



Unlocking the potential of carbon markets: Designing carbon registries for success

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I Credits

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- Carbon markets are essential for the cost-effective reduction of greenhouse gas emissions.
- Recognising carbon as a valuable national asset can help countries to attract investment, accelerate economic growth and promote sustainable development.
- Carbon registries play a crucial role in tracking carbon credits and enhance the credibility of carbon markets, empowering countries and corporations meet their climate commitments confidently and transparently.
- Effective carbon registries support a country’s specific policy objectives. Countries must decide how to access the carbon markets, whether to leverage existing independent standards, engage with the Paris Agreement Crediting Mechanism, develop a national program, or pursue a combination of these options.
- Once these policy decisions have been made, technology options can be considered.

Executive summary

As the world increasingly recognizes the need to combat climate change, carbon markets have emerged as a vital cost-effective mechanism for reducing greenhouse gas emissions.

Recognizing carbon as a valuable national asset allows countries to leverage carbon credits to attract investment, accelerate economic growth and promote sustainable development. Countries like Ghana and Papua New Guinea have adopted this forward-thinking approach by incorporating carbon credits into broader development finance strategies under Article 6, aligning national emissions reduction goals with the transition to a low-carbon economy.

Central to these markets are registries, which play a vital role in a country's climate governance framework by providing a structured method for tracking carbon credits and ensuring accurate documentation of emissions reductions and removals. These registries maintain a secure database of carbon assets, thereby enhancing the credibility of carbon markets and empowering countries and corporations to meet their climate commitments with confidence.

However, a one-size-fits-all registry model is not feasible; effective carbon registries must align with each nation's specific policy objectives.

When organizing participation in the carbon market, countries must carefully consider their options — whether to utilize existing independent standards, engage with the Paris Agreement Crediting Mechanism (PACM), develop a national program, or pursue a combination of the above. This paper aims to clarify the roles and functionalities of different types of registries, along with the key considerations for the options available to countries.

Increasingly, countries are looking to improve the alignment between their national carbon market regulations and

“ Recognizing carbon as a valuable national asset allows countries to leverage carbon credits to attract investment, accelerate economic growth and promote sustainable development. ”

the methodologies and requirements set by independent standards. A prime example of this is the agreement entered into between [Gold Standard and the Indonesian Ministry of Environment](#), which is likely to inspire similar initiatives in the future.

Furthermore, countries should consider whether they plan to implement other policy tools, such as an emissions trading system or a carbon tax, and how they intend to manage nationally determined contributions (NDCs). Integrating these elements with the registry may help facilitate more efficient management and reporting of climate commitments.

Once policy frameworks are established, countries can evaluate technology options and financing avenues, such as the Green Climate Fund and other international donors, which are increasingly linked to registry readiness.

By thoughtfully considering national policy objectives and implementing a registry strategy that aligns with these goals, countries can establish registries that not only aid in achieving their immediate climate objectives but also promote sustainable development and enhance environmental resilience.

What is a carbon registry?

A carbon registry is a digital, electronic database designed to track and manage the life cycle events of carbon instruments. This essential component of carbon market infrastructure enables national and state-level authorities to gather information on emission-reducing activities.

Accurate tracking of emissions and associated instruments through robust registries is crucial; without proper tracking,

a single carbon emission could be counted by multiple instruments, leading to double counting.

Registries are structured according to specific workflows defined by standards or national programs, and they serve both compliance and voluntary carbon markets.



Differentiating standards and registries

Standards (also referred to as programs), and registries fulfil different functions within the carbon market. A standard is the organization that defines the methodologies, processes and rules for generating carbon credits, and also manages life cycle events of carbon instruments. Examples of standards include Verra, Gold Standard and Puro.earth.

Registries serve as essential tools for standards, enabling the issuance, tracking and management of carbon credits throughout their life cycle, thereby ensuring transparency and supporting market integrity.



Types and functions of registries

Carbon registries emerged as essential tools for ensuring transparency and accountability in carbon emissions reduction efforts following the Kyoto Protocol's ratification in 1997. As the first significant global agreement focused on legally binding greenhouse gas emissions targets for developed countries, the Kyoto Protocol necessitated a transparent system to monitor progress. Carbon registries were developed to systematically record emissions reductions and carbon credits generated through various projects, serving as digital platforms that track the issuance, transfer and retirement of credits. This evolution ensured that emission-reduction efforts were transparent, auditable and aligned with international climate commitments.

With the growing demand for carbon trading beyond the Kyoto framework, voluntary carbon market standards, more recently referred to as independent standards, emerged allowing businesses and individuals to offset their carbon footprints without legally binding obligations. The transition from the Kyoto Protocol to the Paris Agreement's Article 6 in 2015 marked a significant evolution in global carbon markets, presenting countries with the option to engage in bilateral carbon credit trading (Article 6.2) or an UN-supervised global carbon credit market mechanism (Article 6.4). As countries navigate the operational challenges of transitioning from legacy Clean Development Mechanism (CDM) systems to Article 6.4 compatible infrastructures, they must tailor technology and process decisions to their circumstances.

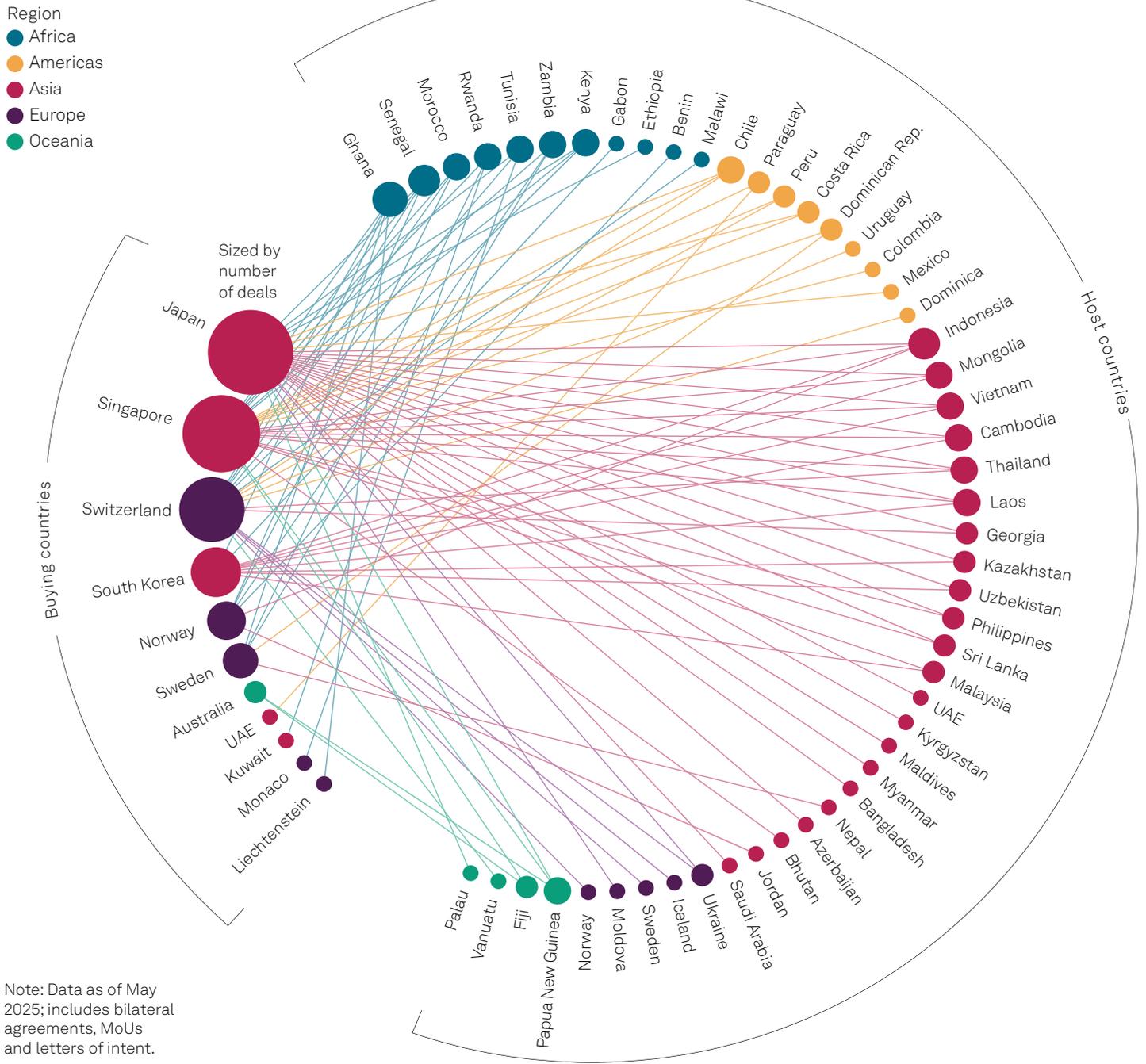
Carbon registries are categorized into two primary types: transactional registries and accounting registries.

- **Transactional registries:** The transactional registries are typically governed by a set of rules or methodologies determined by a standard or national program to issue its own set of credits. These registries will manage the full life cycle of carbon credits, including issuance, transfer and retirement. These systems also play an accounting role and ensure environmental integrity through serialization, project/activity management, and advanced tools. Verra, Gold Standard and Cercarbono are all standards that maintain transactional registries for issuing carbon credits.
- **Accounting registries:** (also called higher-tier registries and pull-and-view registries) aggregate data from multiple transactional registries into a single interface for decision-making purposes. Unlike a transaction registry, a pure accounting registry does not issue its own credits. An example of an accounting registry is the Singapore International Carbon Credit Registry (ICCR), which tracks mitigation outcomes from independent standards deemed eligible by the National Environment Agency of Singapore. The Kingdom of Bhutan has also developed a national carbon registry that tracks credits generated in the Kingdom of Bhutan from independent standards.

Whether a country needs a transactional registry, an accounting registry or a combination of both will depend on how it plans to organize its participation in the carbon market, which is further explained below.

Surge in deals under Article 6.2 of the Paris Agreement

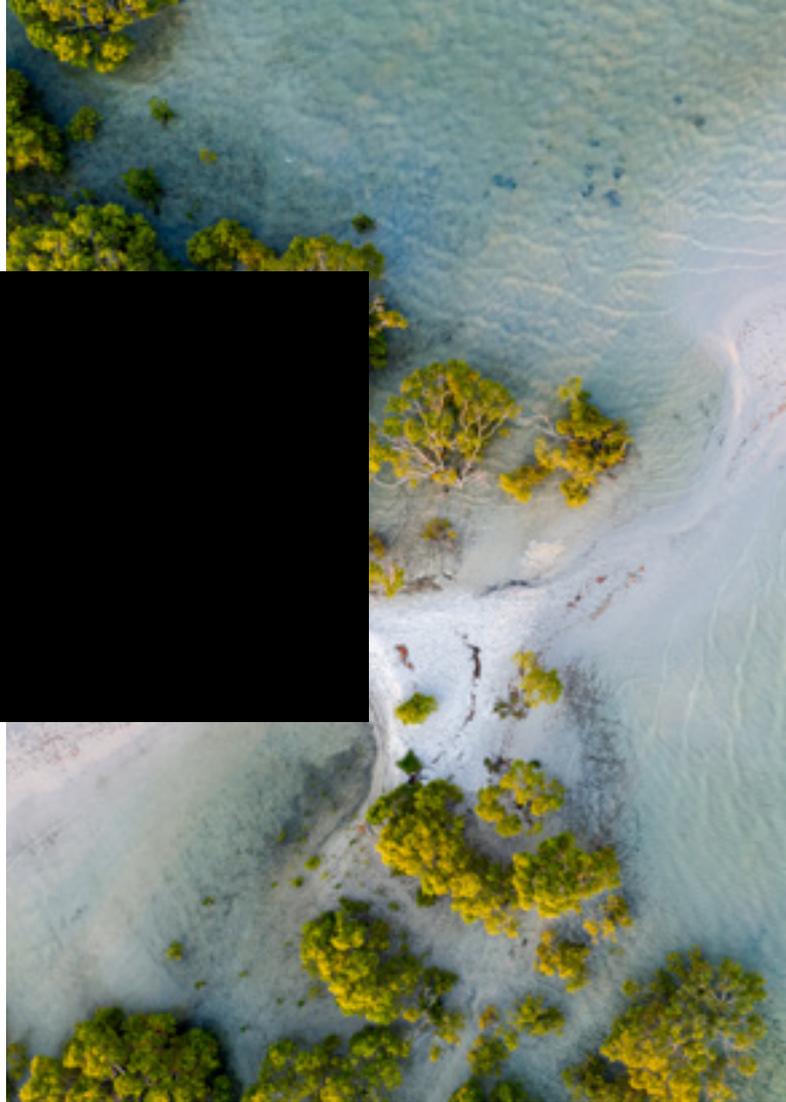
Activity under Article 6.2 is starting to pick up in 2025 after key guidelines for international carbon trading were formalized in November. Nearly 100 bilateral deals have been signed under this mechanism, which sets out a system of national accounting for greenhouse gas emissions, allowing the cross-border exchange of carbon credits.



Note: Data as of May 2025; includes bilateral agreements, MoUs and letters of intent.

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Participation in the carbon markets

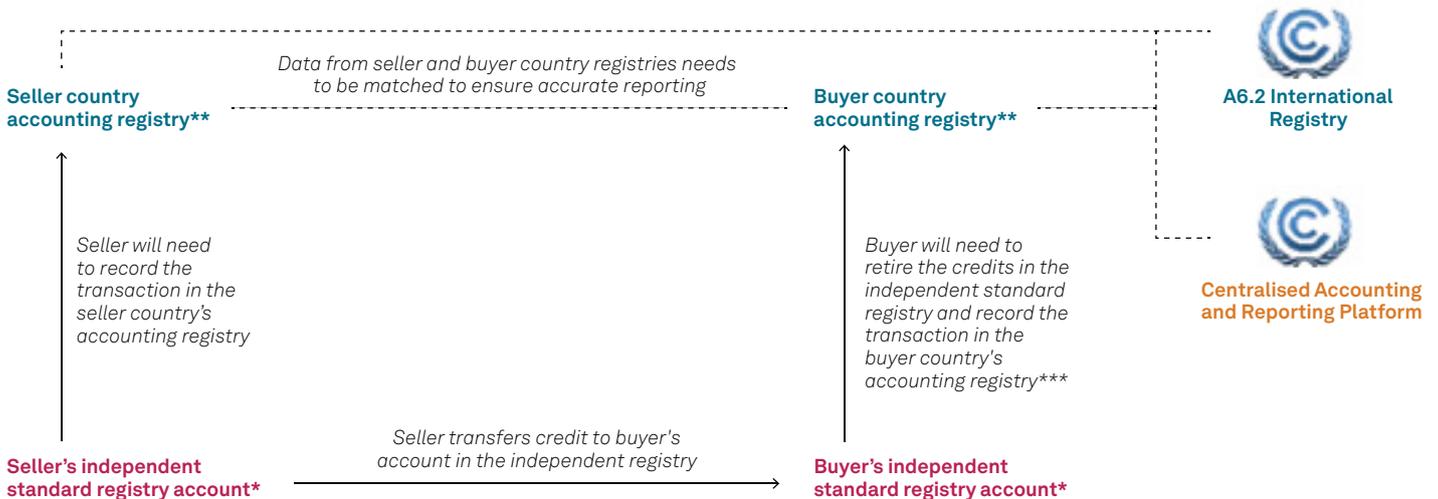
Countries have options for participating in the carbon market. The three primary approaches include leveraging established independent standards, creating a national program and following the PACM. Whichever option or combination of options is chosen, countries will need to decide how they interact with the UN's International Registry.

Below is an overview of each option.

1. Leverage established independent standards

Scenario of how countries can leverage independent standards

Buyer and seller country accounting registries will need to report all transactions to Article 6.2 international registry and send Biennial Transparency Reports to the Centralised Accounting and Reporting Platform (CARP).



*Where an independent standard is utilized, the buyer is likely to be a corporate emitter with an account in the independent standard's registry who is buying credits to offset domestic obligations, rather than the country itself. Likewise, the seller is likely to be a project developer with an account in the independent standard's registry.

**Country can also use the Article 6.2 registry as their accounting registry.

***Where the buyer does not have an account at the independent registry, the seller can retire the credit on the buyer's behalf and record the transaction in the buyer's country accounting registry.

Countries can choose to leverage the existing independent standards that have been developed over time, such as Verra or Gold Standard, or more recently Global Carbon Council, Puro.earth and others. These standards provide rigorous methodologies and an established framework for carbon credit generation, verification and trading.

Countries such as Ghana and Rwanda have indicated that they will sell credits issued by independent standards, while Singapore has indicated it will buy eligible credits to meet its NDC.

Countries taking this route should provide letters of authorization (LOAs) for credits issued in the registries of independent standards and provide corresponding adjustments. This is to ensure transparency in both the national registry and independent standard's registry. This information will also need to be reflected in their NDC.

Advantages:

- **Established credibility:** Independent standards have a track record and are recognized in the market, which can enhance the credibility of and demand for the credits issued.
- **Capacity:** By adopting independent standards, countries can benefit from the established operational capability of that standard, including its methodologies and procedures for project development and credit issuance, reducing the time and resources required to access the carbon market.
- **Operational efficiency for buyers and sellers of credits:** Cooperating with independent standards can help to reduce the risk of fragmented registry solutions and improve the chances of a more harmonized and better-functioning international market.
- **Fungibility:** Credits generated under independent standards attract demand from various markets, including the voluntary market, Article 6.2, and for use for NDCs. The broader the range of markets, the higher the potential price compared to less fungible alternatives.

Challenges:

- **Flexibility:** While independent standards are receptive to new methodology proposals and amendments, countries will need to accept the methodologies and procedures established by international standards, instead of creating customized approaches.
- **Independence:** Countries must acknowledge that international standards will play a governance role within the country specific carbon industry, following the respective country's rules and regulations.

- **Costs and fees:** Independent standards will impose fees, which might otherwise be fully captured by a national program.
- **Article 6 interaction:** Countries need to address the challenge of how to approve LOAs and apply corresponding adjustments within existing registries.

When exclusively following independent standards, a country can opt for a simple accounting registry that integrates with the independent standards to monitor all projects and credits within its jurisdiction. This method can be cost-effective and provides good value for money for countries. An example of such a solution is the S&P Global Meta Registry®, which pulls data from independent standards, providing countries with the ability to view credits within their jurisdiction and track corresponding adjustments.

2. Create a national program

Countries may wish to develop a proprietary national carbon market program tailored to their specific needs and circumstances. This approach involves establishing a unique set of rules, methodologies and governance structures to manage carbon credit activities, and building a registry to manage the issuance and tracking of carbon credits.

Advantages:

- **Customization:** A national program allows countries to design a system that aligns with their unique regulatory, economic and environmental concerns, ensuring that it addresses local priorities and challenges and supports broader climate and environmental policies.
- **Independence:** By creating a national program, countries can manage carbon as a national asset on their own terms.
- **Governance control:** Countries have full control over the governance of their carbon market, including the ability to set standards, manage the registry and ensure compliance with national policies.

Challenges:

- **Fungibility:** Credits issued under a national program may face challenges in gaining international recognition, which could restrict their global fungibility. This limitation may affect pricing for credits issued.

- **Cost:** Countries must develop comprehensive operational support for their programs, including an effective administrative function. Any constraints on efficiency relative to independent standards will similarly restrict fungibility and may affect pricing.
- Robust coordination among relevant government departments is key to ensuring timely implementation.

For effective management of carbon as a national asset, countries should ideally have visibility on credits issued under independent standards as well as those produced through a national program, necessitating both a transactional registry and an accounting registry.

Increasingly, countries are looking to improve the alignment between their national carbon market regulations and the methodologies and requirements set by independent standards. One example of this is the mutual recognition agreement recently established by Gold Standard and the Indonesian Ministry of Environment. Formed through a memorandum of understanding (MoU) signed in May 2025, this task force aims to support the development of carbon mitigation projects in Indonesia that uphold Gold Standard's environmental integrity and sustainable development requirements. By enabling compatibility between Gold Standard's methodologies and Indonesia's national registry system, this collaboration demonstrates a growing trend among countries of leveraging independent standards for improved carbon market participation.

3. Harnessing the Paris Agreement framework

Article 6 of the Paris Agreement allows countries to cooperate voluntarily to enhance their climate actions through both market-based and non-market-based mechanisms. The United Nations Framework Convention on Climate Change (UNFCCC) has provided a clear overview of the overall infrastructure. However, it is currently working on defining the specifics of each registry, including their features and interoperability standards.

For market-based mechanisms, there are two key elements, the advantages and challenges of which are further described below.

Article 6.2 (also referred to as “cooperative approaches”):

Enables countries to trade carbon credits across borders through a mutually agreed-upon set of rules, which may include national or international standards. The credits transacted under this cooperation are known as internationally transferred mitigation outcomes (ITMOs). The UN has defined parameters for the creation of an international registry that can connect to independent and national, transactional and accounting registries.

The advantages and challenges of this approach are similar to those set out above, depending on whether the country seeks to leverage existing independent standards or establish a national program.

Article 6.4: Establishes a centralized mechanism called the Paris Agreement Crediting Mechanism (PACM), which sets global methodologies and verification rules to ensure the quality of emissions reductions. This framework allows countries to trade credits based on predefined rules and methodologies. For Article 6.4 the UN has defined parameters for the creation of an Article 6.4 or Mechanism Registry that will function as a full, independent transactional registry.

Advantages

- Article 6.4 provides countries with a centralized and standardized approach determined by the UN, which provides credibility and predictability.

Challenges:

- Methodologies will be under the direct oversight of the UNFCCC. As such, they may be less flexible than national programs or independent standards as any changes will require approval from a broader range of stakeholders.

The decision regarding whether and how to participate in Article 6.2 and Article 6.4 is a matter of sovereign policy. However, country registries will need to connect with the PACM Registry and/or the International Registry depending on which route the country takes.

Article 6.8 involves non-market-based approaches, where countries cooperate on climate action, including efforts like capacity building, technology transfer and policy collaboration, without the use of carbon credit trading mechanisms. While the registry infrastructure for Article 6.8 is likely to differ from that of Article 6.2 and 6.4, it may still require mechanisms to track and report activities, depending on how countries choose to structure such initiatives.

Technology options available to countries

After a country has determined its approach to accessing the carbon markets, it can begin to explore technology options. Several options are available, each providing unique functionalities, benefits and challenges. Below are the main technology options that countries can evaluate when developing their carbon market frameworks:

1. Manual tracking systems

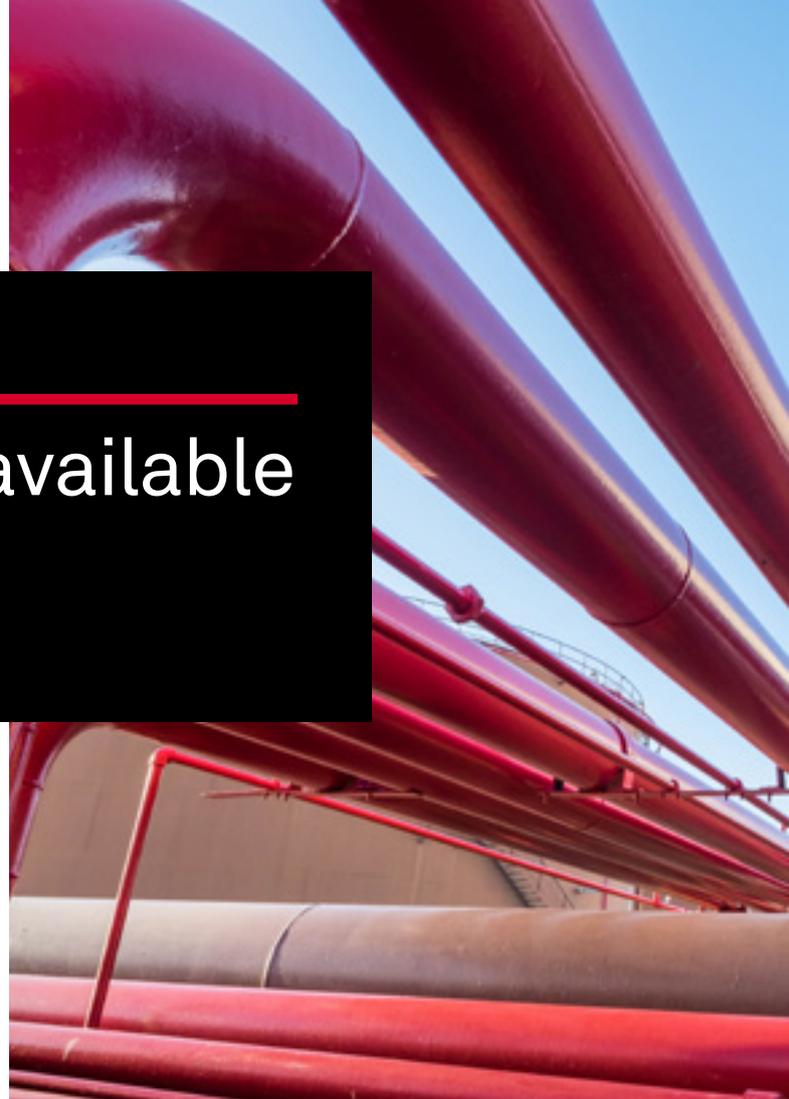
Some countries currently rely on manual emissions tracking using spreadsheets and paper records. While this approach provides a low-cost entry point for registry management and may be suitable for a government managing smaller amounts of data, it comes with significant drawbacks as activity and data starts to scale.

Advantages:

- **Ultra-low cost:** Using installed, general-use software for tracking credits in a country means little outlay in terms of cost for software or operations.

Challenges:

- **Accuracy:** Manual data entry may increase the risk of human error, which can compromise data integrity and lead to inaccurate reporting.
- **Security:** Paper records and spreadsheets lack robust security measures, making them vulnerable to loss or tampering.
- **Interoperability:** Spreadsheets are unable to provide the interoperability needed as Article 6 becomes fully operationalized. A lack of integration may hinder effective data sharing and collaboration among stakeholders.



As climate policies demand greater transparency and accuracy, countries may wish to consider transitioning to a more sophisticated registry system to enhance data accuracy, reduce administrative burdens and ensure compliance with evolving policies.

2. Build a national registry

Countries that do not want to use independent standards, but wish to build a national program, will need to build a carbon market registry. This approach can involve several options:

Open-source registry: An open-source registry is built using open-source software, allowing users to access, modify and distribute the source code freely.

Advantages:

- **Cost-effective:** An open-source registry offers an initial cost-effective approach by following free, publicly available code.

Challenges:

- **Capacity:** Requires dedicated in-house resources for software development, deployment, customization and ongoing maintenance and security.
- **Limited configurability and potential to upgrade:** Open-source registries may lack advanced features and flexibility, which can lead to higher long-term costs and scalability challenges

In-House proprietary registry: Countries can choose to build their own proprietary registry from scratch. This option allows for complete control over the design, features and functionalities.

Advantages:

- **Customization:** An in-house proprietary registry can be tailored to meet the specific needs and regulatory requirements of the country, ensuring full alignment with local policies and practices.
- **Governance control:** Countries retain full governance over the system, including data management, compliance and security protocols.
- **Data sovereignty:** Having an in-house system allows countries to maintain full ownership and control over their data, alleviating security and privacy concerns.

Challenges:

- **Resource intensive:** Developing an in-house registry requires significant investment in both financial and human capital, technical expertise, development resources and ongoing maintenance.
- **Time-consuming:** Building a proprietary system can be a lengthy process, delaying access to carbon markets and hindering timely emissions reductions.

International registry provider solutions

Transactional registry

Countries can choose to engage a registry provider to build their transactional registry. This option allows countries to benefit from the expertise and resources of specialized vendors.

Advantages:

- **Robust functionality:** Commercial solutions typically offer comprehensive features tailored for carbon market management, compliance monitoring and connectivity.

- **Technical and operational support:** Vendors provide ongoing support, maintenance and updates, ensuring that the system remains current with regulatory changes and market developments, as well as operational support to help run the registry and manage client enquiries.

Challenges:

- **Cost:** Cost may be a barrier for countries with limited budgets and smaller volumes of data to manage.

Accounting registry

In addition to a transactional registry, countries may wish to implement an accounting registry from a registry provider. The purpose of this registry would be to obtain a comprehensive overview of credits within a country’s jurisdiction, across independent standards and any national programs, while also allowing for connectivity to the Article 6.2 and Article 6.4 registries as required.

Advantages

- Provides the operational benefit of a unified view, delivering an accurate and reliable representation of carbon credits across all standards and programs within the jurisdiction.
- Offers a cost-effective solution that provides governments with value for money.
- Assists countries in fulfilling compliance obligations and managing reporting requirements to the UNFCCC.

Challenges

- Although it includes most features needed by governments, it may not be possible to fully customize to meet specific national requirements.

S&P Global’s Meta Registry® can be used as an off-the-shelf accounting registry. Alternatively, S&P Global can also build bespoke, stand-alone, accounting registries.

Technology options available to build a national registry		
	Advantages	Challenges
Open-source registry	Cost-effective	Limited flexibility Maintenance concerns
In-house proprietary registry	Customization Governance control Data sovereignty	Resource intensive Time-consuming
International registry provider	Robust functionality Technical and operational support	Cost

Registry interoperability

Interoperability in carbon markets is crucial for fostering a cohesive and efficient marketplace, encompassing both data compatibility and the establishment of connections between various registries. Currently, the carbon markets are fragmented, consisting of over 60 different standards, each with its own unique set of data attributes. This data attributes fragmentation is likely to increase further as countries establish national programs, creating significant challenges for interoperability. When registries are unable to communicate, carbon credits generated in one registry cannot be verified in another, leading to potential integrity issues, such as double counting.

To address these challenges, harmonizing data across standards and programs is essential. This harmonization will facilitate effective tracking, enable checks against double counting, and promote the global adoption of carbon credits. S&P Global is part of the Carbon Data Open Protocol, a group seeking to define an open-source protocol for data in the carbon market.

Additionally, standards should consider implementing machine-readable templates for reporting project and monitoring data to streamline processes further.

Establishing connections between carbon registries can significantly enhance the efficiency and integrity of carbon markets in several ways:

Supporting market integrity: Once registries are connected, integrity checks can be undertaken across them that help prevent double counting and inaccurate claims of carbon credits. Furthermore, linking registries to digital monitoring, reporting and verification (DMRV) systems may allow for more effective monitoring of the efficacy and quality of carbon projects. Such integration simplifies the oversight of carbon credits.

Supporting liquidity: Interoperability with electronic marketplaces and exchanges where carbon credits can be traded enhances market access and trading opportunities. This connectivity leads to greater liquidity and facilitates the price discovery necessary for well-functioning markets.

“ Establishing connections between carbon registries can significantly enhance the efficiency and integrity of carbon markets. ”

Supporting climate goals: As countries strive to fulfil their NDCs, the design and interconnection of registries with relevant market mechanisms — such as domestic emissions trading schemes and carbon taxes — become increasingly important. These linkages enable a more cohesive approach to carbon data management, allowing countries to align their strategies with international standards and practices. Additionally, connecting registries with tools that assess the marginal abatement cost of carbon credits, could allow countries to make informed decisions regarding which credits to retain for their own NDCs and which to sell to potential buyers. This strategic evaluation ultimately enhances a country's ability to participate effectively in carbon markets and meet its climate goals.

To facilitate registry interoperability, countries may consider employing various technological solutions, such as application programming interfaces (APIs) and blockchain technology. APIs can enable seamless data exchange between different registries and systems. Blockchain can also provide a secure and transparent method for tracking transactions and verifying credit ownership. However, while blockchain presents benefits in transparency and automation, it's worth noting that some governance entities and integrity bodies are evaluating its auditability and suitability.

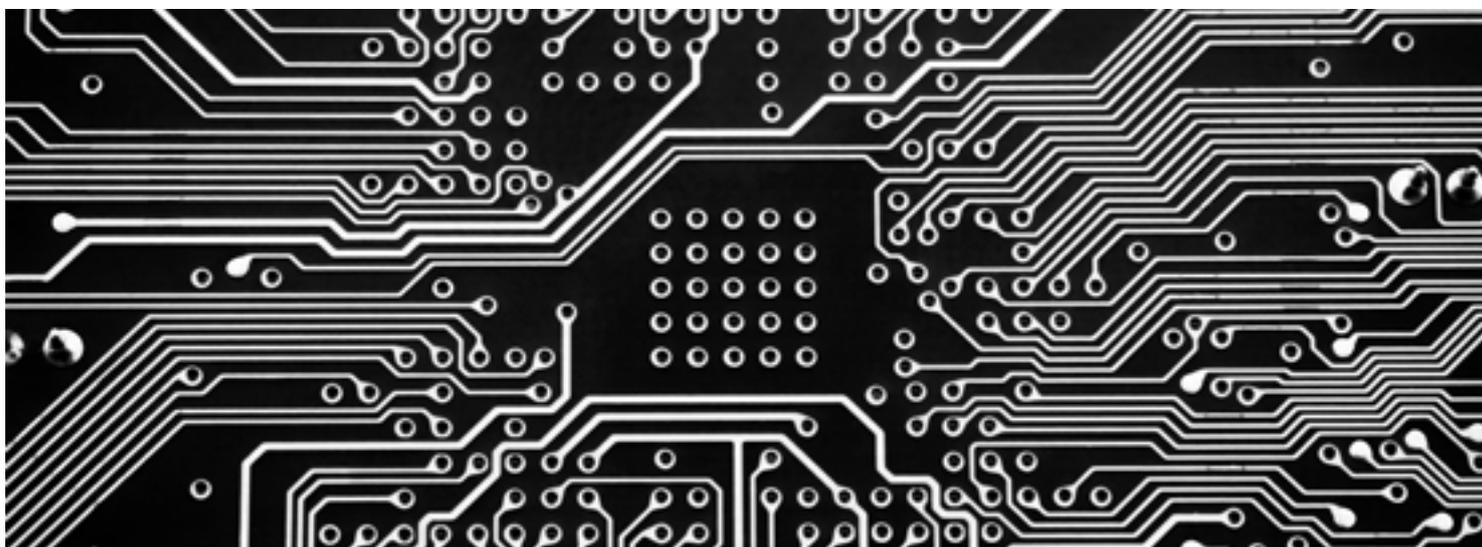
Other core technical requirements

As countries establish national carbon market programs, the importance of robust security cannot be overstated. Transactional registries safeguard assets that have a financial value. Therefore, ensuring the security and integrity of registries to international standards is essential for maintaining trust and confidence among account holders and other stakeholders.

S&P Global is a member of the Carbon Markets Infrastructure Working Group (CMI WG) convened by the World Bank, which is currently developing a comprehensive report that provides detailed guidance on security and other elements of transaction integrity. We encourage you to read this report to gain a complete understanding of the critical importance of security in this context.

Other technical requirements for a national registry include:

- Robust user access controls with role-based permissions and full audit logging to ensure accountability across all stakeholders.
- Full unit life cycle support, from issuance and transfer to retirement and cancellation, with traceability features that allow each credit to be tracked back to its origin.
- Account management, project and credit registration workflows, and support for multiple credit types.
- API connections to appropriate UN systems to align with international frameworks.





Next steps

As nations embark on the journey of establishing their national carbon registries, a thoughtful and strategic approach to design and implementation is essential. Countries should consider the following key factors as they decide which registries to use and how to structure them:

- **Carbon market participation:** Countries must determine how they wish to engage with carbon markets. They can either leverage independent standards, benefiting from the operational capacity, methodology expertise and established reputation of these, utilize the PACM, or they can create a national program that allows for full governance and economic control. They may wish to leverage a combination of these options.
- **Evaluate anticipated involvement in Article 6 markets:** Countries should assess their expected level of participation in Article 6 markets, including estimating the number of bilateral agreements, transactions and international program linkages they intend to pursue.
- **Registry type selection:** The chosen policy approaches will influence which type of registry best suits the country's needs — whether a national program and transactional registry or accounting registry, or combination is appropriate.
- **Interoperability:** Countries should evaluate the necessary degree of linkage with other systems for effective carbon management. Considerations should include whether the country plans to implement policy measures such as a carbon tax or emissions trading scheme, and whether it makes sense to connect the registry with these mechanisms. All registries will need to link with the UN mechanism.
- **Once policy positions have been established,** a country can start to explore how to operationalize them, which includes assessing the available technology options, including whether it is appropriate to build a registry in house or utilize the services of an international registry provider.



Conclusion

Registries play a critical role in enabling countries to manage carbon as a national asset. However, there is no one-size-fits-all solution; each country must carefully consider its unique policy objectives and strategic goals, as these will inform the type of registry that best meets its needs.

As countries navigate the complexities of carbon market participation, it is important to recognize that registries should be considered as long-term investments. They must be designed with the flexibility to evolve alongside the market, adapting to changing regulations and technological advancements.

Ultimately, investing in a well-structured carbon registry will empower countries to maximize the benefits of carbon markets to play a meaningful role in the global transition to a low-carbon economy.



I About Us

S&P Global is the world's leading provider of environmental registry infrastructure solutions, with over 15 years' experience and deep knowledge and expertise of the carbon markets.

Learn more: spglobal.com/environmental-solutions