

ERIA ISSUE PAPER

Digital MRV in ASEAN: Building the Trust Infrastructure for Carbon Markets

- Digital MRV transforms emissions data into trusted market evidence by linking measurement, reporting, verification, registry records, and interoperability.
- Carbon pricing, carbon crediting, Article 6 co-operation, and CBAM-related reporting are making credible emissions data a competitiveness issue for ASEAN.
- ASEAN pathways differ, but all require emissions data that are traceable, verifiable, reusable, and interoperable.
- Legal scope, methodologies, identifiers, verifier requirements, registry logic, and data standards should guide digital investment from the outset.
- Experience from East Asia and other advanced economies shows that reporting, verification, sector-specific MRV, and registry transparency should mature before regulatory obligations are tightened.

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1. Introduction

Measurement, reporting, and verification (MRV) is the backbone of credible carbon markets and the foundation that makes carbon pricing work. MRV determines whether reported emissions and mitigation outcomes are credible, independently verified, uniquely counted, and fit for policy or market use. Because these emissions data can affect taxes, business transactions, investment decisions, and trade access, they must be trusted.

Digital MRV refers to the use of digital technologies, governed data systems, and electronic workflows to manage the full process by which emissions information is produced, measured, reported, verified, and shared (World Bank, 2022). In practice, Digital MRV replaces manual document exchange with structured systems that capture data, support verification, and connect to inventories, registries, or markets whilst protecting data quality and preventing double counting. These systems can improve the speed, consistency, accuracy, scalability, and security of emissions reporting (Amellina, 2017; Schletz et al., 2023). For ASEAN, Digital MRV is strategic economic infrastructure for carbon markets, climate finance, Article 6 co-operation, and trade competitiveness. As Member States pursue different carbon market pathways, trusted emissions data can help reduce transaction costs, improve market confidence, support cross-border recognition, and strengthen ASEAN's collective position in the emerging low-carbon economy.

The global context makes this agenda increasingly important. As of 1 April 2026, 87 direct carbon pricing instruments had been implemented worldwide, comprising 47 carbon taxes and 40 emissions trading systems, covering 29% of global GHG emissions and generating US\$107 billion in public revenue in

2025. Average direct carbon prices have risen by more than 7% since April 2025 and have roughly doubled since 2016 to nearly US\$21/tCO₂e (World Bank, 2026). These data show that carbon pricing is becoming a policy operating condition for ASEAN.

Carbon credit markets reinforce the same message. The voluntary carbon market declined to about US\$535 million in 2024, from a peak of US\$2.1 billion in 2021, but the market is becoming more selective rather than simply weaker (Ecosystem Marketplace, 2025). Global credit issuance rose by 8% from 2024 to 2025, with price premia increasingly linked to compliance eligibility, integrity labels, and third-party ratings (World Bank, 2026). For ASEAN, the opportunity lies in its strong potential for reforestation, avoided deforestation, and blue carbon (BloombergNEF, 2025). Carbon finance will flow most readily to credits backed by credible measurement, clear data ownership, independent assurance, registry integrity, and safeguards against double counting.

In addition, trade policy has also increased the value of credible emissions data. Since the EU CBAM entered its definitive phase in 2026, embedded emissions reporting has become part of trade compliance for iron and steel, aluminium, cement, fertilisers, electricity, and hydrogen. For ASEAN exporters, reliable installation- and product-level emissions data are now essential for market access, compliance, and carbon cost management, especially where documented domestic carbon prices may be deducted (European Commission, 2026).

2. How Digital MRV Strengthens Carbon Market Trust

Digital MRV strengthens carbon market trust by turning reported emissions and mitigation outcomes into structured records that can be traced, verified, and used for compliance or market decisions. Traditional MRV often relies on spreadsheets, scanned documents, and end-of-cycle checks. This may work for small systems but becomes fragile as facilities, projects, users, and claims expand. Fragmented tools, inconsistent emission factors, weak audit trails, limited verifier capacity, and disconnected registries raise the risk of errors and double counting. They also create a time-value problem: delays in verification and credit issuance can postpone revenue, weaken project bankability, and slow the delivery of mitigation benefits. Digital MRV addresses these weaknesses by making the evidence chain traceable from data capture to final use. It can use digital forms, smart meters, continuous emissions monitoring systems, satellite and remote sensing, APIs, automated validation checks, and registry links. These tools can improve data quality, reduce transaction costs, and shorten the time between monitoring, verification, issuance, and payment. Their value depends on approved methodologies, clear data governance, and independent assurance, not on technology alone.

For ASEAN, new reporting and crediting methodologies should be digital-ready from the outset. A compliance-grade system should be able to reconstruct one tonne of emissions from raw evidence to final use. Standardised templates, mandatory fields, monitoring plan links, digital signatures, evidence metadata, and correction histories create data discipline. The World Bank (2022) likewise argues that common data exchange

standards and APIs are essential to support compatibility and interoperability in Digital MRV systems.

3. A Practical Digital MRV Framework: The Layers

A practical Digital MRV framework can be understood as a set of interconnected and interdependent layers.

(i) Governance

Governance is the layer that gives MRV its legal force. Digital tools can organise the process, but regulation gives each digital record its legal meaning. It defines who reports, to which authority, using which methodology. Mature systems anchor MRV directly in primary legislation. For example, under the EU Emissions Trading System, every covered installation must operate under a monitoring plan approved by the competent authority before the monitoring period begins, submit an annually verified emissions report, and surrender allowances to match. For international transfers, Article 6 adds further rules: Article 6.4 requires host-country approval through a designated national authority, whilst Article 6.2 requires systems to authorise, track, and report internationally transferred mitigation outcomes (UNFCCC, 2021a, 2021b, 2022).

(ii) Measurement/Monitoring

The measurement layer defines what must be measured, how it is measured, which data are accepted, and how data quality is checked. In practice, this means setting monitoring plans, identifying emissions sources, choosing calculation methods and emission factors, maintaining calibration records, applying QA/QC checks, and defining how missing or abnormal data should be treated. The evidence may come from different sources, such as meters, Continuous Emissions Monitoring Systems (CEMS), smart meters, IoT sensors, satellite imagery, Light Detection and Ranging (LiDAR), drones, or field-data applications, depending on the source and the level of accuracy required. The purpose of measurement is to create reliable source-level evidence that can be reported and verified.

(iii) Reporting

Reporting turns measured data into an official and auditable record. In a Digital MRV system, firms should not submit disconnected spreadsheets, PDFs, or scanned files. They should use structured templates that link each value to the approved monitoring plan, source evidence, methodology, reporting period, and responsible user. Built-in checks can flag missing fields, incorrect units, and unsupported calculations before verifier review. This reduces manual re-entry and creates a clear audit trail for regulators, verifiers, registries, and future compliance decisions. For ASEAN, the priority is to build reporting portals that support online verification and connect with national registries from the outset.

(iv) Verification

Verification makes reported emissions data credible to regulators, buyers, and investors. It should be carried out by independent and accredited validation and verification bodies. Digitalisation reshapes verification from a periodic document-based exercise into something closer to continuous assurance.

Verification timelines of several months are common under manual processes; digital interfaces that give verifiers direct access to source data, sensor feeds, and satellite imagery can compress these cycles and shift verifiers from annual audits towards ongoing oversight (Ecklu and Thomas, 2025; SustainCERT, 2023).

(v) Registry and Compliance

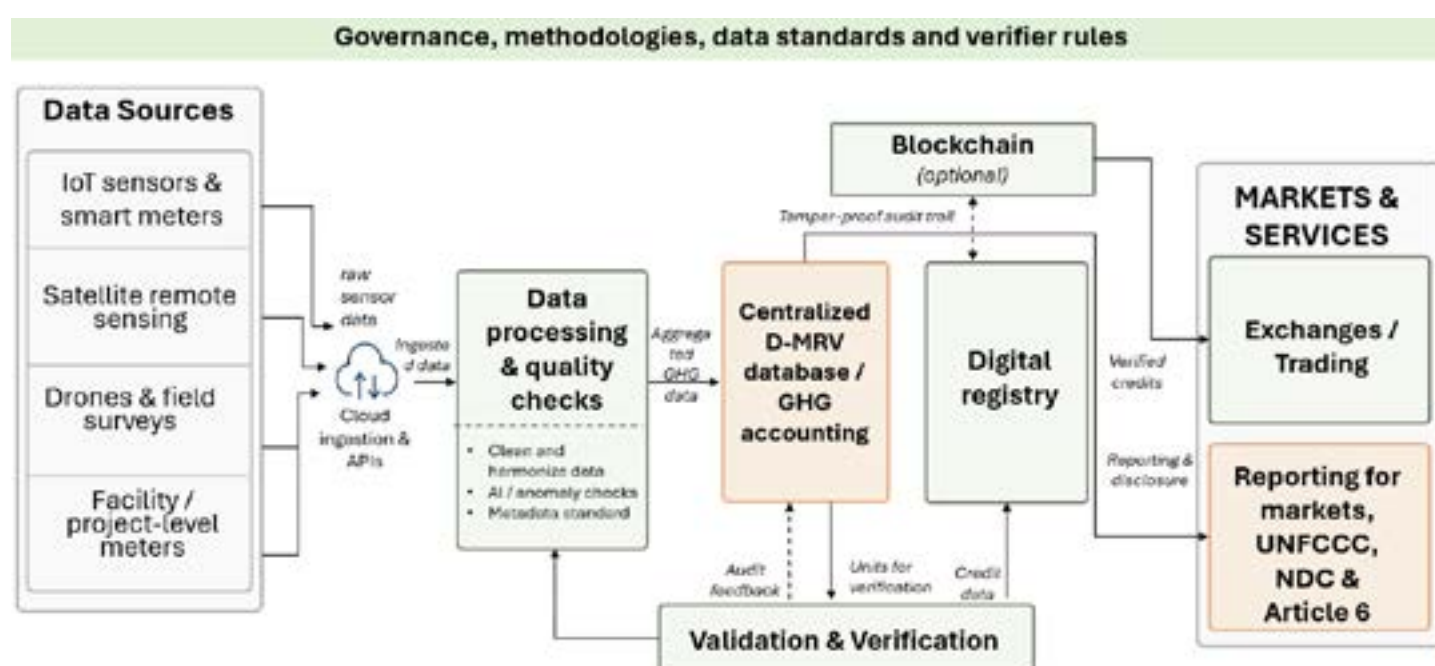
Registry and compliance functions turn verified data into legal or market outcomes. The key requirement is that every unit or compliance record has a unique identifier and a clear status so that it cannot be issued, used, or claimed twice. Under Article 6, registries also need to record host-country authorisation, first transfer, use purpose, and corresponding-adjustment status to prevent double counting between the

host country and the buyer country (UNFCCC, 2025). For example, the Climate Action Data (CAD) Trust – developed by the World Bank, the Government of Singapore, and the International Emissions Trading Association (IETA) – provides a decentralised, blockchain-based metadata layer that links registries and makes double-counting risks visible across systems that would otherwise be invisible to one another (Climate Action Data Trust, n.d.).

(vi) Interoperability

Interoperability is the layer that allows the other five to connect – across instruments, across borders, and across the voluntary and compliance markets. It has three dimensions: technical interoperability, meaning systems can send and receive data; semantic interoperability, meaning shared data fields carry

Figure 1. End-to-end Digital MRV Architecture for Carbon Markets



Source: Author.

the same meaning; and procedural interoperability, meaning the underlying legal and administrative consequences are aligned.

Figure 1 shows Digital MRV as an end-to-end evidence chain. Data from meters, sensors, satellites, drones, and facility records are captured, validated, verified, recorded in registries, and used for carbon markets, Article 6, NDC reporting, and CBAM. The key message is that ASEAN can maintain different project methodologies – for example, for renewable energy, forestry, biochar, methane, soil carbon, and blue carbon – whilst standardising workflows, data fields, verifier hand-offs, and registry links.

4. Country Pathways and Sequencing Lessons for Digital MRV in ASEAN

ASEAN countries are developing carbon markets through different pathways, but they share one core requirement: credible emissions data. The regional priority is to ensure

that emissions data are traceable, verifiable, reusable, and interoperable across carbon taxes, ETSs, crediting systems, Article 6 co-operation, CBAM, and voluntary carbon markets.

Experience from Japan, the Republic of Korea, Australia, and New Zealand shows that credible carbon markets are built through administrative sequencing, not trading scale alone. Japan's GX-ETS used a voluntary phase to build corporate reporting and verification capacity before mandatory participation began in 2026. The Republic of Korea's K-ETS was preceded by the Target Management System and the web-based National Greenhouse Gas Management System (NGMS), which established verified reporting routines before full ETS operation. Australia's Safeguard Mechanism demonstrates that baseline-and-credit systems can build on national facility reporting infrastructure before market deepening, whilst New Zealand highlights transparent registries, predictable unit supply, and clear price-control rules as core elements of market integrity.

The lesson for ASEAN is that MRV capacity should mature before carbon-pricing obligations become more stringent or market coverage expands. Voluntary reporting can prepare firms for compliance; sectoral expansion should be matched by clear methodologies and sufficient verifier capacity; and registries should be treated as core market infrastructure.

5. Implementation Risks

Digital MRV is not constrained primarily by the availability of technology. The main risks are high upfront costs, technical complexity, uneven digital infrastructure, limited verifier readiness, sensitive-data concerns, and weak data governance (World Bank, 2022). A portal, dashboard, or ledger can be built quickly, yet still fail if the data model is unclear or the legal rulebook is incomplete. The safer sequence is to define the rulebook first. This includes legal mandates, user roles, monitoring-plan requirements, identifiers, registry logic, confidentiality rules, and evidence standards. Platform design should follow those rules.

Several safeguards are essential. Digital MRV should allow flexible data collection whilst preserving auditability. Large facilities may use CEMS, smart meters, and automated data feeds. Smaller projects may use mobile forms, GPS-tagged evidence, periodic sampling, and assisted uploads. Systems also need clear confidentiality rules because emissions data can reveal production levels, fuel use, technology choices, and other commercially sensitive information. Automation should support accountability, not replace it. Anomaly detection, AI screening, blockchain anchoring, and smart-contract triggers should generate flags for human review. Interoperability should also be treated as core infrastructure. APIs are useful only when supported by shared data dictionaries, stable identifiers, and compatible evidence formats.

6. Strategic Policy Recommendations

6.1 Establish an ASEAN Digital MRV Interoperability Framework

ASEAN should establish an ASEAN Digital MRV Interoperability Framework as a regional technical framework for carbon-market data to ensure that national MRV systems can communicate where cross-border recognition is needed. The framework should begin with a minimum common data dictionary covering facilities, projects, emission sources, methodologies, evidence types, verifier metadata, carbon units, transactions, retirements, Article 6 authorisation, corresponding-adjustment status, and CBAM-relevant fields. This would allow different national platforms to use different software whilst recognising the same core data objects.

The evidence supporting this recommendation is strong. ASEAN's own regional policy direction already points towards interoperability. The ASEAN Strategy for Carbon Neutrality calls for a regional MRV framework to enable high-quality carbon credits and address double counting, whilst the AEC Strategic Plan 2026–2030 promotes common recognition and interoperability amongst carbon markets (ASEAN, 2023, 2025). A regional interoperability framework would reduce the cost of future integration, lower the risk of double counting, and make ASEAN-origin credits and emissions records more credible to buyers, regulators, EU importers, Article 6 partners, and financial institutions.

6.2 Build Legal and Governance Foundations before Procuring Platforms

The legal and governance foundations of Digital MRV should be defined before procuring or expanding digital platforms. This

means clarifying covered entities, sectors, authorities, data ownership, confidentiality rules, monitoring-plan approval, verifier recognition, registry functions, and appeal procedures. These decisions determine whether emissions data have legal effect.

ASEAN's carbon-market challenge is not the absence of policy momentum. The deeper constraint is uneven readiness across the institutional chain. The policy sequence should therefore be: approve the rulebook, then procure the system. A simple reporting platform with legally defined data fields, monitoring-plan links, user roles, audit trails, and correction workflows is more valuable than a sophisticated platform whose records have uncertain legal meaning. The World Bank's D-MRV report supports this governance-first approach, which can improve reporting speed, consistency, accuracy, scalability, and database security. For ASEAN, this recommendation also reduces procurement risk. If a country builds a platform before defining its legal and governance foundations, costly redesign may later be required.

6.3 Make Methodologies and Monitoring Plans Digital-Ready

ASEAN should require reporting and crediting methodologies to be digital-ready from inception. Each methodology should define the required data fields, accepted evidence, calculation rules, uncertainty treatment, verifier inputs, and registry outputs. The monitoring plan should be the first digital object in the MRV system because it establishes the method, source streams, data hierarchy, QA/QC rules, and evidence requirements that make subsequent reporting credible.

ASEAN will need both digitised and natively digital methodologies. Digitised methodologies convert existing rules into electronic forms. Natively digital methodologies are designed from the outset for machine-readable data, digital evidence, automated checks, and registry connectivity. New methodologies for sectors such as power, cement, steel, rice methane, forestry, soil carbon, biochar, and blue carbon should therefore be designed as digital-ready from the outset. This will reduce future redesign costs and make emissions reports and carbon-credit claims easier to verify, compare, and use across registries.

6.4 Strengthen Verification and Registry Integrity

ASEAN should strengthen verification and registry integrity before scaling carbon-market transactions. Verification turns self-reported data into credible evidence for regulators, buyers, and investors. Registries then convert verified evidence into legal or market outcomes such as tax assessments, allowance surrender, credit issuance, transfer, retirement, cancellation, Article 6 authorisation records, and CBAM documentation. These functions are distinct but inseparable: a registry is only credible when the data underpinning each unit have been independently verified, and verification has limited value if the resulting outcomes are not recorded in a reliable registry.

Verification should be based on accredited scopes, risk-based review, and conflict-of-interest safeguards. National systems should align with relevant standards such as ISO 14065, ISO/IEC 17029, and ISO 14064-3, where applicable. Registry integrity should be treated as a core element of market design. Registries should define accounts, unit status, transaction states, surrender, cancellation, retirement purpose, and corresponding-adjustment requirements. This helps prevent double issuance, double use, and double claiming, whilst supporting credible Article 6 implementation and CBAM-related reporting (ISO, 2019, 2020; UNFCCC, 2025).

6.5 Create Regional Capability and Financing Mechanisms

ASEAN should support Member States through shared Digital MRV capability. Support should focus on reusable public-good foundations such as common data standards, registry templates, verifier training, reporting pilots, cybersecurity safeguards, and CBAM- and Article 6-readiness tools. Financing should be practical and blended. Concessional loans can support national reporting platforms and registries, whilst Article 6 co-operation and development-finance programmes can help fund MRV readiness. Implementation safeguards should be built in from the outset. Systems should support different data-collection channels for large facilities and smaller projects whilst maintaining audit trails, data protection, and cybersecurity. Platform procurement should follow the data architecture, not precede it (World Bank, 2022).

7. Conclusion

ASEAN's carbon-market agenda has moved to implementation. Carbon taxes, ETS pilots, voluntary crediting, Article 6 co-operation, and CBAM-related reporting are advancing through different national pathways. Carbon prices and carbon credits will only be credible when the underlying tonne can be measured under an approved methodology, reported through a controlled workflow, independently verified, recorded in an accountable registry, and used consistently across systems. Digital MRV is the infrastructure that makes this evidence chain operational.

The priority is not to procure technology first, but to define the authoritative records, rules, and data objects that give digital systems legal and market value. ASEAN's practical pathway is to standardise rules and data fields, digitise controlled workflows, integrate reporting with verification and registry settlement, and automate only once the underlying rules are stable. This approach respects national sovereignty whilst creating interoperability without requiring uniformity. Digital MRV can become a regional comparative advantage, helping to mobilise climate finance, support NDC implementation, protect trade competitiveness, and build international confidence in ASEAN carbon markets

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References

- ACMF (2025), Voluntary Carbon Market Development Plan. ASEAN Capital Markets Forum. <https://www.theacmf.org/sustainable-finance/publications/acmf-voluntary-carbon-market-development-plan>
- Amellina, A. (2017), 'Enhancing the Joint Crediting Mechanism MRV to contribute to sustainable development', In: J. I. Uitto, J. Puri, and R. D. van den Berg (Eds.), *Evaluating Climate Change Action for Sustainable Development* (pp.111–27). Springer. https://doi.org/10.1007/978-3-319-43702-6_7
- ASEAN (2023), ASEAN Strategy for Carbon Neutrality. ASEAN Secretariat. <https://asean.org/wp-content/uploads/2023/08/Brochure-ASEAN-Strategy-for-Carbon-Neutrality-Public-Summary-1.pdf>
- ASEAN (2025), ASEAN Economic Community Strategic Plan 2026–2030. ASEAN Secretariat. https://asean.org/wp-content/uploads/2025/05/07.-AEC-Strategic-Plan-2026-2030_adopted.pdf
- Climate Action Data Trust (n.d.), Connecting Carbon Markets through Open Data. Retrieved 10 June 2026, from <https://climateactiondata.org/>
- Ecklu, J. and E. Thomas (2025), Digital monitoring, reporting, and verification technologies supporting carbon credit-generating water security programs: State of the art and technology roadmap. *Environmental Science & Technology Letters*, 12(3), <https://doi.org/10.1021/acs.estlett.4c01048>
- Ecosystem Marketplace (2025), State of the Voluntary Carbon Market 2025. Forest Trends' Ecosystem Marketplace. <https://www.ecosystemmarketplace.com/publications/2025-state-of-the-voluntary-carbon-market-sovcml/>
- European Commission (2026), Carbon Border Adjustment Mechanism. Taxation and Customs Union. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en
- Schletz, M., A. Constant, A. Hsu, S. Schillebeeckx, R. Beck, and M.E. Wainstein (2023), 'Blockchain and Regenerative Finance: Charting a Path toward Regeneration', *Frontiers in Blockchain*, 6, Article 1165133. <https://doi.org/10.3389/fbloc.2023.1165133>
- SustainCERT (2023), How – and why – should we prepare for digital MRV? Retrieved 10 June 2026, from <https://www.sustain-cert.com/news/how-and-why-should-we-prepare-for-digital-mrv>
- Sylvera (2025, 14 November), Article 6 authorizations & corresponding adjustments. <https://www.sylvera.com/blog/article-6-authorizations-corresponding-adjustments>
- UNFCCC (2021a), Decision 2/CMA.3: Guidance on cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement. United Nations Framework Convention on Climate Change. <https://ppp.worldbank.org/library/decision-2-cma-3-guidance-cooperative-approaches-referred-article-6-paragraph-2-paris-agreement>
- UNFCCC (2021b), Decision 3/CMA.3: Rules, modalities and procedures for the mechanism established by Article 6, paragraph 4, of the Paris Agreement. United Nations Framework Convention on Climate Change. <https://ppp.worldbank.org/library/decision-3-cma-3-rules-modalities-and-procedures-mechanism-established-article-6-paragraph-4-paris-agreement>
- UNFCCC (2022), Decision 6/CMA.4: Matters relating to cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement. United Nations Framework Convention on Climate Change. <https://ppp.worldbank.org/library/decision-6-cma-4-matters-relating-cooperative-approaches-referred-article-6-paragraph-2-paris-agreement>
- UNFCCC (2025), Article 6.2 reference manual for the accounting, reporting and review of cooperative approaches. United Nations Framework Convention on Climate Change. <https://unfccc.int/documents/634354>
- World Bank (2022), Digital Monitoring, Reporting, and Verification Systems and their Application in Future Carbon Markets. World Bank. <https://documents1.worldbank.org/curated/en/099605006272210909/pdf/IDU0ca02ce8009a2404bb70bb6d0233b54ffad5e.pdf>
- World Bank (2026), State and Trends of Carbon Pricing 2026. World Bank. <https://doi.org/10.1596/978-1-4648-2348-0>

Annex Table 1. Where Digital Tools Add Value

Tool (example)	Best Fit in the Layers	Value Added
CEMS / smart meters	Measurement; Reporting	Higher-frequency source data; faster anomaly detection.
Mobile apps / GPS	Measurement; Verification	Geo-tagged field evidence and user accountability.
Automated validation	Reporting; Verification	Rejects incomplete, inconsistent or implausible submissions before review.
Blockchain / DLT	Registry & Compliance	Immutable transaction history and duplicate-use prevention.
APIs and data dictionary	Interoperability	Lower-cost exchange with registries, Article 6 systems and CBAM evidence users.

Source: Author.

Annex Table 2. ASEAN Carbon Market Pathways and Digital MRV Priorities*

Country	Carbon-market Pathway	Digital MRV Priority
Singapore	Operational carbon tax under the Carbon Pricing Act. Rate rises to S\$45/tCO ₂ e in 2026–2027, with a policy range of S\$50–80/tCO ₂ e by 2030.	Strengthen interoperability across tax records, international carbon credit (ICC) eligibility, Article 6 authorisation, corresponding adjustments, registry reconciliation, and CBAM evidence exports.
Indonesia	Operational power-sector ETS, IDXCarbon exchange, National Climate Change Control Registry System (SRN-PPI) registry, and Carbon Economic Value framework.	Integrate reporting, verification, registry, exchange, and compliance records before sector expansion. Priorities include stable facility IDs, unit serials, automated validation, and Article 6 metadata.
Viet Nam	Pilot ETS in force, initially focused on thermal power, iron and steel, and cement. Domestic trading platform and registry functions are still developing.	Complete the national digital reporting platform, domestic verifier accreditation, registry settlement, and authority workflows before full market operation.
Thailand	Established T-VER and Premium T-VER voluntary crediting system. Draft Climate Change Act approved by Cabinet in 2025, with an ETS pilot targeted for 2029.	Convert T-VER experience into facility-level compliance MRV, including monitoring plans, annual reporting, verifier accreditation, compliance, and electronic reporting.
Malaysia	Bursa Carbon Exchange, National Carbon Market Policy, and planned carbon tax and ETS foundations.	Build mandatory facility reporting, carbon-tax MRV, national registry design, verifier accreditation, and co-ordination.
Philippines	Investment-first and voluntary-crediting pathway. The Low Carbon Economy Investment Act remains under Senate deliberation.	Build minimum viable MRV: legal mandate, registry governance, verifier recognition, project-evidence standards, data ownership rules, and double-counting safeguards.

Note: *Selected ASEAN countries.

Source: Author's compilation

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Sentral Senayan II, 5th, 6th, 15th floors
Jalan Asia Afrika No. 8
Senayan, Central Jakarta 10270, Indonesia
Tel: (62-21) 57974460
E-mail: contactus@eria.org

