[12] Charles River Associates. "Enabling 24/7 Carbon-Free Energy: Modeling Tools and Decision Frameworks." CRA Insights, June 2024.
https://media.crai.com/wp-content/uploads/2024/06/20133933/Enabling-24.7-carbon-free-energy-CRA-Insights-June-2024.pdf
[13] Charles River Associates. "Enabling 24/7 Carbon-Free Energy: Modeling Tools and Decision Frameworks."
[14] U.S. Department of Energy. "Demand Response and Time-Variable Pricing Programs."
https://www.energy.gov/femp/demand-response-and-time-variable-pricing-programs

Transactions of Energy Attribute Certificates (EACs)

For the purposes of this initiative, EAC transactions can occur through a range of market mechanisms, including bilateral transactions, auctions, online marketplaces, spot markets, power purchase agreements, or dedicated trading platforms. Market participants include tracking systems, brokers, aggregators, utilities, generators and corporate buyers seeking flexibility to complement, supplement, or rebalance long-term clean energy portfolios.

Certificate granularity and transaction structure are separate concepts. Granularity refers to the temporal resolution at which an environmental attribute is defined (quarterly, monthly, or hourly). Transaction structure, on the other hand, refers to how the contract is structured. EACs of any granularity may be procured through long-term or short-term contracts, at fixed or variable prices. As markets mature, however, long-term agreements are increasingly being designed to incorporate certificates associated with specific hours of generation.

This evolution is particularly important for granular EACs that support 24/7 clean energy claims. Unlike quarterly or monthly certificates, granular claims require closer alignment between generation and consumption, creating a need for frequent portfolio adjustments. A functioning granular market enables buyers to manage their portfolio by selling surplus hours, procuring certificates during hours of limited clean generation, and rebalancing positions to better match hourly load profiles. In much the same way that traditional, annual EAC matching has historically allowed buyers to refine long-term procurement strategies, transactions of hourly information can provide the flexibility and liquidity to align supply and demand at a much finer temporal scale.

Hourly EACs and Information

Like conventional monthly or quarterly Renewable Energy Certificates (RECs), GCs rest on the same legal foundation: a tradable instrument conveying the property right to the environmental attributes of one megawatt-hour of renewable electricity. Traditional RECs can contain hourly generation profile information that can be used by buyers to make hourly matching claims, while still using existing REC market and tracking infrastructure. Alternatively, GCs are tradable instruments conveying the contractual right to the environmental attributes of one unit of renewable electricity generated in a specific hour, at the watt-hour level. Like RECs, GCs may be traded independently of the underlying electricity but must be retired for a renewable use claim to be made.[15]

The mechanisms below represent the ways market participants can claim and transact this hourly information, ranging from full granular functionality in tracking systems to adaptations of existing REC infrastructure.

[15] Center for Resource Solutions. The Legal Basis for Renewable Energy Certificates. Version 2.0, April 2023. https://resource-solutions.org/wp-content/uploads/2015/07/The-Legal-Basis-for-RECs.pdf

Direct Hourly Metered Generation into an Hourly Certificate

The most straightforward approach is to issue certificates from generation on an hourly (or sub-hourly) basis using metered data collected from independent system operator (ISO) market settlements. All ISOs already collect granular meter data for settlement purposes. For example, the California ISO (CAISO) collects 5-minute interval meter data from generators providing regulation and ancillary services, and hourly data from other ISO-metered entities.[16] The New York ISO (NYISO) requires Revenue Quality Meter data to be submitted hourly by a Meter Authority, while its Instantaneous Meter Data system provides real-time, six-second scans of actual energy flows.[17] In areas where there are not ISOs, data can be collected from a Qualified Reporting Entity (QRE), who can submit the generation meter data.

Tracking systems can use these data to then issue certificates at the watt-hour level with explicit hourly timestamps and associated attributes, such as generation location and energy source. However, not all ISOs or QREs make these data readily available to external parties. And while some tracking systems already support hourly functionality or are beginning to pilot hourly transactions, most registries were originally designed to issue monthly or quarterly certificates and therefore require enhancements to issue and manage hourly certificates at scale. Moreover, because most registries were created to support RECs for state compliance purposes – such as Renewable Portfolio Standards (RPS) or Clean Energy Standards (CES)- implementing hourly functionality may require approval from state regulators.

Instead of creating explicit granular certificates, methods are emerging to transact and claim hourly information using traditional EACs and the associated timestamped information.

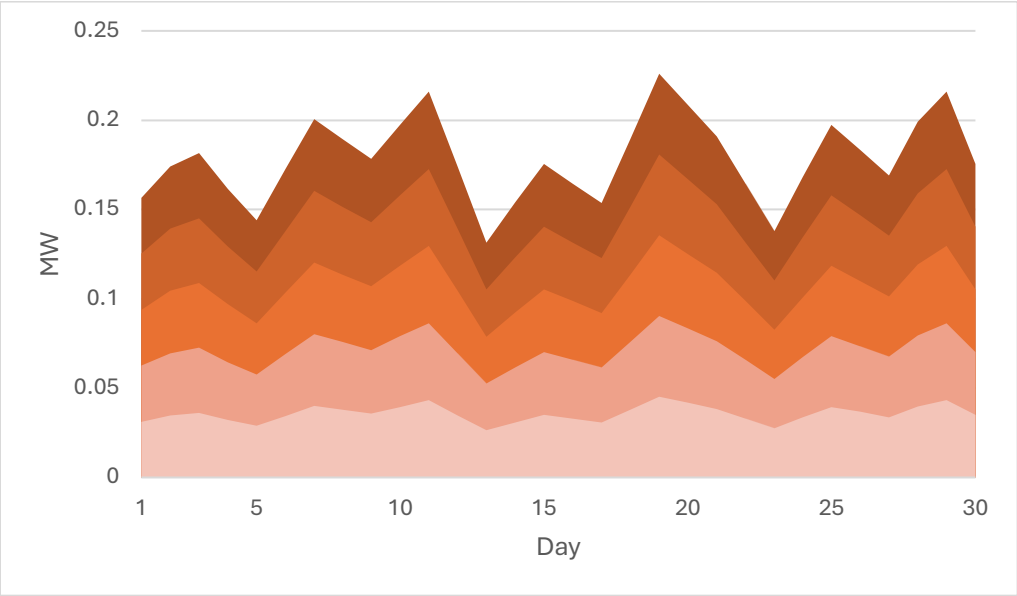
Shaped EACs (Horizontal Slicing)

“Shaped hourly EACs” are created by disaggregating existing monthly or quarterly certificate batches into hourly blocks using generation profiles provided by the generator. Under this approach, hourly volumes are derived from the proportional “shape” of the generator’s output over time.

Monthly and quarterly EACs typically include information such as generation asset type, location, technology, and vintage, but do not specify the precise timing of generation. However, during local power market settlement, generators record production data at half-hourly or 15-minute intervals, which makes it possible to approximate hourly generation when this data is available. This “shaped EAC” approach allocates monthly and quarterly certificate batches across hours on a pro-rata basis, using the proportional generation profile of the underlying asset. By applying the asset's hourly metering data to disaggregate the monthly certificate volume, buyers receive the right to claim corresponding hourly generation volumes

[16] California Independent System Operator. Business Practice Manual for Metering, Version 24 (Redline). California ISO. https://bpmcm.caiso.com/BPM%20Document%20Library/Metering/BPM%20for%20Metering_v24_Redline.pdf
[17] New York Independent System Operator, Metering Fundamentals. https://www.nyiso.com/documents/20142/3035389/Metering-Fundamentals.pdf/a619e549-90bc-9819-1218-5c10fa96ae35/

while ensuring the same rights are not sold to another party.[18] Importantly, shaped EACs preserve the integrity of the underlying EAC and remain anchored to registry-issued certificates, maintaining the registry as the single source of truth for environmental attribute ownership. Hourly claims are fully constrained by—and reconciled to—the total volume of the original EAC.



[19]

Graph 1: An illustrative generation profile of an asset over the course of a day, with total generation equal to 5 MWh. Each shade represents one MWh, showing how generation can be divided horizontally, with each unit receiving a proportional share of the generation profile across each hour. In this example, 5 different parties could each claim one MWh and match it to their load.

Because all hours of a given asset and vintage are treated identically, shaped EACs avoid "cherry-picking" only high-value hours and instead allocate hours proportionally. Breaking or selectively reallocating the shape could advantage one buyer at the expense of another by assigning better or worse generation profiles.[20]

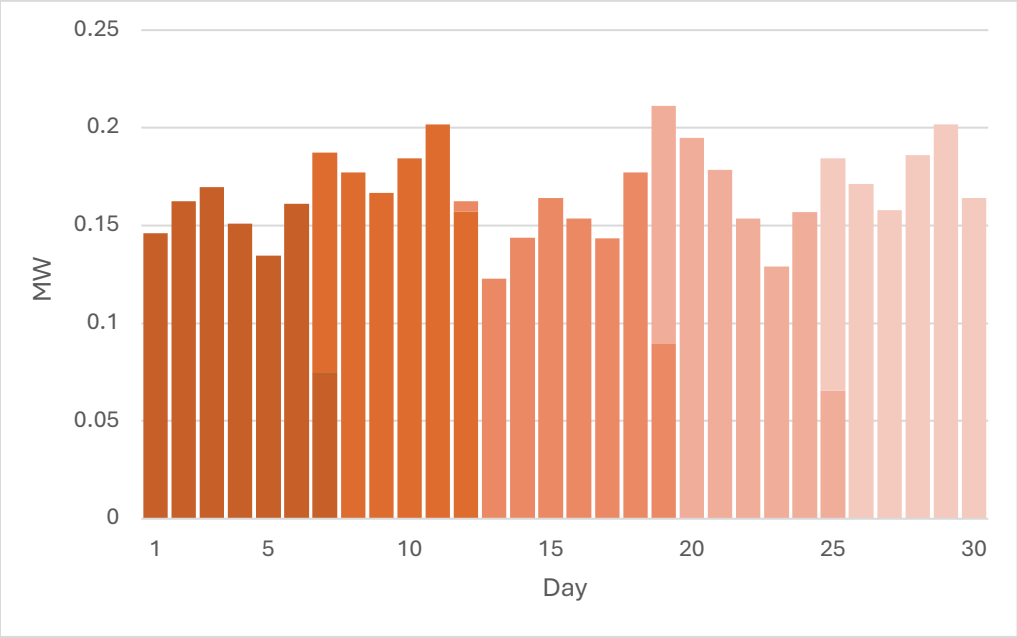
Vertical Slicing

Vertical slicing, on the other hand, divides a generation bundle by allowing buyers to select specific hours of output. This gives buyers and sellers the flexibility to transact particular hours of generation, which can help companies meet high-percentage hourly matching targets. However, this approach introduces two distinct problems. First, high-value hours tend to be cherry-picked by buyers. This can undermine the hourly claims of other buyers drawing from the same generation source, as the most desirable hours are disproportionately claimed before others can access them.

---

[18] Granular Energy. "Introducing Shaped EACs: A New Tradeable Instrument for Deep Decarbonisation." Granular Energy, July 15, 2025. https://www.granular-energy.com/insights/what-are-shaped-eacs
Granular Energy. "Demystifying the Meaning of Hourly Matching." Granular Energy, April 24, 2025. https://www.granular-energy.com/insights/demystifying-the-meaning-of-hourly-matching?category=insight
[19] Graphs 1 and 2 are for illustrative purposes only, demonstrating how horizontal and vertical slicing works. They do not represent a real-world generation scenario.
[20] Granular Energy, "Introducing Shaped EACs: a New Tradeable Instrument for Deep Decarbonisation,"

Second, without standardized mechanisms for transacting timestamped hourly information, vertical slicing risks double-counting. Because there is currently no standardized way to transact hourly information beyond including it on monthly or quarterly EACs, the same hourly MWh could be claimed by multiple parties. This is also known as shape-breaking, where, unlike with horizontal slicing, the shape of the generation profile is split across buyers, creating the potential for overlapping claims in the absence of rigorous auditing.



Graph 2: An illustrative generation profile of an asset over the course of a day, with total generation equal to 5 MWh. Each shade represents one MWh, showing how generation can be divided vertically into hourly slices. In this example, five different parties could each claim one MWh and match it to their load by selecting the hours that best align with their consumption profile.

While direct hourly issuance offers the highest level of temporal precision, horizontal and vertical slicing offer credible near-term mechanisms for transacting timestamped information within existing market infrastructure. As registry infrastructure and data availability continue to improve, these approaches are expected to coexist and converge with the shared goal of supporting credible issuance, retirement, and trading of hourly EACs at scale.

Market Participants in Hourly Energy Tracking

Tracking System Functionality[21]

Several U.S. clean energy tracking systems now support hourly functionality. The North American Renewables (NAR) registry was the first registry in North America to

[21] All information about US tracking systems and registries is accurate as of February, 2026. Functionality is constantly being updated. Rely on each registry website or portal for the most up to date information.

issue fully tradable hourly EACs, launching its hourly program in 2022 in collaboration with Google. Since then, NAR has issued 13 million hourly RECs. The program allows users to issue and transact RECs at an hourly level, and subdivide the generated hourly quantities for transaction with multiple counterparties.[22] Hourly activity is not currently supported by the Application Program interface (API).[23]

PJM's Generation Attribute Tracking System (GATS) allows users to view hourly generation from registered PJM generators and convert monthly certificates into hourly ones, either in full or in part, down to the watt-hour level at retirement—provided the energy resource is registered within the user's own GATS Account or received via a standing order.[24] Conversions from monthly certificates may be made using a CSV File Upload or through a REC selection via the GATS. Retired hourly quantities may not exceed the total volume of the original monthly certificate, and available hourly generation decreases as hourly certificates are retired; any remaining quantities are handled in monthly certificate format. If a user has a Standing Order in place for a PJM generator, available hourly generation is calculated based on the percentage designated in the active standing order at the time of monthly certificate creation. Hourly certificate functionality is available through the GATS user interface only and is not accessible via API. PJM-GATS also hosts the first U.S. hourly GC auction, led by LevelTen, the Granular Certificate Trading Alliance, and Intercontinental Exchange, within the PJM Interconnection.[25]

CleanCounts' M-RETS registry mints monthly certificates with associated hourly data. While certificates are retired in full monthly batches, the registry embeds interval production data directly into the retirement record; generation is uploaded in kWh increments, though certificates are still created in MWh. M-RETS can pull hourly generation data for generators above 5MW located in the MISO and SPP footprints. Eligible certificates with hourly data can be retired with an option to make an hourly claim from the retirement screen. Only intact certificate batches (those that have not been split, transferred, or partially retired) are eligible for hourly claims. Users may retire multiple intact batches simultaneously, with the system presenting aggregated data by hour, day, and month.[26]

NEPOOL-GIS supports the tracking and issuance of hourly certificates for eligible generators and imports. Account Holders with eligible NEPOOL generators or importing units can opt to have their monthly generation tracked in the Hourly Generation Ledger, with the resulting certificates — referred to as Hourly Claim

[22] XPansiv. "NAR Renewable Energy Registry." https://www.xpansiv.com/registries/nar-renewable-energy-registry
[23] Xpansiv, "NAR Registry," Xpansiv Developer Portal, https://developer.xpansiv.com/developer-portal/nar-registry
[24] PJM EIS. Hourly Certification Info Sheet. Generation Attribute Tracking System (GATS). https://www.pjm-eis.com/-/media/DotCom/pjm-eis/rec-creation/hourly-certification-info-sheet.ashx
PJM Environmental Information Services (PJM EIS). 2025. "REC Creation – Getting Started." Last modified September 27. https://www.pjm-eis.com/getting-started/rec-creation
PJM Environmental Information Services. 2024. Generation Attribute Tracking System (GATS) Operating Rules. Revision 12. January 26, 2024. https://www.pjm-eis.com/-/media/DotCom/pjm-eis/documents/gats-operating-rules.pdf
[25]Jakob Olsen. "A Historic Milestone: The First-Ever Hourly Granular Certificate Auction in the United States." Granular Certificates. December 7, 2025. https://granularcertificates.com/first-us-hourly-granular-certificates-auction-2025/uncategorized/
[26] M-RETS. "Hourly Data: Make an Hourly Claim." M-RETS Help Documentation. https://mrets.github.io/Help/hourly_data_make_an_hourly_claim
CleanCounts. "Home Page." https://cleancounts.org/,
Midwest Renewable Energy Tracking System. 2024. M-RETS Operating Procedures. Version 2024.2. Effective September 16, 2024. https://cleancounts.org/wp-content/uploads/2024/10/MRETS-Operating-Procedure-2024.2.pdf

Certificates — denoted in full MWh.[27] Hourly generation data are recorded in the ledger in thousandths of a MWh and is provided by an RTO, ISO, electric utility, nationally recognized tracking system, or third-party meter reader.[28] When transferring Hourly Claim Certificates, the transferring account holder must specify the date and hour of the associated generation, after which the GIS Administrator confirms in the ledger that the claimed generation does not exceed uncommitted generation for those periods.[29] Where the total generation in a transfer request does not result in whole MWhs, the number of certificates transferred is rounded down to the nearest whole MWh.[30]

Existing Standards

At the time of publication, EnergyTag's Granular Certificate Scheme Standard and Granular Certificate Matching Standard are the only two standards specifically designed to standardize the transaction of hourly/granular certificates.[31] The EnergyTag Granular Certificate Scheme Standard defines three configurations for how GCs relate to existing EAC registries: Configuration 1, 2, and 3. Under Configuration 1, the GC scheme evolves directly from the EAC system, with registries acting as GC issuers. Account holders can transfer GCs multiple times until cancellation, and issuers may either convert EACs into GCs or issue GCs directly. Under Configuration 2, the GC scheme operates alongside the EAC system, with GCs issued on a platform managed by either a third party or the EAC issuing body, always referencing the underlying EAC registry. Transfers in the GC registry must remain coordinated with the EAC system. Under Configuration 3, GCs are created from canceled EACs; issuers generate non-transferable GCs linked to those canceled EACs for the same beneficiary, and the GCs are immediately canceled upon issuance.[32] At the time of publication, only Configuration 1 GCs are able to be traded or transferred.

Current Market Players

Energinet, Flexidao, and Granular are all Accredited Organizations of the EnergyTag Granular Certificate Scheme. Energinet operates under Configuration 1, issuing native hourly certificates directly within Denmark's national registry using verified meter data. Flexidao and Granular are both accredited under Configuration 3 and have developed their own methods for producing timestamped certificates from underlying EACs.

Flexidao, a data and software company focused on clean energy portfolio management, demonstrated this approach through its work with Google. Rather

---

[27] A NEPOOL Generator that is also a Zero Emissions Generator, or an Importing Account Holder importing Imported Unit Energy from a Zero Emissions Generator, may opt to have the Certificates for its generation in any calendar month denoted as being tracked in the Hourly Generation Ledger. https://nepoolgis.com/wp-content/uploads/sites/3/2025/07/GIS-Operating-Rules-Effective-7-1-25.pdf

[28] New England Power Pool (NEPOOL). GIS Operating Rules Working Group: CPECs, Password, API, and Hourly Certificates. September 8, 2023. https://nepool.com/wp-content/uploads/2023/09/GISORWG_20230908_CPECs_Password_API_Hourly_Certificates.pdf

[29] New England Power Pool (NEPOOL). NEPOOL Generation Information System (GIS) Operating Rules. Effective July 1, 2025. https://nepoolgis.com/wp-content/uploads/sites/3/2025/07/GIS-Operating-Rules-Effective-7-1-25.pdf

[30] New England Power Pool (NEPOOL). CPECs, Password API, and Hourly Certificates. Memorandum to the GIS Operating Rules Working Group, September 8, 2023. https://nepool.com/wp-content/uploads/2023/09/GISORWG_20230908_CPECs_Password_API_Hourly_Certificates.pdf

[31] EnergyTag. Granular Certificate Scheme Standard (Version 2). December 2024. https://energytag.org/wp-content/uploads/2024/12/EnergyTag_Granular-Certificate-Scheme-Standard-V2.pdf.
EnergyTag. Granular Certificate Matching Standard (Version 1). March 2024. https://energytag.org/wp-content/uploads/2024/03/Granular-Certificate-Matching-Standard_V1.pdf

[32] EnergyTag. Granular Certificate Scheme Standard V2. December 2024.

than relying on pre-issued hourly certificates, Flexidao acquired and retired Google's monthly certificates while simultaneously collecting hourly production data from each associated project. By linking individual certificates to project-level meter data through a unique, auditable chain of custody, the company was able to produce timestamped hourly certificates that were returned to Google with a verifiable record available for independent audit.[33]

Granular Energy provides software for managing EAC portfolios and has built tools that enable shaped EAC transactions within its management platform.[34] The platform draws on hourly or sub-hourly generation data alongside customer consumption profiles to support voluntary hourly matching. This makes granular accounting feasible even in markets where fully timestamped certificates are not yet widely available.[35]

Other platforms and market participants have also emerged to support hourly-aligned procurement across different markets. Renewabl operates a digital marketplace for corporate clean energy procurement, through which buyers can source and manage EACs, PPAs, and green tariffs matched to their consumption on an hourly basis.[36] The platform calculates a CFE score for each buyer reflecting the share of consumption covered by clean energy in each hour.[37] Voltfox offers a SaaS platform for granular emissions accounting and 24/7 CFE matching, serving utilities, corporate customers, and decarbonization intermediaries such as REC traders. The platform connects supply and demand data, supports certificate retirement, calculates location-based hourly grid emissions factors and 24/7 CFE scores, and generates audit-ready reports aligned with ETS Phase 4, CBAM, CSRD/ESRS E1, GHG Protocol Scope 2, RE100, and ISO 14064.[38]

Quinbrook Infrastructure Partners, primarily an infrastructure investment manager, developed Quintrace as a digital platform for carbon tracking and hourly clean energy matching. The platform allows customers to trace the origin of electricity consumed at their facilities back to specific renewable supply projects on a 24/7 basis, drawing on real-time supply and demand data from wind, solar, and battery storage assets. It also incorporates grid carbon intensity data, giving users an hourly view of the net carbon impact across their portfolio.[39] The Granular Certificate Registry (Granular Cert-OS) is an open-source demonstration platform that creates unique identifiers for timestamped hourly certificates, supports one-to-one matching of certificates to battery charging, and applies allocation methods to account for storage discharge and time-shifting of clean energy.[40]

The Granular Certificate (GC) Marketplace—a joint initiative of LevelTen Energy and ICE—provides a structured venue for buying and selling GCs through over-the-

[33] Flexidao. "Hourly Energy Accounting at Scale: Flexidao Supports Google in Converting Global Portfolio of Energy Purchases into Hourly Certificates." Flexidao, September 17, 2025. https://www.flexidao.com/resources/google-portfolio-gc-conversion
[34] Granular Energy. 2025. "Modernising EAC management: from spreadsheets to smart software." Insights blog, April 11. https://www.granular-energy.com/insights/eac-management-at-granular-energy
[35] Granular Energy, "Introducing Shaped EACs: a New Tradeable Instrument for Deep Decarbonisation,"
[36] Renewabl Ltd. 2025. "Impactful Renewable Energy Procurement. Easy Reporting." https://www.renewabl.com/
[37] Renewabl Ltd. 2025. "The Ultimate Guide to Getting Started with Hourly Renewable Energy Matching." Renewabl. Last updated August 7. https://www.renewabl.com/post/the-ultimate-guide-to-getting-started-with-hourly-renewable-energy-matching
[38] Voltfox, https://voltfox.io/
[39] Quintrace. https://www.quintrace.com/
[40] Future Energy Associates. GranularCert OS. https://www.futureenergy.associates/granularcert-os

counter auctions. Buyers submit their hourly net need profiles ahead of each auction, and can participate in either a forward market, where GCs correspond to future generation, or a spot market for already-minted certificates. Forward market trades are structured in four-hour blocks on a quarterly basis, while spot market transactions occur in one-hour blocks monthly. LevelTen manages physical delivery and acts as intermediary once supply and demand are matched.[41]

WattCarbon runs the WEATS registry that records physical and ownership details of EACs as well as transfers of ownership, including actions like asset registration, EAC creation, EAC allocation. EAC transactions, EAC transfers, and EAC retirements. The ledger provides transparent and auditable granular certificate tracking.[42]

Singularity offers data and software tools that support both hourly and annual tariff structures and estimate hourly emissions from generation sources.[43] Cleartrace provides an analytics platform through which suppliers and buyers can pursue 24/7 hourly load matching by integrating weather, generation, emissions, certificate, and consumption data alongside third-party sources.[44] Clean Incentive operates the Granular Registry, which converts standard RECs into timestamped certificates, though these exist outside of a tracking system. Clean Incentive runs an accompanying marketplace where buyers can procure these certificates filtered by hourly timestamp, carbon impact, and additionality criteria.[45]

Taken together, these platforms and organizations represent the rapidly growing market and ecosystem for hourly clean energy trading and matching. They include accreditation organizations, software platforms, and marketplaces. While they differ in what they provide, all are working toward enabling buyers and sellers to credibly account for and transact clean energy hourly information.

Gaps and Barriers

Despite significant progress in the development of hourly EACs and transaction platforms, several gaps continue to limit the scale, accessibility, and consistency of this emerging market. These challenges relate less to the feasibility of hourly accounting, and more to market design, standardization, and claims governance.

Market Gaps

Current activity in EAC trading, where individual hours are bought and sold as discrete instruments, remains concentrated among a small group of corporate buyers, brokers, and platforms. As a result, traded volumes and liquidity are limited. Participation is also largely confined to buyers who are pursuing high hourly matching targets and scores (i.e. 100%) or arbitrage opportunities of “scarce” hours.

[41] LevelTen Energy, Granular Certificate (GC) Marketplace. https://www.leveltenenergy.com/platform/gc
[42] WattCarbon, “WEATS Registry.” https://www.wattcarbon.com/weats
[43] Singularity Energy, Utility and Grid Operator Solutions. https://singularity.energy/utility-and-grid-operator-solutions
[44] Cleartrace. https://cleartrace.io/
[45] Clean Incentive. https://www.cleanincentive.com/

The initiatives mentioned above have made significant progress toward creating hourly EACs, assigning hourly generation emission factors to load, and enabling hourly matching, but these approaches rely on bespoke accounting methods and buyer-specific methodologies rather than a shared market framework. Without standardized market design, including clear conversion rules across quarterly, monthly, and hourly products; registry interoperability; and standardized treatment of "shape-breaking" and double-counting risks, hourly EAC markets risk remaining fragmented and difficult to access for smaller or regional buyers.

Technical and Interoperability Barriers

Tracking systems vary considerably in their readiness to issue, transfer, and retire timestamped information or hourly certificates, with some supporting fully tradable hourly certificates, others implementing only partial or hybrid functionality, and others with no hourly functionality.

Because EAC tracking systems were originally designed to track monthly or quarterly vintages to be matched on an annual basis, enabling hourly functionality requires upgrades to underlying infrastructure, data collection, and regulatory approvals. Differences in timestamping conventions, data formats, and user interface design could limit interoperability across regions. Initiatives like the Registry Acceleration Fund (RAF) and CRS's Clean Energy Tracking Collaborative (CETC) are working to address these gaps.

Claims Integrity

The credibility of clean energy markets has long depended on robust verification, auditing, and consumer protection to ensure the integrity of clean energy claims. Existing EAC registries already play a critical role in preventing the double-counting of certificates, but as markets shift toward transacting granular certificates and timestamped information, the risk of greenwashing, double-claiming, and inaccurate marketing grows. The Green-e® Energy program is adapting to verify time-based and time-matched products for clean energy generation and consumption and to ensure the accuracy of claims related to granular tracking and matching. Advancing this capability requires harmonized reporting standards and standardized third-party audit frameworks.[46]

Until these gaps are addressed, granular EAC markets will remain fragmented and difficult to access for many buyers. The path forward lies in coordinated action: registries, platforms, and standards bodies aligning on common frameworks; forums like CETC and RAF driving interoperability; and the broader market embracing transacted timestamped information as a practical, scalable bridge, one that operates within the existing EAC structure while enabling companies to pursue increasingly ambitious hourly matching goals.

[46] Center for Resource Solutions. Green-e® Energy Time-Based Products. San Francisco, CA: Center for Resource Solutions, March 2026. https://www.green-e.org/wp-content/uploads/2026/03/Green-e-Energy-Time-Based-Products.pdf?highlight=time-based&_rt=MXwxfHRpbWUtYmFzZWR8MTc3NDM2OTE1NQ&_rt_nonce=b56bbfa1ce

Conclusion

Transacting timestamped information can support credible, voluntary hourly matching and clean energy claims while balancing supply and demand across all hours of the day. By enabling buyers and sellers to trade generation profiles within existing EAC registries, it provides the liquidity, transparency, and flexibility that will become increasingly important as state RPS programs and voluntary frameworks such as the GHGP, SBTi, and RE100 continue to update their standards and quality criteria, respectively. While technical, policy, and market challenges remain, ongoing registry enhancements, innovative trading platforms, and pioneering corporate procurement strategies point to rapid progress toward greater temporal granularity in clean energy and carbon accounting. Transacted timestamped information could become a foundational feature of clean energy markets, ensuring that accounting practices keep pace with the ambitions of grid decarbonization.

These concepts will be explored further through the Accounting for Transacted Timestamped Information CEAP Working Group and be expanded upon in the forthcoming Guidance Report, allowing stakeholders to engage in deeper technical discussions and contribute to the development of practical, consensus-based recommendations.

Bibliography

California Independent System Operator. Business Practice Manual for Metering, Version 24 (Redline). California ISO. https://bpmcm.caiso.com/BPM%20Document%20Library/Metering/BPM%20for%20Metering_v24_Redline.pdf.

Center for Resource Solutions. Green-e® Energy Time-Based Products. San Francisco, CA: Center for Resource Solutions, March 2026. https://www.green-e.org/wp-content/uploads/2026/03/Green-e-Energy-Time-Based-Products.pdf.

Center for Resource Solutions. The Legal Basis for Renewable Energy Certificates. Version 2.0. April 2023. https://resource-solutions.org/wp-content/uploads/2015/07/The-Legal-Basis-for-RECs.pdf.

Charles River Associates. "Enabling 24/7 Carbon-Free Energy: Modeling Tools and Decision Frameworks." CRA Insights, June 2024. https://media.crai.com/wp-content/uploads/2024/06/20133933/Enabling-24.7-carbon-free-energy-CRA-Insights-June-2024.pdf.

Clean Incentive. https://www.cleanincentive.com/.

CleanCounts. "Home Page." https://cleancounts.org/.

Cleartrace. https://cleartrace.io/.

Duke Energy. "Duke Energy to Help Customers Go 100% Renewable." https://news.duke-energy.com/releases/duke-energy-to-help-customers-go-100-renewable.

EnergyTag. Granular Certificate Matching Standard, Version 1. March 2024. https://energytag.org/wp-content/uploads/2024/03/Granular-Certificate-Matching-Standard_V1.pdf.

EnergyTag. Granular Certificate Scheme Standard, Version 2. December 2024. https://energytag.org/wp-content/uploads/2024/12/EnergyTag_Granular-Certificate-Scheme-Standard-V2.pdf.

Entergy. "Entergy Arkansas and U.S. Government Sign First MOU to Work Toward 24/7 Carbon-Pollution-Free Electricity." https://www.entergy.com/news/entergy-arkansas-u-s-government-sign-first-mou-work-toward-24-7-carbon-pollution-free-electric.

Eurelectric. "Exploring the 24/7 Carbon-Free Energy (CFE) Ecosystem: The Future of Corporate Procurement." November 2024. https://www.eurelectric.org/in-detail/exploring-the-24-7-carbon-free-energy-cfe-ecosystem-the-future-of-corporate-procurement/.

Flexidao. "Hourly Energy Accounting at Scale: Flexidao Supports Google in Converting Global Portfolio of Energy Purchases into Hourly Certificates." Flexidao, September 17, 2025. https://www.flexidao.com/resources/google-portfolio-gc-conversion.

Future Energy Associates. GranularCert OS. https://www.futureenergy.associates/granularcert-os.

GHG Protocol. "Upcoming Scope 2 Public Consultation: Hourly Matching and Deliverability." https://ghgprotocol.org/blog/upcoming-scope-2-public-consultation-hourly-matching-and-deliverability.

GHG Protocol. "GHGP Public Consultation Draft – Scope 2." 2025. https://ghgprotocol.org/sites/default/files/2025-10/GHG-Protocol-Scope2-Public-Consultation.pdf.

Golin, Caroline, and Devon Swezey. "A Policy Roadmap for 24/7 Carbon-Free Energy." Google Cloud Blog, April 14, 2022. https://cloud.google.com/blog/topics/sustainability/a-policy-roadmap-for-achieving-247-carbon-free-energy.

Granular Energy. "Demystifying the Meaning of Hourly Matching." Granular Energy, April 24, 2025. https://www.granular-energy.com/insights/demystifying-the-meaning-of-hourly-matching.

Granular Energy. "Introducing Shaped EACs: A New Tradeable Instrument for Deep Decarbonisation." Granular Energy, July 15, 2025. https://www.granular-energy.com/insights/what-are-shaped-eacs.

Granular Energy. "Modernising EAC Management: From Spreadsheets to Smart Software." Granular Energy, April 11, 2025. https://www.granular-energy.com/insights/eac-management-at-granular-energy.

Cramer, Hallie, and Savannah Goodman. "T-EACs Show Promise for Helping Decarbonize the Grid." Google Cloud Blog, November 15, 2023. https://cloud.google.com/blog/topics/sustainability/t-eacs-show-promise-for-helping-decarbonize-the-grid.

Olsen, Jakob. "A Historic Milestone: The First-Ever Hourly Granular Certificate Auction in the United States." Granular Certificates, December 7, 2025. https://granularcertificates.com/first-us-hourly-granular-certificates-auction-2025/uncategorized/.

Latham & Watkins. "One Big Beautiful Bill: New Law Disrupts Clean Energy Investment." Latham & Watkins Insights. https://www.lw.com/en/insights/one-big-beautiful-bill-new-law-disrupts-clean-energy-investment.

LevelTen Energy. Granular Certificate (GC) Marketplace. https://www.leveltenenergy.com/platform/gc.

M-RETS. "Hourly Data: Make an Hourly Claim." M-RETS Help Documentation. https://mrets.github.io/Help/hourly_data_make_an_hourly_claim.

Midwest Renewable Energy Tracking System. M-RETS Operating Procedures. Version 2024.2. Effective September 16, 2024. https://cleancounts.org/wp-content/uploads/2024/10/MRETS-Operating-Procedure-2024.2.pdf.

New England Power Pool (NEPOOL). NEPOOL Generation Information System (GIS) Operating Rules. Effective July 1, 2025. https://nepoolgis.com/wp-content/uploads/sites/3/2025/07/GIS-Operating-Rules-Effective-7-1-25.pdf.

New England Power Pool (NEPOOL). "CPECs, Password API, and Hourly Certificates." Memorandum to the GIS Operating Rules Working Group, September 8, 2023. https://nepool.com/wp-content/uploads/2023/09/GISORWG_20230908_CPECs_Password_API_Hourly_Certificates.pdf.

New York Independent System Operator. Metering Fundamentals. https://www.nyiso.com/documents/20142/3035389/Metering-Fundamentals.pdf/a619e549-90bc-9819-1218-5c10fa96ae35/.

Peninsula Clean Energy. "24/7 Carbon-Free Energy White Paper." 2023. https://www.peninsulacleanenergy.com/wp-content/uploads/2023/01/24-7-white-paper-2023.pdf.

PJM Environmental Information Services. Generation Attribute Tracking System (GATS) Operating Rules. Revision 12. January 26, 2024. https://www.pjm-eis.com/-/media/DotCom/pjm-eis/documents/gats-operating-rules.pdf.

PJM Environmental Information Services. Hourly Certification Info Sheet. Generation Attribute Tracking System (GATS). https://www.pjm-eis.com/-/media/DotCom/pjm-eis/rec-creation/hourly-certification-info-sheet.ashx.

PJM Environmental Information Services. "REC Creation – Getting Started." Last modified September 27, 2025. https://www.pjm-eis.com/getting-started/rec-creation.

Quintrace. https://www.quintrace.com/.

Renewabl Ltd. "Impactful Renewable Energy Procurement. Easy Reporting." 2025. https://www.renewabl.com/.

Renewabl Ltd. "The Ultimate Guide to Getting Started with Hourly Renewable Energy Matching." Renewabl. Last updated August 7, 2025. https://www.renewabl.com/post/the-ultimate-guide-to-getting-started-with-hourly-renewable-energy-matching.

Science Based Targets Initiative. "Draft Corporate Net-Zero Standard V2 Explained: Scopes 1, 2 and 3." March 18, 2025. https://sciencebasedtargets.org/blog/draft-corporate-net-zero-standard-v2-explained-scopes-1-2-and-3.

Singularity Energy. Utility and Grid Operator Solutions. https://singularity.energy/utility-and-grid-operator-solutions.

The Climate Group. "24/7 Technical Criteria May 2025." May 2025. https://www.theclimategroup.org/sites/default/files/2026-02/24_7%20CFE%20technical%20criteria%20and%20appendices%20-%20v1.02%20-%20PUBLIC%20VERSION.pdf.

U.S. Department of Energy. "Demand Response and Time-Variable Pricing Programs." https://www.energy.gov/femp/demand-response-and-time-variable-pricing-programs.

Voltfox. https://voltfox.io/.

WattCarbon, “WEATS Registry,” https://www.wattcarbon.com/weats

World Resources Institute. "24/7 Carbon-Free Energy: Progress." https://www.wri.org/insights/247-carbon-free-energy-progress.

Xpansiv. "NAR Registry." Xpansiv Developer Portal. https://developer.xpansiv.com/developer-portal/nar-registry.

Xpansiv. "NAR Renewable Energy Registry." https://www.xpansiv.com/registries/nar-renewable-energy-registry.