EnergyTag

APAC FACTBOOK ON GRANULAR ELECTRICITY ACCOUNTING

Empowering APAC Stakeholders to Align Local Energy Transitions with the Global 24/7 Carbon-Free Energy Movement

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EXECUTIVE SUMMARY

Granular Electricity Accounting is Uniquely Suited to APAC's Energy Transition Challenges

Granular accounting aligns Scope 2 accounting with reality. It means electricity consumers can only claim to use power that is **deliverable** to them and produced in the **same hour** as their consumption. It also supports the transition to net-zero by ensuring that existing clean electricity is fairly allocated, while making new clean power a central part of the strategy.

In the APAC region, granular electricity accounting is gaining growing significance. This study has selected twelve markets based on their relevance and market size to conduct our analysis: Australia, China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, and Vietnam. In these markets, fossil fuels still dominate electricity generation, but renewables are scaling rapidly under ambitious decarbonization goals, led by the rapid growth of solar energy. As renewables integrate into the national grids, APAC markets are beginning to experience **transitional challenges that granular electricity accounting is tailored to solve:**

1. Tackling the duck curve with increased storage

The "duck curve" is a growing challenge in electricity systems with high solar penetration, especially across the Asia-Pacific region. It describes a pattern where solar generation causes a sharp drop in net electricity demand during midday, followed by a steep ramp-up in the evening as solar output declines and demand rises.

Instead of relying on annual averages or offsets that ignore timing, hourly accounting encourages the use of clean electricity when it is most needed, especially during evening peaks. This creates a direct incentive to deploy storage, demand response, and dispatchable clean resources that can fill the gap when solar drops off.

2. Reduce the operation cost of the power system

Annual matching focuses on variable renewables, such as solar, but it does not align generation with consumption in real-time. This leads to higher system costs, including increased ramping and startup costs for dispatchable generators, and no contribution to peak capacity. Hourly strategies reduce the need for costly system balancing and contribute to all grid services, unlike annual strategies that provide only energy value.

3. Unlocking cheap round-the-clock solar

Granular electricity accounting combined with recent breakthroughs in battery technology is enabling 24-hour solar generation. Solar-plus-storage systems flatten the load curve and avoid costly grid upgrades by allowing 5x more solar capacity behind the same grid connection. The opportunity now is for policymakers and investors to enable the scaling of this model, especially across the sun-rich APAC region, facing rising power demand and ambitious decarbonization goals.

The next phase of APAC's energy transition will focus on making clean energy dependable, integrating it into the grid without compromising reliability or driving up system costs. Granular electricity accounting is not just a tool for better reporting; it is a foundational enabler for this shift.

Granular Electricity Accounting Prepares APAC's Exports for Evolving Trade Requirements and Carbon Reporting Standards

For the export-oriented economies in APAC, granular electricity accounting is key to safeguarding industrial competitiveness amid tightening global carbon regulations.

Greenhouse Gas Protocol (GHGP) on Scope 2 accounting

The principle for the **update** in the GHG Protocol is as follows: a company's market-based Scope 2 emissions should be calculated based on purchased clean energy that aligns with where and when a company consumes electricity, without relying on clean energy rightfully claimed by others.

The proposed update requires companies to use hourly accounting for their market-based Scope 2 inventories. To make a market-based claim, a company would need to match its consumption to the generation occurring in the same hour. This change would better align corporate clean energy claims to the reality of electricity markets and systems, which operate at hourly (or sub-hourly) intervals.

Carbon Border Adjustment Mechanism (CBAM)

CBAM applies carbon pricing to imported goods such as hydrogen, steel, cement, and aluminium, requiring producers to verify the emissions intensity of their manufacturing processes, including the electricity used. Unlike annual REC systems, which verify clean electricity procurement on a yearly basis, granular tracking provides time- and location-specific data. While the EU CBAM does not currently mandate temporal matching, such requirements are already in place under the EU rules for **renewable hydrogen under Renewable Fuels of Non-Biological Origin (RFNBO)** - signaling a broader shift toward more precise electricity attribution in trade-related regulations.

As 10 of the 12 APAC markets examined have announced hydrogen strategies, adopting granular electricity tracking is not just about compliance — it's about maintaining access to global markets and positioning APAC industries as credible suppliers in a low-carbon economy.

Together, these regulations push APAC steelmakers, aluminum smelters, electronics assemblers, chemical producers, and others to integrate renewable energy and track it in real time. Granular electricity accounting will become key to maintaining market access and cost advantages. In contrast, high-carbon producers may face tariffs, lose green premiums, or be excluded from supply contracts.

APAC is Ready to Deliver Flexible, Real-time Clean Energy

The Asia-Pacific region already possesses the technical, market, and policy foundations to support the adoption of granular electricity accounting. We found that several APAC nations already have advanced grid infrastructure, growing smart meter penetration, and sophisticated energy markets that can handle real-time data exchange and settlement.

1. The data is already available

Many APAC power markets operate at 15- or 30-minute settlement intervals (some as fast as 5 minutes). The granular data can be used as a reference for time-stamped tracking and future time-based procurement mechanisms.

2. Market reforms are enabling time-based clean energy

Vietnam, the Philippines, and India are building competitive electricity markets with time-of-day pricing. China is launching a national real-time power trading market in 2025.

3. Corporate demand is rising fast

In 2024, 12.9 GW of corporate PPAs were signed in APAC — up 34% from 2023. 75% of new RE100 members in 2024 are from the APAC region, many seeking more credible, granular procurement options.

4. The policy is moving in the right direction

India's Round-the-Clock (RTC) tenders, Australia's REGO hourly certificates, and China's expanding green certificate markets are all paving the way for regional 24/7 energy frameworks.

By embracing granular electricity accounting, APAC can leapfrog traditional carbon accounting methods, optimize its clean energy deployment, and lead the world in building a flexible, affordable, and resilient net-zero power system.

Balancing Periods Across APAC Electricity System

Ranging from 5 to 30 minutes

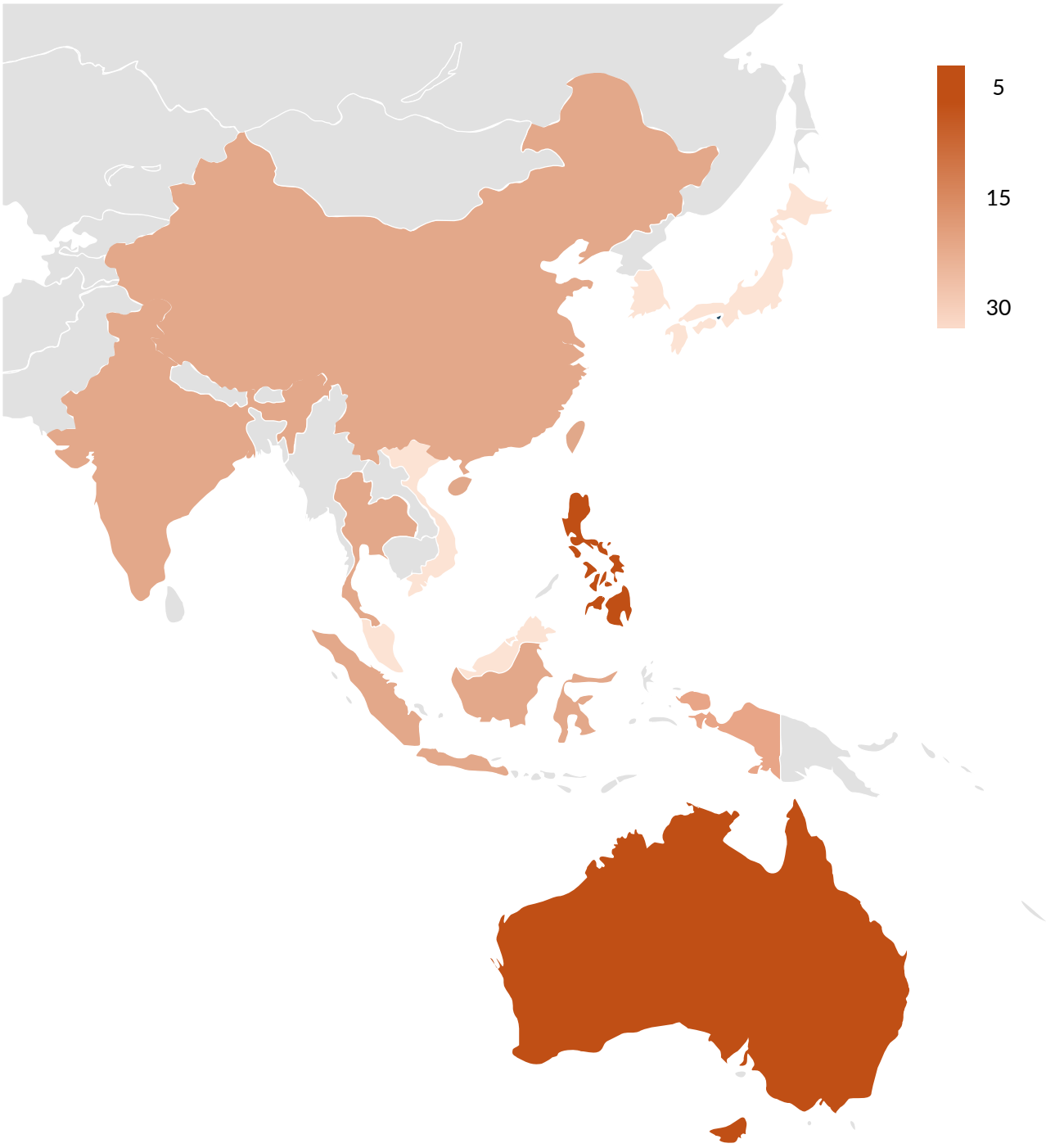


Fig. 1. Balancing period granularity: a key enabler for hourly matching in APAC

[1]Only the 12 markets under the research scope are included: Australia, China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam

UNDERSTANDING KEY CONCEPTS

1. Granular Electricity Accounting

What is it?

Granular electricity accounting refers to the tracking and verification of electricity generation and consumption at an hourly or even sub-hourly level. Unlike traditional systems that rely on monthly or annual averages, it enables energy users to credibly demonstrate when and where their electricity use is carbon-free. Power markets in APAC already operate at high temporal resolution, with settlement intervals commonly set at 15, 30, or even 5 minutes - the data for this accounting is already there in many cases. Granular electricity accounting brings clean energy claims in line with how the grid and power markets actually work.

Why do we need it?

Carbon-Free-Energy (CFE) sources like Solar and wind power are variable by nature, and annual matching often hides the hours when fossil-based electricity is used by allowing, for example, solar power usage claims at night. Hourly matching fills this gap by aligning consumption with the real-time availability of clean energy, leading to more accurate carbon accounting and stronger climate credibility. Granular electricity accounting also enables real-time price signals, storage optimization, and investment in clean energy when it's most needed, helping build the systems required for deep decarbonization. In particular, it enables the integration of cheap renewable energy around the clock by encouraging the buildout of energy storage and demand flexibility to reach high levels of matching. As global **frameworks like the GHG Protocol** and SBTi evolve to address temporal matching and credibility gaps in Scope 2 emissions, granular accounting is quickly becoming the new standard for trustworthy carbon claims. The benefits of this approach are supported by robust research from the International Energy Agency, MIT, Princeton University, and the Technical University of Berlin, among others.

What does it require?

Granular electricity accounting fundamentally depends on hourly generation and consumption data, data commonly used for billing electricity and running the power grid. Its feasibility is further boosted by a supporting ecosystem that includes smart metering, high-frequency grid data, certificate issuance platforms, and rules for tracking, verification, and retirement. Coordination between regulators, market operators, and certificate registries is important to ensure integrity and avoid double-counting.

How is it done?

Granular electricity accounting is enabled through the use of Granular Certificates (GCs)- digital records that represent one unit of carbon-free electricity generated in a specific hour (or sub-hour) and location. These certificates are issued, matched, and retired, allowing consumers to verify that their electricity use is backed by clean generation on an hour-by-hour basis. This system builds on traditional Energy Attribute Certificates (EACs), but adds temporal and locational precision, which is essential for credible claims, regulatory compliance, and 24/7 CFE commitments.

In APAC, granular accounting is becoming a reality. Multiple pilots of hourly matching have taken place in major economies, including **China, Japan, Singapore,** and **Thailand**. On a system level, **Australia** and **Taiwan** have adapted their national EAC using hourly and sub-hourly matching mechanisms.

2. 24/7 Carbon-Free Energy

What is 24/7 Carbon-free energy?

24/7 Carbon-Free Energy (CFE) means that every kilowatt-hour of electricity consumed is matched with carbon-free electricity, every hour, every day, and in the same regional grid. Unlike annual matching, which averages clean energy procurement over a year or month, 24/7 CFE ensures that clean sources continuously power electricity use in real-time and at the same location. **Crucially, the path to 100% 24/7 hourly matching is a journey. No company will start at 100% but the point is to track progress over time based on robust, granular accounting.**

Why does it matter?

Traditional "100% renewable" claims often rely on annual matching, allowing organizations to appear green while consuming fossil power during many hours of the day. This gap weakens the credibility of climate commitments. 24/7 CFE addresses this by directly targeting the most carbon-intensive hours on the grid, aligning clean energy supply with demand, and driving deeper, more transparent decarbonization.

How is it implemented?

Achieving 24/7 CFE involves:

- **Time-based matching** of clean electricity to consumption using instruments like Granular Certificates (GCs).
- **Local sourcing**, ensuring generation and use happen within the same grid region.
- **Technology-inclusive strategies**, leveraging energy storage, demand flexibility, and smart metering infrastructure.
- **Enabling new clean capacity**, by creating demand signals for carbon-free electricity during low-supply hours, encouraging investment in storage, and firm renewables.
- **System-level value**, by enhancing grid flexibility, reducing curtailment, and lowering the need for fossil-based backup.

3. Why Does APAC Matter?

The Asia-Pacific region is pivotal:

- Home to the fastest-growing energy demand globally.
- Hub for clean tech manufacturing, but also high fossil fuel dependence.
- A region where policy, finance, and public support can leapfrog traditional models with modern, smart-grid-enabled, decentralized solutions.

With emerging government interest (e.g., in China, India, South Korea, and ASEAN) and abundant solar potential, APAC can become a global leader in implementing 24/7 CFE solutions from the ground up.

Why this Factbook? Who is it for?

This Factbook is designed for climate campaigners, corporations, energy advocates, civil society leaders, and local policymakers across Asia-Pacific. We have chosen 12 markets to conduct our analysis: Australia, China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, and Vietnam. This analysis focuses on APAC markets that are significant for global decarbonization efforts based on three criteria: 1) high relevance to corporate renewable energy sourcing or hydrogen development policies, 2) large market size as measured by GDP, and 3) substantial electricity production.

The Factbook aims to:

- Demystify granular electricity accounting and 24/7 CFE.
- Equip stakeholders with concrete regional facts to engage in policy dialogues, corporate accountability efforts, and clean energy transitions.
- Offer regionally grounded advocacy tools that connect granular accounting methods with local energy justice and equity goals.

In short, this is your guide to advocate smarter, campaign stronger, and shape a future-ready electricity system in APAC.

WHY DOES 24/7 MATTER FOR APAC?

The Asia-Pacific region faces the world's most complex energy transition, balancing soaring electricity demand, deep fossil fuel dependence, and rising decarbonization ambitions. The top ten electricity-producing countries in the region are led by China (8,599 TWh), India (1,635 TWh), and Japan (1,050 TWh) in 2021, also including South Korea, Indonesia, Chinese Taipei, Australia, Vietnam, Malaysia, and Thailand. Together, they reflect both the immense scale and diversity of APAC's energy landscape.

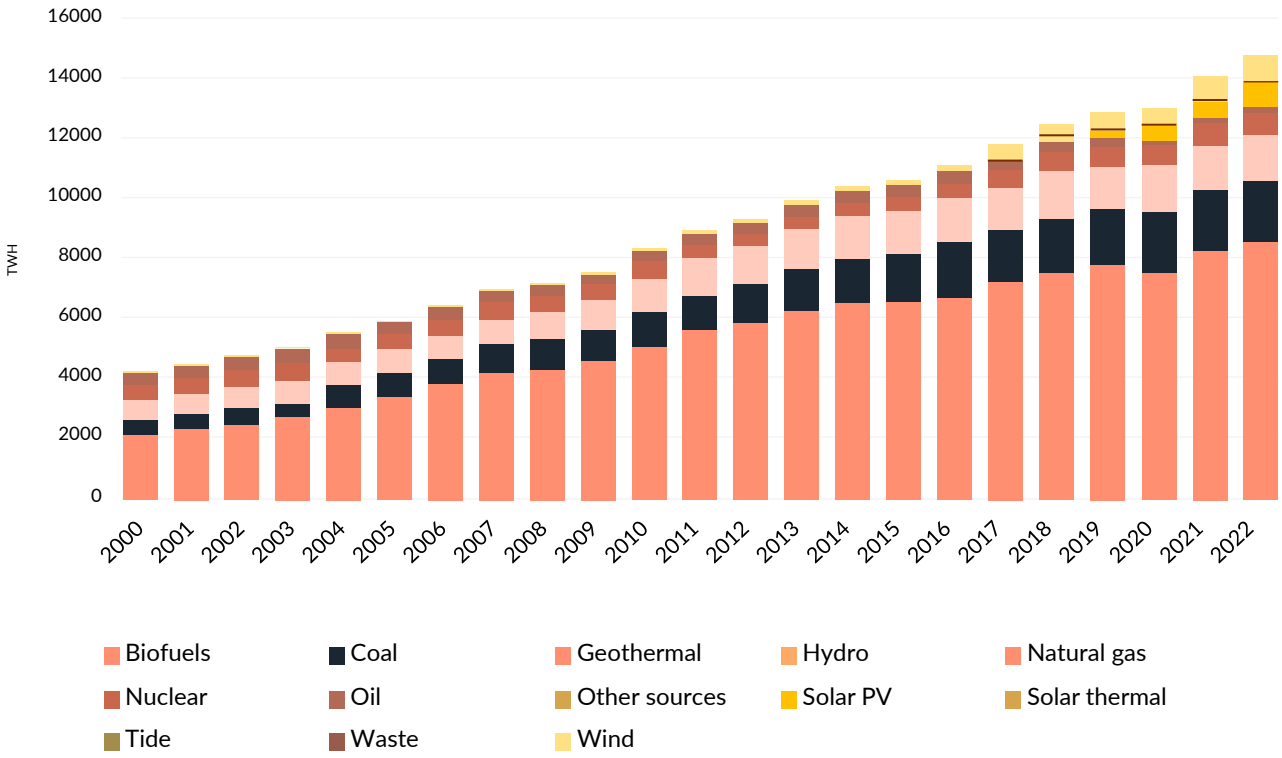


Fig 2. Electricity generation by source in APAC (source: IEA, 2022)

Electricity systems remain dominated by coal and gas, but signs of transformation are emerging across the region. The region is now a clean energy growth engine, with renewable capacity having grown at 8% annually between 2000 and 2022, primarily led by solar. However, as renewables scale rapidly, many APAC grids may confront new operational challenges, chief among them, the emerging duck curve.

The duck curve challenge in APAC

As solar capacity rises across the Asia-Pacific region, electricity demand curves are becoming increasingly misaligned with renewable supply patterns, a phenomenon known as the duck curve. Characterized by midday oversupply of solar power followed by steep evening ramp-ups in fossil generation, the onset of the duck curve is now visible in markets like India, China, and parts of Southeast Asia.

In India, for example, the Central Electricity Authority (CEA) has flagged growing solar **curtailment risks** and pronounced evening demand peaks, especially in high-solar states such as Gujarat and Rajasthan. In China, steep ramping requirements are emerging in several provinces as **solar and wind capacity grow rapidly**. These imbalances result in increased grid stress, greater reliance on fossil fuels, and curtailment of clean energy, all of which undermine decarbonization progress. These dynamics reflect the growing need for enhanced grid flexibility and storage solutions to ensure clean energy is used effectively. When paired with storage and demand-side flexibility, renewables can reliably and cost-effectively meet demand across hours and seasons. Fortunately, solutions exist to address this and ensure the continued and successful integration of cheap renewable energy across APAC.

Addressing the duck curve requires:

- Time-based procurement mechanisms that incentivize clean energy delivery during peak demand hours.
- Storage deployment to shift solar generation into the evening.
- Granular electricity accounting that aligns consumption with clean supply in real-time.

The duck curve makes a strong case for 24/7 Carbon-Free Energy systems that match consumption with clean electricity at the time it's generated.

24/7 CFE Brings Much More Societal Value

System costs and value contribution in India and Indonesia, 2030

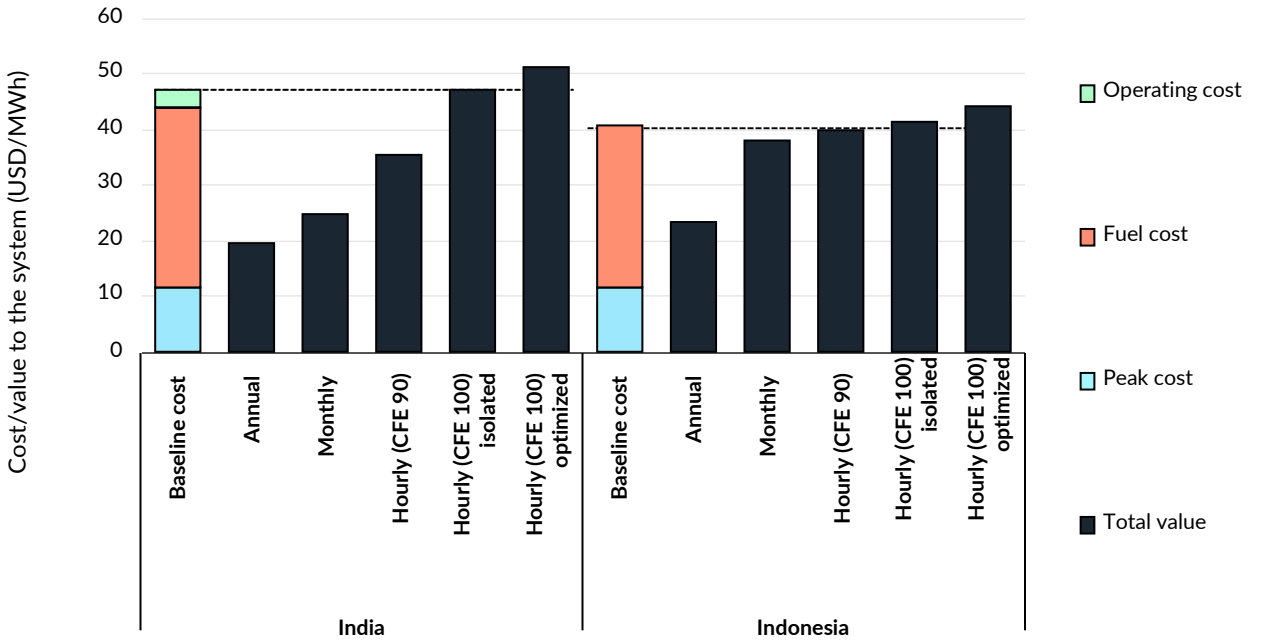


Fig 3. System costs and value contribution in India and Indonesia, 2030 (Source: IEA)

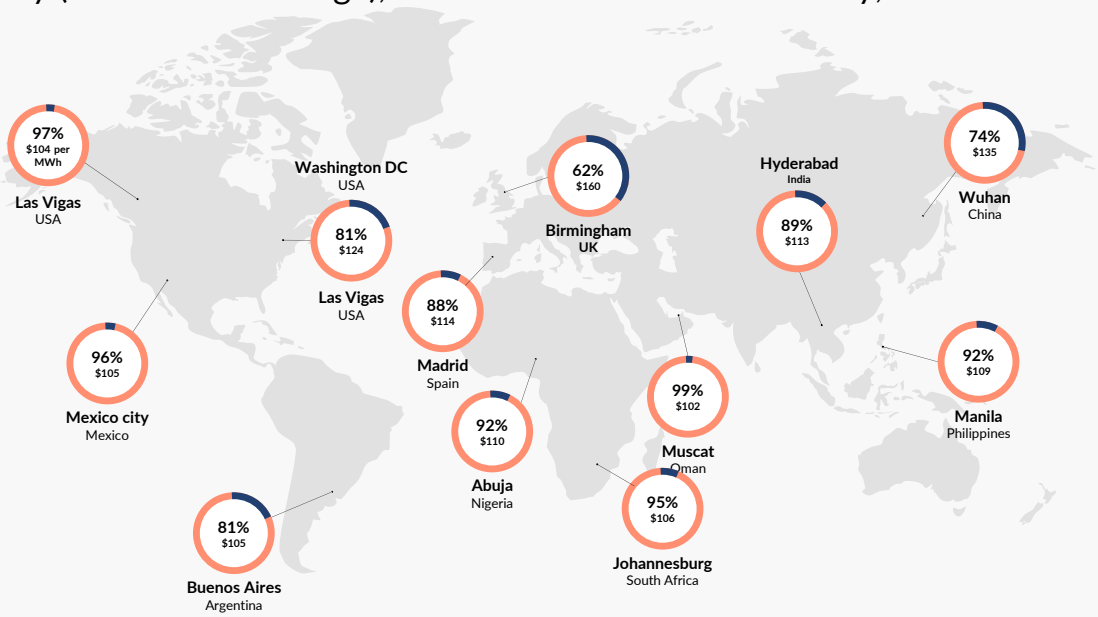
24/7 portfolios incur significantly lower costs on the power system compared to 100% annual matching. Annual matching allows corporations to offset their emissions with RE credits that are not time-aligned with consumption, potentially leaving grid operators to manage variability and gaps. By contrast, 24/7 CFE portfolios use a mix of technologies—including dispatchable clean generation, storage, and demand response—to align supply and demand hourly. This alignment reduces reliance on grid services and backup capacity, offering a higher value to the power system and more accurately reflecting the true cost of serving the load.

24/7 matching imposes significantly less operational strain and balancing cost on power systems compared to annual matching models, which shift system costs to the broader customer base, especially in less wealthy regions.

24/7 CFE Encourages Affordable Round-the-Clock Solar – A Huge Economic Opportunity

Many sunny places can get at least 90% of the way to constant 24/365 solar generation from around $100/MWh

Share of 1GW constant electricity supplied, using 6 GW solar with 17 GWh battery (2005-2023 average), and Levelized cost of electricity, USD/MWh



Source: Ember analysis of JRC hourly solar radiation data
Key assumptions: CAPEX - $388/KW solar, $165/KWh battery; Other costs: $76/KW grid connection; $48/kW inverter; 10% total cost markup for soft costs; 7.7% discount rate over 20 years lifetime; losses: 3.8% PV to grid; 5.6% PV to grid via battery; 90% usable battery capacity

EMBER

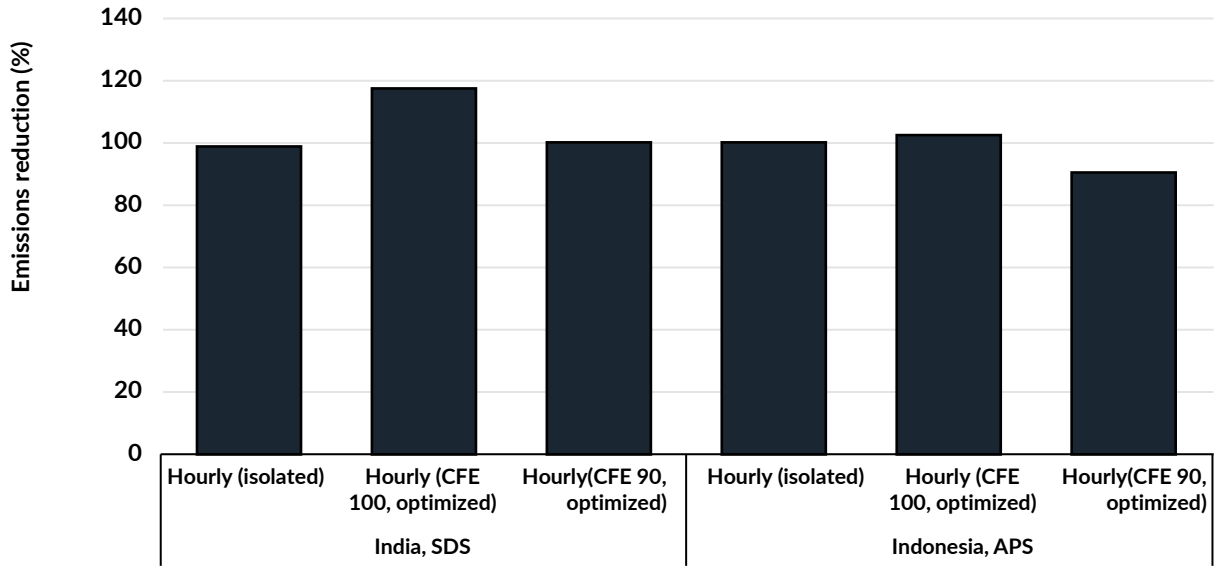
Fig 4. Share of 1 GW constant electricity supplied (Ember)

Recent advances in battery technology have made it economically viable to deliver solar electricity at all hours, even in the absence of sunlight. For example, in sunny cities like Las Vegas, 5 kW of solar panels paired with a 17 kWh battery can deliver 1 kW of stable, round-the-clock power. This model is highly relevant to APAC's sunny regions, where solar-plus-storage systems could dramatically reduce curtailment and grid expansion costs. The Ember report demonstrates that sunny areas can now achieve up to 97% of 24/365 solar generation — clean electricity every hour of every day — for just $104/MWh, a price that undercuts new coal and nuclear generation.

This cost-effective round-the-clock solar model not only enables deeper renewable integration into APAC's power systems but also opens new industrial and economic development pathways. Off-grid or weak-grid regions can host solar-powered industrial zones, data centers, and manufacturing facilities without waiting for costly grid upgrades. Countries like India and Indonesia, where grid access is uneven and expensive, stand to benefit immensely. By leveraging cheap 24/7 solar, APAC can accelerate decarbonization, support industrialization in rural areas, and reduce reliance on fossil fuels — all while managing peak demand and system variability more effectively.

24/7 Drives Emissions Reductions Beyond Annual Matching

Reduction in CO_2 emissions due to different clean energy strategies with both siloed and optimized dispatch for hourly matching in India and Indonesia, 2030



Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario.

Fig 5. Reduction in CO2 emission due to different clean energy strategies with both siloed and optimized dispatch for hourly matching in India and Indonesia (IEA)

Traditional annual or monthly renewable energy accounting methods can obscure the true emissions profile of electricity use by averaging out clean energy consumption over time. This allows organizations to appear green even during hours when fossil fuels are powering their operations. In contrast, 24/7 Carbon-Free Energy (CFE) requires clean electricity to be matched to consumption every hour, driving real decarbonization of the grid. It exposes gaps in renewable coverage, sends clear market signals for flexible, dispatchable clean technologies like storage and demand response, and accelerates the phase-out of fossil fuels during peak demand hours. According to the IEA, hourly CFE drives up to 120% emission reduction when compared with traditional accounting methods. As the need for fossil-fuel power generation during peak demand hours is significantly reduced, granular accounting enables immediate and impactful decarbonization.

Growing trade-related regulations that require temporal matching

Global markets are raising the bar on carbon accountability. Emerging rules in the EU and US require exporters to prove their products are made with low-carbon processes, pushing APAC manufacturers to adopt granular renewable electricity accounting to remain competitive. Here are several regulatory trends in which granular electricity accounting will be crucial to secure market access and trade competitiveness:

Carbon Border Adjustment Mechanism (CBAM)

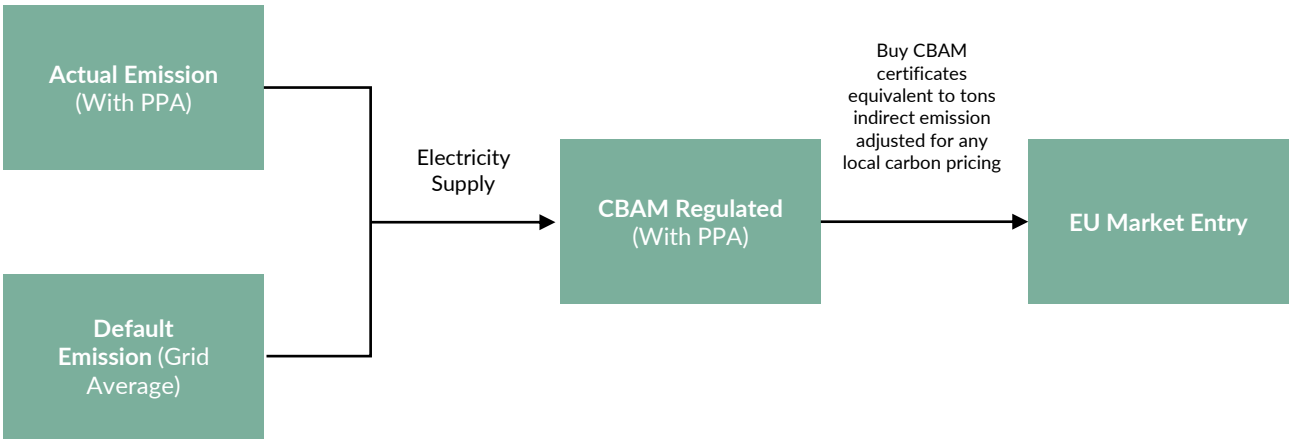


Fig 6. Indirect emission reporting for CBAM products

CBAM is an EU carbon neutrality strategy that addresses the risk of carbon leakage where businesses relocate production to countries with less stringent carbon policies. By imposing a carbon levy on imports of certain carbon-intensive products into the EU, CBAM aims to ensure that imported goods face a carbon price comparable to those produced within the EU under the EU ETS. Initially, CBAM covers direct and indirect emissions of products in high-emission sectors: iron & steel, aluminum, cement, fertilizers, electricity, and hydrogen. By 2026, it will become fully operational: EU importers will have to purchase CBAM certificates for the CO_2 emissions of their imports.

One key compliance strategy is to reduce the carbon intensity of electricity used in production. For energy-intensive sectors like steel or aluminum, a large share of their total emissions comes from power consumption. According to CBAM's **official guidance** published on 23 November 2023, there is a strict hierarchy for how electricity emissions are calculated. The preferred approach is to use data from self-generation or directly connected renewable power sources. Physical power purchase agreements (PPAs) are also eligible. If these are unavailable, companies must default to national or regional average emission factors. Importantly, the guidance explicitly states that market-based instruments — such as guarantees of origin or green certificates — are not accepted for emissions reduction under CBAM.

Renewable Fuel of Non-Biological Origin (RFNBO):

The EU has introduced Delegated Acts under its Renewable Energy Directive (RED II) to define what counts as a "Renewable Fuel of Non-Biological Origin" (RFNBO), covering fuels like hydrogen, ammonia, synthetic methanol, or jet fuel produced from renewable electricity. The EU requires strict temporal and geographic correlation between renewable energy generation and the RFNBO production.

The RFNBO rules effectively demand a location and time-based tracking and certification system. Producers will need to document exactly when and where their energy originated. In anticipation, various certification schemes, such as Europe's CertifHy or schemes under development by the Global Assurance for Hydrogen, are being established to audit these temporal/geographic **matches.**

For APAC exporters, these RFNBO rules are highly relevant if they plan to sell green hydrogen or derived fuels to Europe. 10 out of 12 markets we investigated have formally established their hydrogen strategies. Countries like **Australia**, **Korea**, India and **China** are eyeing hydrogen/ammonia exports. APAC producers will likely need to have their projects certified by EU-recognized bodies to sell into that market. This is a clear case where granular electricity accounting isn't just a nice-to-have for sustainability – it's a legal requirement for market entry.

Greenhouse Gas Protocol (GHGP) Scope 2 accounting:

Beyond formal regulations, the standards for corporate emissions accounting are also evolving toward granular energy usage tracking. The Greenhouse Gas Protocol is in the midst of updating its guidance for Scope 2 emissions. The current Scope 2 Guidance allows companies to use a market-based method: purchasing renewable energy certificates (RECs) or signing power contracts to claim renewable electricity use, often summed on an annual basis. This enabled the rise of corporate renewable procurement but has also led to concerns about credibility, as companies could claim "100% renewable" while still drawing power from fossil-fueled grids at certain times.

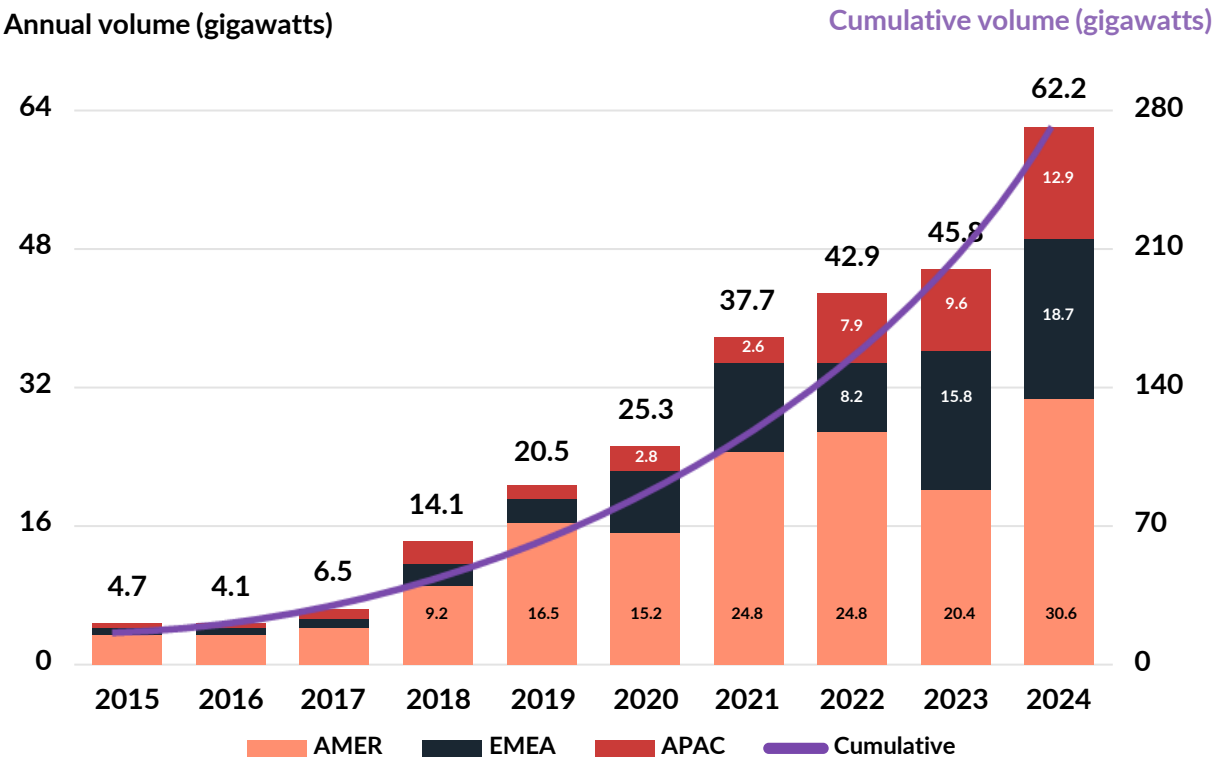
In response, the GHG Protocol's technical working group has floated **proposals** to tighten the rules to reflect the actual time and location of electricity use. Specifically, leading proposals would require companies to match their electricity consumption with clean electricity generation on an hourly basis, within the same regional grid system. Additionally, the revisions may narrow the geographic scope for matching, moving from national or multinational regions to more localized grid boundaries.

For APAC exporters, aligning early with these emerging guidelines could be a competitive advantage. Companies that invest in energy monitoring systems, smart meters, and integrated renewable supply will be able to provide the data that future audits and reports demand. On the flip side, companies that ignore these trends might find their market-based emissions reductions discounted or disqualified in the near future, affecting their attractiveness to global customers committed to true zero-carbon sourcing.

APAC GRANULAR MARKET READINESS

Granular-Ready Markets in APAC

While much of the Asia-Pacific region is still in the early stages of adopting granular electricity accounting and 24/7 CFE frameworks, several key markets are laying the technical and policy foundations needed to enable this transition. Multiple readiness indicators, such as sub-hourly or hourly market settlement intervals, time-of-day (ToD) tariffs, battery storage policies, smart meter rollouts, and electricity market liberalization, suggest that these countries are increasingly equipped to support 24/7 CFE implementation. Although none of these markets have fully developed granular certificate systems or enforced temporal matching in policy, the underlying infrastructure and momentum indicate a strong trajectory.



Source: BloombergNEF. Note: Chart shows only offsite power purchase agreements. Asia Pacific capacity estimated. Figures are subject to change as more information made available. Data through December 2024.

Fig. 6 Global corporate clean power purchase agreement volumes (source: BloombergNEF)

Rising Corporate Demand for Clean Electricity in APAC

Corporate demand for clean electricity is rising rapidly across Asia-Pacific. From multinational RE100 members to local manufacturers, buyers are pushing for more credible, clean electricity procurement options. In 2024, corporate power purchase agreements (PPAs) for clean electricity in APAC reached 12.9 gigawatts—an increase of 34% over 2023.

This surge in demand is expected to continue. The clean electricity shortfall among RE100 members alone could drive up to 126 gigawatts of new renewable demand by 2030. Notably, 75% of new RE100 signatories in 2024 came from the Asia-Pacific region, highlighting the region's growing leadership and commitment to clean energy transformation.

Key Market Developments:

Australia: Renewable Electricity Guarantee of Origin

What is it — Renewable Electricity Guarantee of Origin (REGO) is a certificate under Australia's new Guarantee of Origin Scheme, set to replace the existing system of Large-scale Generation Certificate (LGCs) post 2030.

Why does it matter for 24/7 CFE?

Each REGO is time-stamped, allowing businesses and buyers to match energy consumption to actual renewable supply, hour by hour. REGO is essential for compliance with international requirements such as EU RFNBO or US clean hydrogen incentives that mandate hourly matching.

The market value of REGOs will vary by time—scarce during peak fossil periods and abundant midday—creating price signals that encourage energy storage, flexible demand, and renewables deployment where needed.

China: A Unified Real-Time Power Trading Market

What is it — In 2025, China is launching a nationwide unified electricity trading market, replacing its long-standing fragmented regional systems. The platform will operate under a single regulatory framework, integrating spot and medium-term trading contracts into a national digital marketplace. This reform aims to liberalize electricity pricing, facilitate efficient power dispatch, and promote a more competitive and transparent energy market.

Why does it matter for 24/7 CFE?

China's unified trading market is a cornerstone reform that directly supports the country's carbon neutrality targets and clean energy scale-up by:

Enabling real-time pricing, which provides more accurate signals for flexible, 24/7 clean energy deployment.

Encouraging interprovincial transmission is critical for smoothing regional mismatches in renewable supply and industrial demand.

Unlocking granular data availability, the unified platform will collect and process detailed, time-stamped electricity generation and consumption data across the country. This rich data infrastructure is exactly what's needed to implement granular electricity accounting at scale, proving that China has both the technical foundation and digital readiness to make 24/7 CFE a reality.

India: Round-the-Clock Tenders (RTC tenders)

What is it — RTC Renewable Energy refers to a power supply model where renewable sources like solar and wind are integrated with energy storage systems (ESS) and/or firming sources like hydro or thermal to provide uninterrupted electricity 24/7.

India's RTC Tenders, launched by SECI in 2019, are tariff-based competitive bidding mechanisms that require power developers to deliver renewable electricity at a high annual capacity utilization factor (CUF)—typically 80–85%—all year round, simulating firm power supply.

Why does it matter for 24/7 CFE?

RTC power is a key transitional solution that helps India and other emerging economies move toward 24/7 Carbon-Free Energy by addressing the intermittency challenge of solar and wind.

Delivers firm and predictable renewable power, easing scheduling for grid operators and Load Dispatch Centres.

Enables hourly balancing, which is critical for green hydrogen production, industrial loads, and clean energy procurement by corporations.

Encourages innovation in **hybrid systems, storage integration**, and **demand-side flexibility** through clear performance incentives.

Japan and South Korea: Smart meter rollout

Japan's near complete smart meter rollout: The Ministry of Economy, Trade, and Industry (METI) required 100% smart meter coverage by 2025, with targeted rollout phases for different regions (e.g., Chubu and Kansai by FY 2022, Okinawa by FY 2024). As of 2023, over 74–80 million smart meters have been installed across Japan. TEPCO alone installed 28.4 million meters for its residential and business customers by FY 2020, with data collected every 30 minutes.

South Korea's comprehensive rollout via Smart Grid Roadmap 2030: The government's 2030 roadmap targets nationwide smart grid coverage, including mass deployment of electricity, gas, and water meters using PLC, RF, cellular, and 5G networks.

Why does it matter for 24/7 CFE?

Increased infrastructural readiness: Smart meters record electricity consumption in short intervals (e.g., every 30 minutes in Japan, 15–60 minutes in Korea). This enables hourly matching of electricity demand with renewable generation.

Philippines: Wholesale Electricity Spot Market (WESM)

What is it — The Philippines Wholesale Electricity Spot Market (WESM) is a competitive electricity market where generation companies sell power and distribution utilities or large consumers buy electricity based on real-time prices. WESM operates on an hourly pricing system, recently enhanced to 5-minute dispatch intervals, although settlement is still typically based on hourly average prices.

Why does it matter for 24/7 CFE?

Enhanced market signals help improve grid reliability and integration of variable renewables.

Real-time market prices reflect the true value of renewable energy, especially during peak or low supply periods.

Singapore: Cross-border renewable energy certificate

What is it — Singapore is actively developing a cross-border REC framework to enable the import of renewable electricity from neighboring countries—such as Malaysia, Laos, and Australia—and for that clean energy to be credibly counted towards corporate sustainability commitments made under RE100, the Greenhouse Gas Protocol (GHGP), and CDP.

Why does it matter for 24/7 CFE?

Unlocks Access to Regional Renewables: Singapore cannot meet 24/7 CFE goals with local generation alone. A credible cross-border REC system allows the import of verifiably clean electricity from neighboring countries (e.g., Malaysia, Laos, Australia) while ensuring it aligns with international standards.

Taiwan: Taiwan Renewable Energy Certificate (T-REC)

What is it — The Taiwan Renewable Energy Certificate (T-REC) represents 1 megawatt-hour (MWh) of electricity generated from renewable sources such as solar, wind, hydro, or geothermal energy. Issued by the T-REC Center under the Ministry of Economic Affairs, T-RECs are verified using 15-minute interval data from Taiwan's Advanced Metering Infrastructure (AMI), enabling high-resolution matching of renewable generation and consumption.

Why does it matter for 24/7 CFE?

Smart meters deployed across Taiwan allow for high-resolution tracking, creating the technical foundation for GC.

Supports Corporate Demand for 24/7 CFE: Global companies like Google are already investing in Taiwan's clean energy infrastructure, using its T-REC framework to support their 24/7 CFE strategies. This enhances Taiwan's competitiveness as a hub for sustainable manufacturing and data services.

Vietnam: 30-minutes full market price (FMP)

What is it —Vietnam's power market operates on a 30-minute Full Market Price (FMP) system, where electricity prices are updated every half hour based on real-time supply and demand. This pricing structure applies in the Vietnam Wholesale Electricity Market (VWEM) and is used for settlement, particularly under the Direct Power Purchase Agreement (DPPA) model.

Why does it matter for 24/7 CFE?

Granular Time Signal for Energy Use - The 30-minute pricing intervals create a granular, real-time snapshot of electricity generation and consumption, essential for tracking when renewable energy is actually being used.

Supports Market-Based Clean Energy Procurement — Through virtual DPPA models and Contracts-for-Difference (CfDs) settled against the 30-minute FMP, large consumers can financially engage with renewable energy in real time — aligning market activity with actual clean energy availability.

China

- Unified national power market enabling real-time trading
- Hourly matching pilots in yantai
- Provincial RPS targets and GEC market expansion
- Grid digitization and storage investments accelerating

India

- Growing Round-The-Clock (RTC) tenders backed by storage
- Shift from electricity banking to real-time matching in PPAs
- 15-min Real Time Market (RTM) /Day Ahed Market (DAM)
- State Renewable Purchase Obligations / REC

Thailand

- Hourly accounting pilot conducted by Chiang Mai University
- Hybrid/Firm PPA Scheme (2017) to provide Round-the-Clock procurement

Vietnam

- 30-minute Full Market Pricing (FMP) enables granular dispatch
- DPPA approved with FMP exposure for corporate buyers
- PDP8 supports renewables, storage, and grid strengthening

Malaysia

- The Corporate Renewable Energy Supply Scheme (CRESS) enables physical PPAs through third-party access
- First grid-scale BESS tender for Peninsular Malaysia launched in June 2025

Singapore

- GoNetZero * UBS hourly matching pilot
- Cross-border REC framework in development
- REC trading valued ~ $60 M in 2024

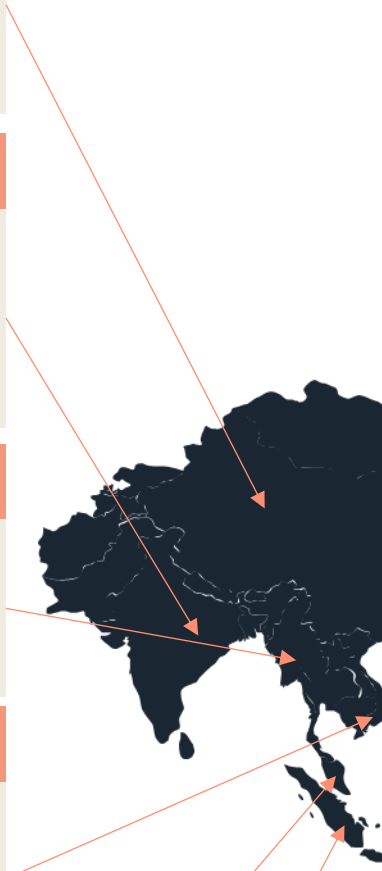
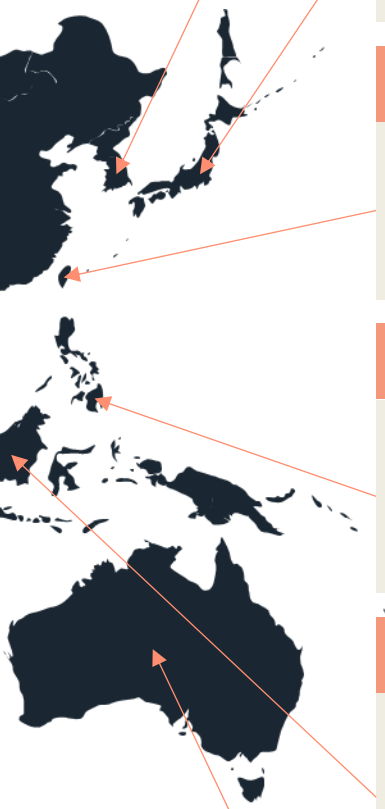


Fig. 7 Granular Electricity Market Signals in APAC



Korea

- 26 GW BESS target by 2036
- On-site, bilateral, trilateral PPAs supported by K-RE100

Japan

- JERA Group & Granular Energy pilot on hourly renewable data
- 100 million smart meter installations by 2025
- 1.3GW of BESS in 2024 Long-Term Decarbonation Power Source Auction (LTDS)

Taiwan

- T-REC system users 15-minute AMI data to match generation and consumption data
- Smart meters ~ 80% deployed

Philippines

- 5-minute dispatch and WESM reform in progress
- Increasing RE-plus-storage auctions
- RPS targets scaling alongside emerging carbon regulations
- Green Energy Option Program (GEOP) enables RE sourcing by large users

Indonesia

- Regulation 11 allows REC issuance
- Perusahaan Listrik Negara (PLN) launched a 5MW BESS pilot
- PPA allowed under MEMR Regulation No.5 of 2025

Australia

- Granular certificate (i.e.REGO) scheme launched in 2024
- 5-minute settlement in National Electricity Market (NEM)
- Utility-scale batteries enabling firmed renewables and 24/7 CFE
- RET/RPP targets and battery support schemes expanding

Fig. 7 Granular Electricity Market Signals in APAC

FREQUENTLY ASKED QUESTIONS

A. Fundamental Concepts

1. Why do we need hourly matching? Isn't annual matching good enough?

Annual matching can misrepresent actual emissions. It allows "100% renewable" claims even during fossil-powered hours, based on being solar-powered at night, for example. Hourly matching aligns consumption with real-time clean energy generation, ensuring credible climate claims.

2. What are granular certificates (GCs), and how do they work?

Granular Certificates (GCs) are time- and location-specific energy attribute certificates. Under the EnergyTag standard, one GC represents one watt-hour of carbon-free electricity generated within a specific hourly interval. GCs help buyers procure clean energy in real-time and incentivize supply during high-emission hours.

3. Wouldn't large-scale energy storage solve the clean energy time-matching challenge on its own?

Energy storage plays a crucial role in enabling 24/7 matching by shifting renewable electricity from when it's generated to when it's needed. However, granular tracking is still essential to ensure the stored energy is verifiably clean and used at the right time. Storage helps solve intermittency, but without transparent tracking, there's no way to verify the climate benefit of energy consumed. Granular accounting ensures integrity and prevents double-counting, whether energy is used directly or via storage.

B. Market Impacts

4. Will granular matching and 24/7 CFE hurt APAC markets or limit investment?

No, Granular tracking enhances market transparency, attracts premium buyers, and builds long-term investor confidence. It positions APAC markets for global alignment and encourages procurement portfolios that minimize grid costs for all.

5. Doesn't this make clean energy procurement more expensive?

Not necessarily. Research from TU Berlin and Princeton shows that up to 90–95% hourly matching is **only slightly more expensive than 100%** annual matching. The real goal is to start matching now, even partially, because it creates price signals that accelerate innovation and lower costs over time. Plus, hourly PPAs offer better price stability and lower exposure to market volatility than traditional annual contracts.

6. Is this relevant to developing or emerging markets?

Yes — it's a **chance to leapfrog**. Many emerging markets are building new grid infrastructure. They can embed smart, 24/7-ready systems from the start.

7. What about cross-border REC claims — are they still valid?

Cross-border REC claims can be valid, but only under certain conditions. To be credible, they should reflect real physical electricity flows between interconnected grids, not just financial trades. If RECs are claimed across borders without actual power flow, aligned market rules, or synchronized timing, they risk double-counting, undermining integrity, and reducing investments in renewables where they are needed more locally. It is important to design clear boundaries, time-stamped RECs, and avoid claims that exceed real power transfer.

C. Alignment With Global Trade & Regulations

8. How does this affect carbon reporting frameworks like SBTi or GHG Protocol?

These frameworks are **evolving** to favor time- and location-specific clean energy data. Hourly matching offers a more accurate representation of Scope 2 emissions.

9. How does this align with global trade rules like CBAM or EU hydrogen?

According to the Carbon Border Adjustment Mechanism (CBAM), hydrogen, cement, steel, aluminum, fertilizers, and electricity exported to the EU must meet strict carbon intensity and traceability standards or face carbon-based tariffs.

For APAC countries, adopting granular electricity accounting is now essential to certify hydrogen as truly "green" under EU and US standards, and enhance access to low-carbon preferential markets.

D. Accessibility & Scalability

10. Is 24/7 CFE only for large tech companies?

No — hourly matching is simple and scalable in APAC, leveraging existing hourly meter data. You don't need to be a tech giant—any organization can align energy use in real time. These initiatives prove that with no major infrastructure changes, hourly tracking is already working globally.

- **AsiaREC** coordinated a pilot in Yantai, Shandong Province, successfully matching hourly renewable generation to industrial load (via 5,000 MWh of Green Electricity Certificates). This demonstrates China's ability to scale hourly carbon accounting using its existing Green Electricity Certificate (GEC) system.
- **Taiwan's Renewable Energy Certificate (T-REC) system** already supports sub-hourly matching. While certificates are currently issued monthly, the architecture is explicitly designed for granular allocation: 15-minute interval matching followed by a monthly balancing stage.

11. Isn't this too complex to implement?

It's not too complex, it's systemic. The tools (EnergyTag standards, storage, smart meters, digital platforms) already exist. APAC can shape the future by joining early.

E. Technologies enabling 24/7 CFE

12. What technologies support 24/7 CFE?

It's technology-inclusive: solar, wind, hydro, geothermal, nuclear, batteries, and digital platforms (e.g., smart meters and matching software) all play a role. However, given the urgent need to decarbonize, it is important that companies focus on procuring new clean energy, which is where renewables and storage will be most important, given how much faster they are growing than other sources.

13. Do I need new hardware to track hourly energy use?

Not necessarily. Most commercial and industrial meters already record data hourly or every 15 minutes. Matching software and registries can use this data without requiring new hardware.

14. What role do digital platforms and registries play?

Platforms match generation and consumption data, timestamp it, and issue digital GCs. Registries provide public verification and avoid double-counting.

15. Can storage be used to shift renewable energy across hours?

Yes. Batteries (BESS), pumped hydro, and thermal storage allow renewable energy to be stored and dispatched to align with demand, essential for 24/7 CFE.

F. System readiness & policy levers

16. What role can governments play in supporting hourly matching?

Governments can:

- Mandate or encourage time-stamped energy tracking.
- Support pilot programs or public registries.
- Incentivize 24/7 tariffs and hourly PPAs.
- Align national rules with international standards.

17. How do utilities fit into this transition?

Utilities can:

- Offer time-of-use and 24/7 carbon-free tariffs.
- Partner with registries and platforms.
- Enable customers to choose matched clean energy.

18. How can small or less-developed markets get started?

Start with pilots. Focus on large buyers or industrial zones with smart meters. Partner with existing platforms like EnergyTag, M-RETS, Flexidao, Granular Energy, Energinet or Powerledger to test time-based claims.

KEY MESSAGES

Credibility & climate leadership

- Hourly tracking = **accurate climate claims**. Avoid greenwashing like "100% solar-powered—at night."
- 24/7 CFE is the **end state** of a fully decarbonized electricity system.
- Leading companies (**Google** and **Microsoft**) are already shifting to 24/7 tracking to future-proof their climate goals.

Aligning with global trade and regulation

- The EU's Carbon Border Adjustment Mechanism (CBAM) and hydrogen import rules require hourly matching, local procurement, and additionality.
- **APAC's hydrogen ambitions** will depend on robust, credible electricity sourcing to open up markets with increasingly **stringent** requirements on hourly matching.

Avoiding obsolescence in APAC markets

- **Annual-only REC frameworks are becoming outdated**. They risk locking markets into low-integrity accounting.
- International buyers **increasingly** expect hourly, local, additional clean energy, not credits from legacy hydropower or distant regions.
- APAC energy systems are digitizing rapidly—**don't retrofit yesterday's rules on tomorrow's infrastructure.**

Policy influence & market innovation

- NGOs and civil society can push for **data transparency, equitable access, and smarter regulation** in energy systems.
- Corporations can shape **next-gen energy markets**—from 24/7 utility tariffs to CFE-based procurement contracts.
- **Smart metering, flexible tariffs, and granular RECs** unlock more affordable and inclusive energy transitions.

APAC CASE STUDIES

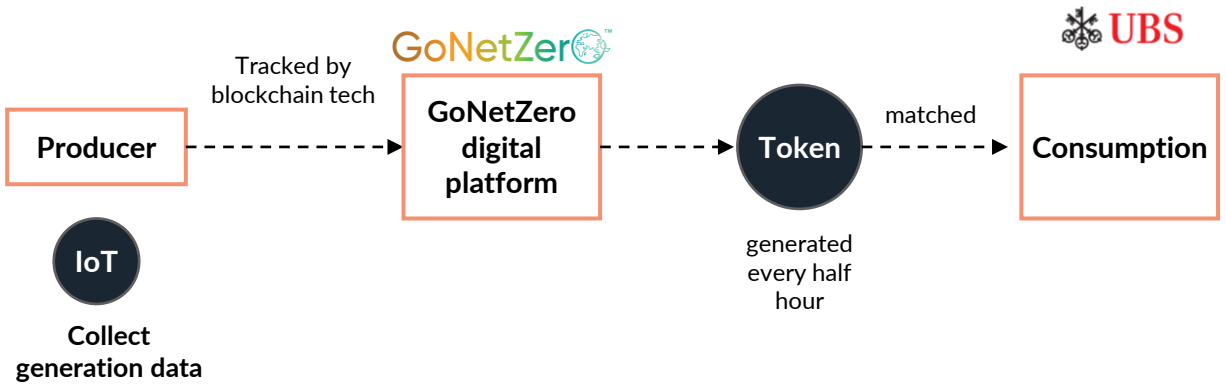


Fig. 8 Singapore's case study: go NetZero x UBS

In a first for Asia, GoNetZero has utilized blockchain technology to track granular issuance of RECs from a 6 MWp solar generation site and successfully piloted hourly matching of power consumption with renewable energy for UBS in Singapore.

Benefits:

- Identify opportunities for further carbon footprint reduction.
- Verifies the integrity of RE consumption ~7 GWh/y.
- Enhanced data transparency.

More APAC case studies on the EnergyTag website:

Country	Case Studies
Japan	Flexidao and Jera Cross: Hourly Clean Energy Matching for Business Customers
	D-Sharing Co., Ltd. and Cyber Souken Co., Ltd: Half-Hourly Matching for EV Daytime Charging by Distributed Community Solar Energy
China	AsiaREC, Shandong Luneng Group, and Wanhua Chemical Group: China's First Hourly Matched Pilot
Thailand	Chiang Mai University and Powerledger: Smart City at Chiang Mai University
Taiwan	The Concept of 24/7 Bundled T-RECs Mechanism
Australia	Enosi and UNSW: Hourly Matching of Solar Supply for University Campus

ENERGYTAG STANDARDS & OTHER RESOURCES

Granular Certificate Scheme Standard:

The GC Scheme Standard details the criteria to be followed to run a robust GC Scheme. It defines the governance, processes, data requirements, and verification mechanisms that ensure the integrity and transparency of GC. GC Issuers must be EnergyTag Accredited to be "EnergyTag Compliant".

Users: GC issuers, regulators and policymakers.

Granular Certificate Matching Standard:

The GC Matching Standard details the criteria to be followed to ensure robust GC Matching.This Standard defines how claims of hourly (or sub-hourly) clean energy usage should be constructed, documented, and verified. Claim Verifiers must be EnergyTag Accredited to verify claims as being "EnergyTag Compliant".

Users: Corporate energy buyers.

GC Registry API Specification:

The GC registry API specification ensures that the registry adheres to standardized protocols for certificate issuance, transfer, retirement, and data access. The aim of the project was to facilitate the implementation of Granular Certificate registries with robust technical harmonization.

Users: prospective GC registries.

GC Scheme Protocol Template:

This document describes the Granular Certificate (GC) Scheme Protocol of the Issuer. It supports the assessment process for becoming an EnergyTag Compliant Granular Certificate Issuer by demonstrating compliance with the EnergyTag Granular Certificate Scheme Standard.

MEDIA RESOURCES

MEDIA RESOURCES

Category	Institution	Media Link
Granular Electricity Accounting Standards	EnergyTag	EnergyTag Granular Certificate (GC) Scheme Standard
	EnergyTag	EnergyTag Granular Certificate (GC) Matching Standard
Regional Corporate Procurement Studies	Bloomberg	24/7 Carbon-Free Energy Procurement in APAC: Pathways for Companies and Countries
	KPMG	Decarbonization Through Renewable Energy: Understanding Asia Pacific's Corporate Power Purchase Agreement Landscape
Practical Guides to Hourly Matching	UN	UN 24/7 CFE Compact
	24/7 CFE Coalition	24/7 CFE Coalition Technical Criteria
	Eurelectric	Getting to 24/7 Carbon-free Energy - Practical Steps for Buyers and Suppliers
System Value of CFE	TU Berlin / Princeton University / Google	24/7 Carbon-free Electricity Matching Accelerates Adoption of Advanced Clean Energy Technologies
	Ember	24/7/365 Solar and Batteries
	IEA	Advancing Decarbonisation Through Clean Electricity Procurement
	Princeton University	The Influence of Demand-side Data Granularity on the Efficacy of 24/7 Carbon-free Electricity Procurement
	TU Berlin	On the Means, Costs, and system-level impacts of 24/7 carbon-free energy procurement
	Princeton University	Electricity System and Market Impacts of Time-based Attribute Trading and 24/7 Carbon-free Electricity Procurement
	Princeton University	System-level Impacts of 24/7 Carbon-free Electricity Procurement

MEDIA RESOURCES

Category	Institution	Media Link
Credibility of Accounting	Denmark Technical University	Does the purchase of voluntary renewable energy certificates lead to emission reductions? A review of studies quantifying the impact
	Princeton University	The Influence of Demand-Side Data Granularity on the Efficacy of 24/7 Carbon-Free Electricity Procurement
Green Hydrogen Production	EPRI	Impacts of IRA's 45V Clean Hydrogen Production Tax Credit
	Florence School of Regulation	Green Hydrogen – How Grey Can It Be?
	TU Berlin	Hourly Versus Annually Matched Renewable Supply for Electrolytic Hydrogen
Regional Renewable Energy Updates	David Fishman (The Lantau Group)	Q&A: China Announces Huge Policy Shake-up, Pushing More Renewables into the Market
	The International Tracking Standard Foundation	China Introduces New EAC Policy
	EQUINIX	Equinix Energizes Digital Landscape in Singapore with an Additional 58.5 MWp of Solar Energy
	RE100	China's Energy Market "Open for Business" After Support from RE100 on Certificates
	Happy Eco News	Singapore Drives Cross-Border Renewable Energy Certification
	Wood Mackenzie	Renewable Energy Certificate (REC) Prices to Drop 76% by 2050 Due To Surging Renewable Generation in Asia Pacific
Trade Alignment	EnergyTag	A Closer Look At The 45V Final Rule
	Wood Mackenzie	A Second Trump Administration. And What It Means For Energy and Natural Resources
	Heatmap	Hydrogen Tax Credit Rules Will Be Done by the End of the Year

COUNTRY FACTSHEET

1. Policy Ambition & Target		
Long-term clean energy target	✓	82% renewable electricity by 2030
Specific battery storage goal	✓	1.7 GW additional battery capacity planned by 2025
Green hydrogen policies present	✓	15 M mt of hydrogen annually by 2050
Green hydrogen certification	✓	The GO scheme includes hydrogen tracking
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✓	NEM is liberalized across multiple states
Real-time or granular settlement period	✓	5-minutes settlement period
Time-of-Use tariffs are in place	✓	Present
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Significant bottlenecks in some regions
Ability to transmit electricity across regions	✓	Cross-state flow possible
4. Corporate Procurement Options		
PPA mechanisms available	✓	On-site and off-site PPAs through NEM utilities
Certificate tracking options exist	✓	LGCs in REC registry; REGO scheme to granular
RTC procurement mechanisms are available	✓	Capacity Investment Scheme (CIS) tender
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	56% remote meter-read rollout
Real-time consumption data available	✓	accessible for corporate consumers
Granular certificate system exists	✓	REGO to support time-stamped granular claims
Hourly matching pilots exist	✓	Enosi & UNSW: hourly matching to supply 100 GWh from large off-site solar PV.

▲ = insufficient progress **✓ = sufficient progress** **X = no progress**

1. Policy Ambition & Target		
Long-term clean energy target	✓	80% non-fossil energy in the electricity mix by 2060
Specific battery storage goal	✓	Aimed at 100GW by 2030
Green hydrogen policies present	✓	Multiple pathways in the national strategy
Green hydrogen certification	▲	The Hydrogen Alliance defines low-carbon criteria
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	▲	Some regional pilot liberalization
Real-time or granular settlement period	✓	15-minute settlement period
Time-of-Use tariffs are in place	✓	Pricing is divided into 6 blocks
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Major curtailment in the northwest
Ability to transmit electricity across regions	✓	Long-distance HVDC/UHV links help, but bottlenecks persist
4. Corporate Procurement Options		
PPA mechanisms available	✓	On-site and off-site PPAs permitted
Certificate tracking options exist	✓	Green Electricity Certificates (GECs) tracked
RTC procurement mechanism	▲	Large-scale BESS tenders are being launched by PowerChina
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	> 50% of the market covered
Real-time consumption data available	▲	Corporate data access is unclear
Granular certificate system operational	▲	GECs are annual
Hourly matching pilots exist	✓	AsiaREC's Hourly matching pilots in industrial parks in Yantai

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1. Policy Ambition & Target		
Long-term clean energy target	✓	50% electricity from non-fossil fuels by 2030
Specific battery storage goal	✓	41 GW of BESS capacity by 2031
Green hydrogen policies present	✓	5 M mt per annum by 2030
Green hydrogen certification	✓	Green Hydrogen Certification System (GHCI) exists
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	▲	Centralized under CERC rules, but DISCOMs are still dominant
Real-time or granular settlement period	✓	30-minute settlement period
Time-of-Use tariffs are in place	✓	Several states offer TOU rates for large C&I consumers
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Grid is congested 46% of the time
Ability to transmit electricity across regions	✓	Grid is interconnected and operates as a unified national electricity grid
4. Corporate Procurement Options		
PPA mechanisms available	✓	Open access PPAs; growing uptake (~34 GW)
Certificate tracking options exist	✓	RECs available with tracking
RTC procurement mechanisms are available	✓	Round-The-Clock (RTC) tenders backed by storage
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	✗	250M smart meters will be installed by 2026; 14.5 million have been installed in 2024
Real-time consumption data available	✓	accessible for corporate consumers
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✗	None currently implemented

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1. Policy Ambition & Target		
Long-term clean energy target	✓	~35% RE in electricity mix by 2035
Specific battery storage goal	✗	No battery storage goals
Green hydrogen policies present	✓	National Hydrogen Strategy (SHN) targets 9.9M mt by 2060
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✗	PLN monopoly; IPPs allowed, but no liberalization
Real-time or granular settlement period	✓	15-minutes settlement period
Time-of-Use tariffs are in place	✗	Not standardized
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Congestion, integration challenges persist
Ability to transmit electricity across regions	✗	Inter-island links developing
4. Corporate Procurement options		
PPA mechanisms available	▲	PPA regulation updated (MEMR 5/2025), PLN off-takes, DPPA nascent
Certificate tracking options exist	✓	Under PLN REC
RTC procurement mechanisms are available	✗	None currently implemented
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	Aims at 10 M by 2030, current data unavailable
Real-time consumption data available	✗	Not accessible for corporate consumers
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✗	None currently implemented

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1. Policy Ambition & Target		
Long-term clean energy target	✓	40–50% renewables by 2040
Specific battery storage goal	✓	10 GW by 2030
Green hydrogen policies present	✓	$98.8B investment; 12M tons/year target
Green hydrogen certification	✗	Not yet established
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✓	Partially liberalized retail market
Real-time or granular settlement period	✓	30-minute settlement
Time-of-Use tariffs are in place	✓	TOU pricing (8 am–10 pm focus)
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✓	Confirmed
Ability to transmit electricity across regions	✗	Limited inter-regional flow
4. Corporate Procurement options		
PPA mechanisms available	✓	On-site, off-site, and virtual PPA options
Certificate tracking options exist	✓	Under Non-Fossil Certificate (NFC)
RTC procurement mechanisms are available	✓	1.3 GW Large-Scale BESS Contracts via LTDA in 2024
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	✓	80M+ smart meters deployed
Real-time consumption data available	✓	Effective from 2025
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✓	D-Sharing Co., Ltd. and Cyber Souken Co., Ltd: Half-Hourly Matching for EV Daytime Charging/ Flexidao and Granular Energy

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1. Policy Ambition & Target		
Long-term clean energy target	▲	21.6% renewables by 2030; 30% by 2036
Specific battery storage goal	✓	26 GW by 2036
Green hydrogen policies present	✓	Hydrogen Law + Economy Roadmap (2019)
Green hydrogen certification	▲	Emissions threshold: ≤4 kg CO_2e/kg H_2
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✗	Monopoly structure by KEPCO
Real-time or granular settlement period	✓	30-minute settlement period
Time-of-Use tariffs are in place	✗	general pricing via KEPCO, not dynamic
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Grid congestion is a known issue
Ability to transmit electricity across regions	✓	Yes
4. Corporate Procurement options		
PPA mechanisms available	✓	Bilateral, Trilateral; No virtual PPA
Certificate tracking options exist	✓	Under K-REC
RTC procurement mechanisms are available	✓	540 MW auction of BESS capacity launched in mid-2025 via KPX/MOTIE
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	Current data not available
Real-time consumption data available	✗	Not currently accessible to consumers
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✗	None currently implemented

▲ = insufficient progress ✓ = sufficient progress X = no progress

1. Policy Ambition & Target		
Long-term clean energy target	✓	70% renewable electricity share by 2050
Specific battery storage goal	✗	No national capacity target yet
Green hydrogen policies present	✓	Hydrogen Economy and Technology Roadmap (HETR)
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✗	Single-buyer market in transition
Real-time or granular settlement period	✓	30-minutes settlement period
Time-of-Use tariffs are in place	✓	Available for commercial and industrial users under the TNB tariff structure
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	NETR identifies need for major grid upgrades
Ability to transmit electricity across regions	✓	Peninsular Malaysia has an integrated grid, with Singapore interconnection (LTMS-PIP)
4. Corporate Procurement options		
PPA mechanisms available	✓	The Corporate Renewable Energy Supply Scheme enables PPAs via third-party access.
Certificate tracking options exist	▲	No national registries ; Malaysia Renewable Energy Certificate (mREC) system operated by TNBX
RTC procurement mechanisms are available	▲	First competitive bid launched by the utility
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	2.3M units installed; 10.4 M by 2030
Real-time consumption data available	✗	Limited to pilot projects
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✗	None currently implemented

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PHILIPPINES

1. Policy Ambition & Target		
Long-term clean energy target	✓	35% renewables in the power mix by 2030
Specific battery storage goal	✗	No national capacity target yet
Green hydrogen policies present	✗	Hydrogen Roadmap under consultation
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✓	Liberalised wholesale power trading via WESM
Real-time or granular settlement period	✓	WESM 5-minute dispatch exists
Time-of-Use tariffs are in place	▲	TOU rates are available in pilot phases for C&I consumers
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Network reinforcement underway; congestion remains in the Luzon grid
Ability to transmit electricity across regions	✓	HVDCs connect all three grids
4. Corporate Procurement options		
PPA mechanisms available	✓	GEOP allows onsite and offsite sourcing via licensed suppliers
Certificate tracking options exist	✓	National REC platform launched in December 2024
RTC procurement mechanisms are available	▲	Hybrid RE+BESS pilots underway
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	Meralco targets 11 M smart meters by 2035
Real-time consumption data available	▲	No standardized access to consumption data.
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✗	None currently implemented

▲ = insufficient progress **✓ = sufficient progress** **X = no progress**

1. Policy Ambition & Target		
Long-term clean energy target	▲	Solar target of 2 GW (~10% share) by 2030
Specific battery storage goal	✓	200 MW energy storage by 2025
Green hydrogen policies present	✓	The National Hydrogen Strategy was launched in 2022
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	✓	Fully liberalized via the Open Electricity Market
Real-time or granular settlement period	✓	30-minute settlement period
Time-of-Use tariffs are in place	✓	Pilots for residential demand response underway
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Solar integration bottlenecks; interconnection plans (e.g., LTMS-PIP) underway
Ability to transmit electricity across regions	✓	Yes
4. Corporate Procurement options		
PPA mechanisms available	✓	On-site PPAs are common via SP Group; off-site imports are under development
Certificate tracking options exist	✓	SS 673 governs REC issuance and management
RTC procurement mechanisms are available	▲	PacificLight launched the first BESS (600 MW)
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	✓	Advanced meters covered by end-2024
Real-time consumption data available	✓	accessible for corporate consumers
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	▲	GoNetZero and UBS utilized blockchain technology to track granular data

▲ = insufficient progress ✓ = sufficient progress X = no progress

1. Policy Ambition & Target		
Long-term clean energy target	✓	60–70% renewable electricity by 2035
Specific battery storage goal	✓	29 GW renewable capacity target by 2026
Green hydrogen policies present	▲	generation share targets (9–12%)
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	▲	Monopoly by Taipower; liberalised RE market
Real-time or granular settlement period	✓	15-minute settlement period
Time-of-Use tariffs are in place	✓	Pricing is divided into 6 blocks
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	No
Ability to transmit electricity across regions	✓	Yes
4. Corporate Procurement options		
PPA mechanisms available	✓	On-site and off-site PPAs permitted via Taipower
Certificate tracking options exist	✓	T-RECs available with tracking
RTC procurement mechanisms are available	▲	Pilots only: On-site + storage hybrid systems deployed by Taipower at the Tainan Salt Field Solar PV Farm
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	✓	~79% (~3 million units)
Real-time consumption data available	✓	accessible for corporate consumers
Granular certificate system operational	▲	T-REC comes with monthly matching
Hourly matching pilots exist	▲	T-REC issued using 15-minute granular data

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1. Policy Ambition & Target		
Long-term clean energy target	✓	PDP aims for 51% renewables by 2037
Specific battery storage goal	✓	10 GW BESS by 2030 planned
Green hydrogen policies present	▲	Pilot hydrogen projects (e.g., Rayong Smart Park); no formal strategy yet
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	▲	EGAT monopoly in gen & transmission; IPPs/SSPs under AEDP
Real-time or granular settlement period	✓	15-minutes settlement period
Time-of-Use tariffs are in place	▲	DSM programs exist, but no TOU tariff
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Battery/storage expansion needed
Ability to transmit electricity across regions	✓	Yes
4. Corporate Procurement options		
PPA mechanisms available	▲	IPP/SSP PPAs under AEDP; DPPA pilots planned
Certificate tracking options exist	✗	No national registry
RTC procurement mechanisms are available	✓	Through the hybrid firm PPA scheme
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	No detail available
Real-time consumption data available	✗	Not accessible to corporates yet
Granular certificate system operational	✗	None currently implemented
Hourly matching pilots exist	✓	Granular P2P energy trading and carbon intensity tracking by ChiangMai University

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1. Policy Ambition & Target		
Long-term clean energy target	✓	60% renewables by 2030 (PDP8 target)
Specific battery storage goal	✓	Between 10,000 MW and 16,300 MW of BESS capacity by 2030
Green hydrogen policies present	✓	10 to 20 M mt by 2050
Green hydrogen certification	✗	No green hydrogen certification
2. Electricity Market Structure and Operation		
Liberalized wholesale/retail market	▲	Monopoly by EVN; IPPs are allowed only in generation
Real-time or granular settlement period	✓	30-minute settlement period
Time-of-Use tariffs are in place	✓	TOU pricing is in use across sectors
3. Infrastructure and Grid Capabilities		
Sufficient grid capacity for renewable energy	✗	Grid congestion and limitations are significant
Ability to transmit electricity across regions	✓	Yes
4. Corporate Procurement options		
PPA mechanisms available	✓	DPPA and synthetic PPA frameworks have been proposed, but are not yet operational
Certificate tracking options exist	✗	No national REC has yet been established
RTC procurement mechanisms are available	✗	None currently implemented
5. Data Access and Tracking Readiness		
Smart meter rollout >75%	▲	95% coverage by 2030, current status unclear
Real-time consumption data available	✗	Not available to consumers or corporates
Granular certificate system operational	✗	No infrastructure for time-stamped tracking
Hourly matching pilots exist	✗	None currently implemented

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