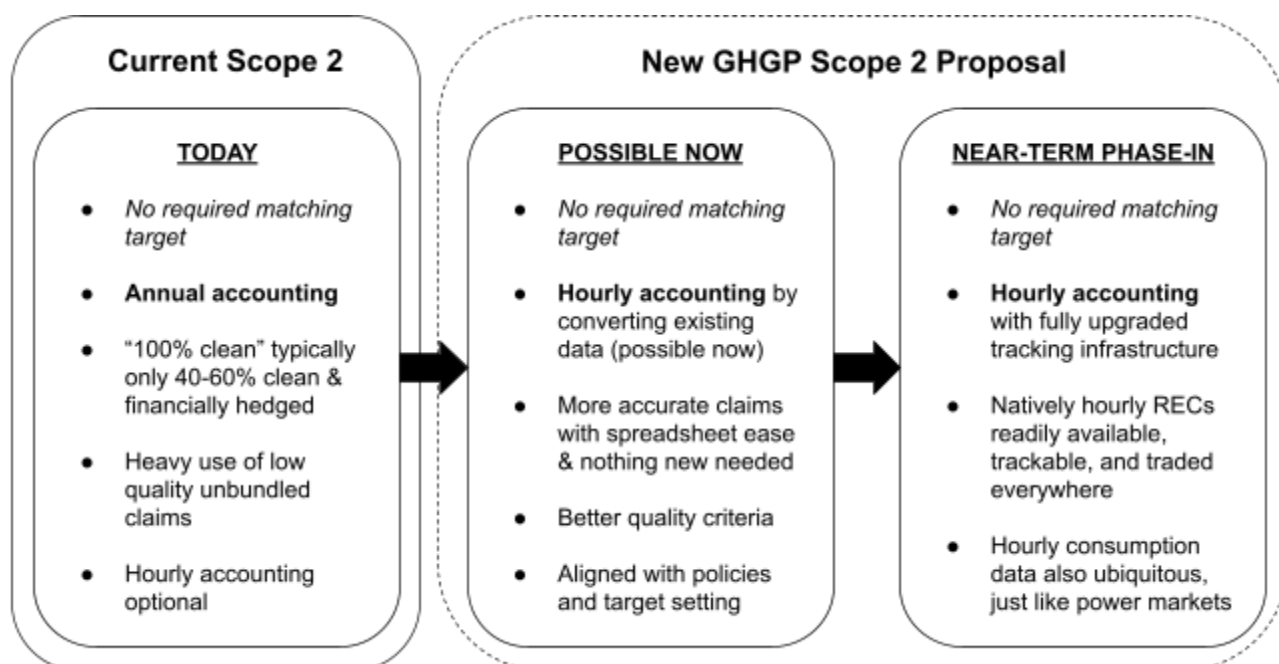


Hourly Emissions Accounting is Feasible *Today*

Key takeaways:

- Hourly matching has been demonstrated at TWh scale around the world. At least 46 suppliers already offer hourly matched tariffs to over 1,500 businesses. Hourly matching tariffs are available in countries representing 73% of global electricity demand.
- GHGP's proposed updates include feasibility measures that allow immediate conversion of existing monthly/annual data into hourly data. This method is already available in 47 countries on 4 continents through open-source audited standard methodologies.
- Tools to enable hourly accounting have been developed and are being developed by multiple parties to reduce the perceived complexity of hourly accounting for companies of all sizes. Free hourly matching tools have been developed, and nearly a dozen software companies are supporting companies with hourly matching today.
- EAC registries worldwide are moving towards hourly issuance at scale.
- Markets, policies & regulations, research, and public opinion are moving toward granular accounting. The questions are no longer around "if" but "when".

This document summarizes progress made in global hourly matching, including in the year since the GHGP Independent Standards Board voted to proceed with proposed updates to Scope 2 accounting. This document spotlights present-day hourly matched contracts and supplier products. It explains how to immediately perform hourly emissions accounting using Scope 2 feasibility measures and examines the infrastructure, market signals and policy environment that bolster these updates.



Takeaway 1: Hourly matching is already happening today

10+ TWh of hourly matching is occurring today worldwide

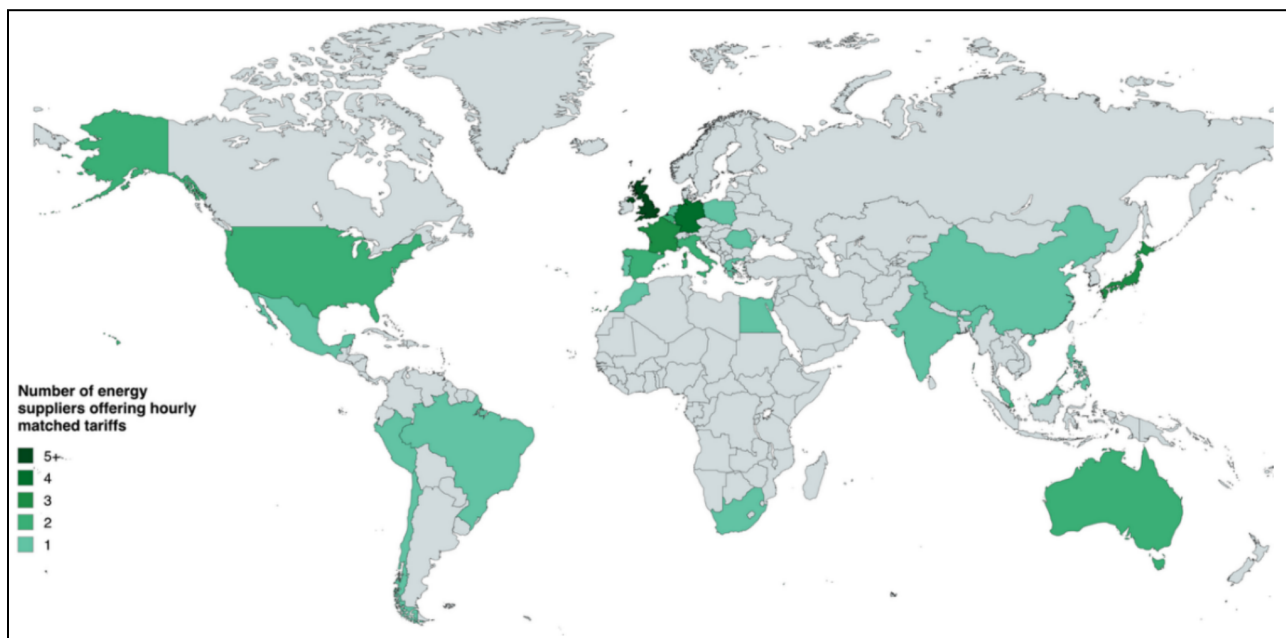
Hourly matching contracts & demonstrations

Organizations, big and small, have **announced clean energy agreements** specifying some portion of their demand will be matched on an hourly or sub-hourly basis, including (not exhaustive):

- | | | |
|---|---|--|
| <ul style="list-style-type: none"> • Bagel shop 90% match (Einstein Bros. & ENGIE) • 100+ data center sites (Iron Mountain) • 85% match for Google (ENGIE Germany) • Indian data center (Flexidao, Tata, & PDG) • 10.5 TWh in 7 countries (Google & Flexidao) • Subhourly Burger King (Evolve Energy) | <ul style="list-style-type: none"> • 13.8 GWh Chinese pilot (Guangzhou Hualing) • 6 Swedish data centers (Digital Realty, Vattenfall) • Hydro for JP Morgan (Brookfield, Cleartrace) • Spanish wind & hydro (Acciona, Flexidao) • Virginia data center (Microsoft, Constellation) • Dutch offshore wind (Eneco & Microsoft) | <ul style="list-style-type: none"> • PJM hybrid renewables (AES & Microsoft) • 90% match in Virginia (Google & AES) • Mining giant in Australia (BHP & Neoen) • 1 GW baseload UAE solar (Masdar & EWEC) • 500 GWh of Chile mining (Grenergy & Codelco) • RTC clean Indian cement (Gentari & UltraTech) |
|---|---|--|

See [10+ TWh and 40+ examples](#) of hourly matching case studies - it's already happening at scale. As was the case for annual matching, products and tracking systems will evolve to enable the hourly era. This memo demonstrates how policies and standards moving to hourly are already leading to new products.

Hourly matching supplier tariffs



"Hourly matching tariff availability in the world, November 2025." Source: [Granular Energy](#)

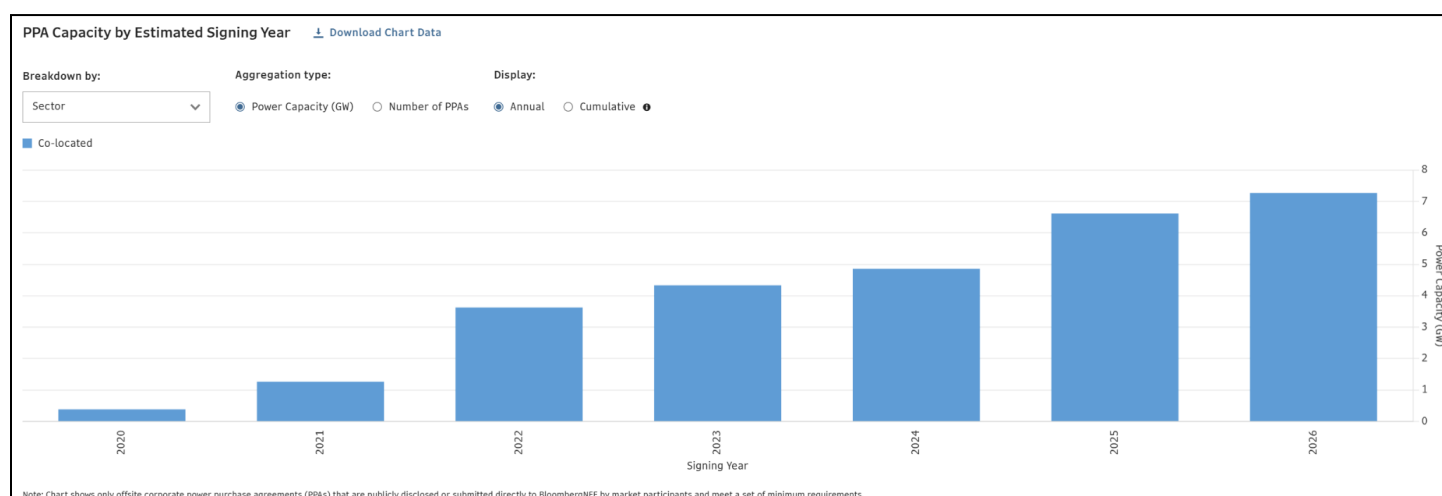
Utilities and energy suppliers have a key role to play in scaling hourly matching for business customers by providing hourly information and tracking. Recent data demonstrates that they are stepping up to the task. A January 2026 [survey report](#) by Granular Energy and Baringa found that **46+ suppliers** already offer hourly matched tariffs, making them available to **73% of global electricity demand**. This is a **4x YoY increase** in the number of hourly tariffs available. There are now [more than 1,500 businesses](#) measuring their clean electricity consumption on an hourly basis, via their energy suppliers.

Examples include (a longer, but not exhaustive, list can be found [here](#)):

- | | | |
|--|--|---|
| <ul style="list-style-type: none"> • Half-hourly matching (SSE Energy, UK) • Hourly C&I offering (Catalyst, US) • Hourly matching in Japan (Jera Cross, Japan) • Green Energy Match (A2A, Italy) | <ul style="list-style-type: none"> • Largest Greek utility (PPC Group, Greece) • Energy giant's offering (TotalEnergies, UK) • 86% half-hourly match (Good Energy, UK) • Scandinavian matching (Statkraft, Norway) | <ul style="list-style-type: none"> • 92% in Silicon Valley (SVCE, US) • Electric Match (Octopus Energy, UK) |
|--|--|---|

In the United States, Google has developed **hourly clean energy tariffs** (the Clean Transition Tariff, or CTT) with utilities in [Nevada](#), [Minnesota](#), and [Michigan](#). This enables a portfolio of clean energy projects to be deployed in partnership with vertically integrated utilities to enable hourly matching. Amazon recently [used](#) the same CTT mechanism in Nevada to add geothermal, solar PV, and battery storage to power its Nevada data centers. The **Center for Resource Solutions** just released the [Hourly Clean Energy Utility Product Designs](#) report, which is meant to guide suppliers in designing, offering, and communicating hourly matched clean energy tariffs. The market demand for hourly tariffs is great and growing.

In addition to hourly supplier tariffs, companies are matching more of their hourly electricity demand through PPA contracts and certificate purchases. The **PPA market in the U.S. and globally reached new records in 2025**. Bloomberg New Energy Finance reports that the number of hybrid renewable projects (e.g. solar + wind, solar/wind + storage) has increased to over 7 GW in the first half of 2026 from less than 1 GW in 2020.



Source: Bloomberg New Energy Finance Corporate PPA Database

Hourly certificate markets

In October of 2025, the Granular Certificate Trading Alliance held the [first-ever spot auction](#) of granular (hourly) certificates (GCs). Six organizations participated, resulting in **919 unique trades matched**, with GCs prices between \$30 and \$37.5 per MWh, which is only **a small premium (<10%) relative to annual PJM RECs**. The auction represents a clear signal from both sides of the market: buyers are expressing demand for individual GCs in PJM, and sellers are undergoing trades to discover the appropriate prices for their matching supply.

Takeaway 2: Proposed GHGP rules enable hourly accounting to be immediately feasible through the use of meter data or profiles

The proposed Scope 2 rules include a data quality hierarchy which allows companies to translate the data they already have into highly credible hourly accounting.

Hourly accounting is simply a comparison of hourly energy **consumption** and hourly energy **production**. This can already be determined. Production (renewable generation):

1. Hourly contractual instruments (EACs):
 - a. These are available in some markets (e.g., PJM), and registries are upgrading to offer these in more places around the world (see Takeaway 4).

However, **hourly EACs are not necessary** to do hourly accounting.

2. Where hourly EACs do not yet exist, companies can use the same monthly or annual EACs they use for Scope 2 reporting today. They can combine those EACs with any of the options below to get an accurate hourly accounting of clean supply:
 - a. Hourly production meter data,
 - b. Hourly facility-specific production profiles, or
 - c. Hourly regional production profiles (e.g. [Renewables Ninja](#) or other forthcoming tools)

Companies are [already doing this](#) at TWh scale today.

<i>Proposed hierarchy of temporal data for contractual instruments</i>		
Temporal Granularity	Derived from	Applicable to:
Hourly	Hourly contractual instruments	Electricity consumption above exemption threshold
	Monthly or annual contractual instruments combined with hourly production meter data from the same production asset	
	Monthly or annual contractual instruments combined with hourly facility-specific production profile	
	Monthly or annual contractual instruments combined with hourly regional publicly available production profile	

Source: [GHGP Scope 2 Proposal](#)

Consumption (electricity demand):

1. Hourly meter data (becoming more prevalent and accessible).

If hourly meter data is not yet available, **hourly accounting is still achievable**. Option 2 in the hierarchy enables hourly accounting for all other scenarios.

2. Where hourly meter data is unavailable or inaccessible, companies can take total consumption data (over the course of a month or year, whatever is used for billing) and generate an hourly breakdown in one of the following ways:
 - a. Facility-specific load profile (i.e., grocery store, retail store, office building, or data center)
 - b. Market-boundary load profile
 - c. Time-of-use average (on-/off-peak billing used to then average out usage per hour)
 - d. Flat average (total consumption divided by total hours; least specific but still enables hourly accounting). A flat average leads to significantly more accurate accounting than today's annual standard, while [maintaining the positive impacts](#) of hourly matched procurement incentives.

<i>Proposed hierarchy of activity data for matching contractual instruments</i>		
Data Granularity	Consumption Data Derived from	Applicable to
Hourly	Meter data Primary hourly meter data	Electricity consumption above exemption threshold
	Facility-specific load profile Total facility consumption scaled according to an estimated facility-specific load profile	
	Market-boundary publicly available load profile Total market-boundary consumption scaled according to a general or customer class-specific market-boundary load profile	
	Time-of-use average Total consumption for time-of-use billing periods (e.g., on-/off-peak hours) scaled to the proportion of electricity consumed during each time-of-use period. then averaging by the number of hours within that time-of-use period	
	Flat average Total consumption divided by the number of hours in the corresponding period for which data is available (e.g., if a reporting entity has annual consumption data, they would divide the yearly total by 8,760 hours to calculate an average hourly load)	

Source: [GHGP Scope 2 Proposal](#)

Takeaway 3: Simple tools show accounting math isn't a bottleneck

Many tools have been developed to support hourly accounting, and many more are in development.

1. Free calculators have already been developed to help companies understand hourly accounting and support corporate planning. Including:
 - An hourly CFE Score estimator from [Renewabl](#)
 - An hourly matching calculator from [Constellation](#).
 - A free, publicly available [Granular Scope 2 Estimation Worksheet](#)
 - A free [dashboard](#) showing the difference between hourly and annual accounting in all U.S. regions.
2. Other companies have developed granular accounting and reporting software as a service. Watershed [reports](#) that the additional costs of services can be small and should only decline as greater competition and market adoption occur. These providers include, but are not limited to:

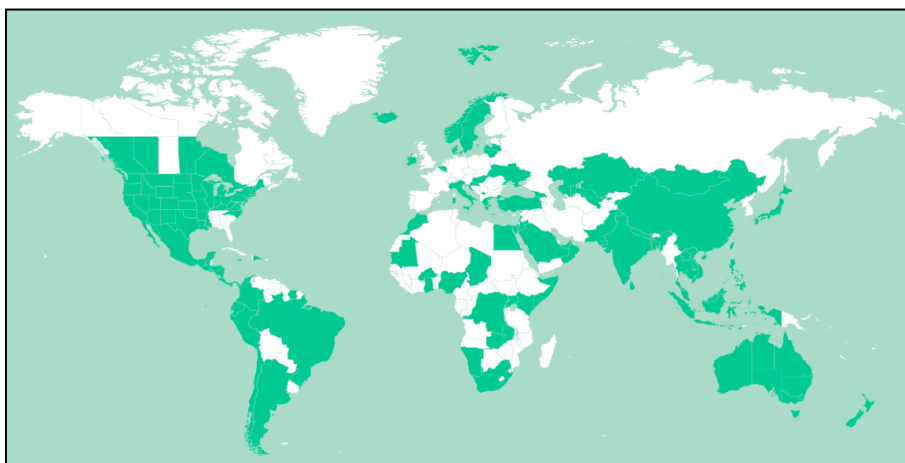
○ Flexidao ○ ClearTrace ○ Soldera ○ Renewabl	○ RE24 ○ Clean Incentive ○ Granular Energy ○ Singularity	○ Enosi ○ Voltfox
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Takeaway 4: Registries are upgrading to hourly

Registries issue RECs and EACs today. Over 70 countries and 4,000 TWh are covered by registries in the process of upgrading to issuing hourly RECs and EACs.

LevelTen Registry Acceleration Fund

In July of 2025, the Registry Acceleration Fund (RAF) [announced grants](#) to support EAC registry modernization. The RAF is an initiative launched by LevelTen Energy and backed by the [Granular Certificate Trading Alliance](#) to modernize EAC registry infrastructure towards hourly tracking. The five registries awarded — CleanCounts, Evident, Grexel Systems, Unicorn Systems, and Xpansiv — collectively issue or track more than 4,000 TWh of certificates **across over 70 countries for more than 40,000 account holders**. The upgrades are making verified, hour-by-hour carbon-free energy even more accessible worldwide.



"Coverage Areas of Registry Acceleration Fund Award Recipients." Source: [LevelTen Energy](#)

Center for Resource Solutions

The Center for Resource Solutions [announced](#) the Clean Energy Tracking Collaborative (CETC), an effort that offers **technical support to registries moving to hourly REC functionality** in the United States.

CRS and LevelTen recently convened a workshop on Operationalizing Granular Certificates at the Renewable Energy Markets Asia conference, which included APAC stakeholders (tracking systems, utilities, government officials, clean energy buyers) to discuss progress in overcoming technical and policy barriers.

In June, **ERCOT became the most recent registry to [approve](#) hourly EAC issuance**, joining PJM and Clean Counts, which already issue hourly EACS in the U.S. today.

Takeaway 5: The GHGP is not alone; all roads lead to hourly accounting & matching

Market signals, policies & regulations, research, and public opinion all point towards the necessary & feasible evolution to reality-based hourly matching.

Market signals

- [PPA experts](#) & [portfolio managers](#) agree: updated rules align with the clean power purchases companies [already make](#) for better [hedging value](#) & **firmed clean energy supply**.
- India's government is issuing [Round-the-Clock \(RTC\) renewable energy tenders](#), recognizing the greater system value of clean energy able to generate at all times of day. **Over 400 MW of renewables + storage** have been approved so far, with even more planned to be approved this year. Indian energy leaders [note](#) that companies are increasingly asking for hourly matched renewables.
- **8 companies across 6 industries and geographies** (including Google, AirTrunk, and AstraZeneca) are party to Climate Group's [24/7 Carbon-free Coalition](#), launched as a pilot in September 2024. Following its success, more international businesses, including Unilever and Cathay Financial Holdings, joined the Coalition during London Climate Action Week 2026. The Coalition aims to advance 24/7 clean energy solutions by putting hourly and local matching into practice, touting the benefits of secure supply, greater insight, regulatory readiness, and competitive advantage.

Policies & regulations

- **Europe's [Carbon Border Adjustment Mechanism \(CBAM\)](#)** rules, finalized at the end of 2025, will require that companies exporting goods to the EU substantiate electricity emissions reductions with "physically deliverable, hourly-matched clean electricity" via PPAs.
- In April of 2026, the **European Commission** [proposed](#) a data center sustainability label that would measure companies based on their renewable energy use. They proposed that, for data centers to make a credible renewable energy usage claim using unbundled EACs, they must be matched in the

same bidding zone and same 15-minute interval as consumption (granular accounting).

- **US states** are introducing bills to require hourly accounting *and* matching of clean energy, including [Colorado](#) and [Illinois](#).

Standards

In June 2026, the Science-based Targets Initiative [released](#) V2 of its Corporate Net Zero Standard. The new standard requires that company purchases be made on grids that could plausibly serve their electricity loads (“deliverability”) and also requires companies above a certain size (deemed “Category A” companies) to report their level of locational and hourly matching. In other words, SBTi’s new standard is largely aligned with the proposed changes in the GHGP. This is despite an unfortunate removal of hourly matching as part of SBTi Net Zero targets.

In May of 2025, The Climate Group published detailed [Technical Guidance](#) for hourly clean energy matching as part of its 24/7 Carbon-free Coalition. Companies signing up to the coalition will measure and report hourly matching in at least one market within two years of joining the campaign.

Grid operator perspectives

- [Monitoring Analytics](#), the **Independent Market Monitor of PJM**: “The market solution is to require data centers to bring their own new generation. This would include an expedited fast-track load and generation interconnection process for large new data center loads that bring their own new generation with locational and temporal characteristics reasonably matched to their load profile.”
- [ENTSO-E](#), the **organization of EU grid operators**: “The current system does not provide sufficient incentives for the development of RES [Renewable Energy Sources] and the consumption of green electricity at the right time and in the right geographical location.”
- [NESO](#), the **energy system operator of the UK**: “24/7 CFE EACs could also accelerate grid decarbonisation, by providing time-based signals for the use of CFE and demand side response (DSR), encouraging investment and innovation. Currently storage and DSR are unable to participate in EAC markets, as the annual granularity does not create an ability to trade these certificates in a useful timeframe.”

Research snapshot

- **IEA [Energy and AI report](#)** shows 80%+ hourly matching is cost competitive with both annual volume matching projects *and* with industrial retail electricity prices in the world’s largest economies.
 - A deeper dive on these findings, with graphics, can be found in this memo’s Annex.
- **EPRI [paper](#)** estimated that hourly matching in the US can reduce consequential emissions **42x more than status quo annual matching** by boosting energy storage and broader technology portfolios to fully decarbonize corporate demand by reducing gas reliance.
- **IRENA [24/7 renewables report](#)** shows 95%+ firm renewable supply is becoming cost competitive. The report also highlights the importance of hourly accounting in the GHG protocol update: “The ongoing revision of the GHG Protocol Scope 2 Guidance proposes to extend this logic globally, requiring hourly and location-matched certificates as the basis for corporate market-based emissions claims. When

adopted, this shift will transform demand for firm renewable electricity from a voluntary commitment by leading buyers into a mainstream feature of corporate energy procurement worldwide."

- [17 leading academics](#) (including from Princeton, TU Berlin, the University of Edinburgh, UNSW Sydney, the Colorado School of Mines, the Technical University of Denmark) agree the GHGP Scope 2 hourly accounting rules updates are critical, and that status quo annual accounting is unacceptable.

Civil society & integrity

- [17 organizations \(including Meta, Microsoft, Constellation, and CEBA\)](#) signed a letter in 2023 urging more granular temporal matching in Scope 2 rules.
- [40 civil society organizations signed a letter](#) this year urging GHGP to finalize hourly matching Scope 2 rules.

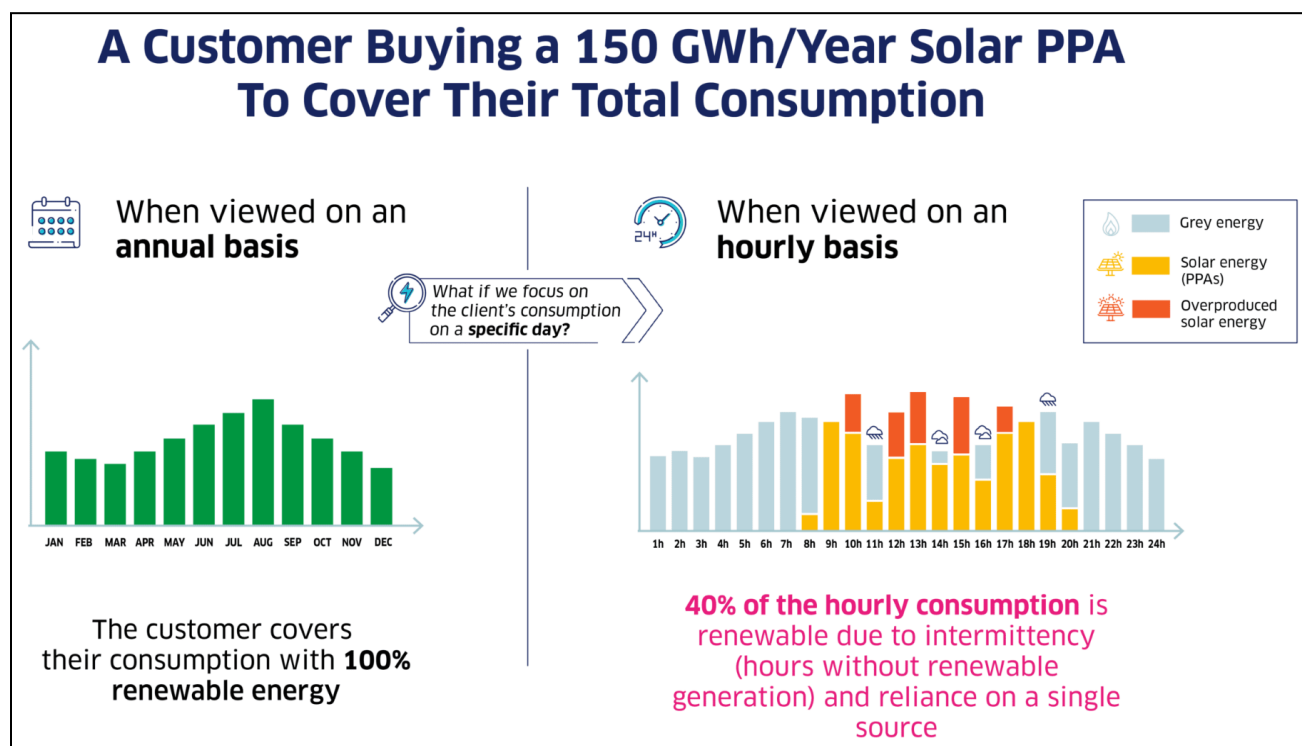
Media coverage

- **Financial Times:** [Corporate climate plans arbiter draws critics on new 'net zero' rule book](#)
- **Financial Times:** [Big Tech's bid to rewrite the rules on net zero](#)
- Reuters: [Big Tech splits over proposed shake up of clean energy accounting](#)
- **Financial Times:** [Tech groups score win on clean energy rules for gas-powered data centres](#)
- **The Guardian:** [Data center emissions probably 662% higher than big tech claims. Can it keep up the ruse?](#)
- **Bloomberg:** [How Tech Companies Are Obscuring AI's Real Carbon Footprint](#)
- **Utility Dive:** [As Google, Meta eye clean energy buys, researchers find widely used strategy has scant carbon benefits](#)
- **Wall Street Journal:** [Climate-Reporting Rules Could Let Companies Look Greener Than They Are](#)

ANNEX

Matching levels & cost-competitiveness

All physically delivered clean energy contracts are doing some level of hourly matching - hourly accounting is just a matter of determining *how much matching is happening*. Annual matching ignores this entirely, leaving companies exposed to unhedged hours and overstating emissions reductions by approximately 50%.



Source: [Engie](#)

The solar-only annual matching example above demonstrates that, by default, ~40% hourly matching is obviously cost-competitive with ~100% annual volume matching because it is *the exact same procurement*.

However, **hourly matched procurement is cost-competitive** at much higher levels than 40%:

- **40-60%+ hourly:** typical levels reached by solar- and wind-only procurement, per the [IEA](#).
 - Single-technology procurement is common for simple annual volumetric matching, and therefore 40-60% hourly matching is, again, *cost-competitive by default because it is the same portfolio*.
 - The hourly *accounting* simply provides decision-useful information on the exposure to fossil-fueled hours.
- **80-90%+ hourly:** cost-competitive with both annual volume matching projects *and* with industrial retail electricity prices in the world's largest economies, per the IEA.
 - IEA's figures, reproduced below, clearly demonstrate the cost-competitiveness of high levels of hourly matching.
 - They also demonstrate how higher levels of hourly matching substantially reduce both the exposure to grid electricity prices and the resultant electricity-related emissions (Scope 2).

Figure 2.19 ▶ Total cost of electricity per unit consumed for hybrid options of wind, solar PV and battery in the United States, Europe and China

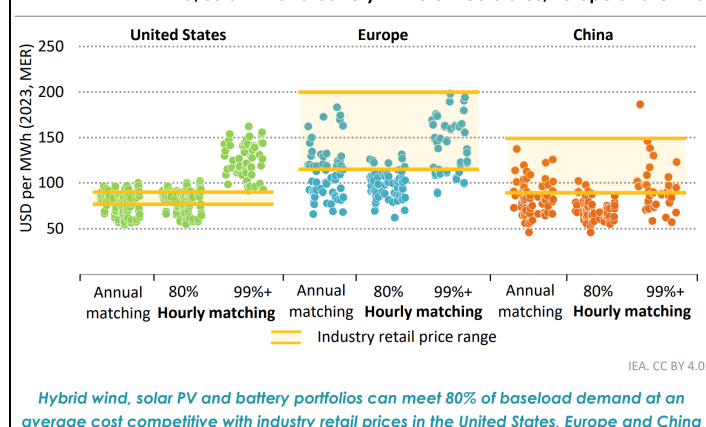
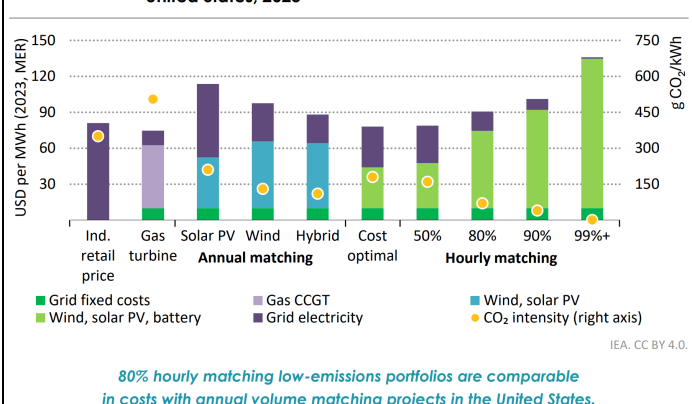


Figure 2.18 ▶ Average cost of electricity consumed by component for different portfolios and average CO₂ emissions intensity in the United States, 2025



Source: [IEA Energy and AI report](#), pages 85 and 83, respectively.

While the above analysis also shows that very high levels of hourly matching (90-95%+) are more expensive at present, that also illuminates these **three key takeaways that must be taken together**:

1. **GHGP is a standards body that does not mandate *any* targets** - companies remain entirely free to scale their clean energy matching based on their budget and climate ambition.
2. **80%+ hourly matching is cost-competitive *today***, and
3. **95%+ firm renewables + storage is falling rapidly in cost** per [IRENA](#), expanding the accessibility of this very high level of hourly matching across the globe each passing year.

Claims that hourly matching/accounting is inherently much more expensive therefore do not hold up to scrutiny.

Such claims often rely on modeling that forces immediate, full 100% hourly matching (“24/7”), which is indeed difficult and expensive at present and more costly than annual volumetric matching. But this is a false comparison, as *no level of matching* is required by GHGP under status quo annual accounting *or* under proposed updates to hourly accounting for large energy users.

“100%” is already not the only goal *today*, and it definitely won’t be under hourly matching either - true decarbonization is a journey. The evolution towards hourly accounting is necessary to differentiate genuine procurement ambition from administrative compliance and provide decision-useful data. Put simply: 95% hourly matching means *a lot more* than 95% annual matching.

Links to additional resources

Additional granular matching case studies:

- | | | |
|--|---|--|
| <ul style="list-style-type: none"> • Good Energy & Stellium (United Kingdom) • Gridmatic & Sol Systems (ERCOT, United States) • Tokyo Metro & Cosmo (Japan) • Believ & UrbanChain (United Kingdom) | <ul style="list-style-type: none"> • Amazon & NV Energy (Nevada, United States) • AES & Microsoft (CAISO, United States) • AM Green Group (Andhra Pradesh, India) • Citicore Renewable Energy (Philippines) | <ul style="list-style-type: none"> • Statkraft & Mercedes-Benz (Germany) • Powerledger & ekWateur (France) • JERA Cross & Flexidao (Japan) • EDF & JPMorgan Chase (United Kingdom) |
|--|---|--|

- [Brookfield & Cleartrace](#)
(NYISO, United States)
- [Svea Solar & Spritju](#)
(Sweden)

High-quality research on granular accounting:

Study	Institution	Author	Year
Potentials and pitfalls around green claims of e-fuels: insights from an exploratory case study	Denmark Technical University	Caroline H Gebara, Maria Flora Andersen, Edoardo Simioni, Julien Lavalley and Anders Bjørn	2026
System Effects of Carbon-Free Electricity Procurement: Regional Technology and Emissions Impacts of Voluntary Markets	EPRI	John Bistline, Geoffrey Blanford, Adam Diamant, Arin Kaye, Daniel Livengood, Qianru Zhu, Francisco Ralston Fonseca	2026
Impacts From Procuring Clean Electricity Under Different Inventory Accounting Methods	National Renewable Energy Lab / Colorado School of Mines	Pieter Gagnon, Maxwell Brown	2026
Temporal matching as an accounting principle for green electricity claims	TU Munich	Hanna F. Scholta, Maximilian J. Blaschke	2025
Modelling 24/7 Carbon Free Electricity (CFE) in Japan	Transition Zero	Transition Zero	2025
The impact of temporal hydrogen regulation on hydrogen exporters and their domestic energy transition	TU Berlin / Potsdam Institute for Climate Impact Research / University of Applied Sciences (OTH) Regensburg / Open Energy Transition	Various	2025
Modelling 24/7 Carbon Free Electricity (CFE) in India	Transition Zero	Transition Zero	2025
24/7 carbon-free electricity matching accelerates adoption of advanced clean energy technologies	TU Berlin / Princeton University / Google	Igor Riepin, Tom Brown, Jenkins, Jesse D., Devon Swezey	2025
The Influence of Demand-Side Data Granularity on the Efficacy of 24/7 Carbon-Free Electricity Procurement	Princeton University	Ricks, Wilson & Jenkins, Jesse D.	2024
Does the purchase of voluntary renewable energy certificates lead to emission reductions? A review of studies quantifying the impact	Denmark Technical University	Lissy Langer, Matthew Brander, Shannon M. Lloyd, Dogan Keles, H. Damon Matthews, Anders Bjørn	2024
On the means, costs, and system-level impacts of 24/7 carbon-free energy procurement	TU Berlin	Igor Riepin, Tom Brown	2024
Spatio-temporal load shifting for truly clean computing	TU Berlin	Igor Riepin, Tom Brown, Victor Zavala	2024
System-level Impacts of Voluntary Carbon-free Electricity Procurement Strategies	Princeton University	Qingyu Xu, Wilson Ricks, Aneesha Manocha, Neha Patankar, Jesse D. Jenkins	2024
The influence of additionality and time-matching requirements on the emissions from grid-connected hydrogen production	MIT	Michael A. Giovanniello, Anna N. Cybulsky, Tim Schittekatte, Dharik S. Mallapragada	2024

Impacts of IRA's 45V Clean Hydrogen Production Tax Credit	EPRI	EPRI, GTI Energy	2023
Minimizing emissions from grid-based hydrogen production in the United States	Princeton University	Wilson Ricks, Qingyu Xu, Jesse D. Jenkins	2023
Hourly versus annually matched renewable supply for electrolytic hydrogen	TU Berlin	Elisabeth Zeyen, Iegor Riepin, Tom Brown	2022
IEA- Advancing Decarbonisation through Clean Electricity Procurement	International Energy Agency	IEA	2022
System-level impacts of 24/7 carbon-free electricity procurement in Europe	TU Berlin	Iegor Riepin, Tom Brown	2022
Electricity System and Market Impacts of Time-based Attribute Trading and 24/7 Carbon-free Electricity Procurement	Princeton University	Qingyu Xu, Jesse D. Jenkins	2022
Green hydrogen – How grey can it be?	Florence School of Regulation	Manuel Villavicencio, Johannes Brauer, Johannes Trüby	2022
System-level Impacts of 24/7 Carbon-free Electricity Procurement	Princeton University	Qingyu Xu, Wilson Ricks, Aneesha Manocha, Neha Patankar, Jesse D. Jenkins	2021