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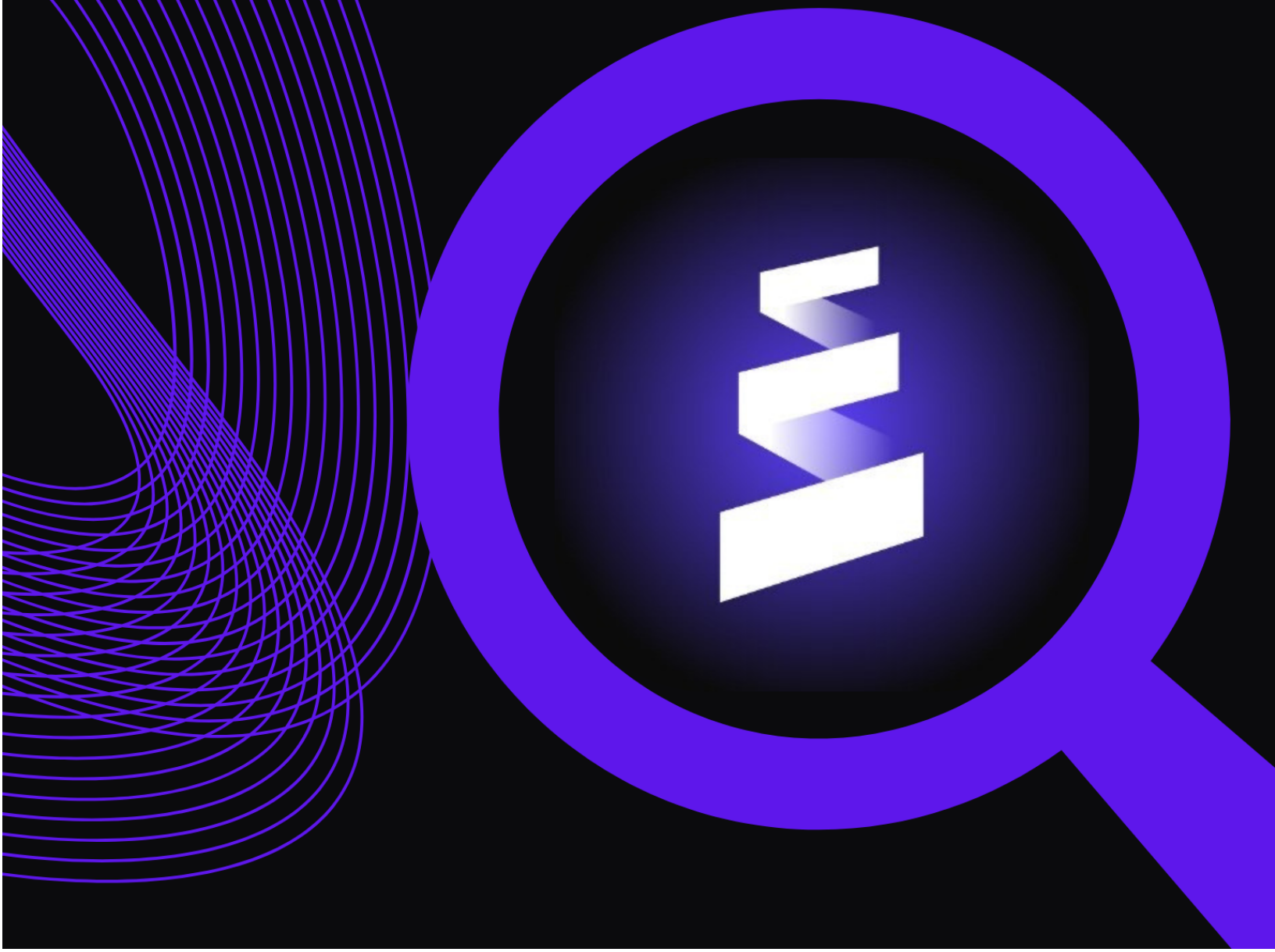
RWA in Practice: Three Pathways for Traditional Enterprises



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Abstract

Lead-in: A practical look at three RWA pathways—attestation, payments, and financing—using a renewable-energy case to clarify benefits, limits, and risk trade-offs.

RWA (Real-World Assets on-chain) is not a new concept, but it has recently regained strong momentum. As regulatory attitudes shift in the U.S. and policy support grows in Hong Kong, on-chain experiments have accelerated — from tokenized U.S. Treasuries, equities, and fund-of-funds to initiatives bringing physical assets onto blockchain networks. According to DefiLlama, global RWA TVL reached US$15.7 billion as of September 15, 2025, up 279% from January 2024[1]. The RWA that truly matters is not simply "porting" existing financial products onto a blockchain; it is embedding blockchain capabilities into real business workflows across traditional industries—so that verifiable data, automated processes, and innovative financing can reinforce one another.

This article outlines three implementation pathways for RWA in traditional enterprises. Pathway 1 focuses on on-chain attestation/registration (no token issuance). Pathway 2 issues tokens without conferring securities characteristics (payment/store-of-value/utility). Pathway 3 issues tokens with securities characteristics (financing/income-bearing). Using the renewable-energy sector as the running example, we break down how each path can upgrade data trustworthiness, settlement efficiency, and financing capacity—so practitioners can distinguish among them, choose the right approach, and anticipate the risks.

01 / Background and Pain Points: Why Talk About RWA Now

RWA is not a new concept. In the early days of blockchain, there were already attempts to digitize and tokenize assets such as real estate and equity. However, technological and regulatory constraints limited their impact at the time. In recent years, as regulatory attitudes have evolved and technology has matured, RWA has once again become a focal point.

For instance, the DeFi protocol MakerDAO began using U.S. Treasuries as collateral for its stablecoin DAI as early as 2019. In late 2023, BlackRock tokenized shares of its short-term Treasury fund on Ethereum, allowing investors to receive bond yields in real time through on-chain tokens. These milestones signaled that large traditional institutions were beginning to embrace the RWA concept—bringing highly liquid traditional assets such as government bonds and money market funds into blockchain ecosystems.

At the same time, non-financial use cases for RWA have also gained traction. Examples include tokenizing and tracking supply-chain receivables, carbon credits, and intellectual property rights to enable verifiable data and transferable ownership on-chain.

Overall, RWA development is moving from proof-of-concept → regulatory sandbox → policy framework formation → compliant deployment. There is still no unified legal regime for RWA; most jurisdictions manage it under existing financial laws. Tokens with securities characteristics fall under securities regulation, while those related to payments or settlement are governed by payment and stablecoin rules.

In the United States, institution-led tokenized fund shares and bond issuances are regulated as securities, while Federal Reserve initiatives such as Project Cedar remain in settlement sandboxes. In Hong Kong, the Stablecoin Ordinance will take effect in 2025, complemented by the Project Ensemble sandbox that explores RWA use cases—including renewable energy revenue rights. In the European Union, the MiCA framework governs stablecoins and crypto service providers, while securities-type RWA continue to fall under existing capital-market laws such as MiFID II.

Table 1: RWA Cases in Non-Financial Industries

Date	Region	Project / Event	Type of Project	Scale	Description
Mar 2017	China	IBM × Energy-Blockchain Labs Carbon Asset Platform	Carbon / Green Asset Management	—	Built on Hyperledger Fabric, one of the earliest enterprise blockchain pilots in carbon markets.
Sep 2018	Global	komgo Trade Finance Platform Launch	Trade Finance / Document Digitalization	—	Joint initiative of multiple global banks to digitize letters of credit and trade documents.
Oct 2018	Singapore	SP Group Blockchain Renewable Energy Certificate (REC) Market	Green Certificate / Renewable Energy Credit	—	Among the world's first blockchain-based REC markets.
Nov 2018	United Kingdom	VAKT Crude Oil Trading Platform (Shell, BP etc.)	Post-Trade Commodity / Certificate Tokenization	—	Enterprise-grade production system for energy trading settlement.
Sep 2020	China	PBoC "Trade Finance Blockchain Platform"	Receivables / Cross-Border / Invoice Verification	RMB 1.8 – 1.9 trillion cumulative	Connected dozens of banks; prevented duplicate pledging in supply-chain finance.
Aug 2024	Hong Kong	LongShine × Ant Group: EV Charging Pile RWA Pilot	Renewable Energy / Charging Pile Revenue Rights	~ RMB 100 million	First charging-pile RWA issuance anchored on "New ET Network" assets in Hong Kong.
Aug 2024	Hong Kong	HKMA Launches "Project Ensemble" Sandbox	Settlement / Supply-Chain / Green / Fixed-Income Themes	—	Regulatory sandbox exploring four RWA themes.
Dec 2024	Hong Kong	GCL Energy Tech × Ant Group: Solar Plant RWA	Solar Cashflow / Revenue Rights	RMB 200 million +	Cross-border financing for distributed rooftop solar projects.
Mar 2025	Hong Kong	Eagle Group: Battery-Swap Cabinet / Lithium-Battery RWA Private Placement	Battery-Swap Network Assets / Revenue Rights	~ HK $68 million	Private offering to qualified investors for RWA-based energy-infrastructure assets.
Sep 2025	China	ZhongWang Charging × QingNeng "Energy Badge (Yuanqi Edition)" Launch	User Rights Certificate / Incentive Token	—	Sold out in eight minutes; combined data services and charging credits for users.

Source: Pharos Research

Traditional industries face long-standing pain points that make RWA particularly relevant. For years, real-world asset transactions and financing have struggled with unclear ownership, inefficient processes, and limited liquidity.

Take renewable energy as an example. Ownership of cash flows from solar plants is often not transparently registered or transferable, which complicates due diligence and delays monetization. The immutability, traceability, and transparency of blockchain can provide verifiable proof of ownership, ensure auditable data trails, and enable automated settlement—helping reduce information asymmetry and enhance operational efficiency. In supply-chain finance, if contracts and collateral status are shared on-chain, lenders can easily verify asset pledges and prevent double-financing or other types of fraud.

Cross-border payments are another major bottleneck. SWIFT-based transfers often take days, involve multiple intermediaries, and incur high fees with limited visibility. In contrast, blockchain-based payment tools enable 24/7 real-time settlement within minutes at a cost of less than one U.S. dollar—an attractive proposition for renewable-energy firms that depend on global supply chains.

From a regulatory and auditing perspective, traditional financing lacks sufficient data transparency. RWA can solve this by using verifiable on-chain data and transparent disclosure, allowing every asset transfer and yield distribution to be audit-ready and traceable in real time—balancing trust and efficiency.

At the same time, global financial and technology players are accelerating their RWA initiatives. Citi and Standard Chartered are exploring tokenized settlements; Ant Group has launched Jovay, an RWA blockchain for institutional use; and regulators in Hong Kong and other jurisdictions are introducing licensing regimes and sandbox programs based on the principle of substance over form.

Overall, the combination of compliance and innovation has become the central theme of RWA development. The structural pain points of traditional industries and the inherent advantages of blockchain technology now form a clear supply-demand fit—while regulatory relaxation has ignited a new wave of real-world adoption.

02 / Three RWA Pathways for Traditional Industries

RWA does not necessarily mean token issuance or fundraising. For traditional enterprises, RWA implementation can follow three main pathways—distinguished by whether tokens are issued and what kind of attributes they carry. The following sections define each model and analyze its application scenarios, value propositions, and limitations.

2.1 Pathway 1: Attestation / Proof-of-Ownership RWA (No token issuance)

In this model, no transferable tokens are issued. Instead, blockchain serves as a proof-of-ownership and data-attestation tool embedded into existing business processes. Rather than financing through token sales, enterprises use on-chain hash records, timestamps, and distributed ledgers to register ownership, record asset status, and enable verifiable data flows for physical or data-based assets.

Typical use cases include:

- **Real estate** — synchronizing property registration on-chain to prevent double sales or ownership disputes;
- **Industrial equipment** — using IoT sensors to record operational data (e.g., solar-plant power generation, EV-charging duration) in real time, ensuring transparency and preventing asset misuse;
- **Data assets** — recording the entire lifecycle of data collection, attestation, and ownership rights on-chain to clarify data provenance and usage rights.

In the renewable-energy sector, Path 1 typically involves uploading generation data and carbon-reduction certificates of solar or wind plants onto the blockchain to form an authoritative, tamper-proof digital record base. These verified data sets can then be referenced by financial institutions, improving the efficiency and credibility of carbon-trading audits and green-loan reviews.

Case Study: Singapore Project Greenprint (Monetary Authority of Singapore, 2021) [2]

The Monetary Authority of Singapore (MAS) launched Project Greenprint in 2021 to enhance transparency in ESG and green-finance data through blockchain and API technologies. Under this initiative, the ESGenome platform allows companies to disclose ESG data that are hash-anchored on-chain to ensure immutability and traceability. In parallel, the Energy Market Authority (EMA) and SP Group introduced a Renewable Energy Certificate (REC) platform where enterprises can purchase, transfer, and retire green-power certificates, each recorded on-chain to meet carbon-reduction compliance and green-loan verification needs. Together, these systems established credible attestation and traceability for Singapore's green-energy consumption and ESG disclosures, providing an auditable foundation for both institutional investors and regulators.

Value and Advantages:

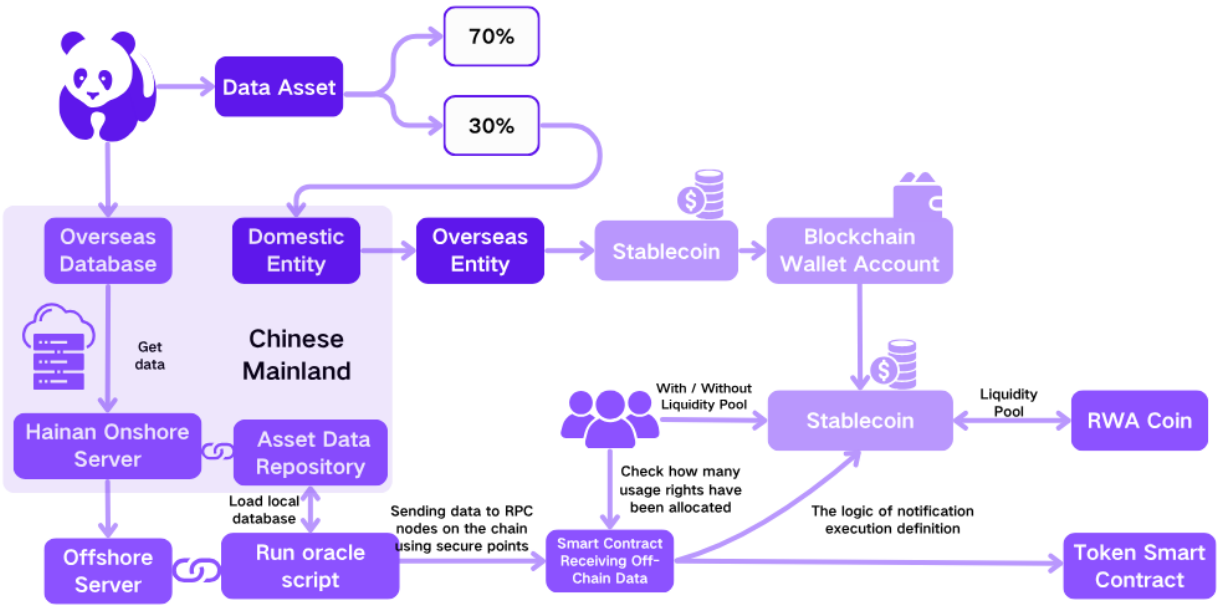
1. **Improved due-diligence and risk-control efficiency** — Immutable on-chain data streamline audits and verification. For example, banks reviewing renewable-energy project loans can directly access on-chain operational and revenue data, reducing reliance on reports and manual validation.

2. **Fraud prevention and anti-double-pledging** — Since asset ownership and collateral status are shared within consortium or permissioned chains, lenders can verify whether an asset has already been pledged, eliminating multiple-financing risks.

3. **Lower coordination costs** — Multiple stakeholders can reach consensus on a single, trusted data source, avoiding multi-layer reconciliations and disputes.

In essence, Path 1 is akin to building a shared registry for assets and data across an industry—where verified data equals verified ownership—providing a trusted foundation for all transaction participants.

Figure 1. Illustration of Cross-Border Data Flow, On-Chain Asset Registration, and Rights Distribution in an RWA Project



Source: Pharos Research

For example, a renewable-energy power plant can collect operational data in real time through a dedicated API, first uploading the data to a trusted onshore server within Mainland China. After regulatory approval, the data are transmitted on-chain to establish verified ownership of the asset data. Subsequently, when tokens are issued for financing, domestic and overseas entities can transfer funds via stablecoins, while smart contracts automatically execute revenue distribution based on changes in the on-chain data.

Limitations and Constraints

The primary limitation of attestation/proof-of-ownership–type RWA is that it does not directly enable financing. It functions mainly as an infrastructural upgrade within enterprises or industry consortia—enhancing data credibility and process efficiency rather than unlocking new capital sources. Remaining at this stage means the enterprise must still rely on traditional financing channels, as the absence of token issuance precludes capital formation.

In addition, Pathway 1 implementations typically adopt consortium or private blockchains to meet data-privacy and regulatory-compliance requirements. Such networks are inherently less open, and the cross-system interoperability or secondary-market value of their data remains limited.

Finally, from a return perspective, the absence of tradable tokens means that participants benefit indirectly—through higher efficiency and lower risk—without direct incentives for external investors. In short, Pathway 1 is well-suited to scenarios emphasizing supply-chain transparency and risk prevention, but it does not extend into capital-market functionality. Its boundary lies in enhancing creditworthiness rather than creating liquidity.

Application in the Renewable-Energy Sector

In distributed solar, EV-charging, and similar businesses, operating entities are typically small in scale, geographically dispersed, and characterized by frequent transactions. Because of information asymmetry and high risk-control costs, traditional financial institutions tend to be cautious in lending. By placing receivables and metering data on-chain for verified attestation, banks and other credit providers can access trustworthy digital evidence—thereby improving both the efficiency and the size of financing available to small and medium-sized renewable-energy enterprises.

Typical scenarios include household solar installations and EV-charging operators, whose projects generate steady sales or charging revenue but struggle to raise funds due to their small scale and fragmented data. The Shanghai Data Exchange introduced the concept of Real Data Assets (RDA), which encapsulates operational data from physical assets such as industrial equipment or agricultural systems into Data Asset Shells (DAS) for on-chain attestation and transfer, turning them into standardized, financeable asset units.
In 2024, this mechanism helped multiple projects obtain more than RMB 700 million in bank credit—demonstrating the feasibility of converting operational data directly into enhanced creditworthiness.

2.2 Pathway 2: Payment / Store-of-Value RWA (Non-security token issuance)

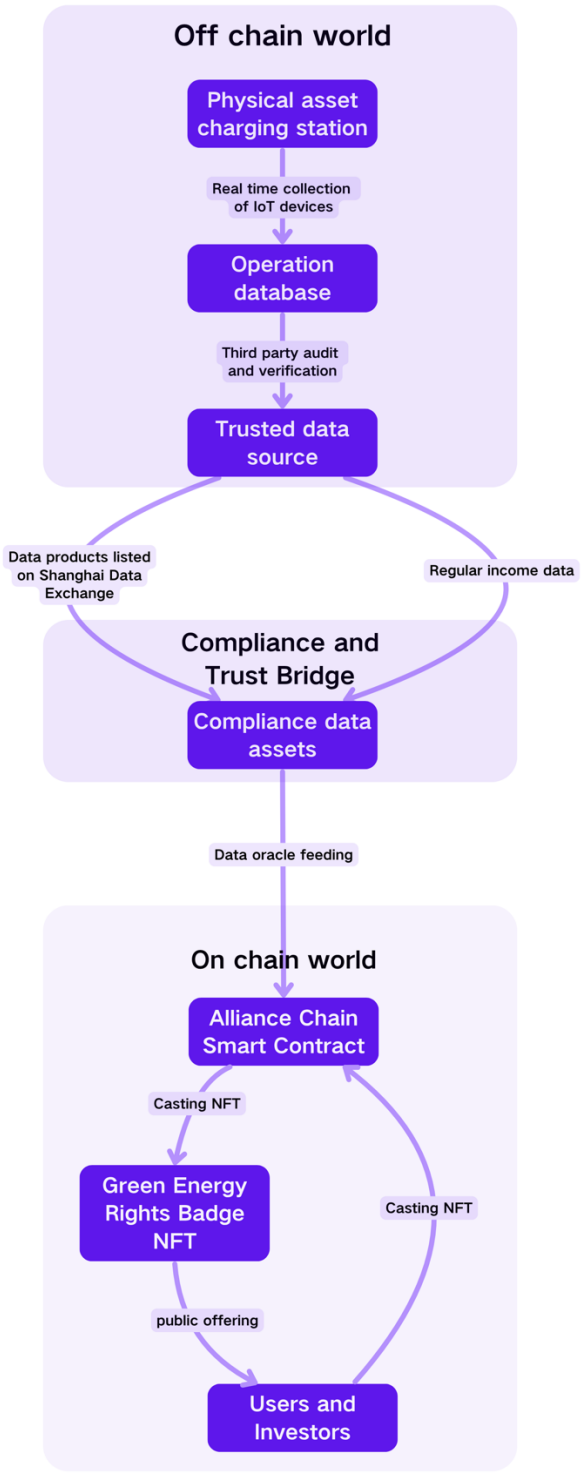
Pathway 2 refers to the issuance of **non-security tokens**—that is, tokens that do not confer dividend or interest rights. Their primary functions are **payment, value storage, or proof of entitlement** rather than investment. Typical formats include:

- **Stablecoins or tokenized deposits** — pegged to fiat currency or bank deposits, used for cross-border payments and supply-chain settlements;
- **Consumer or membership tokens** — such as loyalty points, membership passes, or green-energy rights tokens, used for service redemption or ecosystem incentives;

- **Commodity certificates** — such as warehouse receipts or carbon credits.

A representative example is the “QingNeng Energy Badge (Yuanqi Edition)”, released in September 2025 by Zhongwang Charging. The program issued blockchain-based digital rights tokens corresponding to EV-charging service usage rights. Holders of the badges can enjoy specific benefits within the network, while the enterprise achieves transparent on-chain settlement and customer-incentive management. Pathway 2 thus goes beyond the idea of stablecoins—it encompasses programmable tokens designed for concrete business scenarios involving payment or stored value.

Figure 2: Zhongwang Charging – QingNeng Energy Badge (Yuanqi Edition) [3]



Source: Shanghai Data Exchange; Pharos Research

Case Study: The QingNeng Energy Badge (Yuanqi Edition) falls under Pathway 2 — a payment / store-of-value / utility-token RWA model. Operational and metering data from charging piles are collected through IoT devices and verified by third parties under unified standards. These verified data assets are listed on a data-exchange platform and tokenized via consortium-chain smart contracts that mint the badge (NFT). Each badge bundles multiple user entitlements—such as charging credits, data services, and insurance coverage—into a transferable on-chain credential. When users consume services, their wallet addresses are verified on-chain and balances deducted accordingly, with all redemption and settlement records traceable on-chain. The product makes no yield promises and offers no dividend rights, positioning it as a programmable payment and store-of-value tool. Its core value lies in enhancing settlement transparency and reconciliation efficiency, while also establishing a compliant data-feed channel that could support an upgrade to yield-bearing RWA in the future if needed.

Advantages and Value

The core value of payment / store-of-value-type RWA lies in improving capital-flow efficiency, reducing transaction costs, and avoiding complex securities regulation. In cross-border payments, on-chain tokens can achieve real-time settlement, dramatically shortening cash-cycle times. Transaction fees, which traditionally cost tens of U.S. dollars per transfer, are reduced to minimal levels. Every transfer is fully transparent on-chain, enabling easier financial monitoring and reconciliation.

Moreover, corporate-issued tokens can integrate with smart contracts to trigger automated payments—for example, distributing funds based on real-time operational data from renewable-energy projects. Overall, Pathway 2 enhances efficiency and coordination through programmable payments, but it does not carry any investment or dividend-sharing function.

Limitations and Compliance Requirements

Although Pathway 2 does not fall under securities regulation, it must still comply with payment-sector and electronic-money regulations. Issuers may need an electronic-money or payment-service license, particularly in jurisdictions where stablecoins are regulated.

- In Hong Kong, issuance of fiat-referenced stablecoins will become a regulated activity under the Stablecoin Ordinance, effective August 1, 2025. Only licensed issuers under the Hong Kong Monetary Authority (HKMA) may issue or market such tokens.

- In the European Union, MiCA Titles III (ART) and IV (EMT) have applied since June 30, 2024, imposing requirements for one-to-one redemption, reserve and liquidity management, governance, and white-paper disclosure.

- In Singapore, the MAS Stablecoin Framework allows compliant issuers of single-currency stablecoins (SCS) pegged to the SGD or G10 currencies to label their products as “MAS-regulated stablecoins.” Requirements include 100% high-quality reserves, segregated custody, monthly attestation, annual audit, and redemption at par within five business days.

Token designs must avoid creating an expectation of profit, to prevent classification as securities. They must also be backed by genuine commercial use cases; otherwise, their economic value cannot be sustained.
Enterprises should collaborate with upstream and downstream partners—and with banks—to build shared ecosystems that ensure token acceptance and circulation.

In summary, **Pathway 2 serves as a capital-flow instrument rather than a financing mechanism**. It alleviates payment and settlement frictions but does not generate new capital inflows.
For capital-intensive sectors such as renewable energy, sustainable growth will still depend on solid cash-flow performance or access to other financing channels.

Table 2: Stablecoin / Tokenized Deposit Regulatory Comparison (Cross-Jurisdiction)

Jurisdiction	Licensed Entity / Scope of Application	License / Status (as of date)	Key Obligations (Summary)
Hong Kong (HKMA)	Issuance of fiat-referenced stablecoins (FRS) is a regulated activity; issuance, offers, and marketing within Hong Kong are all covered.	Stablecoin Ordinance effective Aug 1, 2025. Issuers must obtain a license from the HKMA; no licensed entities yet.	Based on two final guidelines: Issuer Regulatory Guideline and AML/CFT Guideline. Covers governance, reserve and redemption requirements, risk management, custody and disclosure, transition arrangements, and restrictions on misleading representations.
European Union (MiCA)	Issuance, public offering, and exchange listing of ART (asset-referenced tokens) and EMT (e-money tokens) are regulated activities.	MiCA Titles III (ART) and IV (EMT) applicable from Jun 30, 2024; related EBA final guidelines / technical standards (e.g., redemption plans) are being phased in.	1:1 redemption obligation (as applicable by type), reserve / liquidity and governance requirements, white-paper disclosure, significance assessment and reporting, and service restrictions for non-compliant ART/EMT (as clarified by ESMA / EC Q&A).
Singapore (MAS)	Single-currency stablecoins (SCS) pegged to SGD or G10 currencies and issued in Singapore. Compliant issuers may label their products as "MAS-regulated stablecoin."	Framework finalized Aug 15, 2023, adding the Stablecoin Issuance Service under the Payment Services Act; implementing rules and labeling standards are being rolled out.	100 % high-quality reserves (segregated custody, monthly verification / annual audit), redemption at par ⩽ 5 business days, capital / liquidity requirements, disclosure and anti-misrepresentation obligations (only compliant issuers may use the "MAS-regulated stablecoin" designation).

Source：Pharos Research

Application in the Renewable-Energy Sector

The renewable-energy value chain is highly globalized. Upstream critical materials—such as lithium, cobalt, and photovoltaic silicon—are primarily sourced from overseas, while automakers and battery manufacturers must also engage in international sales and procurement. Traditional cross-border payment and settlement systems suffer from long processing cycles, high fees, and significant foreign-exchange risk, all of which constrain corporate cash flow and cost management.

For instance, when a large renewable-energy company imports a shipment of lithium ore, the process from order placement to final payment may take several weeks, involving multiple correspondent banks and cumulative transaction fees of 1–2% of the total amount. Exchange-rate fluctuations can further erode profit margins.

By adopting an on-chain payment / store-of-value model—using stablecoins or central bank digital currencies (CBDCs) for settlement—enterprises can accelerate the payment and remittance process, reduce transaction costs, and hedge against currency volatility. This approach offers a practical solution for use cases such as cross-border goods payments, overseas project settlements, and international carbon-credit transactions.

2.3 Pathway 3: Financing / Yield-bearing RWA (Security-type token issuance)

Pathway 3 represents the full-fledged financing model of RWA—where tokens with securities characteristics are issued to investors in exchange for capital contributions, granting them rights to the future income or benefits of the underlying real-world assets.

In simple terms, this model functions as an on-chain securities offering (STO), but with greater flexibility in the nature of underlying assets and with settlement executed directly on the blockchain.

Such RWA structures are applied in corporate financing and investment contexts.
Examples include:

- Tokenizing the next 25 years of electricity-sales revenue from a renewable power plant, allowing investors to receive quarterly profit distributions;
- Issuing tokens backed by receivable rental pools from electric-vehicle leasing companies, where investors share in the cash flow generated from lease payments;
- Financing green infrastructure projects through special-purpose vehicles (SPVs) that issue tokenized notes, with project operating income used to redeem or distribute proceeds to token holders.

Essentially, tokens in this pathway grant holders rights to the cash flows of the underlying assets. As a result, in most jurisdictions, such tokens are treated as securities or investment contracts and are subject to corresponding regulatory oversight.

Case Study: LongShine Technology × Ant Digital – Charging-Pile RWA (Hong Kong, 2024)

In August 2024, LongShine Technology and Ant Digital launched a tokenized private placement in Hong Kong, backed by the operational cash flows of approximately 9,000 EV-charging piles within the “Xin Diantu” network. The project raised around RMB 100 million, using verifiable IoT metering and operational data as the underlying reference. Tokens representing partial revenue rights from the charging-pile assets were issued on-chain, and the proceeds were primarily allocated to fund expansion in energy-storage and charging-infrastructure businesses.

The project retained its securities nature—only the issuance medium changed. Offering and distribution targeted professional and qualified investors, while disclosure, KYC/AML, and transfer restrictions followed existing securities regulations. During the token’s life cycle, cash-flow distributions were automatically executed by smart contracts based on real-time operational data and proportional token holdings, greatly enhancing payout transparency and auditability.

The initiative was later cited as one of the representative cases within Hong Kong’s Project Ensemble regulatory sandbox, illustrating the integration of off-chain legal rights with on-chain settlement. Off-chain, the revenue-sharing rights were legally structured and registered through SPV and contractual arrangements; on-chain, the registration, distribution, and record-keeping were automated via blockchain. Secondary trading was conducted through whitelisted or restricted channels, or hosted on licensed platforms, thereby avoiding the regulatory red line of “public offering.”

For renewable-energy assets, this model effectively links high-frequency, metered cash flows with a compliant private-placement framework, paving the way for future scalable asset pools and structured tranches under a legally recognized tokenization architecture.

Value and Innovation of Security-Type RWA

The **security-type RWA model** expands the boundaries of traditional corporate financing and introduces multiple layers of financial innovation:

1. **Broader Access to Capital**
   Traditionally, small and mid-sized renewable-energy projects have had limited access to financing channels. By issuing RWA tokens, project owners can directly reach global investors.
   For example, within Hong Kong's Project Ensemble sandbox, certain mainland renewable-energy operators have tokenized their future revenue rights, successfully attracting cross-border institutional capital.
   This marks a new financing route that bridges assets previously constrained by geographic or credit-quota limitations with international liquidity sources.

2. **Lower Investment Thresholds and Enhanced Liquidity**
   Blockchain-based tokens can be fractionalized into very small units, allowing infrastructure investments that once required hundreds of thousands of U.S. dollars per ticket to become accessible to smaller investors.
   For instance, instead of issuing a high-denomination bond, a power-plant project can divide one revenue-right unit into thousands of tokens. These tokens can be traded peer-to-peer on secondary markets, improving liquidity and enabling investors to exit before maturity.

3. **Transparent and Automated Cash-Flow Distribution**
   With smart contracts, the distribution of project income and execution of risk-control measures can be automated and verifiable.
   For example, once rental or electricity-sales proceeds enter a designated on-chain escrow account, the contract automatically allocates funds to token holders according to their ownership ratios, with the remainder reserved for operations or credit enhancement.
   If income falls short in a given period, the contract can automatically adjust payouts based on pre-defined rules.
   This code-driven transparency reduces manual intervention, enhances auditability, and strengthens investor confidence.

4. **Structured and Customizable Product Design**
   Security-type RWA also enables more flexible structured financing models, such as through special-purpose vehicles (SPVs) with risk segregation and tiered tranching.
   In such arrangements, the SPV issues multiple classes of tokens—senior and junior—each with different risk-return profiles.
   Smart contracts can be programmed to follow priority-of-payment waterfalls, activate reserve accounts, or trigger credit-enhancement mechanisms automatically.
   In essence, Pathway 3 embeds blockchain programmability into the process of asset securitization, creating globally reachable, transparent, and composable financing instruments—effectively a new way to unlock liquidity from real-world assets.

Limitations and Risks

While security-type RWA opens new horizons for financing, it also comes with the **highest regulatory barriers and operational complexity** among all three pathways. Its limitations and risks can be summarized as follows:

1. **High Compliance and Structuring Costs**
   Issuing security-type tokens is, in essence, equivalent to conducting a securities offering, and must therefore comply with stringent securities regulations. Enterprises often need to engage legal and financial advisors to design cross-border SPV structures (commonly in Hong Kong or Singapore), prepare detailed white papers or prospectuses, and meet

disclosure and due-diligence requirements. Industry data suggests that initial legal and consulting fees alone can range from USD 100,000 to 500,000, excluding ongoing audit and compliance expenses. Even after issuance, the issuer must maintain continuous disclosure, perform AML/KYC checks, and undergo external audits—making total compliance costs substantial.

2. **Regulatory Uncertainty and Jurisdictional Divergence**
   Regulatory interpretations of tokenized securities differ across jurisdictions, and conflicts may arise. In the United States, the SEC has repeatedly emphasized through enforcement actions (e.g., the Ripple case) that certain tokens qualify as investment contracts under the Howey Test, thus falling under securities laws. In mainland China, some underlying assets—such as renewable-energy concession rights—are subject to restrictions on transferability. Even if tokenized offshore, the legal enforceability of investors' rights remains uncertain and may require judicial precedents to clarify.

3. **Intersection of Code and Law**
   The principle of "code is law" faces limits when real-world legal contingencies arise. Smart contracts execute automatically and immutably, yet may conflict with real-world clauses such as force majeure or contract amendment. Moreover, whether on-chain ownership or lien registration is legally recognized off-chain remains unsettled in many jurisdictions. In the event of default or fraud, investor protection and dispute resolution would still revert to traditional legal frameworks.

4. **Investor-Protection Constraints**
   Security tokens attract strong market interest, but regulators typically adopt a prudential approach to protect retail investors. For instance, Hong Kong currently restricts participation in such tokenized private placements to professional investors, allowing broader retail access only under sandbox environments. As a result, the initial investor base of security-type RWA projects is often limited to institutional or accredited investors, which may constrain early-stage liquidity.

5. **Market Liquidity and Secondary-Trading Limitations**
   In theory, security tokens could trade freely, but in practice, liquidity is limited by compliance obligations—such as lock-up periods and restrictions to licensed trading venues. When secondary-market depth is low, investor exit remains difficult, potentially reducing the attractiveness of the offering.

In summary, Pathway 3 is a double-edged sword: it offers traditional enterprises direct access to global capital and innovative securitization mechanisms, but also imposes heavy compliance burdens and legal complexity. Firms pursuing this model must conduct comprehensive risk assessment and regulatory planning, ensuring that innovation benefits outweigh the associated legal and operational costs.

Compliance Considerations and Common Misconceptions

For issuers adopting Pathway 3, two key compliance risks deserve particular attention:

1. **"No Yield Promise" Does Not Mean "Non-Security"**
   Whether a token qualifies as a security depends on its substantive economic function, not on

its literal wording. If token holders stand to gain profits from the efforts or management of others, regulators may still classify it as a security—even if the issuer avoids explicit promises of "principal protection" or "guaranteed returns." Therefore, omitting yield commitments does not exempt a project from securities regulation; compliance obligations must still be assessed based on the actual rights and expectations attached to the token.

2. **"Public vs. Private Chain" Does Not Determine Legality**
   Some assume that issuing tokens on a private chain falls outside regulatory oversight, or conversely, that using a public chain is inherently illegal—both are misconceptions. Regulators focus on the nature of the rights represented by the token and the target audience of the offering, rather than on the underlying technical infrastructure. Whether the issuance takes place on a public or consortium chain, if it involves public investment or securities characteristics, it remains subject to securities laws. Conversely, a properly structured and compliant issuance can be legally accepted even when deployed on a public blockchain. The decisive factors are the design of the rights structure and clear investor qualification, not the technological medium.

Application in the Renewable-Energy Sector

Renewable-energy projects typically feature high upfront capital expenditure and long-term, stable cash-flow profiles. For instance, solar-power plants often operate under Power Purchase Agreements (PPAs) that lock in electricity-sale revenues for as long as 20 years, while EV-charging and battery-swapping networks require large initial investments yet generate sustainable operating cash flow over many years.

Traditionally, such assets have been financed through bank lending or asset securitization, both of which involve complex procedures and high entry barriers—making it difficult for small and mid-sized projects to access capital markets directly.

RWA provides an alternative route by tokenizing future revenue rights into digital securities. In renewable-energy generation and charging-infrastructure projects, enterprises can issue tokens representing claims on future project income to raise capital from a global investor base, thereby achieving diversified financing channels and unlocking the liquidity of long-duration real-world assets.

Table 4: Comparative Overview of the Three RWA Pathways

Dimension	Pathway 1: Proof-of-Ownership / Data-Attestation RWA (No token issuance)	Pathway 2: Payment / Store-of-Value RWA (Non-security token issuance)	Pathway 3: Financing / Yield-bearing RWA (Security-type token issuance)
Core Feature	Uses blockchain as a trusted data ledger	Uses blockchain as a payment and settlement network	Uses blockchain as a platform for securities issuance and trading
Token Issuance	Not issued (no tradable tokens)	Issued	Issued
Token Nature	None (data hash / attestation only)	Non-security (payment / store-of-value / utility token)	Security-type (equity / debt / revenue-sharing)
Core Value Proposition	Enhances data credibility, process efficiency, and risk control	Reduces cross-border payment costs, increases settlement efficiency, enables programmable payments	Expands financing channels, lowers investment thresholds, and improves asset liquidity
Main Limitations	No direct financing; limited ecosystem openness	Generally non-financing; attempts to bypass securities regulation carry compliance risk	High regulatory barriers; legal and technical risks coexist
Key Compliance Focus	Data privacy, industry standards, judicial recognition	Payment-licensing, stablecoin regulations, AML/CFT requirements	Securities laws, qualified-investor rules, disclosure obligations
Typical Cost Level	Low (hundreds of thousands RMB)	Medium (millions RMB)	High (tens of millions RMB)
Applicable Renewable-Energy Scenarios	Green power traceability, carbon-footprint tracking, on-chain operational data for credit enhancement	Cross-border raw-material procurement, overseas project settlement, supply-chain payment flows	Power-plant future-income financing, charging-network ABS, tokenized green bonds

Source：Pharos Research

03 / Implementation Planning

3.1 Comparing the Three RWA Pathways

To ensure smooth implementation of RWA projects, renewable-energy enterprises should develop a phased roadmap and carefully plan the budget allocation for each stage.

In general, the complexity and cost intensity of RWA deployment vary significantly across the three pathways, which can be categorized as low, medium, and high levels of investment.

- **Pathway 1 – Proof-of-Ownership / Data-Attestation (Low Cost)**

  The implementation cost for Pathway 1 is relatively low. Most of the expenditure goes toward IoT device deployment, on-chain attestation platform setup, and system integration with banking or credit institutions. For a mid-sized renewable-energy enterprise, the pilot-stage investment typically ranges from several hundred thousand RMB, covering sensor procurement, blockchain node deployment, and system configuration. Once the infrastructure is established, the marginal cost of onboarding new asset types declines progressively, making it scalable across multiple projects.

- **Pathway 2 – Payment / Store-of-Value (Medium Cost)**

  The cost level of Pathway 2 is moderate. It involves cross-border payment system upgrades, digital wallet management, and security and compliance frameworks. Typical project budgets fall in the range of a few million RMB, encompassing internal workflow redesign, staff training, and external legal or compliance consulting fees. If the enterprise integrates with existing third-party stablecoin payment providers, costs can remain relatively low. However, building a proprietary network allows greater customization but requires higher upfront investment.

- **Pathway 3 – Security / Financing (High Cost)**

  Pathway 3 entails the highest cost and resource intensity, as it requires comprehensive work on legal compliance, structuring, issuance, and underwriting. A full-cycle project may cost tens of millions of RMB. Major cost components include legal and licensed intermediary fees, technical development (e.g., cross-chain bridges, smart-contract audits), market roadshows, and investor engagement. That said, this pathway typically supports the largest single-round financing volumes—often hundreds of millions of RMB—which means that despite the high entry cost, the return on investment can still be attractive for qualified issuers.

Table 4: Comparative Overview of the Three RWA Pathways

Dimension	Pathway 1: Proof-of-Ownership / Data-Attestation RWA (No token issuance)	Pathway 2: Payment / Store-of-Value RWA (Non-security token issuance)	Pathway 3: Financing / Yield-bearing RWA (Security-type token issuance)
Core Feature	Uses blockchain as a trusted data ledger	Uses blockchain as a payment and settlement network	Uses blockchain as a platform for securities issuance and trading
Token Issuance	Not issued (no tradable tokens)	Issued	Issued
Token Nature	None (data hash / attestation only)	Non-security (payment / store-of-value / utility token)	Security-type (equity / debt / revenue-sharing)
Core Value Proposition	Enhances data credibility, process efficiency, and risk control	Reduces cross-border payment costs, increases settlement efficiency, enables programmable payments	Expands financing channels, lowers investment thresholds, and improves asset liquidity
Main Limitations	No direct financing; limited ecosystem openness	Generally non-financing; attempts to bypass securities regulation carry compliance risk	High regulatory barriers; legal and technical risks coexist
Key Compliance Focus	Data privacy, industry standards, judicial recognition	Payment-licensing, stablecoin regulations, AML/CFT requirements	Securities laws, qualified-investor rules, disclosure obligations
Typical Cost Level	Low (hundreds of thousands RMB)	Medium (millions RMB)	High (tens of millions RMB)
Applicable Renewable-Energy Scenarios	Green power traceability, carbon-footprint tracking, on-chain operational data for credit enhancement	Cross-border raw-material procurement, overseas project settlement, supply-chain payment flows	Power-plant future-income financing, charging-network ABS, tokenized green bonds

Source：Pharos Research

3.2 Decision Framework: How to Choose the Right RWA Pathway

Before launching an RWA initiative, enterprises should avoid blindly pursuing “tokenized financing.” Instead, they should start from their **core business pain points and strategic objectives**, using the following self-assessment checklist to determine which pathway best fits their situation.

1. **Goals and Pain Points (What is our core problem?)**
    - **Is financing the primary objective?** If so, Pathway 3 (Security / Financing) should be the ultimate direction — but the enterprise must first assess whether it can bear the associated costs and regulatory risks. If not, Pathway 1 or 2 would be more suitable.
    - **Are operational inefficiencies and lack of trust the main challenges?** For instance, poor supply-chain coordination, unverifiable data authenticity, or a high risk of fraud. If that is the case, Pathway 1 (Proof-of-Ownership / Data-Attestation) is the ideal starting point.
    - **Are high cross-border payment costs and long settlement cycles the major bottlenecks?** If so, Pathway 2 (Payment / Store-of-Value) can deliver immediate and tangible improvements.
2. **Resources and Capabilities (What are our capabilities?)**
    - **Legal and compliance capacity:** Can the company manage complex securities-law and payment-license requirements, and does it have the budget to engage top-tier legal and compliance advisors? This is a prerequisite for pursuing Pathway 3.

- **Technical readiness:** Does the enterprise have an internal blockchain team or reliable technical partners who can ensure the security and stability of on-chain data?

- **Budget allocation:** Based on the cost levels outlined earlier, how much investment is the company willing to commit to its RWA initiative? Is the expected ROI focused on efficiency gains and cost reduction, or on unlocking large-scale financing opportunities?

3. **Ecosystem and Partnerships (Who is in our ecosystem?)**

    - **What partners are required for Pathway 1?** Typically, upstream and downstream industry participants, financial institutions (banks, factoring firms), and auditing bodies — forming a consortium chain is a common approach.

    - **What determines success in Pathway 2?** It depends on whether key counterparties (such as suppliers and customers) are willing to accept the company's token as a payment or settlement tool, which demands strong business-development capability and tangible ecosystem incentives.

    - **What external resources does Pathway 3 rely on?** Licensed exchanges, underwriters, qualified-investor networks, and professional asset-evaluation agencies are essential intermediaries for compliant issuance.

By answering the above questions, enterprises can more clearly identify their current stage and real needs, and design a progressive RWA implementation roadmap that evolves from internal efficiency enhancement to external financing expansion. For most traditional industries, the most pragmatic entry point is to start with Pathway 1, using blockchain to address internal or consortium-level trust and transparency issues. This offers the lowest risk and the fastest return on results.

04 / Conclusion and Outlook

The rise of RWA is not merely a slogan of “putting everything on-chain.” It represents a profound transformation in the digitalization of traditional industries. RWA provides enterprises with a new set of tools to tackle long-standing challenges of trust, efficiency, and liquidity. The three pathways discussed in this paper — proof-of-ownership (data attestation), payment/store-of-value, and security/financing — are not isolated tracks but rather a progressive continuum, each building upon the last in complexity, value, and impact.

For enterprises rooted in the real economy, the true value of RWA lies not in short-term speculation but in returning to the fundamentals of business. **Pathway 1** serves as the foundation — leveraging verifiable data to enhance operations and strengthen risk control. **Pathway 2** acts as the bridge — enabling programmable payments that accelerate the flow of funds and value. **Pathway 3** stands as the lighthouse — opening innovative gateways for quality assets to access global capital markets.

Looking ahead, as global regulatory frameworks become clearer and blockchain technologies continue to advance, the barriers to RWA implementation will steadily decline. The emergence of new primitives — such as high-performance public chains, fully on-chain CLOBs, intent-based DEXs, and agent-to-agent stablecoin payment networks — will expand RWA applications far beyond finance, into broader real-economy sectors. We are likely to see more hybrid models emerge, where a single project integrates **data attestation**, **payment and settlement**, and **yield-bearing tokenization** within one structure.

For forward-looking entrepreneurs, **now is the time** to understand and position for the coming RWA wave. By carefully selecting the pathway that best fits their business model and advancing step by step, enterprises can secure an early-mover advantage in this technology-driven asset revolution.

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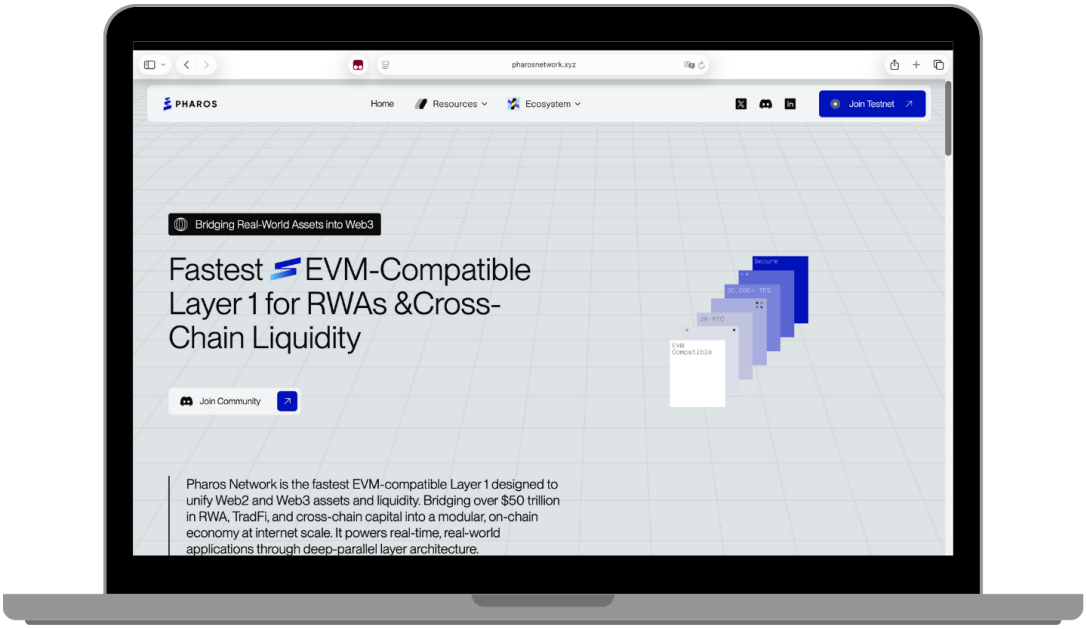

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