



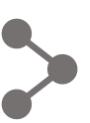
Climate Warehouse

End-to-End Digital Infrastructure
for Carbon Markets



Digital Infrastructure for Carbon Markets
2022





The Scale-up and Growth of Voluntary Carbon Markets



Post-2020 markets under the Paris Agreement will be built through a bottom-up approach, as each party to the Agreement is required to track the greenhouse gas (GHG) emission reductions (or removals) achieved—and has considerable leeway to determine how this will be done.



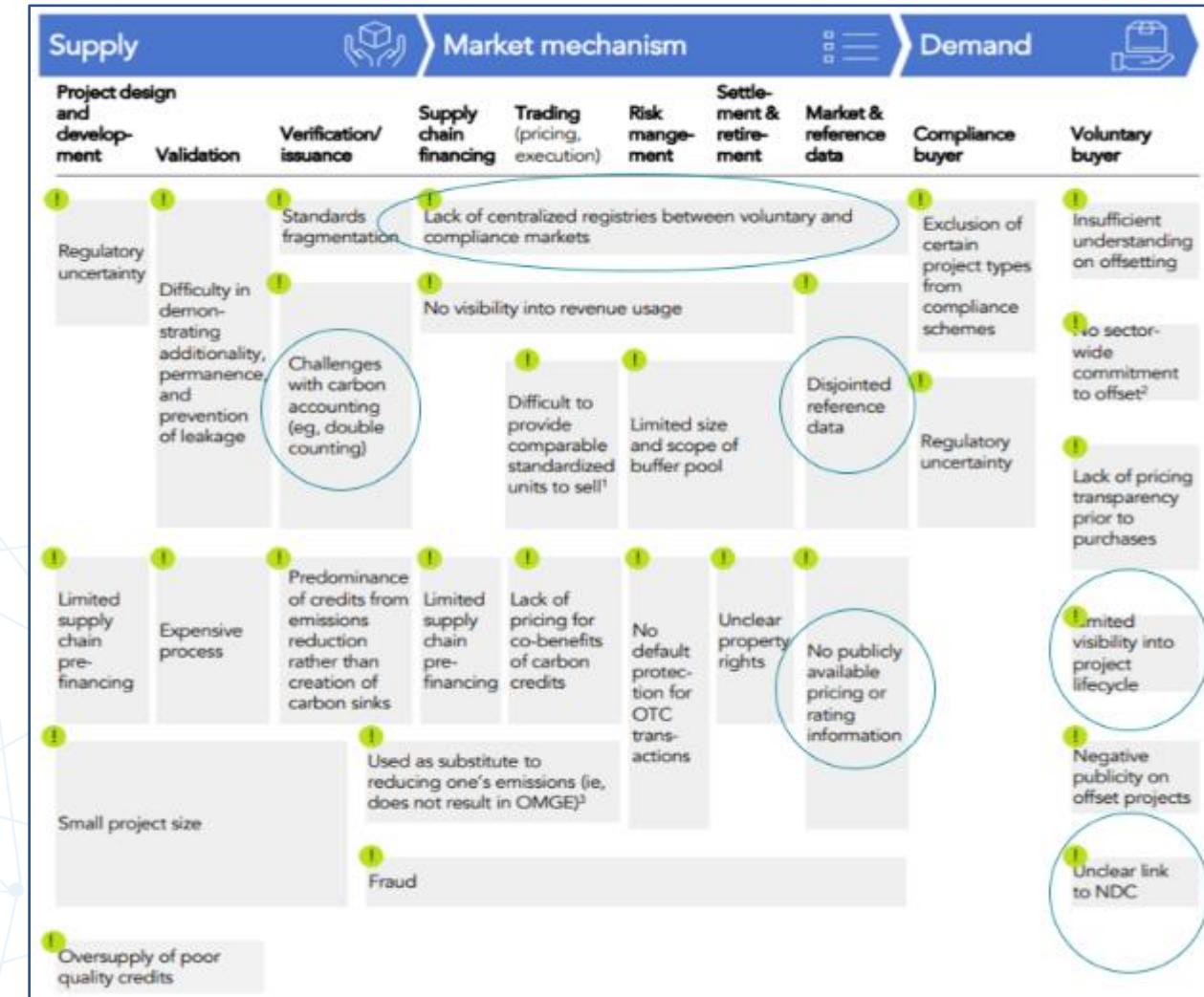
The bottom-up nature of future carbon markets comes with increased complexity and diversity of reporting and verification approaches for GHG emissions inventories and mitigation outcomes:

- Limited transparency
- Limited liquidity
- Market fragmentation and inaccessibility
- Quality variability
- Lagging methodologies



There is significant potential for digital infrastructure to underpin and streamline the functioning of post-2020 carbon markets.

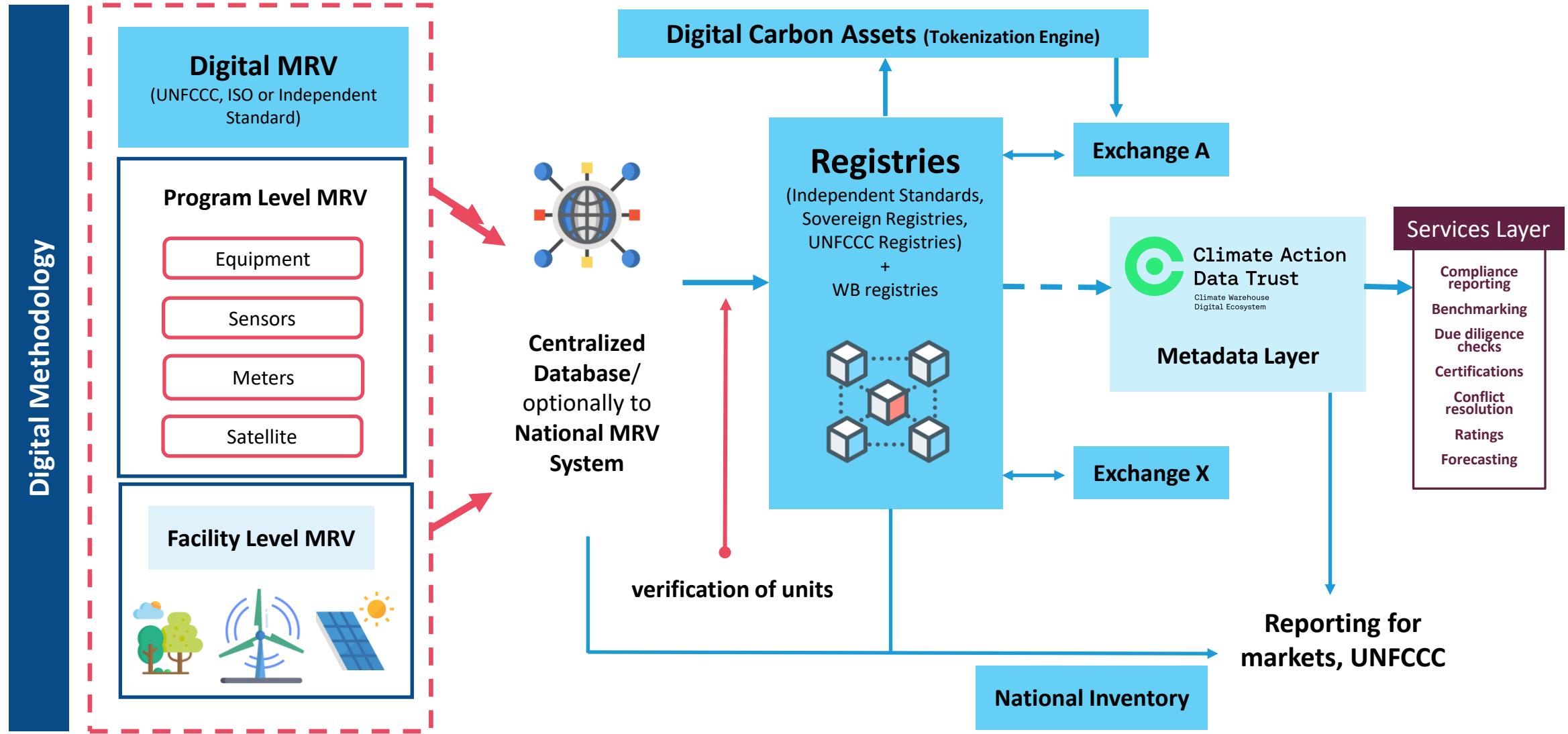
Report by Taskforce on Scaling Voluntary Carbon Markets (TSVCM)



Source: Adams, Tim. Winters, Bill. Nazareth, Annette and Mark Carney Taskforce on Scaling Voluntary Carbon Markets Phase 1 Final Report: January 2021, TSVCM, pg. 45

Data and trade infrastructure is a precondition to scale a transparent and inclusive carbon market

Climate Warehouse: piloting an end-to-end digitization of the carbon market ecosystem



project preparation from document development, approval, validation to registration in applicable standards





The World Bank's Climate Warehouse Program tests, prototypes and develops digital infrastructure for carbon markets





World Bank Climate Warehouse Program:

Building an End-to-End Digital Ecosystem for Carbon Markets



Pillar 1: Piloting and Developing Global Public Goods

Making digital infrastructure for carbon markets available to client countries through development, testing and prototyping of innovative digital infrastructure for carbon markets.

Work Streams:

- **Digital for Climate (D4C) Working Group.** Collaboration with EBRD, UNDP, UNFCCC, and WB for a modular and interoperable end-to-end digital ecosystem for carbon markets.
- **Digital Monitoring, Reviewing and Verification (dMRV) systems.** Piloting the connection between dMRV systems with national carbon registries and national MRV systems.
- **National Carbon Registries.** Development of open source off- and on-chain transaction registries.
- **Tokenization instruments.** Development of tokenization instruments to tokenize carbon markets.
- **Climate Action Data Trust (CADT)**



Pillar 2: Global Knowledge and Capacity-Building

Support countries and jurisdictions to in implementation of digital infrastructure for carbon markets needed for GHG mitigation and NDC implementation through PMI Technical Assistance

Work Streams:

- **Develop knowledge base on digital infrastructure** and facilitate information exchange through technical discussions and knowledge dissemination
- **Assist countries to identify and implement best practice approaches** and, where relevant, achieve compatibility in design to support the development and linking of digital infrastructure for carbon markets
- **Encourage international and national cooperation, and inform the domestic and global policy discussions on GHG mitigation** by sharing lessons learned and providing a platform for collective innovation on digital infrastructure products



WORLD BANK GROUP



PMIF

PARTNERSHIP FOR MARKET
IMPLEMENTATION FACILITY



World Bank Climate Warehouse Program:

Building an End-to-End Digital Ecosystem for Carbon Markets



d-MRV systems

Piloting

National carbon registries

Designing & piloting

Tokenization instruments

Prototyping



Climate Action
Data Trust
Climate Warehouse
Digital Ecosystem

Aggregating registry data in a
blockchain-enabled platform

Launched!

Designing, prototyping, piloting and validating digital infrastructure for the scale up of carbon markets and finance



Climate Action Data Trust

Climate Warehouse
Digital Ecosystem

A global public metadata layer to foster greater transparency, integrity and security in the carbon markets

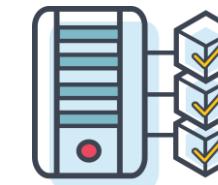
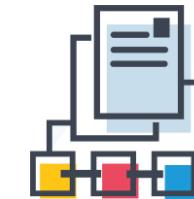




Climate Action Data Trust

Climate Warehouse
Digital Ecosystem

An open-shared infrastructure



Global public good that aims to empower a new global carbon market infrastructure.

Metadata platform that aims to link, aggregate and harmonize underlying registry data to enable transparent accounting as per Article 6.

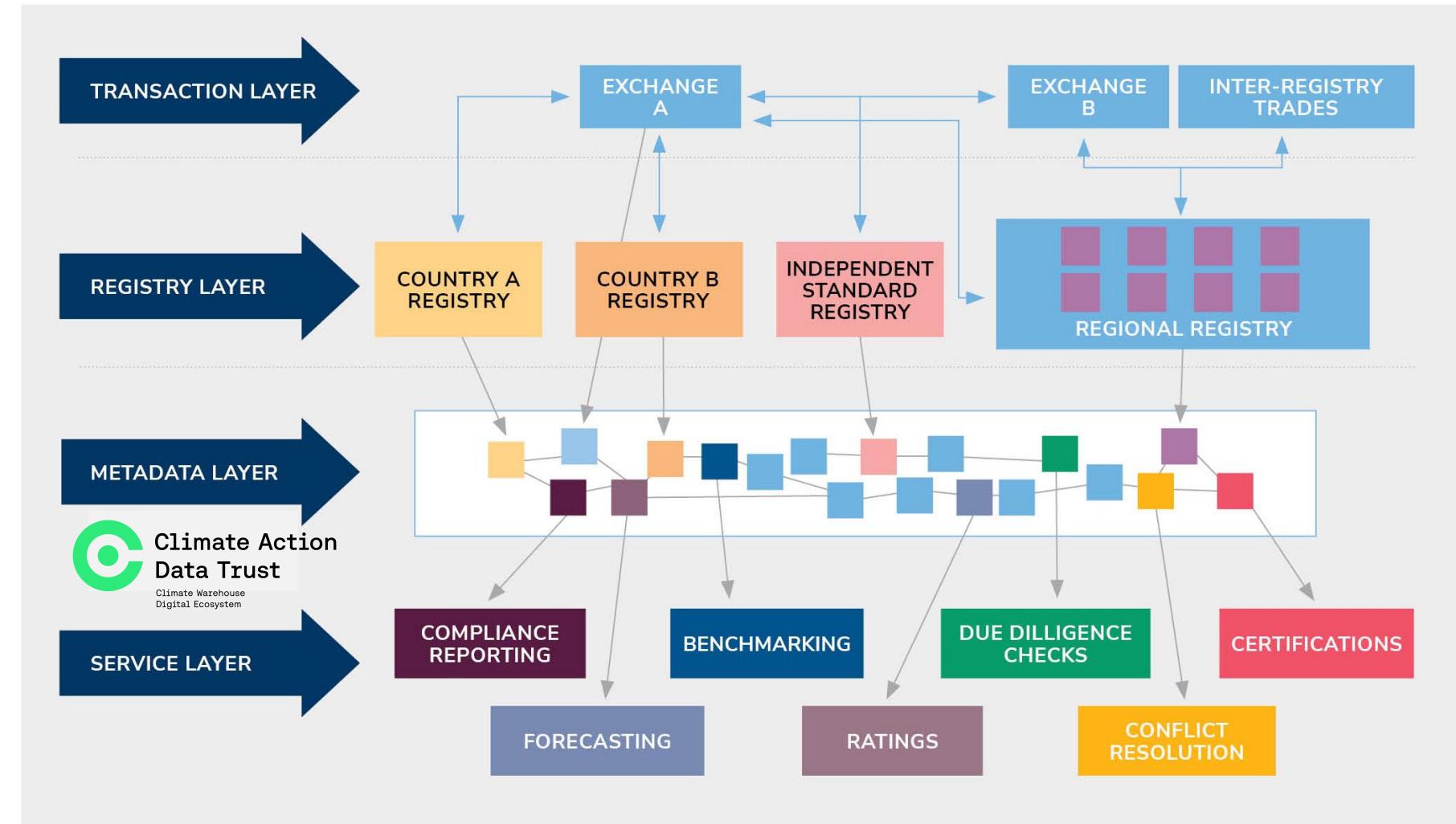
Designed as an open shared infrastructure with a common taxonomy of data that facilitates connection and communication between entities enabled by blockchain technology.

Registry service providers and countries share data to the platform and **public and private sector market players** can host a node and build out the service layer.

Provide visibility into corresponding adjustment procedures and the lifecycle of carbon offsets from issuances to retirement, which will safeguard against double counting and ease reporting requirements.

Climate Action Data Trust - Ecosystem

- Designed as an open shared infrastructure layer
- Common taxonomy of data facilitates communication between entities
- Registry service providers and countries share data to the Climate Action Data Trust (CADT)
- Public and private sector market players can host a node and build out the service layer





Climate Action Data Trust – Timeline of Testing Activities

Product development, Stakeholder participation and Governance model

August 2019



November 2019



January 2022



July 2022



Simulation I



Simulation II

Simulation III



Platform & Governance

- Developed operational prototype as a global public good that aims to empower a new global carbon market infrastructure through a decentralized information technology platform built on blockchain technology
- Implemented the recommendations from the governance consultations on the operational platform conducted by IETA and the Government of Singapore:
 - Conducted fundraising
 - Formation of governing bodies
 - Set up independent legal entity anchored in Singapore
 - Official launch in December 6-8, 2022



Testing activities

75 individual testers 30 participating organizations

11 governments

40 weekly office hour sessions

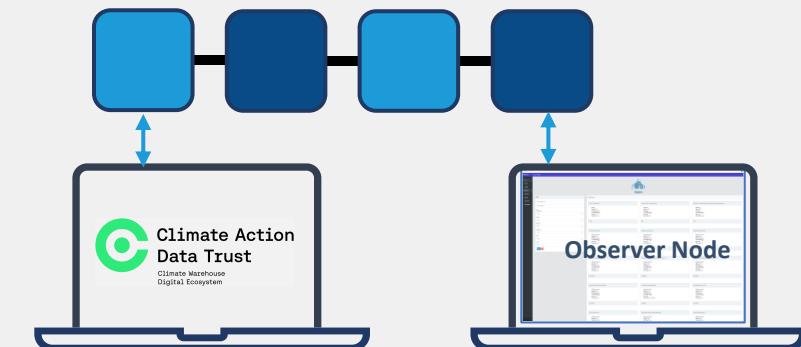
58 testing sessions

30 kick-off and onboarding meetings

514 individual points of feedback, which helped identify 156 development actions, 139 of which were implemented during Simulation III and reflected in the final version of the operational prototype at the end of the simulation.

Key lessons learned and a complete log of all participant feedback shared with the governing body of the operational CAD Trust at the end of Simulation III in August 2022 (Climate Warehouse Simulation III – Final Report)

Participation in CADT Simulation III (2022)



22 full participants:

Chile	IFC	Spain
Japan	WB CATS	
Peru	WB CMI	EBRD
Rwanda		UNDP
Senegal	EcoRegistry Colombia	UNFCCC
Singapore	IHS Markit	
Sweden	SK Certification Center	Climate Ledger Initiative
Switzerland	GenZero	ClimateCheck
UK		IETA
Uganda		Open Earth Foundation
ACR		
CAR		
GCC		
Gold Standard		
Verra		



Feedback from participants of Simulation III

Simulation III scope	Benefits & Feedback	3 types of experts are needed
<ul style="list-style-type: none">• Sim III pushes participants to envision an interconnected ecosystem, beyond their own standalone system• Data added to the Climate Warehouse must be able to bridge process flows across participants• Participants must validate the Climate Warehouse's level of data granularity, status information and units transfer methodology	<p>Benefits</p> <ul style="list-style-type: none">• Increased transparency and data sharing• Addressing double counting risks across registries• Identifying a common data model• Interaction with experts across registries• Ability to access information outside of their own systems <p>Feedback</p> <ul style="list-style-type: none">• Difficulty defining minimum standards needed to link registries• IT complexity, upgrades to existing systems, building integration• Ability to connect regional registry systems• Multiple groups within the same organization will need to coordinate and play a role	<p>3 types of experts are needed</p> <p>Policy Setter</p> <ul style="list-style-type: none">• Provides policies, guidelines, strategy for implementing, projections on future impacts on the inner workings of the organization• Needs to understand how the data will be used internally and by partners in the future, what changes need to occur for this to happen, and what is possible due to technology advances. <p>Registry Administrator</p> <ul style="list-style-type: none">• Create procedures for implementing policies• Needs to understand how workflows will change in the future, implications for their technology tools and the data that needs to be available and captured. <p>IT Support</p> <ul style="list-style-type: none">• Ensure data structure and registry functions are fit for purpose• Needs to understand direction of policies, field definitions to figure out equivalencies for integration.



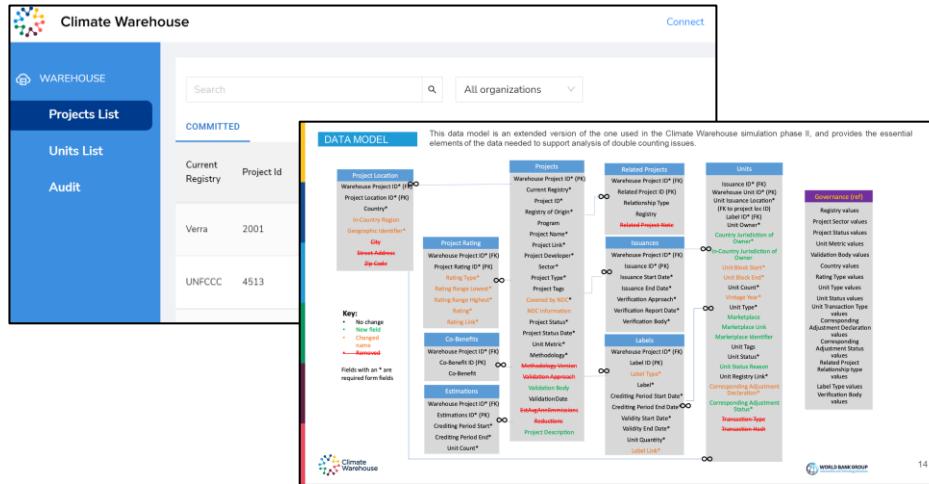
CLIMATE ACTION DATA (CAD) TRUST: Technical Architecture and Data Model



Infrastructure Architecture

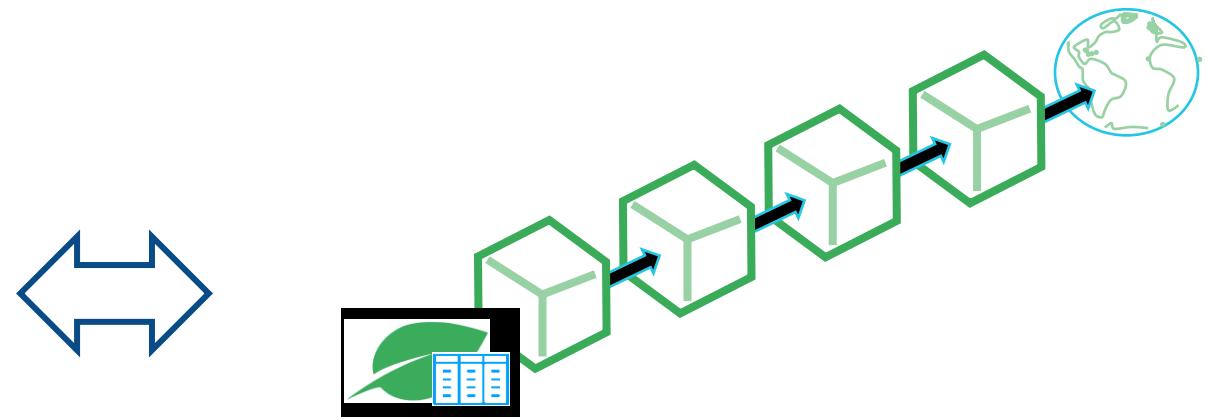
The architecture has 2 layers –
the data layer and the public blockchain layer

Data Layer...



- Defines a common data model and taxonomy
- Reconcile data across registries
- Identify potential double counting
- Enable auditing and reporting

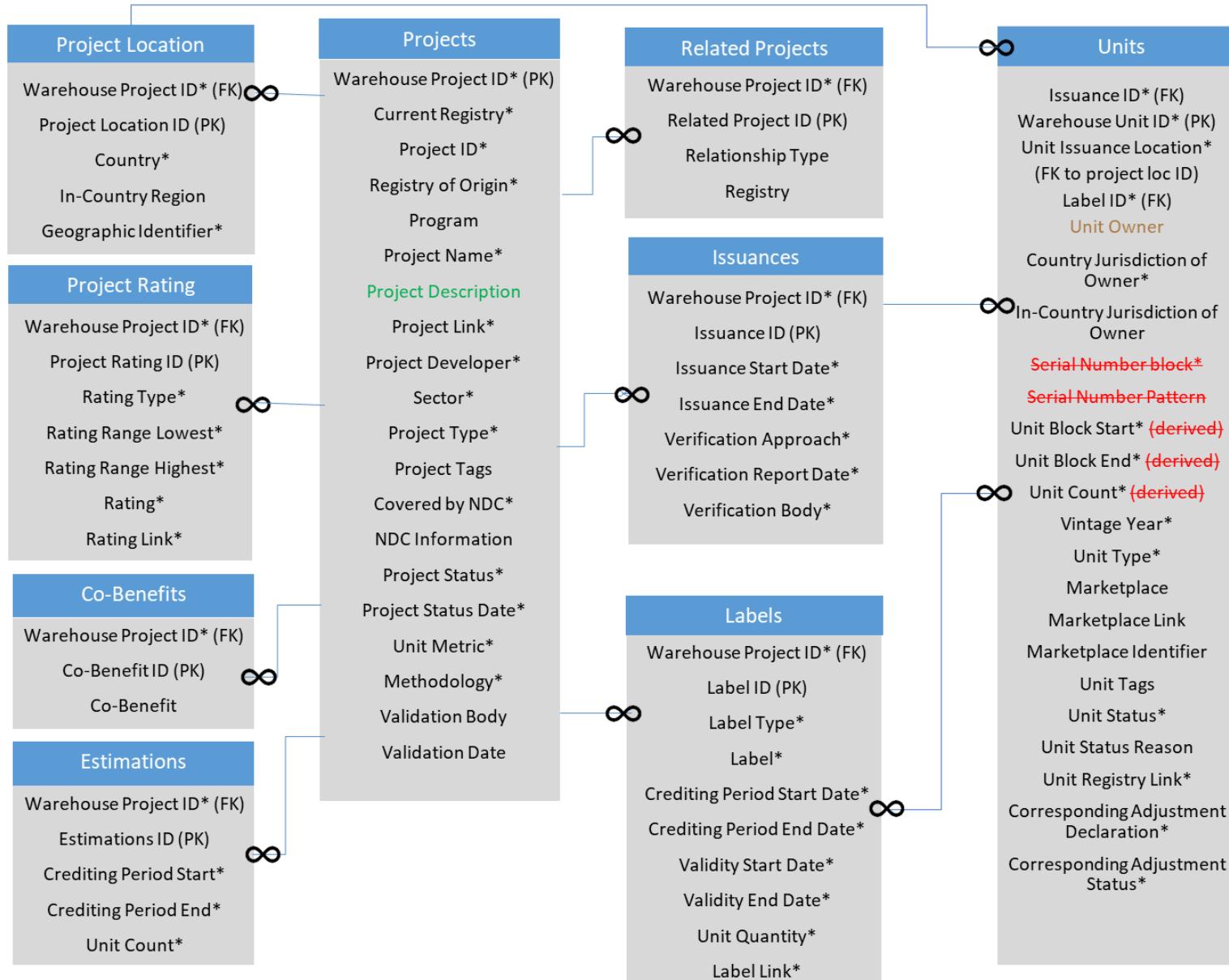
... on a Public Blockchain Layer



- Transparent and Immutable Data
- Auditable
- Accessible and Inclusive
- Public and Transparent
- Open source
- Peer-to-peer governance



Updates to the Simulation III Data Model Based on Feedback

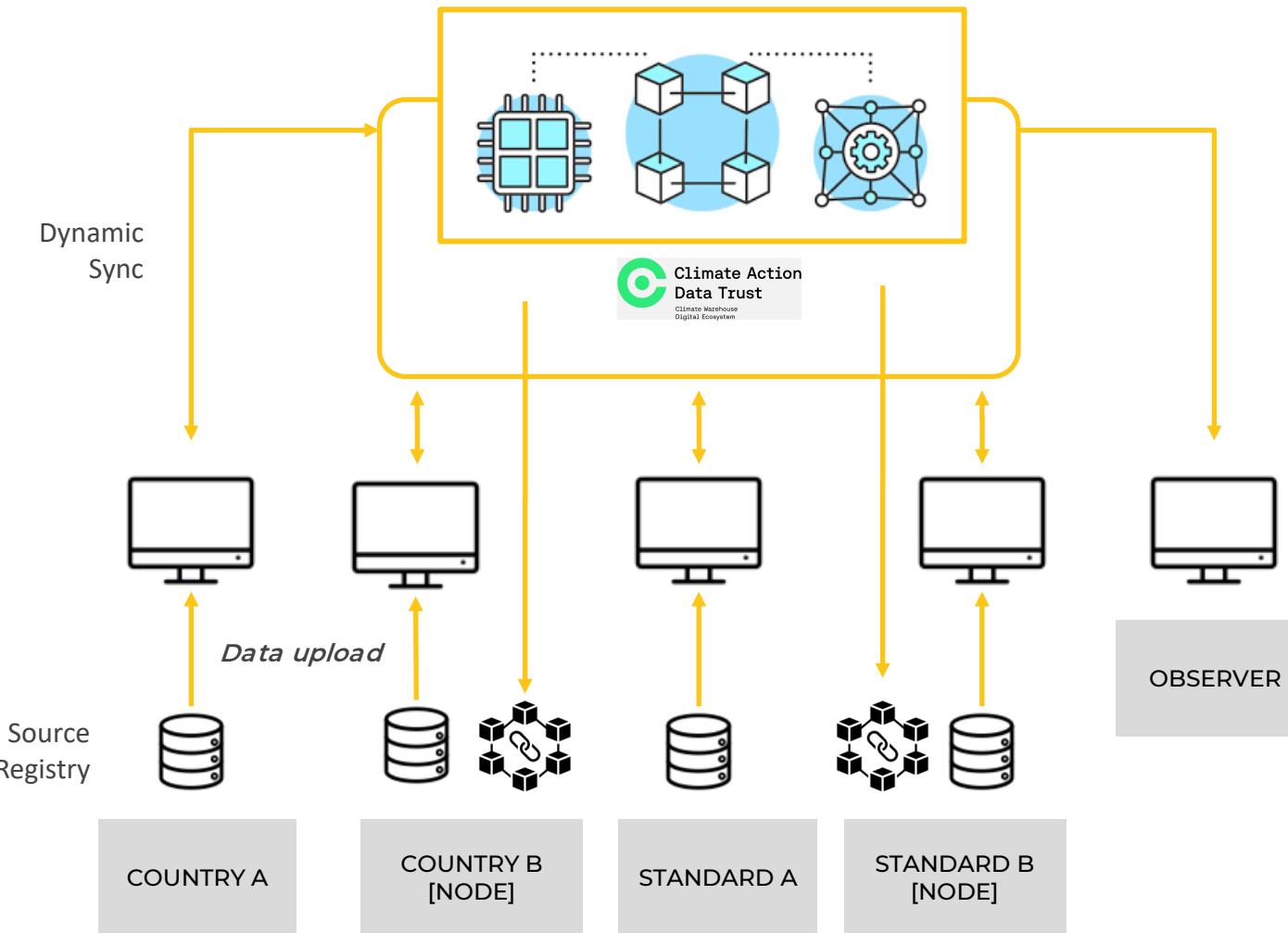


Governance (picklist values)
Registry values
Project Sector values
Project Status values
Project Type values
Methodology values
Unit Metric values
Validation Body values
Country values
Rating Type values
Unit Type values
Unit Status values
Corresponding Adjustment Declaration values
Corresponding Adjustment Status values
Related Project Relationship type values
Label Type values
Verification Body values
Tag values
Cobenefit values

Each ID is globally unique, meaning no organizations will generate the same ID for any table



High-Level Architecture – Climate Action Data Trust



There are **3 ways** to integrate data:

- User Interface
- API
- Spreadsheet import/export

CLIMATE ACTION DATA (CAD) TRUST: Governance & Next Steps



Governance and Finance consultation

September 2021 – March 2022



70+

Entities involved

- Governments
- Independent standards
- Exchanges
- Traders
- Project developers
- Private sector
- Financial institutions
- Technology providers
- NGOs
- Think tanks
- Law firms
- Multilateral development banks
- Observer: UNFCCC



5

Governance models reviewed

- Western Climate Initiative, Inc (WCI, Inc.)
- Integrity Council for Voluntary Carbon Markets (IC-VCM)
- EU-Swiss ETS link
- Joint Crediting Mechanism (JCM)
- British Standards Institution (BSI) & Enterprise Singapore (ES)



6

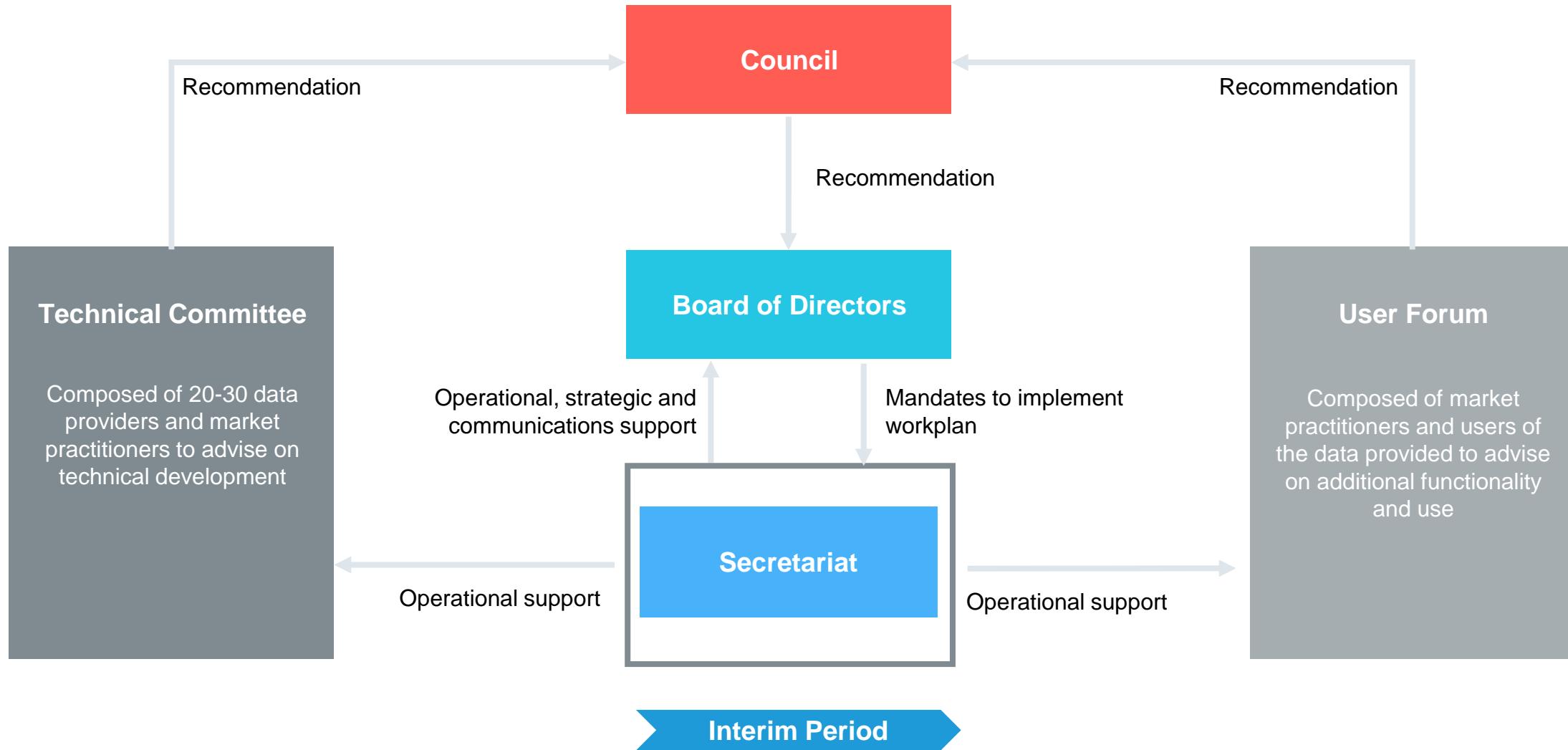
Focus groups conducted

- 4 on governance (46 entities)
- 2 on finance (45 entities)

+ polls and surveys for participant feedback throughout

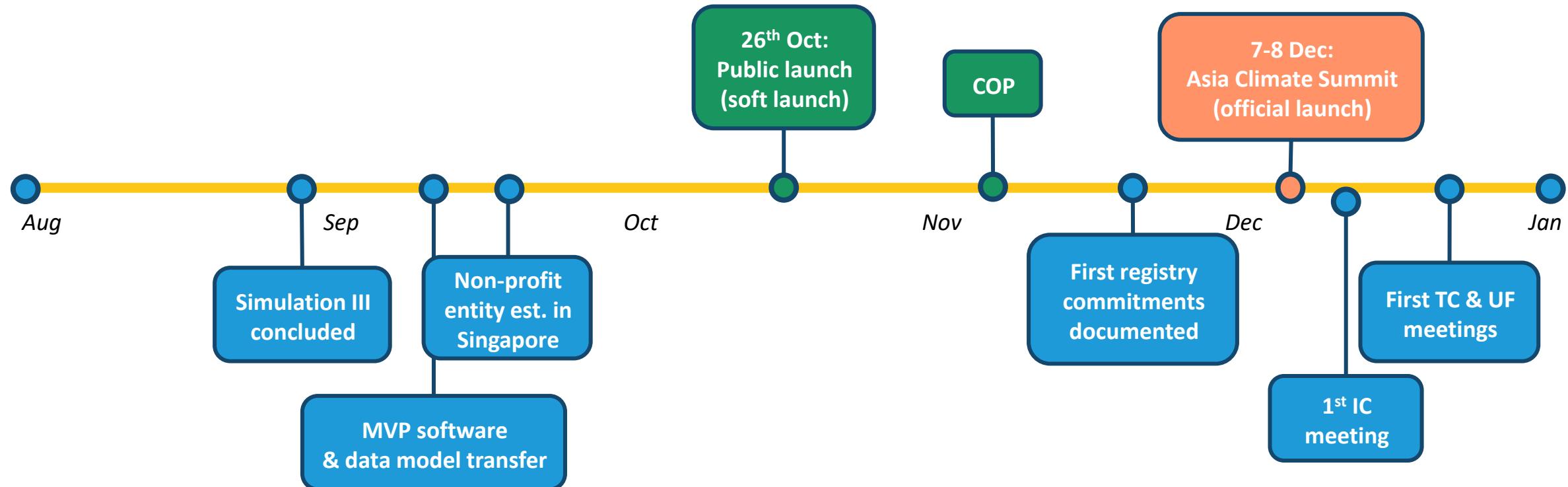


2022 Governance





2022 Outlook and Next Steps





Next Steps

	INCEPTION PHASE 2022	INTERIM PERIOD 2023-2024	PERMANENT GOVERNANCE 2025 Onwards
GOVERNANCE	<ul style="list-style-type: none">IETA, World Bank, and Singapore Government provide governance and supportIETA provides Secretariat functionsInterim Council recruitment	<ul style="list-style-type: none">Interim Council in charge of strategic decisions and transition to permanent governanceIETA provides Secretariat functions	<ul style="list-style-type: none">Permanent Council elected and Council rotation establishedSecretariat transitioned to an independent entity
PRIORITIES	<ul style="list-style-type: none">Establish a legal entityFundraisingIT platform handoverEngagement with independent standardsPublic launch	<ul style="list-style-type: none">Data specification developmentAdoption by independent standards and national registriesMarketing, user adoption	<ul style="list-style-type: none">Further adoption by registries and governmentsBuild a service layerUNFCCC reporting interactionLong-term strategy
FUNDING	<ul style="list-style-type: none">Grant funding	<ul style="list-style-type: none">Grant funding	<ul style="list-style-type: none">Grant fundingMove to self-sustaining finance



Data Provider Onboarding

	Q4 2022	Q1/2 2023	Q3/Q4 2023
INDEPENDENT STANDARDS	<ul style="list-style-type: none">• ECOREGISTRY• PURO EARTH	<ul style="list-style-type: none">• ACR• CAR• VERRA• GOLD STANDARD• GCC	<ul style="list-style-type: none">• SMALLER INDEPENDENT STANDARDS
NATIONAL REGISTRIES		<ul style="list-style-type: none">• INITIAL COUNTRY REGISTRIES (SINGAPORE, SENEGAL, BHUTAN, CHILE, JAPAN, UK)	<ul style="list-style-type: none">• ADDITIONAL NATIONAL REGISTRIES• MULTILATERAL BANK REGISTRIES
MARKET		<ul style="list-style-type: none">• CHAINLINK API• RATINGS AGENCIES• EXCHANGES	<ul style="list-style-type: none">• FINANCIAL INSTITUTIONS• PROJECT DEVELOPERS• TRADERS• TECHNOLOGY PROVIDERS



Climate Warehouse

End-to-End Digital Infrastructure
for Carbon Markets



Q&A, Video & Demo



WORLD BANK GROUP



Climate
Warehouse



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The World Bank National Carbon Registry Offering

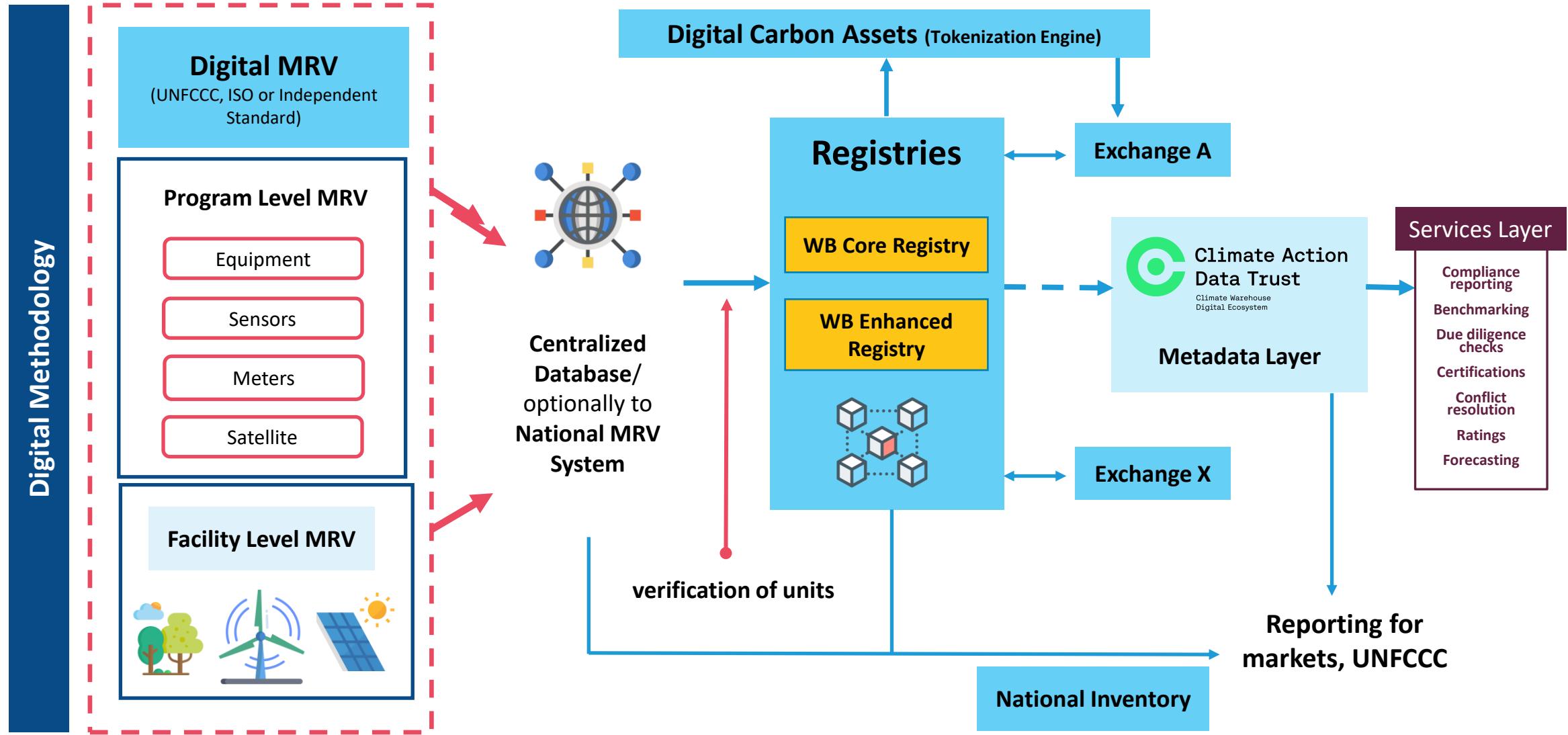
Enabling Decentralized Climate Markets to Share and Track Climate Data



Climate
Warehouse

Digital infrastructure is a precondition to scale a transparent and inclusive carbon market

Climate Warehouse: piloting an end-to-end digitization of the carbon market ecosystem



project preparation from document development, approval, validation to registration in applicable standards





Registry systems enable countries to participate in the carbon markets

- **Individual commitments through nationally determined contributions (NDCs).** The Paris Agreement introduced a bottom-up approach for addressing climate change.
- **A registry is one of several prerequisites for the implementation of a carbon pricing mechanism for the purposes of carbon accounting and compliance with UNFCCC principles.** Pricing schemes aim to reduce GHG emissions with the issuance of tradeable carbon credits and is an effective tool for countries to meet market mechanism requirements under Article 6 of the Paris Agreement.
- **National Carbon Registry:** The carbon registry system allows countries to administer various accounts, perform internal transactions and internationally trade with other registries, amongst other capabilities.

Why implement a national registry system?

- Help countries meet their **NDC requirements**
- Complying with **Article 6** of the Paris Agreement
- Brings **diverse participants** into the global carbon markets
- Supports the move away from fossil fuels and **towards a green economic transition**
- Carbon markets reduce costs to smooth the low-carbon transition
- Guarantees **transparency** through auditable transactions
- Open-source registries promote **inclusiveness**
- Registry systems ensure **integrity and security of project and unit data**



What is the World Bank Registry Offering?

- The World Bank Climate Warehouse umbrella program offers a menu of digital infrastructure for carbon markets, including **two open-source national carbon registries** – **1. Core Registry and 2. Enhanced Registry**
- The registry systems **aim to follow the national and international regulatory requirements** as well as principles for carbon accounting:
 - UNFCCC principles: transparency, completeness, comparability, accuracy, consistency
 - Prevention of the risk of double accounting
 - Independent administration
 - Auditable accounting system
 - Compliance with applicable regulations
 - Suitability for use as evidence of ownership and transfer of ownership in respect of the recorded units
- The registries are **open-source public goods** and promote **interoperability**

1. Core Registry

The Core Registry provides **national-level registry infrastructure** enabling member countries to **issue digital carbon assets**. Users can **manually upload projects and units' data** in sync with the World Bank's CADT Metadata layer.

2. Enhanced Registry

The Enhanced Registry provides **infrastructure to support domestic and international crediting market transactions**. It provides an integrated **d-MRV system/automated entry mechanism** to share projects and units' data, supporting global carbon market activity.



What are the Key Characteristic of the Registry Offering?

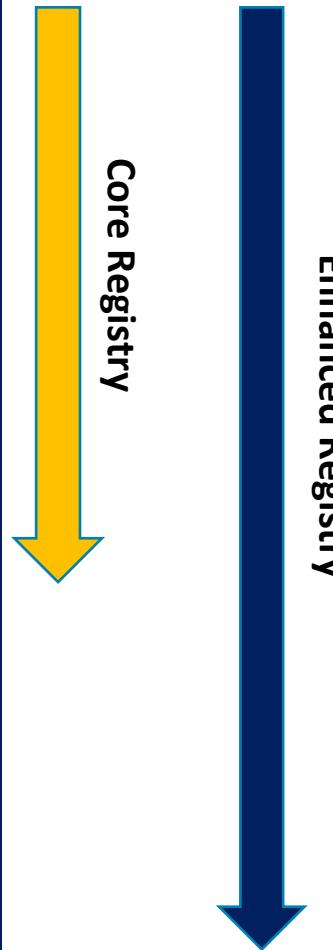
Functionalities	Required for Article 6	Core Registry (On-chain)	Enhanced Registry (with MRV system)
Add/Remove Project	Yes	✓	✓
Issue Units	Yes	✓	✓
Use/Transfer Units	Yes	✓	✓
Allow for Multiple Account Holders	Yes	✓	✓
Label Issued ERs (e.g., ITMO Authorization)	Yes	✓	✓
Dedicated Accounts for OMGE and SOP	Yes	✓	✓
Link to Climate Action Data Trust (CADT)	No	✓	✗
Track and Manage Workstreams	No	✗	✓
Create New Project Types and Methodologies	No	✗	✓
Link to GHG Inventory	No	✗	✓
Report Generation	No	✗	✓
Distributed Ledger Technology	No	✓	✗
Open-source Software	No	✓	✓

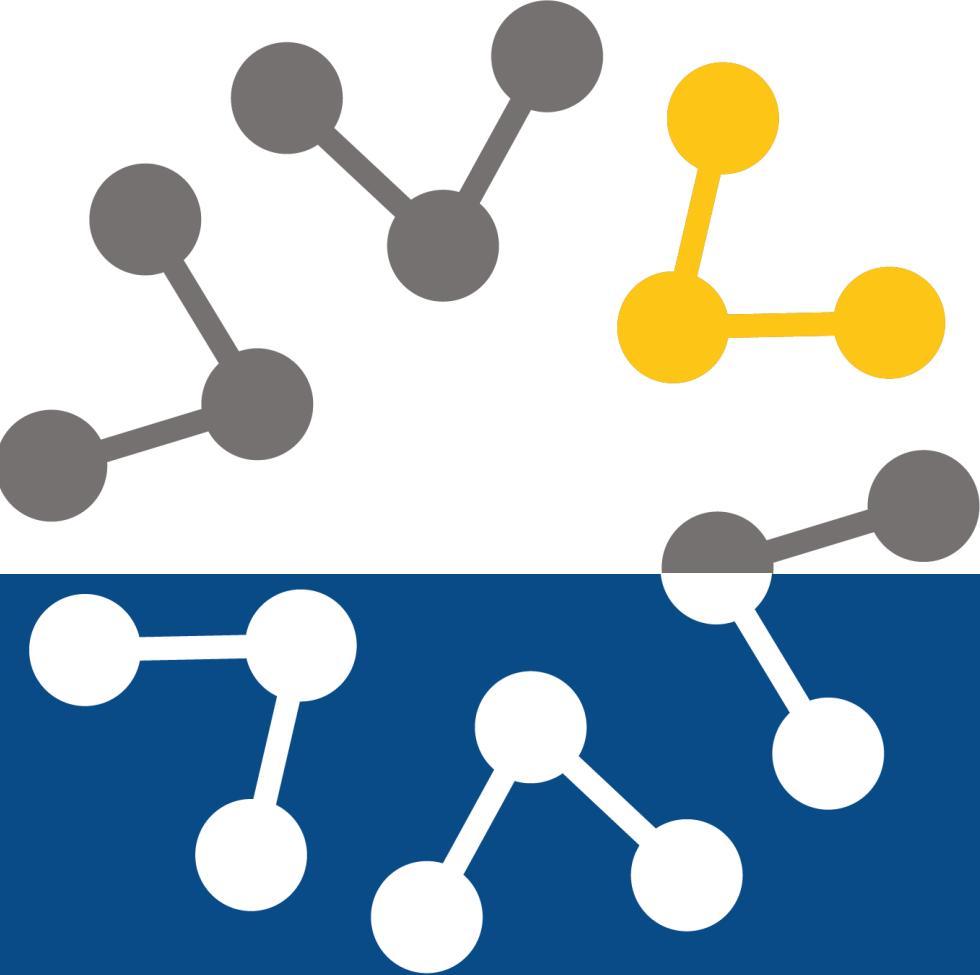


Differentiating between Core Registry and Enhanced Registry

1. Link to Climate Action Data Trust (CADT)
2. Add, edit, and remove Emissions Reductions (ER) projects
3. Issue ERs to the projects
4. Add labels and approvals, with supporting documentation, to issued ERs
5. Retire, cancel, transfer issued ERs
6. Multiple accounts to allow for ER buyers to have an account in the country registry
7. Dedicated accounts for holding ERs as overall mitigation in global emissions (OMGE) or share of proceeds (SOP)

8. Track and manage unit verification process
9. Create new project types with underlying methodologies
10. Link registry to GHG inventory systems and key parameters (Grid Emission Factor, Non-Renewable Biomass fraction)
11. Automatically generate reports on ER projects





2. National Core Carbon Registry



What is the Core Registry?

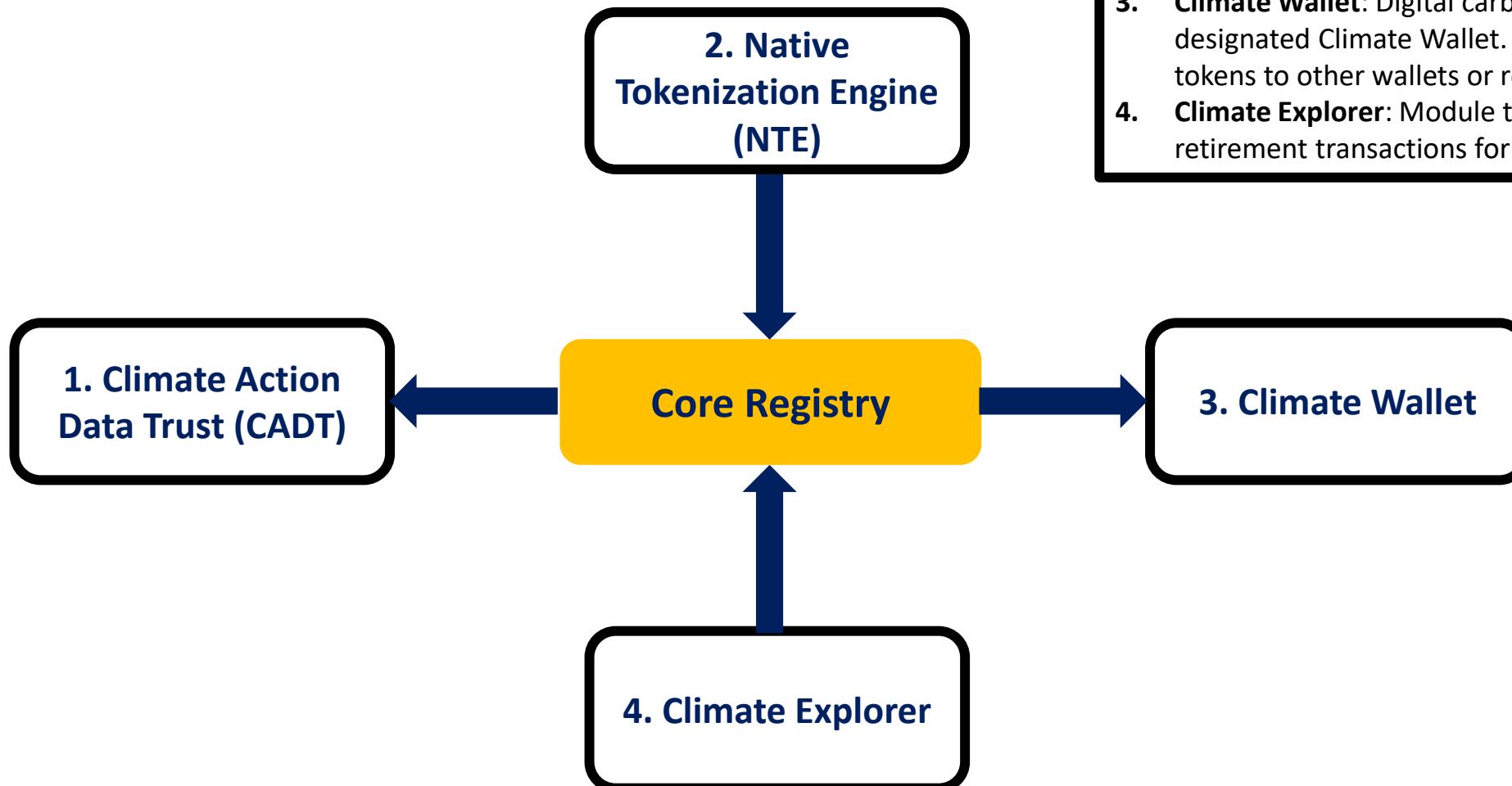
- The World Bank is developing a simplified, **open-source** carbon registry using **distributed ledger technology** (DLT) to enable PMI member countries to directly participate in global carbon markets.
- The public blockchain enables **inclusiveness, accountability** (decentralized governance and peer-to-peer support), **transparency** (fully auditable record of transactions) and **integrity** (fully immutable, traceable and interoperable).
- The Core Registry is currently comprised of two main applications:
 - The **Climate Action Development Trust** (CADT), which will enable market participants to record data about projects and issued units
 - The **Native Tokenization Engine** (NTE) enables the issuance of tradeable instruments based on CADT data
 - Additional modules will be added to expand functionality
- The Core Registry aims to provide a **seamless solution for registry admins to issue digital carbon assets**.

Key Features

- Information about projects and issued units is **published in a publicly viewable and auditable manner**
- **Tokenization** of issued digital climate assets
- **Automated recording of retirements** detected on-chain in the CADT
- **Disable detokenization** for digitally native climate assets



Core Registry Workflow



1. **CADT**: RA submits project and unit information, which includes verified GHG emissions balance
2. **NTE**: RA will be able to issue digital carbon assets (tokens represent carbon credits)
3. **Climate Wallet**: Digital carbon assets are issued into the designated Climate Wallet. Wallet owners are able to transfer tokens to other wallets or retire tokens as needed
4. **Climate Explorer**: Module that monitors the blockchain for retirement transactions for audit and reconciliation purposes



What are the Capabilities of the Core Registry?

Functionality Overview

1. Add, edit, and remove Emissions Reductions (ER) projects
2. Issue ERs to the projects
3. Add labels and approvals, with supporting documentation, to issued ERs
4. Retire, cancel, transfer issued ERs
5. Multiple accounts to allow for ER buyers to have an account in the country registry
6. Dedicated accounts for holding ERs as overall mitigation in global emissions (OMGE) or share of proceeds (SOP)
7. Link to Climate Action Data Trust (CADT)



Once implemented, a Registry Administrator will be able to:

- **Enter and update data** about projects, including:
 - Project name, project ID, and all CADT-defined project metadata
 - Project location GIS files
 - Links to any project information hosted outside of the Core Registry
 - Publish all data to the CADT
- **Issue carbon credits**, including:
 - Entering the data about the issuance into CADT
 - Issuing tokens to the project or their designee as tradable carbon instruments
- **Track retirements and their beneficiaries**, including:
 - Detecting retirements of issued tokens
 - Recording retirements into CADT



What is the Core Registry?

Actor	What will I need?	Benefits
Registry Administrator or Regulator	<ul style="list-style-type: none">Install Registry Software package (Climate Action Data Trust node, Tokenization Engine, Climate Explorer)Software can be installed on local computer, data center, or a cloud-hosted environment	<ul style="list-style-type: none">No need to host registry website or manage usersEasy implementation - minimal hardware requirementsRegistry can still manage credentialing (i.e. who can hold carbon units)
Owner of Carbon Units	<ul style="list-style-type: none">Install Climate WalletSoftware can be installed on local computer, data center or a cloud-hosted environment	<ul style="list-style-type: none">Instant tokenization upon issuanceCan hold tokens from multiple standards
The Public	<ul style="list-style-type: none">Internet access to view Climate Action Data TrustNo software installation needed	<ul style="list-style-type: none">Complete transparency provided by Climate Action Data Trust



Climate Wallet

Climate Wallet 923891804

91.934322447012 TXCH ? txch1.....zrmxn 🔒 ⚡ SYNCED

My Wallet

Label

Sort by Quantity - high to low

Requesting Detokenization

96,096.424 tCO₂e

green project

Vintage Year 2099

Harry Gold Standard

3,049,971.942 tCO₂e

chia project

Vintage Year 2099

ahwwei Gold Standard

chia project

VIEW DETAILS

Project Details

Vintage Year : 2099

Current Registry : ahwwei Gold Standard

Project Link : www.goldstandard.org

Quantity Held

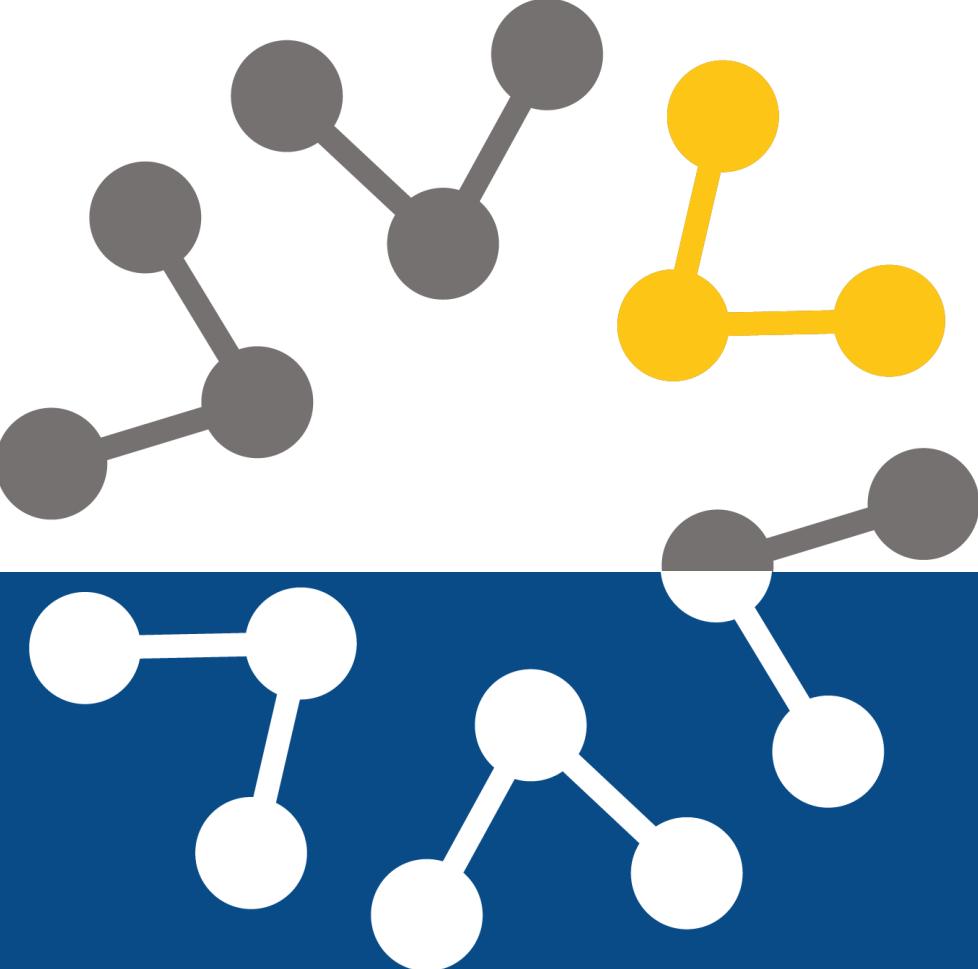
3,049,971.942 tCO₂e

SEND RETIRE REQUEST DETOKENIZATION

Transactions History

Export

Type	Status	Date	Unit Count	Fee
▼ Detokenize	Pending	October 5, 2022 4:53 PM	- 21 tCO ₂ e	0.0000000001 T
▼ Receive	Pending	October 5, 2022 4:51 PM	+ 9,978.28 tCO ₂ e	0 TXCH



2. National Enhanced Carbon Registry



What is the value proposition?

Infrastructure to support domestic and international crediting market transactions

*An open-source
carbon registry*

1

Integrated MRV (Monitoring, Reporting, and Verification) and automated entry mechanism to share projects and units' data, reducing time required to generate and trade an emission reduction. This should also reduce transaction costs, directing a greater percentage of carbon revenues towards mitigation projects. In short, this is an out-of-the-box solution.

2

Provide visibility into corresponding adjustment procedures and the lifecycle of carbon offsets from issuances to retirement, which will safeguard against double counting and ease audit requirements through the registry's transaction, reporting and reconciliation functionality.

3

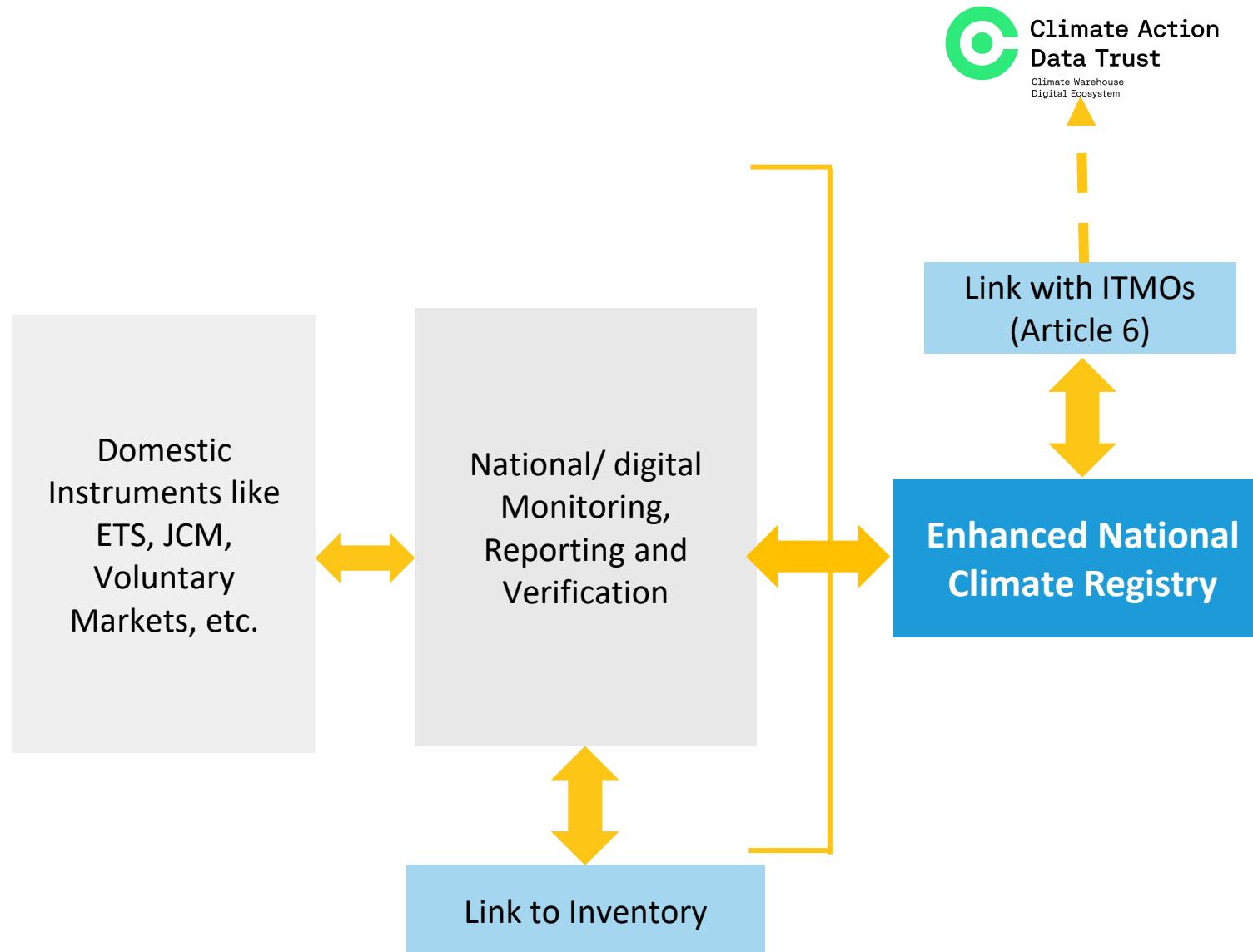
Active participation in international carbon markets, providing the capacity to introduce additional market-based-mechanisms (MBMs). The Enhanced Registry also supports interoperability between domestic mechanisms.

4

Enhance transparency and trust among market participants, with the aim to reduce the risk of double counting and double claiming. The Enhanced Registry does not hold credits or directly facilitate.



The Enhanced Registry Ecosystem

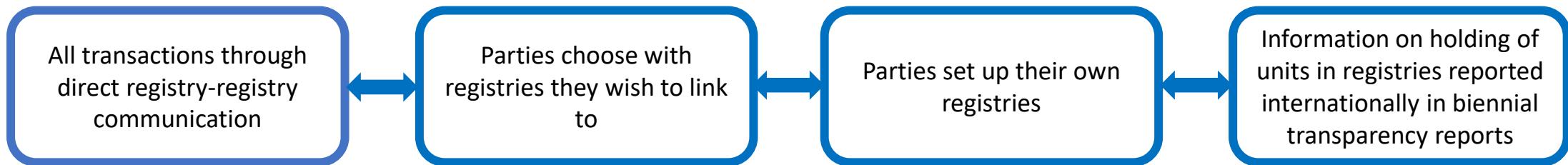


Outcomes

- Tools to support NDC reporting
- Ability to support transactions and interoperability between domestic mechanisms
- Participation in international carbon market
- Address risk of double counting and double claiming



Technical Value Proposition of Enhanced Registry



Benefits

- **Reduced development costs** through access to open source registry code and resulting productization
- **Ease of deployment** – akin to downloading new software
- Application structure will allow for customization
- Allows countries to **address inconsistency** with datasets, parameters, indicators and technological interfaces
- Will **define minimum standard of market ready national registry system** that would allow robust tracking of units and the avoidance of double counting

Requirements

- Countries will **bear responsibility to secure the application** and the IT environment and performing software upgrades, requiring additional dedicated resources
- Countries will **need to customize the registry** to align with their requirements, which may be resource-intensive
- Regulation to **enforce the usage of the system** by all relevant stakeholders in the country
- Buyer and seller countries are **responsible for ensuring unit quality**



Technical Capabilities & Functionalities of Enhanced Registry

Technical Capabilities

The Enhanced Registry aims to provide the country users with the following capabilities:

Technical Admin (TA)

- The TA would be able to **configure the registry to increase the robustness** of transactions.

Registry Admin (RA)

- The RA would be able to **carry out all required transactions** required over the lifetime of a project, **guaranteeing the traceability** the transactions and units
- The RA would be able to **view the balance of several account holders** and a statement of the transactions carried out via the accounts **to manage assets efficiently**.
- The RA would be able to **check the accounts to certify the compliance** of the registry and its reports.



Registry Functionalities

The Enhanced Registry expands on the functionalities of the Core Registry. ER- specific functionality is highlighted.

1. Add, edit, and remove Emissions Reductions (ER) projects
2. Issue ERs to the projects
3. Add labels and approvals, with supporting documentation, to issued ERs
4. Retire, cancel, transfer issued ERs
5. Multiple accounts to allow for ER buyers to have an account in the country registry
6. Dedicated accounts for holding ERs as overall mitigation in global emissions (OMGE) or share of proceeds (SOP)
7. Track and manage unit verification process (MRV)
8. Create new project types with underlying methodologies
9. Link registry to GHG inventory systems and key parameters (Grid Emission Factor, Non-Renewable Biomass fraction)
10. Automatically generate reports on ER projects



For further information:

Climate Warehouse

- Website: <https://www.theclimatewarehouse.org/work/climate-warehouse>
- Testing Activities Video: <https://www.youtube.com/watch?v=cXwTV2bAnvl>
- Online Library: <https://olc.worldbank.org/content/climate-warehouse-learning-series>

Climate Action Data Trust

- Website: <https://climateactiondata.org/>
- Launch Video: <https://olc.worldbank.org/content/introduction-climate-action-data-trust>

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