VOLUNTARY CARBON MARKET LANDSCAPE GUIDE

RMI
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Climate Collective

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Introduction

We have until 2050 to stabilize the global climate. To achieve this goal, we need to reduce our greenhouse gas emissions (GHGs) by 420 gigatons annually and remove 10-13 gigatons of historic emissions annually (Source: RMI, How to Build A Trusted Voluntary Carbon Market). The Voluntary Carbon Market (VCM) – a market mechanism that enables private parties to buy, sell, and invest in carbon credits tied to avoided, reduced, or removed GHG emissions – has the potential to align the incentives, allocate the finance, and build the institutions required to stabilize the climate at the required speed and scale. However, for a myriad of reasons addressed in this Landscape Guide, the market is struggling to reach its transformative potential.

The VCM emerged as a reaction to the 1997 Kyoto Protocol's top-down international carbon trading mechanism and became the more informal, alternative trading mechanism. Over time, it evolved as a range of actors stepped in to shape different parts of the value chain: to pilot new methodologies, build ratings agencies, deploy new technologies, or serve as verification bodies. These voluntary actions give the VCM a dynamism and complexity that reflect both its tremendous potential to finance the required climate transition and its structural and governance limitations.

As a strictly voluntary market, no single entity is responsible for instilling accountability, establishing priorities, defining standards, settling complicated debates, or mandating information disclosure. Each participant's actions shape the market, and all challenges and responsibilities can be redirected. The result is a set of norms-enforced processes that rely on the actions of a loosely-connected set of actors who are struggling with how to define, measure, and verify carbon credits in a transparent, efficient, accurate, and reliable manner. To reach its full potential, the VCM needs to simplify its structures and strengthen two fundamental pillars: its process integrity and data integrity.

The Voluntary Carbon Market Landscape Guide unpacks the core challenges, interconnections, and innovations surrounding these two pillars. It illustrates why most data related to credit quality is currently subjective; how this has resulted in quality claims being mostly determined by process compliance and vetted in an uncertain landscape for buyers; and how innovations in digital technologies – particularly when paired with other process changes – will be instrumental in building a transformative VCM. It concludes with the levers and building blocks required to build a dynamic VCM capable of catalyzing global decarbonization.

Specifically, the Landscape Guide finds:

1. Two core pillars – **process integrity and data integrity** – determine the **identification, verification, and valuation** of carbon credits **based on their climate performance.**

2. **All credits depend on both objective and subjective data** – the integrity of **which is complicated by**: measurement uncertainty, subjectivity, opacity, and a lack of definitive metrics.

3. Currently, **interconnected limitations negatively impact the effectiveness of process integrity**: complex local realities, centralized methodology creation, a lack of accessible data, inadequate data and quality literacy, and a lack of clear buyers' guidance.

4. On the demand side, buy-to-retire and buy-to-trade actors perform a range of critical, but overlapping, market functions.

5. During their **transaction journey, all buyers face considerable risks at each stage of the procurement process** – some of which are being tackled by digital measurement, reporting, and verification (D-MRV) and Web3 technologies.

6. **Key challenges with process and data integrity hinder accurate valuation and pricing of carbon credits**: threadbare benchmarks, information asymmetry, specialized deals, and inconsistent market signals.

7. **Market-wide structural barriers** – information asymmetry, slow evolution of certification systems, and a lack of consensus building – **affect data and process integrity** at all stages of a credit's journey.

8. **Trends across specific VCM functions** – market infrastructure and transactions, coordination and communication, accounting and MRV, and purchase and project financing – **demonstrate a balance of risk mitigation and creative problem solving.**

9. **A transformative VCM (i.e., one with robust data and process integrity) requires building and activating four levers.** These levers will better facilitate market-driven linkages between supply and demand based on credit quality.

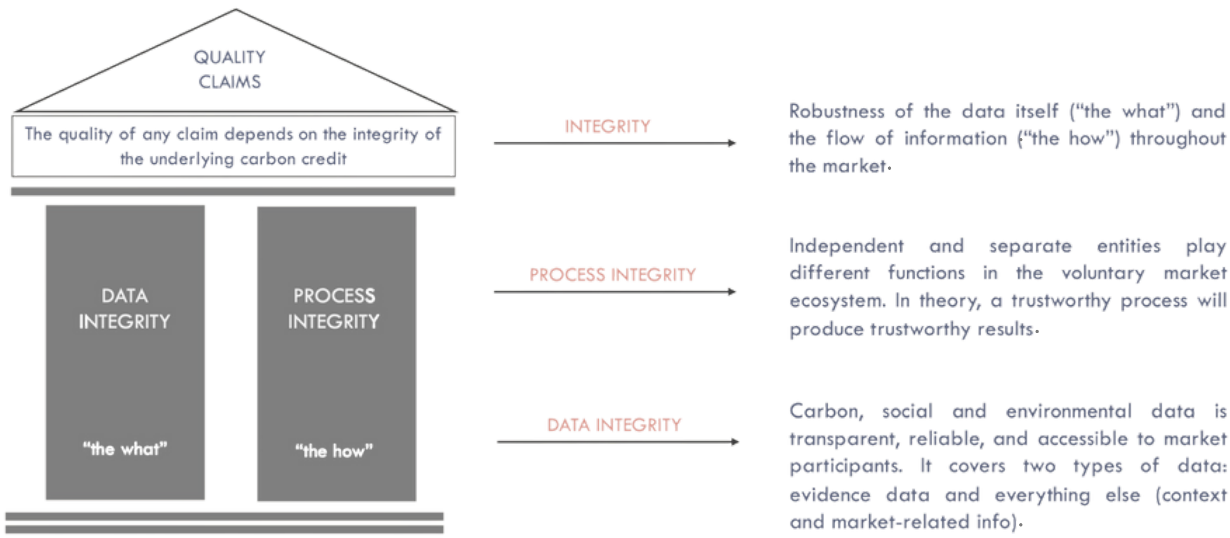
The Guide is intended to accelerate the VCM's ability to accurately and transparently develop and value carbon credits based on their climate performance. The key insights are summarized in the following pages, and more in-depth analysis and findings are discussed in the full guide attached.

Key Insights

1. Two core pillars – process integrity and data integrity – determine the identification, verification, and valuation of carbon credits based on their climate performance.

To reach its potential, the VCM must be able to accurately, transparently, and reliably value carbon credits based on their credit quality (i.e., climate performance). All credit quality is derived from the integrity of both the underlying performance data (i.e., data integrity) and the process through which it is developed, vetted, purchased, and claimed (i.e., process integrity) (see Figure 1).

Figure 1: Defining Data and Process Integrity



Neither data integrity nor process integrity are built in isolation: if the underlying data of a credit is flawed, a flawless process cannot compensate for the fundamental data shortcomings. Conversely, if a credit has near-perfect data, but the process is opaque, unreliable, or clunky, the market will struggle to connect a quality credit with buyers who are willing to pay a premium for those quality attributes. Consequently, the VCM's current struggles with effectiveness and performance are the aggregated results of – and interactions between – the flaws, strengths, and gaps of data integrity and process integrity.

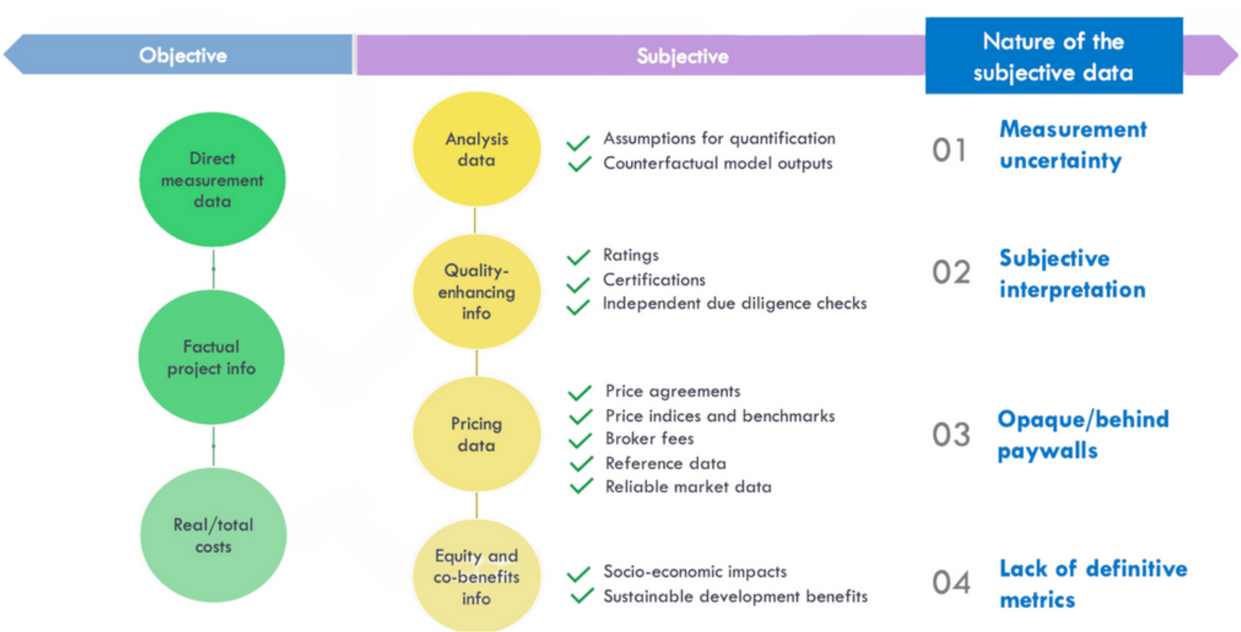
The Landscape Guide explores how data integrity and process integrity shape nearly all aspects of the VCM. It defines the current state of play of both data integrity (slides 28-40) and process integrity (slides 41-67). It examines how buyer interactions (slides

68-84), the transaction landscape (slides 85-87), and industry-shaping guidance (slides 88-102) are affected by entrenched data and process issues. It explores how D-MRV and Web3 technologies are simultaneously introducing critical innovations (slides 58-63, 103-108, and 119-127) and facing constraints with the current limitations of these pillars (slides 58-63).

The Landscape Guide goes searching for an explanation of how prices are set in the VCM and explains how price opaqueness links back to these foundational pillars (slides 109-117). The Guide concludes by identifying the four levers that need to be built and embedded to improve the integrity of each pillar, and ultimately unite them (slides 119-127).

2. All credits depend on both objective and subjective data – the integrity of which is complicated by: measurement uncertainty, subjectivity, opacity, and a lack of definitive metrics.

Figure 2: Anatomy of a Carbon Credit and the Four Challenges with Subjective Data



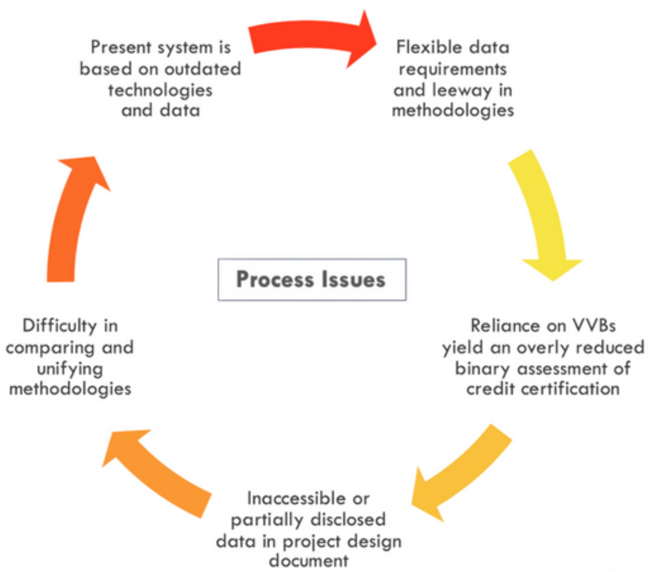
In the current VCM, data integrity is foundational to the market's performance and is riddled with complex data issues. While data integrity is comprised of evidence data (i.e., the data that directly relates to a credit's climate performance) and all other types of data (i.e. market data or qualitative assessments of quality and co-benefits), both categories rely on raw data that is either objective or subjective. Subjective data is a huge issue in today's VCM: it shapes all categories of data but is constrained by four entrenched data challenges (see Figure 2).

These complex data issues (unpacked on slides 28-40) weaken existing process integrity (slides 47-57). As a measure of how the market needs to shift, nearly all the innovations aimed at strengthening data integrity (slides 58-63) are aimed at either reducing the uncertainties and scope of these structural barriers, or making currently subjective data more objective. For example, digital and Web3 technologies are emerging through the data value chain to improve the types and amounts of raw data that feeds into the measurement, reporting, and verification of carbon credits.

3. Currently, the effectiveness of process integrity is negatively impacted by five interconnected limitations.

The existing credit certification system, a key feature of the process integrity pillar, was designed before satellite and remote sensing technologies or blockchain were widely available. Process integrity is built on the philosophy that organizational independence minimizes conflicts of interest, thus creating a trustworthy process whose results are reliable and reflect a balance between methodological rigor and data flexibility. Despite these aspirations, the VCM continues to struggle with inconsistencies, conflicts of interest, and a lack of transparency as highlighted in the five points (see Figure 3).

Figure 3: Five Cyclical Pain Points Limiting Process Integrity

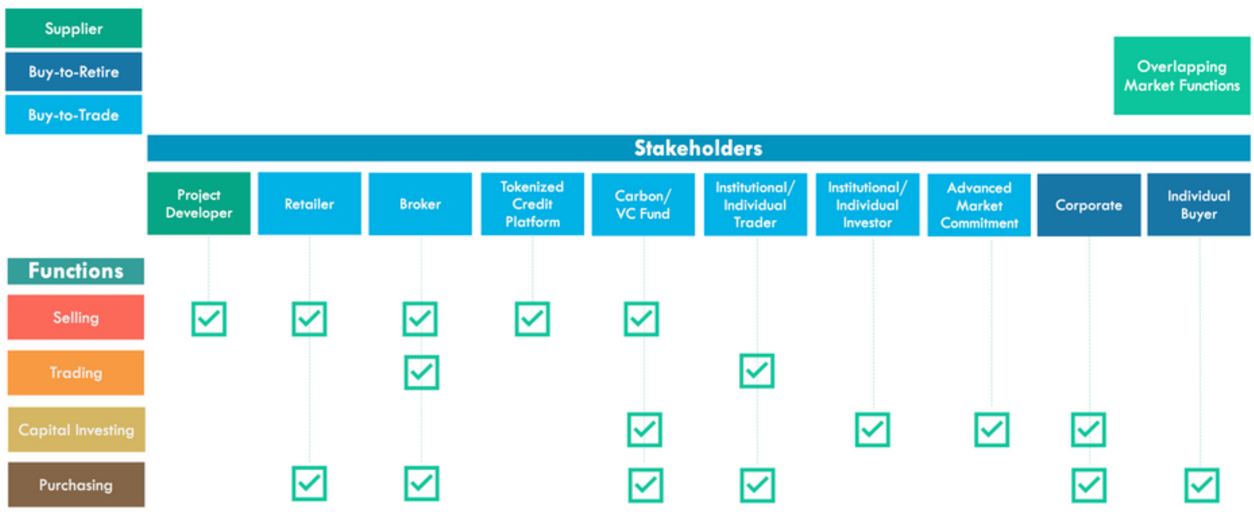


The Landscape Guide provides a deep dive into the current certification system (slides 41-67). It highlights the two central processes for quality control: methodology creation and independent verification (slides 47-57). Despite recent improvements, process integrity will only ever be as strong as its accompanying data integrity. Fortunately, Web3 and D-MRV technologies are playing an increasingly pivotal role in improving how data is collected, stored, produced, processed, and contextualized (slide 58-63). The Landscape Guide concludes with detailed steps on how to strengthen, then merge, process and data integrity (slides 64-67).

4. On the demand side, buy-to-retire and buy-to-trade actors perform a range of critical, but overlapping, market functions.

In the VCM, buy-to-trade actors (i.e., those who buy credits to trade them for a financial gain) and buy-to-retire actors (i.e., those who buy credits to claim the related environmental benefits) shape all market activity. Both buyers play critical, but overlapping, roles in financing and facilitating market interactions. For example, most buyers engage in purchasing (i.e., buying readily available credits), while only corporates and specialized buy-to-trade actors engage in capital investing (i.e., offtake agreements for customized delivery of credits) (see Figure 4).

Figure 4: Functions of Buy-to-Retire and Buy-to-Trade Actors



Due to these overlapping roles and motivations, the buyers' landscape can appear fractured and opaque (see slides 75-84). Specifically, buy-to-trade actors such as retailers, brokers, and institutional traders (i.e., trading desks at investment banks) aim to profit by purchasing credits at a lower price than they ultimately sell them. They typically do not get directly involved in project development or capital investing.

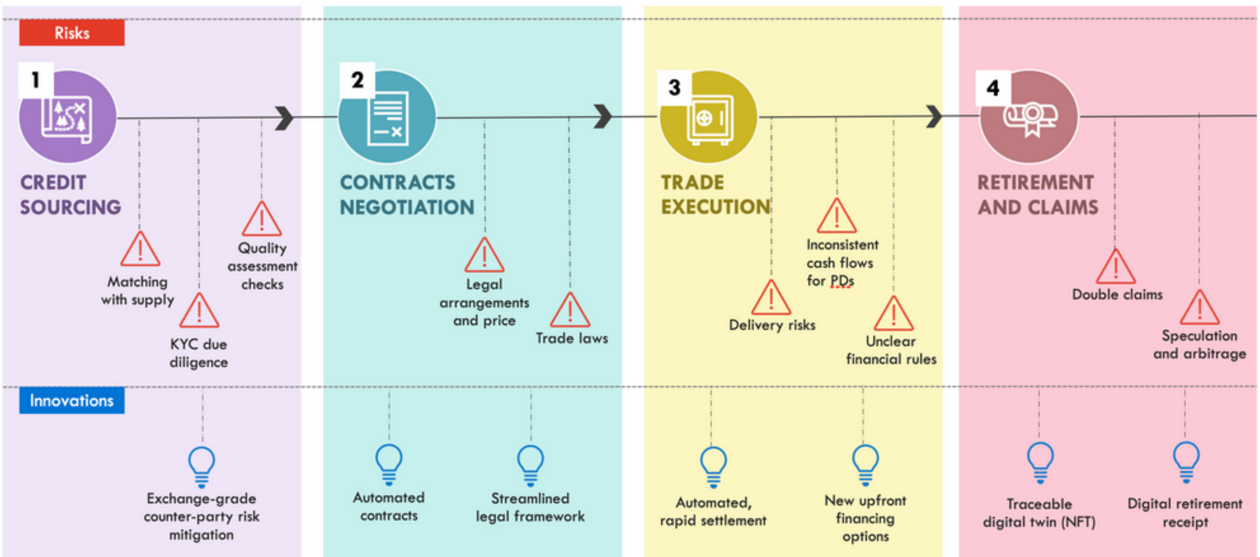
Buy-to-retire actors are either individuals who mainly purchase readily available credits or corporates who purchase credits, either as they become available on the market or through capital investing. Most Advanced Market Commitments (AMCs) or carbon funds and venture capital (VC) funds are built through a consortium of corporate buyers, who pool their resources and leverage their combined purchasing power to negotiate contracts for specific technologies or customize credit purchases (usually offtake agreements). These funds play an outsized role in shaping market activity: they provide critical, up-front financing to project developers and are one of the few concrete demand signals for technologies to scale (see slides 75-84).

5. During the transaction journey, all buyers face considerable risks – some of which are being addressed by D-MRV and Web3 technologies.

Regardless of their initial motivations, once buyers move to procure credits, they all face a complicated transaction landscape (slides 85-92) and significant uncertainty about how carbon credits can or should fit into an overarching net-zero strategy (slides 93-103). Specifically, at each stage of the transaction process, from credit sourcing to retirement, buyers must navigate a unique set of risks, incomplete information, and specific processes, all of which increase transaction costs for buyers (see Figure 5).

Fortunately, streamlining transaction processes is a task well suited to the capabilities of digital and Web3 technologies, and one where many tech-based innovations are breaking through. For example, the VCM is seeing the rapid emergence of decentralized trading platforms, which can transparently store large volumes of information about a credit's history and climate performance. Similarly, new digital and Web3 service innovations are improving the accessibility and traceability of credits, streamlining operations and contracting needs, reducing transaction costs, and providing risk mitigation services at each stage of the transaction process (slides 79-86 and 103-108 in the Landscape Guide).

Figure 5: Risks in the Transaction Journey for Buyers



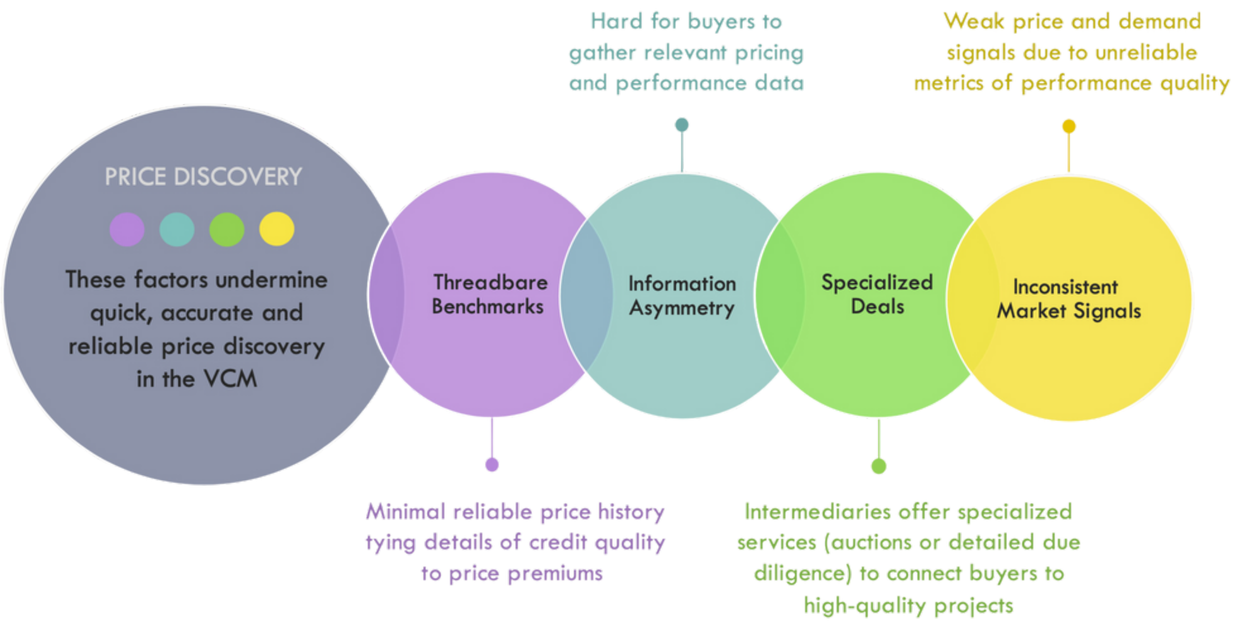
6. Key challenges with current process and data integrity hinder accurate valuation and pricing of carbon credits.

In today's VCM, prices do not serve their typical market function of providing a transparent, objective, and reliable metric of product quality, or even of buyers' preferences, due to four limitations (see Figure 6).

The raw data that underpins a credit's climate impact is neither transparent nor easily replicable. As a result, prices are opaque and largely disconnected from the credit's climate performance, costs of being brought to market, and/or prior transaction history (see slides 109-117 in the Landscape Guide).

Too often, the specifics about prices paid for credits or contracts remain either behind paywalls or kept proprietary to brokers and the growing number of intermediaries. This indicates that market fragmentation is incentivizing entities to profit from information asymmetry and cement the market's reliance on 'over the counter' (OTC) services rather than developing, surfacing, and selling higher quality credits based on a premium for the credit's unique climate and equity attributes (see slides 109-117).

Figure 6: The Four Challenges Hindering Efficient and Accurate Price Discovery



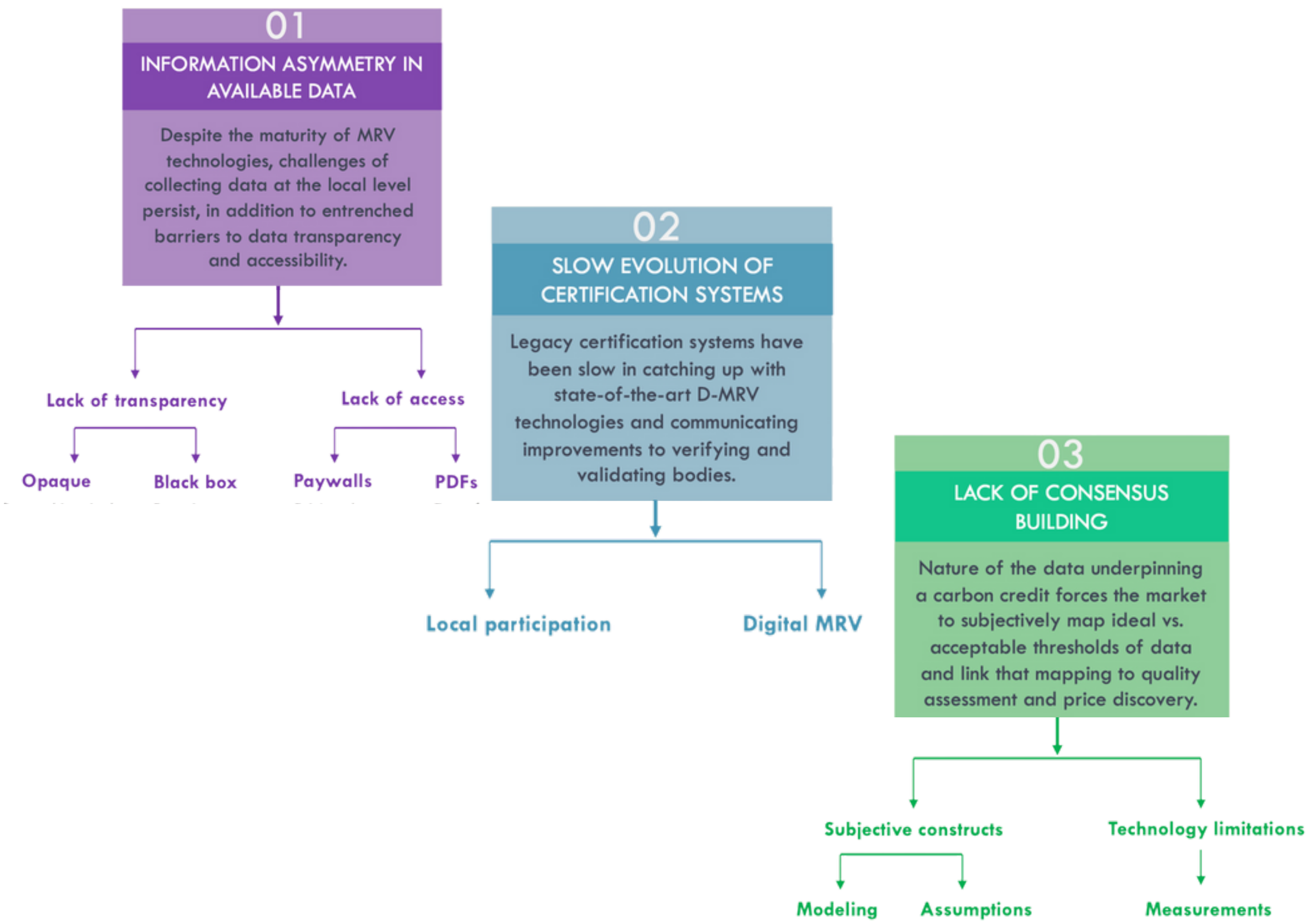
7. Market-wide structural barriers affect data and process integrity at all stages of a credit's journey.

The various limitations with process and data integrity impact nearly every stage of a credit's journey, from origination to retirement (see Figure 7). The Landscape Guide (slides 119-122) examines the three structural barriers (information asymmetry in available data, the slow evolution of certification systems, and a lack of consensus on the definition of quality) driving these limitations, and traces how these structural barriers hinder nearly every step of a credit's journey.

For example, information asymmetry undermines both data integrity – as proprietary models are instrumental to many assessments and ratings of evidence data – and process integrity – where these same models function like a black box in the processes created to certify, verify, and rate the credit's climate performance (see Figure 7 and slides 119-122 in the Landscape Guide). Similar dynamics play out across the slow evolution of certification systems and the market's inability to build consensus around the definition of credit quality.

Without agreement on fundamental issues like these, the VCM will continue to struggle in its efforts to attract more buyers and demonstrate stronger climate impact. However, the tools and technologies needed to reduce these barriers are beginning to emerge and be implemented (see Insights 8 and 9).

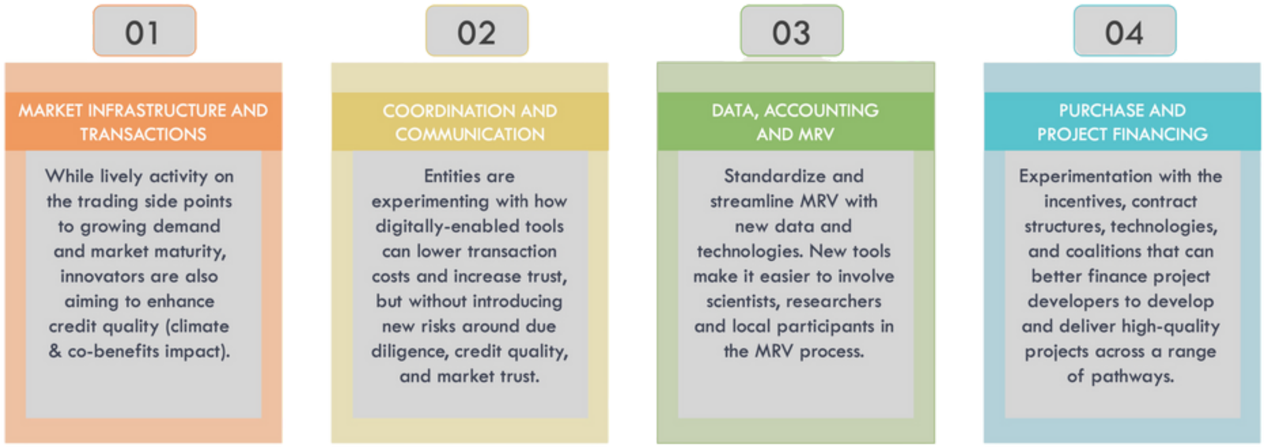
Figure 7: Three Market-wide Structural Barriers Undermining Process & Data Integrity



8. Trends are showing a balance of risk mitigation and creative problem solving to move the VCM forward.

A recent influx of new entrants, technologies, and finance has propelled four core VCM functions into new phases of dynamic iteration, innovation, and growth (see Figure 8). Digital and Web3 technologies are enabling many of these innovations (see the previous insights and slides 118-127 in the Landscape Guide).

Figure 8: Balancing Risk Mitigation and Creative Problem Solving Across Four Market Functions



For example, numerous start-ups are leveraging Web3 technologies to integrate smart contracts, transparent and interconnected registries, and decentralized data collection and storage tools into multiple stages of the credit journey. These technologies are helping to streamline market transactions, enhance market coordination and communication, augment available MRV processes, and encourage experimentation with more appropriate financing mechanisms.

9. A transformative VCM requires building and activating levers that will inform the creation of robust pillars for data integrity and process integrity.

The Landscape Guide delineates how the VCM's current structural barriers can be overcome and builds the case for four levers that, once built, integrated, and scaled, will simultaneously strengthen and merge data and process integrity to build a more accurate and dynamic VCM centered on carbon credit quality (see slides 118-127).

These four levers cover both the supply and demand sides of the market:

1. **The supply and demand sides need to reach consensus on credit quality.** The supply side needs to focus on defining thresholds for data quality that are based on available technological capabilities and measurement limitations. On the demand side, corporate guidance will play a critical role in more consistently pointing buyers to high-quality credits.

2. **Certification bodies need to promptly integrate technological advancements, especially remote sensing and Web3 technologies, into their data value chains** (i.e., how data is collected, stored, produced, processed, and contextualized). Remote sensing, Web3 technologies, machine learning, and artificial intelligence are driving key innovations and showing the most promise to add value at various stages of the data value chain.

3. **Certifiers need to** ensure that methodology creation, verification, and validation processes **adhere to best practices for expert review and independence.**

4. **The VCM** – with these first three levers – **needs to converge around, and build up, a governance model that can transparently surface the market's inherent** limitations and complexities. This requires a market- and climate-aligned resolution, and a commitment to continually iterate on, and integrate improvements in, data collection, management, and verification technologies and processes.

Conclusion

The VCM is in a critical stage of evolution and must resolve structural process and data integrity issues before it can fulfill its potential as a critical financing mechanism for stabilizing the global climate before 2050. These structural issues around data and process integrity are hindering the VCM's ability to align on a definition of credit quality and subsequently send appropriate price signals based on a credit's climate and co-benefit performance. Fortunately, a growing volume of digital MRV and Web3-based technologies that can resolve some of the critical issues on data and process integrity are being developed, integrated, and deployed throughout the VCM. The continued integration of digital tools with complementary market levers will strengthen data and process integrity, thus driving consensus on credit quality and acceptable use. Once constructed, these building blocks can catapult the VCM to its full potential to deliver climate solutions at scale.

About the Authors

RMI is an independent nonprofit that transforms global energy systems through market-driven solutions to align with a 1.5°C future.

Climate Collective is a leading coalition of stakeholders leveraging digital infrastructure to unlock verifiable climate action at scale.

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Voluntary Carbon Market (VCM) Landscape Guide

Unpacking the core issues, trends, and innovations driving the current paradigm shift in the VCM

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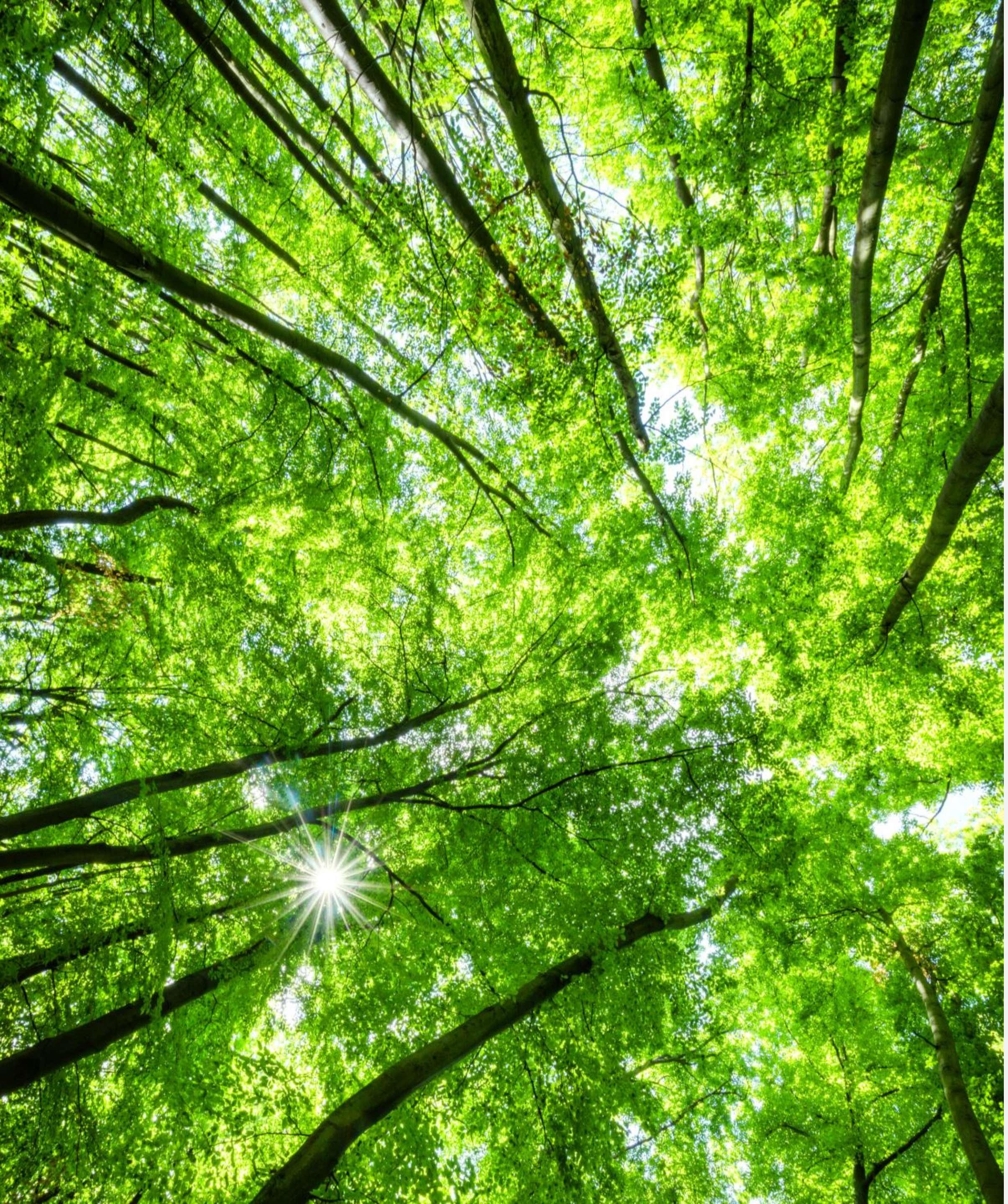
INTRODUCTION



1. Background on the Voluntary Carbon Market and this Guide

Introducing the Voluntary Carbon Market and Carbon Credits

VOLUNTARY CARBON MARKET (VCM)

A market mechanism that enables private parties to buy and sell carbon credits representing the avoidance, reduction or removal of GHGs from the atmosphere. The VCM evolved alongside the Clean Development Mechanism but has a different set of actors and methodologies. Market participants include project developers who design and issue carbon credits for sale; end buyers, like private companies, individuals or institutions seeking to offset their emissions; financial entities looking to trade credits as an asset; and an expanding group of intermediaries such as brokers, traders and retailers, who provide liquidity, distribution and other services to the market. Carbon markets are informally governed by various standard-setting bodies and registries, which set minimum requirements for how credits can be certified and issued and independent third parties who conduct credit-related due diligence and auditing.

CARBON CREDIT

A certified document representing quantities of emissions reduced, removed, or avoided from an authorized climate mitigation project. One carbon credit represents one metric ton of carbon sequestered, avoided, or removed from the atmosphere (mass weighed in units of CO2e). A carbon credit certificate is the outcome of a set of activities to reduce, capture or store carbon through different natural, chemical, geological, and engineered processes. Carbon projects are categorized by type, which include but are not limited to, reforestation and avoided deforestation, renewable energy development, natural or artificial carbon storage, and waste or landfill management. Voluntary carbon projects are governed and certified for sale by legacy and independent certification organizations.

History of the Voluntary Carbon Market

1980s – First carbon credit projects implemented

1997 – The Kyoto Protocol establishes the first international carbon market

2003 – The Gold Standard is launched. The Chicago Climate Exchange (**CCX**) starts trading

2005 – The first Clean Development Mechanism (CDM) credit is issued

2007 – The International Carbon Reduction and Offset Alliance, American Carbon Registry, and Verified Carbon Standard (VCS) are launched

2010 – Following the financial crisis, failure of Waxman-Markey, and stalled climate negotiations in Copenhagen, the **CCX** ceases activity

2011 – California's cap and trade system adopts Climate Action Reserve protocols

2015 – Paris Agreement includes Article 6 provisions for carbon markets

2019 – VCS issues more credits than CDM

2021 – At COP26, the rulebook for Article 6 is finalized

2022 – Global value of the VCM topped $2 billion in 2021(according to Ecosystem Marketplace)

Motivations for This Landscape Guide

The Voluntary Carbon Market (VCM) is in the tumultuous, early stages of a paradigm shift: it struggles to accurately and efficiently define, measure, and verify carbon credits based on their climate and co-benefit performance and to integrate technological advancements (digital technologies and data innovations, among others) that could improve accuracy, efficiency, and transparency. It is also grappling with a recent infusion of investment, scrutiny, and expectations.

This Voluntary Carbon Market Landscape Guide maps the core issues, trends, and innovations driving this paradigm shift. It illustrates why most data related to credit quality is subjective, and provides a detailed overview of the supply-side processes, demand-side considerations, transaction channels, and pricing mechanisms that shape market activity.

Landscape Guide Insights

1. Two vital market pillars - data integrity and process integrity – determine the VCM's ability to identify, verify, and value carbon credits based on their climate performance.

2. Within data integrity, all credits depend on objective and subjective data – the quality of which is hindered by four issues: measurement uncertainty, subjective interpretation, opacity, and squishy metrics.

3. Currently, five interconnected pain points limit the effectiveness of process integrity on the supply side: complex local realities, centralized methodology creation, a lack of accessible data, inadequate data and quality literacy, and a lack of clear buyers' guidance.

4. On the demand side, buy-to-retire and buy-to-trade actors perform a range of critical, but overlapping market functions – including selling, trading, capital investing, and purchasing.

5. During their transaction journey, all buyers face considerable risks at each stage of the procurement process: credit sourcing, contracts negotiation, trade execution, and retirement and claims– some of which are being tackled by D-MRV and Web3 technologies.

6. Four challenges with the current integrity pillars hinder accurate valuation and pricing of carbon credits: threadbare benchmarks, information asymmetry, specialized deals, and inconsistent market signals.

7. Three market-wide structural barriers – information asymmetry in available data, slow evolution of certification systems, and lack of consensus building – carry different implications for data and process integrity and permeate all stages of a credit's journey.

8. Trends across four VCM functions – market infrastructure and transactions, coordination and communication, data, accounting and MRV, and purchase and project financing – are balancing risk mitigation with creative problem solving to move the VCM forward.

9. A transformative VCM (i.e. one with robust data and process integrity) requires building and activating four levers. These levers will better facilitate market-driven linkages between the supply and demand of accessible, transparent, and credible credits.

2. Foundational Frameworks to Understand the VCM

The Climate Performance of a Carbon Credit (i.e., Credit Quality) is Built on its Carbon and Non-Carbon Attributes

The quality of a carbon credit is tied to its climate performance, which is defined by two sets of attributes:

Carbon Attributes

The climate benefits achieved by sequestering or avoiding carbon dioxide (CO_2) emissions or other greenhouse gases (GHG)

Established through a set of calculation rules and methods stated in the project methodology.

Examples → **Quality Criteria**

- Permanence
- Additionality
- Baseline Setting
- Leakage
- Uncertainty

Non-Carbon Attributes

The social and environmental benefits achieved in addition to the carbon-related activities

Derived through a set of project-specific activities stated in the Project Design Document (PDD).

Examples → **Quality Criteria**

- Sustainable Development
- Community Participation
- Biodiversity Protection
- Improved Water Quality
- Access to Clean Energy

All Carbon Credits are Built on Objective and Subjective Data

Tangibly known or provable data

Can be reliably measured and verified

Objective

Subjective

Assumed or modeled data

Difficult to reliably measure and verify

Emissions reduced, avoided or removed verified by an auditor

=

1 carbon credit = 1 metric ton of carbon sequestered or avoided

Tradable unit ready for sale in the VCM

Data components attached to a single credit

OBJECTIVE DATA

- Factual project info
- Real/total costs
- Direct measurement data

SUBJECTIVE DATA

- Quality-enhancing info
- Equity and co-benefits info
- Analysis data
- Pricing data

Examples of Objective and Subjective Data Tied to a Credit

Tangibly known or provable data

Can be reliably measured and verified

Objective

Emissions reduced, avoided or removed verified by an auditor

=

1 carbon credit = 1 metric ton of carbon sequestered or avoided

↓

Tradable unit ready for sale in the VCM $

Data components attached to a single credit

Subjective

Assumed or modeled data

Difficult to reliably measure and verify

Objective

Direct measurement data
- ✓ Measurement procedure and results
- ✓ Known uncertainties
- ✓ Quantitative equity and co-benefits metrics

Factual project info
- ✓ Issuance/retirement
- ✓ Project descriptors (owner, developer, origin, geography, vintage, etc.)
- ✓ Credit pathways

Real/total costs
- ✓ Project development costs
- ✓ Registry registration costs
- ✓ MRV operating costs
- ✓ Supply-demand dynamics

Subjective

Analysis data
- ✓ Assumptions for quantification
- ✓ Counterfactual model outputs

Quality-enhancing info
- ✓ Ratings
- ✓ Certifications
- ✓ Independent due diligence checks

Pricing data
- ✓ Price agreements
- ✓ Price indices and benchmarks
- ✓ Broker fees
- ✓ Reference data
- ✓ Reliable market data

Qualitative equity and co-benefits info
- ✓ Socio-economic impacts
- ✓ Sustainable development benefits

All Objective and Subjective Data Affects the Data Integrity of a Credit and Turns on Two Types of Data: Evidence Data and Non-Evidence Data

Evidence data → Quantification data that forms the basis for climate performance claims

- **Carbon impact**
  Direct measurements and/or modeling techniques to quantify emission reduction
- **Quantitative co-benefits**
  Measurable indicators of a project's social and environmental impact

Non-Evidence data → Facts, information, assessments, forecasts, and insights associated with a carbon credit

- **All other types of data**
  Data found in project design documents (PDD), project running costs, transaction costs, qualitative descriptors and indicators (geography & vintage), accreditation reports, pricing databases, proprietary reference data sources, etc.

Any call on quality depends on the objective and subjective data flowing through the VCM. Here we make a distinction on the two types of data relevant to all aspects of quality judgement.

A Robust MRV System is Essential to Assessing the Performance of Carbon Credits and the Validity of its Associated Claims

An MRV system improves how quantification data and project-specific information can be monitored, tracked, and reported through the entire MRV cycle associated with a carbon credit and it is vital to all carbon credit claims.

Measurement

Measurement or monitoring approaches that quantify the volume of carbon sequestered, avoided, or removed.

Developing and trading a carbon credit is a multi-step process involving multiple activities. Each step produces data and information that is relevant to the credit's quality, price, or buyer preferences.

Reporting

The access to measurement data in a useful format to record and synthesize information in a structured and transparent way.

Supply and demand side participants need a systematic approach and process to collect, store, analyze, and deliver the vast streams of data about the carbon credits issued, bought, and sold.

Verification

The auditing of measurement data and project information for accuracy and completeness to enable independent auditing and monitoring.

This ensures any claims made around the climate impact or additional benefits achieved through the carbon project are real, valid, and reliable.

MRV systems generate accountability and trust. The information in disclosure and claim reports is substantiated by project developers and buyers fulfilling the requirements of the MRV process.

Reporting on impact includes information on objective and subjective data used to assess the validity of a carbon credit purchase.

The flow of information on evidence data and non-evidence data (whether objective or subjective) is the basis of a robust MRV system

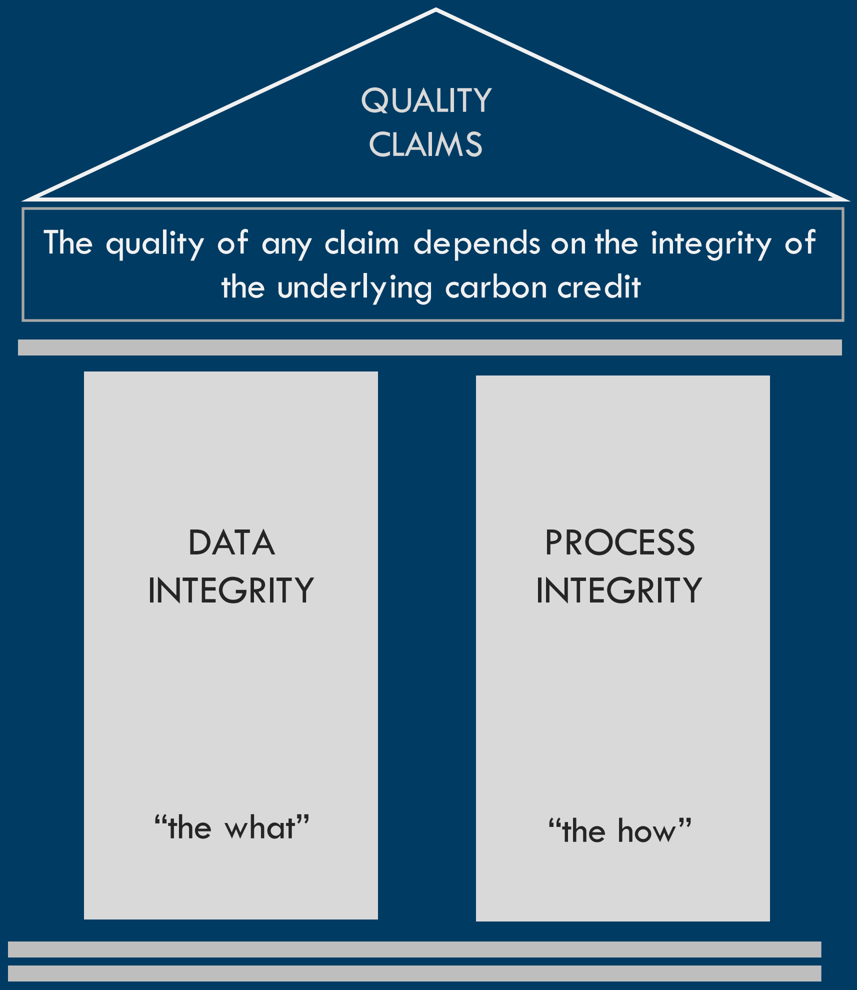
Digital Tools and Technologies are Highly Complementary to Implementing a Robust MRV System

DATA VALUE CHAIN	Data Collection	Data Storage	Data Production	Data Processing	Data Contextualization
DATA TYPES: Evidence data	✓	✓	✓	✓	✓
Non-evidence data	✓				✓
	Use of remote sensing technologies, in addition to field surveys, national inventories, etc. to capture environmental factors	Data received from technologies are stored in specific formats (documents, videos, photos) in data storage systems	Large batches of raw data are cleaned, structured, and indexed to enable interpretation and data distribution	Service providers use custom algorithmic-trained models to analyze relationships and patterns and convert raw data to useful output	Insights are combined from different data sources and types by experts and analysts and designed for use by external audiences

TECHNOLOGIES THAT HAVE SIGNIFICANT POTENTIAL TO IMPROVE THE VCM

- D-MRV (Remote Sensing, Machine Learning, Artificial Intelligence)
- Web 3 (Blockchain, Artificial Intelligence)

Ideally, Any Claim About High-Quality is Built on the Well Functioning, Foundational Pillars of Data Integrity and Process Integrity



INTEGRITY → Robustness of the data itself ("the what") and the flow of information ("the how") throughout the market.

PROCESS INTEGRITY → Independent and separate entities play different functions in the voluntary market ecosystem. In theory, a trustworthy process will produce trustworthy results.

DATA INTEGRITY → Carbon, social and environmental data is transparent, reliable, and accessible to market participants.

The Current VCM Struggles to Achieve Both Data and Process Integrity Due to the Varied and Complicated Structural Barriers

QUALITY CLAIMS

DATA INTEGRITY

Available raw data is not accessible

Importance of raw data → Too often, access to raw data is limited to a handful of entities

Data that helps verify if an associated claim is true and real

Available data is not transparent

Types of data → Evidence data / Non-evidence data

Slow uptake of technological advancements

Lack of consensus on definition of "quality"

PROCESS INTEGRITY

Gatekeepers holding raw data

Importance of philosophy → "If the process is trustworthy, so is the result"

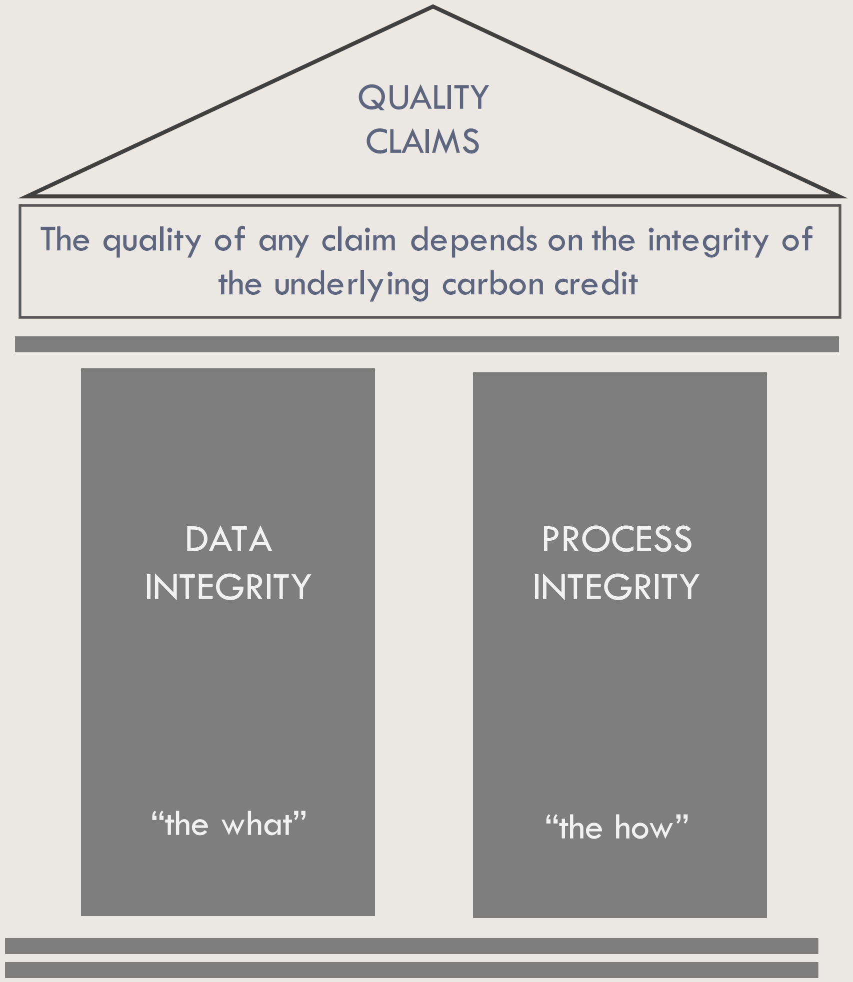
To preserve independence, only verification entities can access raw data for credits. This prevents other entities from using raw data to draw their own conclusions of credit quality.

Centralized governance

A handful of certification bodies issue a pass/fail assessment of a credit's compliance with the process.

3. Guide Insights

INSIGHT 1: The Market's Ability to Identify, Verify, and Value Carbon Credits Based on their Climate Performance Rests on the Strength of Two Vital Market Pillars: Data Integrity and Process Integrity

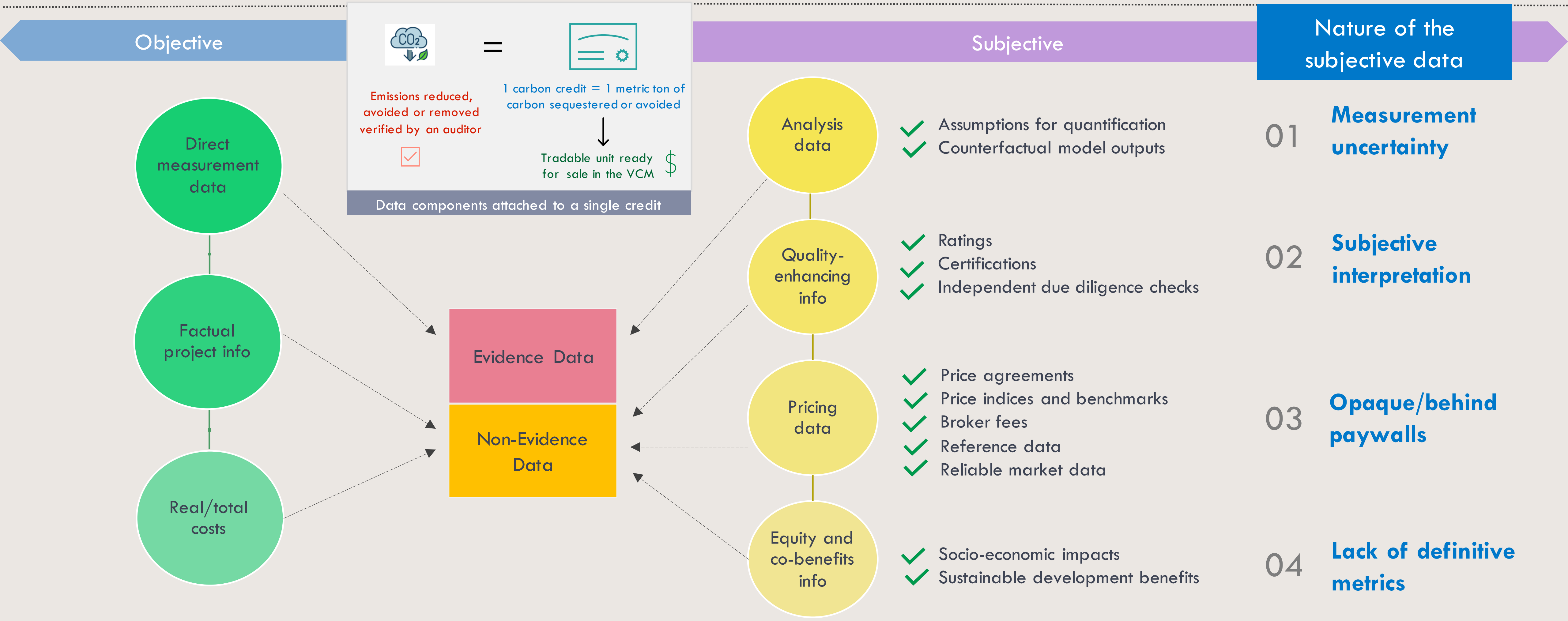


INTEGRITY → Robustness of the data itself ("the what") and the flow of information ("the how") throughout the market

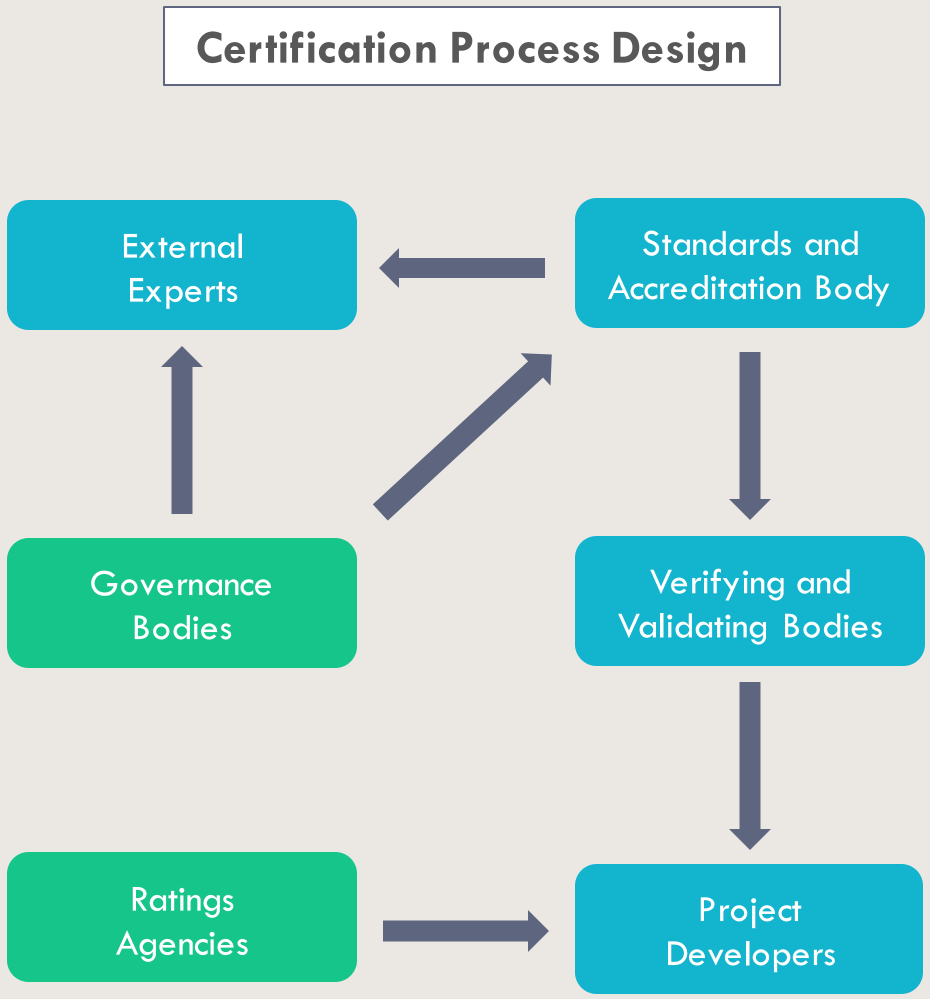
PROCESS INTEGRITY → Independent and separate entities play different functions in the voluntary market ecosystem. In theory, a trustworthy process will produce trustworthy results

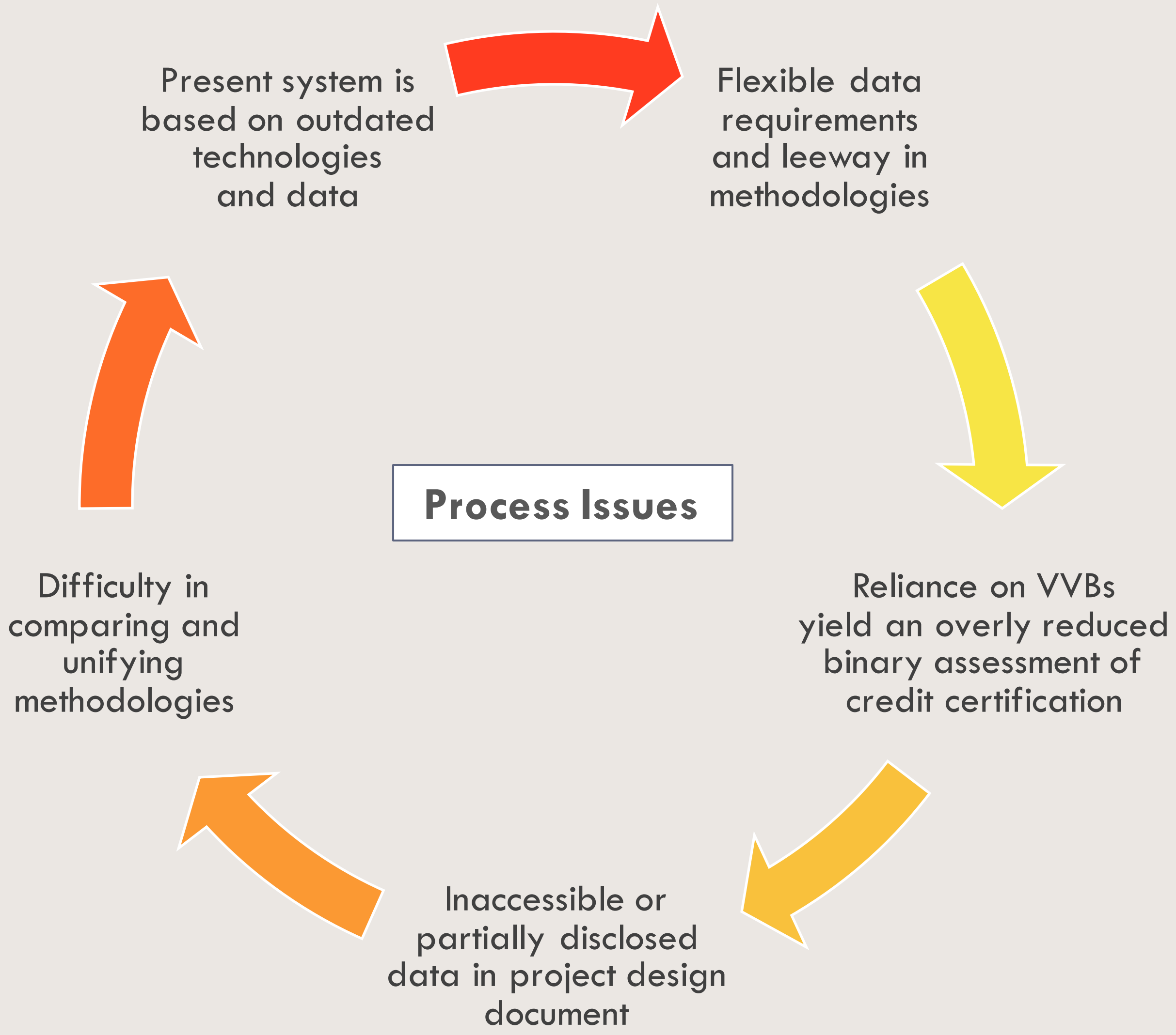
DATA INTEGRITY → Carbon, social and environmental data is transparent, reliable, and accessible to market participants. It covers two types of data: evidence data and everything else (context and market-related info)

INSIGHT 2: Within Data Integrity, All Credits Depend on Objective and Subjective Data – the Quality of Which is Hindered by Four Issues



INSIGHT 3: Currently, the Effectiveness of Process Integrity is Limited by Five Interconnected Pain Points on the Supply Side of the VCM





INSIGHT 4: On the Demand Side of the VCM, Buy-to-Retire and Buy-to-Trade Actors (Buyer Archetypes) Perform a Range of Critical, but Overlapping, Market Functions

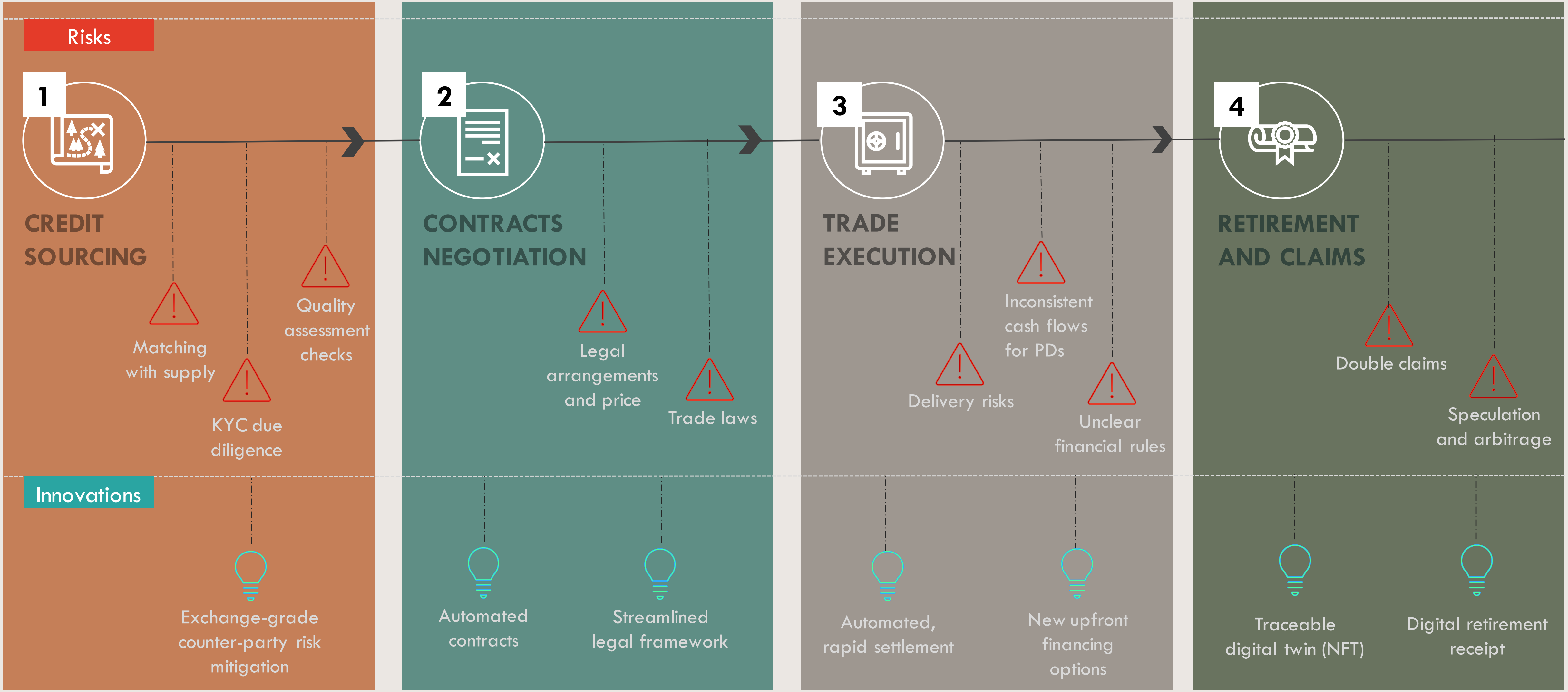
- Supplier
- Buy-to-Retire
- Buy-to-Trade

Overlapping Market Functions

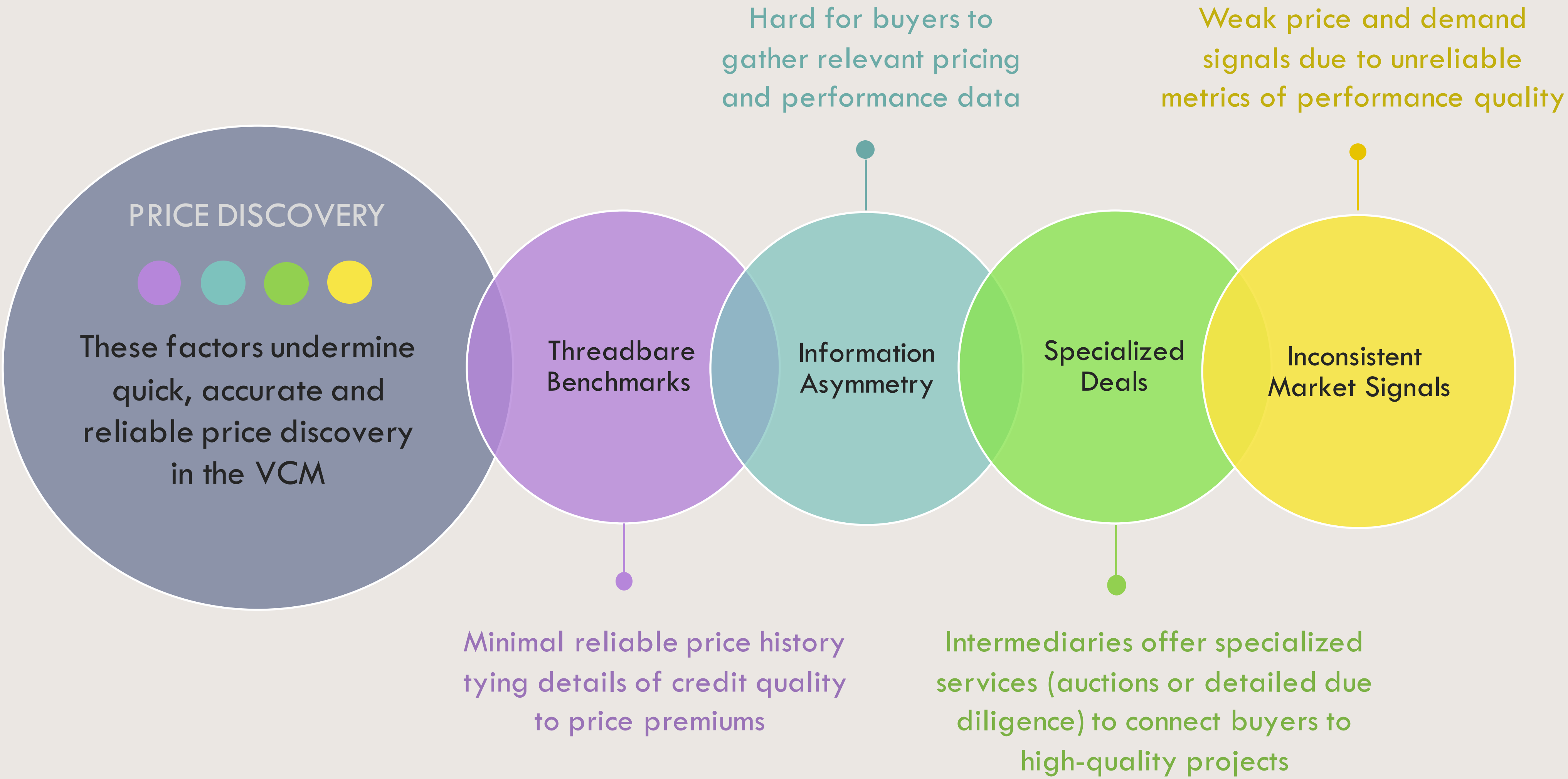
Stakeholders

Functions	Project Developer	Retailer	Broker	Tokenized Credit Platform	Carbon/ VC Fund	Institutional/ Individual Trader	Institutional/ Individual Investor	Advanced Market Commitment	Corporate	Individual Buyer
Selling	✓	✓	✓	✓	✓					
Trading			✓			✓				
Capital Investing					✓		✓	✓	✓	
Purchasing		✓	✓		✓	✓			✓	✓

INSIGHT 5: During their Transaction Journey, all Buyers Face Considerable Risks – Some of Which are Being Tackled by D-MRV and Web3 Technologies



INSIGHT 6: The VCM Struggles to Properly Value Carbon Credits Due to Four Challenges Tied to Current Limitations with Data Integrity and Process Integrity



INSIGHT 7: Three Market-Wide Structural Barriers Carry Different Implications for Data and Process Integrity – and Permeate all Stages of a Credit's Journey

01 INFORMATION ASYMMETRY IN AVAILABLE DATA

Despite the maturity of MRV technologies, challenges of collecting data at the local level persist, in addition to entrenched barriers to data transparency and accessibility.

Lack of transparency

Opaque
- Scarce historical sampling data
- Bilateral deals, closed-door negotiations

Black box
- Proprietary models
- Credit ownership and transfer

Lack of access

Paywalls
- Pricing data
- Transaction costs

PDFs
- Data formats
- Readability

02 SLOW EVOLUTION OF CERTIFICATION SYSTEMS

Legacy certification systems have been slow in catching up with state-of-the-art D-MRV technologies and communicating improvements to verifying and validating bodies.

Local participation
- Remote video checks
- Sampling toolkits

Digital MRV
- Remote sensing
- AI
- ML

03 LACK OF CONSENSUS BUILDING

Nature of the data underpinning a carbon credit forces the market to subjectively map ideal vs. acceptable thresholds of data and link that mapping to quality assessment and price discovery.

Subjective constructs

Modeling
- Avoidance credits

Assumptions
- Co-benefits
- Equity benefits
- SDGs

Technology limitations

Measurements
- Leakage
- Estimating uncertainty
- Non-permanence or reversal risks

INSIGHT 8: Trends are Showing a Balance of Risk Mitigation and Creative Problem Solving to Move the VCM Forward

01

MARKET INFRASTRUCTURE AND TRANSACTIONS

While lively activity on the trading side points to growing demand and market maturity, innovators are also aiming to enhance credit quality (climate & co-benefits impact).

02

COORDINATION AND COMMUNICATION

Entities are experimenting with how digitally-enabled tools can lower transaction costs and increase trust, but without introducing new risks around due diligence, credit quality, and market trust.

03

DATA, ACCOUNTING AND MRV

Standardize and streamline MRV with new data and technologies. New tools make it easier to involve scientists, researchers and local participants in the MRV process.

04

PURCHASE AND PROJECT FINANCING

Experimentation with the incentives, contract structures, technologies, and coalitions that can better finance project developers to develop and deliver high-quality projects across a range of pathways.

INSIGHT 9: An Ideal VCM Requires Building and Activating Four Levers That Will Inform the Creation of Robust Pillars for Data Integrity and Process Integrity

The quality of any claim depends on the integrity of the underlying carbon credit

Integrity of the data itself ("the what") as well as the governance and flow of information ("the how") in a system

Ideal state*

DATA INTEGRITY

Carbon, social and environmental data is accurate, reliable, transparent, verifiable and accessible to market participants and public stakeholders

Lever 1 — Build consensus around quality across the market

Lever 2 — Adopt digital and technological advancements

PROCESS INTEGRITY

Independent and separate entities play different functional and structural roles to govern development of credit projects

Lever 3 — Follow best practices for organizational independence

Lever 4 — Promote bottom-up governance

**Expanded access to and increased transparency around the credibility and granularity of the data underpinning carbon credits can better facilitate the market-driven linkages between the supply and demand of credits.*

SECTION I

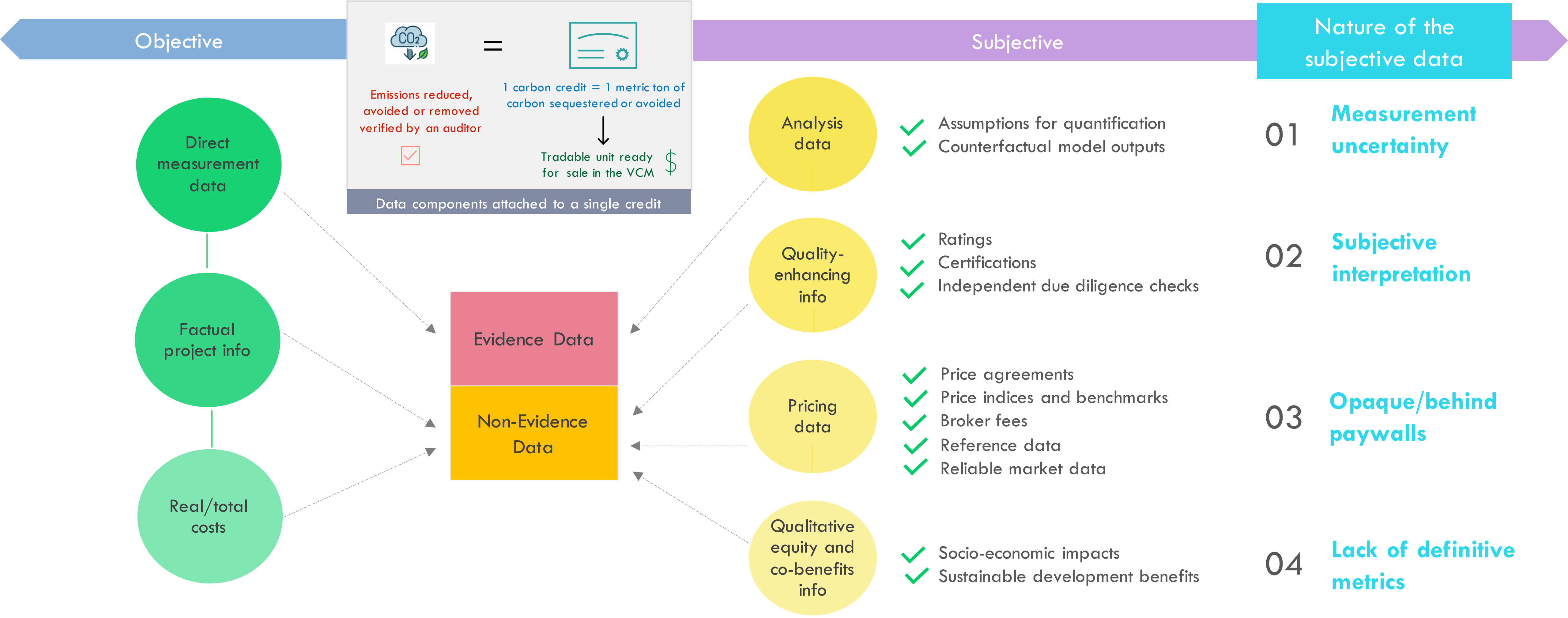
Defining Data Integrity and A Carbon Credit

How does data integrity shape the anatomy of a carbon credit? How do those data features inform ongoing debates in the VCM?

KEY TAKEAWAYS

Defining Data Integrity and A Carbon Credit

Takeaway 1: Subjective Data Traits Make it Hard for the Market to Unambiguously Assess and Value Carbon Credits



SECTION DEEP DIVE

Defining Data Integrity and A Carbon Credit

Subjective Data Traits Drive the Core Measurement Debates on the Carbon Attributes portion of Data Integrity: Disputed Quality

Quality under Controversy

Most **polarized debates** in the VCM are **about how to measure and verify** that the emissions expected to be removed or reduced actually occurred on the scale claimed in the carbon credits.

The **nature of the measurement process** makes it hard to objectively measure some types of data.

Measurement debates are stuck in a vicious cycle

01 Inherent uncertainties and subjective info required to define and verify evidence data

02 Hard to cost-effectively secure data or analysis to reduce those uncertainties

03 Even for a single pathway, the methodology allows for a range of data inputs and assumptions, causes variation in quality

Regardless of the pathway, **experts have differing opinions** on how to calculate key measurements that verify a credit's carbon performance.

Data inputs for avoidance and removal credits differ widely, but both types of credits are needed to reach climate goals.

Avoidance	Removal
Measurement process relies on models and counterfactuals to quantify GHG emissions reduction.	Measurement process can incorporate direct, observed data to quantify GHG emissions reduction.

Subjective Data Traits Drive the Core Measurement Debates on Non-Carbon Attributes Portion of Data Integrity: Highly Context-Specific

Highly Desirable but Complex

Assessing co-benefits is incredibly complicated: **most indicators are subjective and contextualized,** so quantification guidance is **piecemeal and superficial.**

Hard to objectively measure co-benefits due to the contextualized, qualitative or intangible nature of them

Unclear Unit of Measurement

Relies on proxies as most co-benefits lack a universal or objective metric that is a reliable indicator of the progress on, or delivery of, the co-benefit. E.g. Many credits could produce intangible health or community benefits (i.e., mental well-being, psychological safety, or diversified livelihoods).

High Cost of Data Collection

Project developers and local communities need upfront capital to produce robust data to establish baseline metrics and monitor impact, but it is time intensive and costly to gather reliable and granular monitoring data.

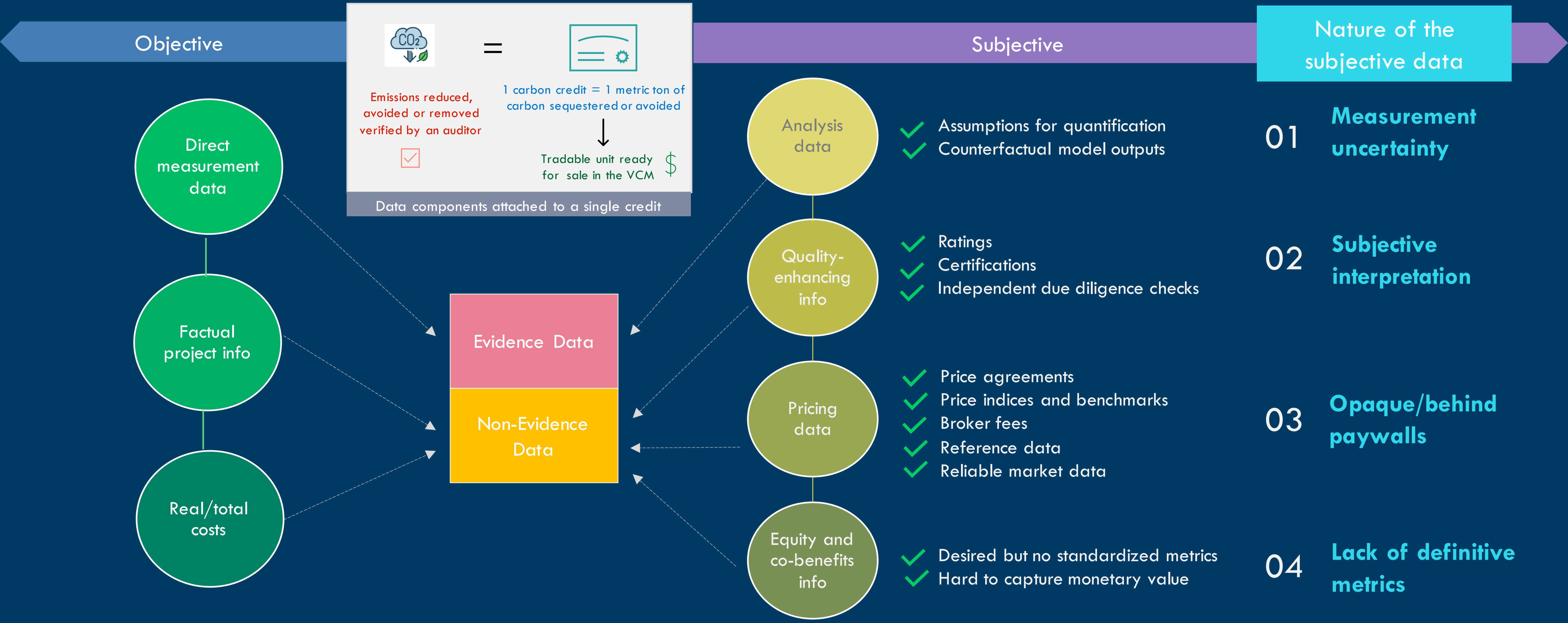
Depends on In-Situ Measurements

Effective quantification relies heavily on local contexts and are hard to scale. For example, relevant biodiversity metrics differ based on the habitat and species in a given eco-region (tropical forest vs. coral reef).

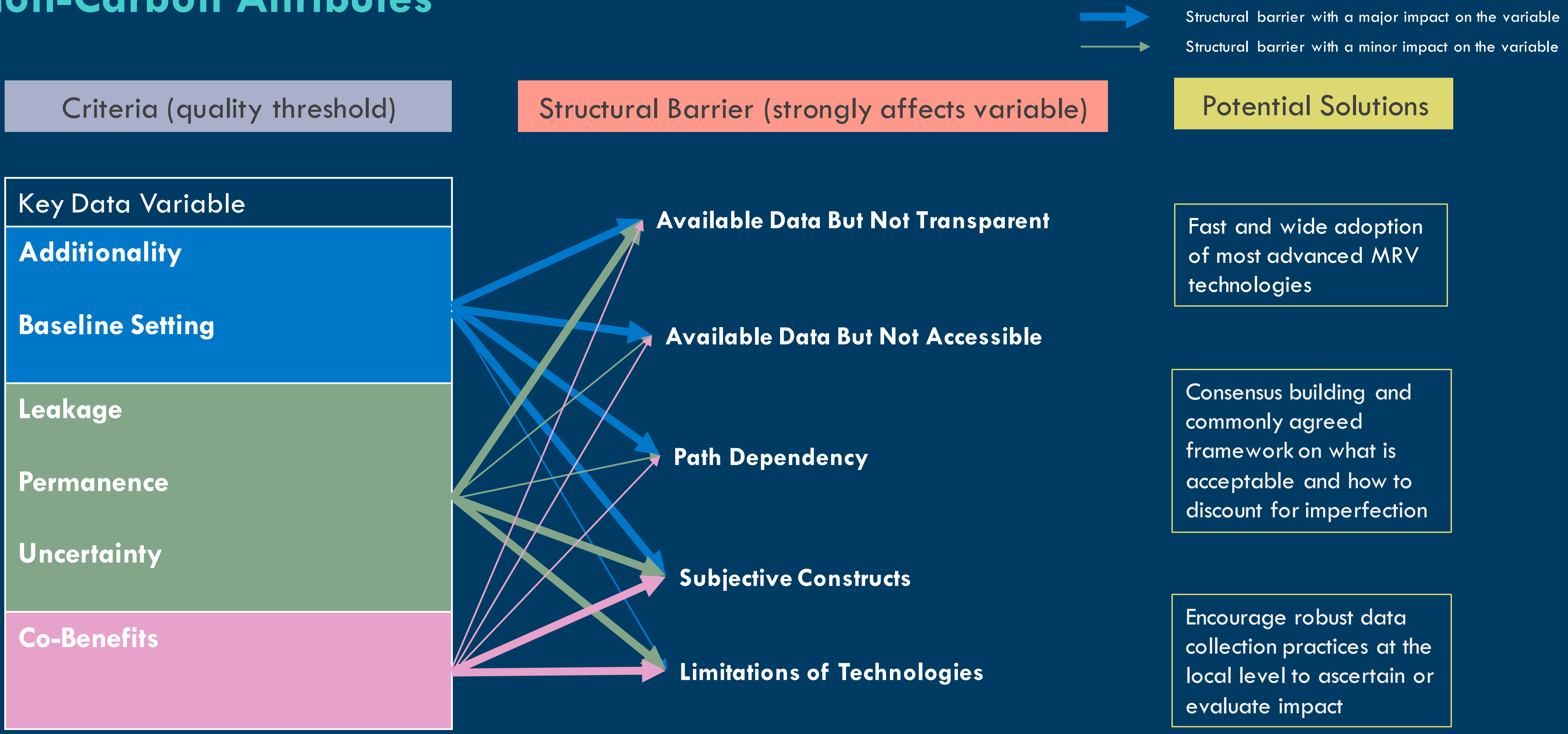
These Debates around Data Integrity are Perpetuated by Structural Barriers

	INFORMATION BARRIER	PROCESS BARRIER	CONSENSUS BARRIER
Evidence data Carbon impact and quantitative co-benefits	**Available Data But Not Accessible** Evidence data is not equally available given its static format and the lack of access to raw data.	**Path Dependency** Slow uptake of new ways of data collection or production (e.g., data captured by remote sensing technologies) weakens the evidence base.	**Subjective Constructs** Inherent complex nature of underlying credit data necessitates the need for measurement models, counterfactual baselines, and assumption-based calculations. **Limitations of Technologies** Naturally dynamic open systems (e.g., forest, soil, ocean) and reversal risks embed uncertainty and inaccuracy in quantification of emission reduction that cannot be overcome with technological tools.
Non-Evidence Data Other types of data (facts, context, forecasts etc.)	**Available Data But Not Transparent** Undisclosed 1:1 bilateral deals or intermediary fees (transactions facilitated by brokers) makes pricing and transaction info opaque. **Available Data But Not Transparent** Model calibration techniques and datasets used to gather on-ground realities are often proprietary or partially disclosed.		**Subjective Constructs** Varied and debatable thresholds for quality lead to varied subjective opinions on quality (e.g., overall rating scores developed by third-party agencies).

The Nature of Subjective Data Trickles Down to How a Credit Gets Designed and Vetted Before Purchase and Sale in the Market



Structural Barriers are Linked to Key Data Variables for both Carbon and Non-Carbon Attributes



Potential Solutions

- Fast and wide adoption of most advanced MRV technologies
- Consensus building and commonly agreed framework on what is acceptable and how to discount for imperfection
- Encourage robust data collection practices at the local level to ascertain or evaluate impact

Key Variables to Assess Quality for both Carbon and Non-Carbon Attributes

Key Data Variable	Quality Criteria
Permanence: The GHG emission reductions or removals shall be enduring (i.e., permanent) or use mitigation measures to compensate for or reduce the risks of reversals.	Critical to shaping the performance expectations of the emissions impact of a credit (i.e., "carbon quality")
Additionality: The GHG reductions that only occur due to the carbon credit system (can be financial, legal, or regulatory additionality).	
Baseline Setting: Estimate of the emissions that would have occurred *without* the carbon credit project. Common modelling methods include default values, common practices, or control sites/groups.	
Leakage: Unintended increases in GHG emissions outside a project's boundaries (can be activity-shifting leakage or market-driven leakage).	
Uncertainty: The expectation that project developers estimate the uncertainties in their measurements of additionality, the baseline, permanence, and leakage.	
Co-Benefits: Community, economic, and ecosystem benefits tied to any carbon credit project. Co-benefits are linked to achieving sustainable development targets.	Critical to "quality-proof" the social and environmental impacts of a credit (when applicable)

Key Carbon Attributes - Additionality And Baseline Setting – Are The Subjects of Intense Measurement Debates Fueled by Data Limitations

Additionality

Main Debates:

- Requires proving a counterfactual, which is inherently difficult and subjective
- Frequent information asymmetry between the project developers (who know more about on-the-ground realities) and the certification bodies (who evaluate additionality claims)
- Can be undone by changes in external conditions (i.e., policy changes or market fluctuations)

Baseline Setting

Main Debates:

- Built on a counterfactual, which can differ based on model inputs and is hard to standardize
- Once validated, remains unchanged for the crediting period (regardless of changes on the ground)
- Project developers have an incentive to establish baselines that over-inflate the impact of their activities

The Complex Nature of Data Limits Perfect Measurement Accuracy for Permanence, Leakage, and Uncertainty – Other Key Variables

Permanence

Main Debates:

- No clear definition of "permanent" (25 years? 50 years? 100 years?)
- Projects occur in open systems in natural environments (e.g., forest, soil, ocean) are complex, partially understood, and constantly evolving
- Mitigation measures (buffer pools and tonnage-year accounting) face their own challenges for accurate quantification

Leakage

Main Debates:

- Inherently difficult to prove and estimate relationships among project activities, project boundaries, and events outside those boundaries
- Little clarity on what is considered best practice for leakage measurement
- No clarity on whether technological solutions or innovations can resolve the measurement complexities

Uncertainty

Main Debates:

- Many sources of uncertainties, but no agreement on which to prioritize or how to account for
- Legacy programs/standards assess or evaluate these uncertainties in different ways
- Uncertainties inherent in calculating the emission reduction quantification of nature-based open systems (e.g., forest, soil, ocean) prevent these estimates from reaching 100% accuracy in the short-term

The Contextualized Nature of Data Imposes Constraints on Measurements for Non-Carbon Attributes (i.e., Co-Benefits and Equity Benefits)

Co-Benefits
Main Debates: • Lack of guidance on how to quantitatively assess co-benefits • Non-rigorous requirements around ongoing monitoring of impacts for co-benefits and equity-related outcomes • Non-existent or limited ways to spot non-compliance of environmental and social safeguards (for e.g., how to set up monitoring systems so buyers have immediate visibility into "red flag" projects?) • Current non-feasibility of available SDG impact quantification methodology tools to accurately assess indicators of SD impacts • Unclear requirements around the "how" aspect of additional positive impact claims (for e.g., how a project meets its listed SDGs) • Question mark on how to effectively integrate co-benefits score with carbon impact score in final project rating

SECTION II

Deep Dive Into the Supply Side

How does the existing certification system work? What are the limitations of process integrity? How can data integrity break institutional cycles?

KEY TAKEAWAYS

Deep Dive Into the Supply Side

Takeaway 1: Pain Points Hinder the Effectiveness of Process Integrity in Vetting Credit Quality

01 Complex local realities

Under existing methodologies, available data and technologies are inadequate to accurately and cost-effectively capture complex local realities.

02 Centralized methodology

Centralized bodies trying to make methodologies applicable across ecosystems, geographies, and timescales. To accommodate, data requirements are flexible.

03 Lack of accessible data

VVB findings simplify the complexity of the data tradeoffs inherent in credit design into binary results (pass/no pass) and creates barriers for others to access raw data.

04 Data & quality literacy

Complex nature of data, varied data quality, and inaccessibility to raw data make it extremely difficult to compare credits across methodologies.

05 Lack of clear buyers' guidance

The market lacks a nuanced or harmonized definition of data quality, so struggles to incentivize incumbents to collect and share data.

Takeaway 2: Data Integrity Underpinned by Digital MRV and Web3 Technologies Will Move the Needle on Process Integrity

TECHNOLOGY TYPES	Data Collection	Data Storage	Data Production	Data Processing	Data Contextualization
D-MRV	✓		✓	✓	
Web3		✓		✓	✓
DATA VALUE CHAIN	Data Collection	Data Storage	Data Production	Data Processing	Data Contextualization
WHERE WE SEE THE MOST POTENTIAL FOR TECHNOLOGICAL IMPROVEMENT	**Remote sensing technologies (e.g., satellites, drones, sensors) make *data collection* more accurate and less resource intensive – especially for MRV**	**Web3 technologies enable *secure and trusted data storage* of the full lifecycle of carbon credits: more local and inclusive data collection and MRV processes, standardized legal documents, and more transparent transaction and retirement process**	**Many public remote sensing datasets are accessible and applicable to baseline calculations and subsequent *MRV approaches***	**Machine Learning and Artificial Intelligence enable automation of essential *data processing* steps, particularly during the MRV cycle: baseline modelling and emission reduction monitoring**	**Web3 public platforms *enables better access* to price and transaction data. Blockchain technologies can also introduce *better linkages* between underlying MRV data and prices**

Takeaway 3: Innovations in Data Integrity are Breaking the Vicious Cycle, but Still a Long Way to Go for Large-Scale Adoption

01 Complex local realities

- Align data collection with local priorities and consolidate existing data sources.

02 Centralized methodology

- Develop tools to connect scientists and local participants to promote the quality and speed of data collection and methodology updates.

03 Lack of accessible data

- Operationalize secure data storage, make contextualized data accessible to all stakeholders, and encourage transparency of processed data.
- Registries to implement appropriate data aggregation that protects individual privacy but improves data accessibility.

04 Data & quality literacy

- Resource-intensive, multi-year initiatives to uniformly compare & assess methodologies.
- Harmonized framework to assess uncertainties and quality of modelling techniques for data processing.

05 Lack of clear buyers' guidance

- Buyers enabling price premium for credits with high-quality data and provide incentives for landowners and developers to share data.

Action under development
Action yet to happen

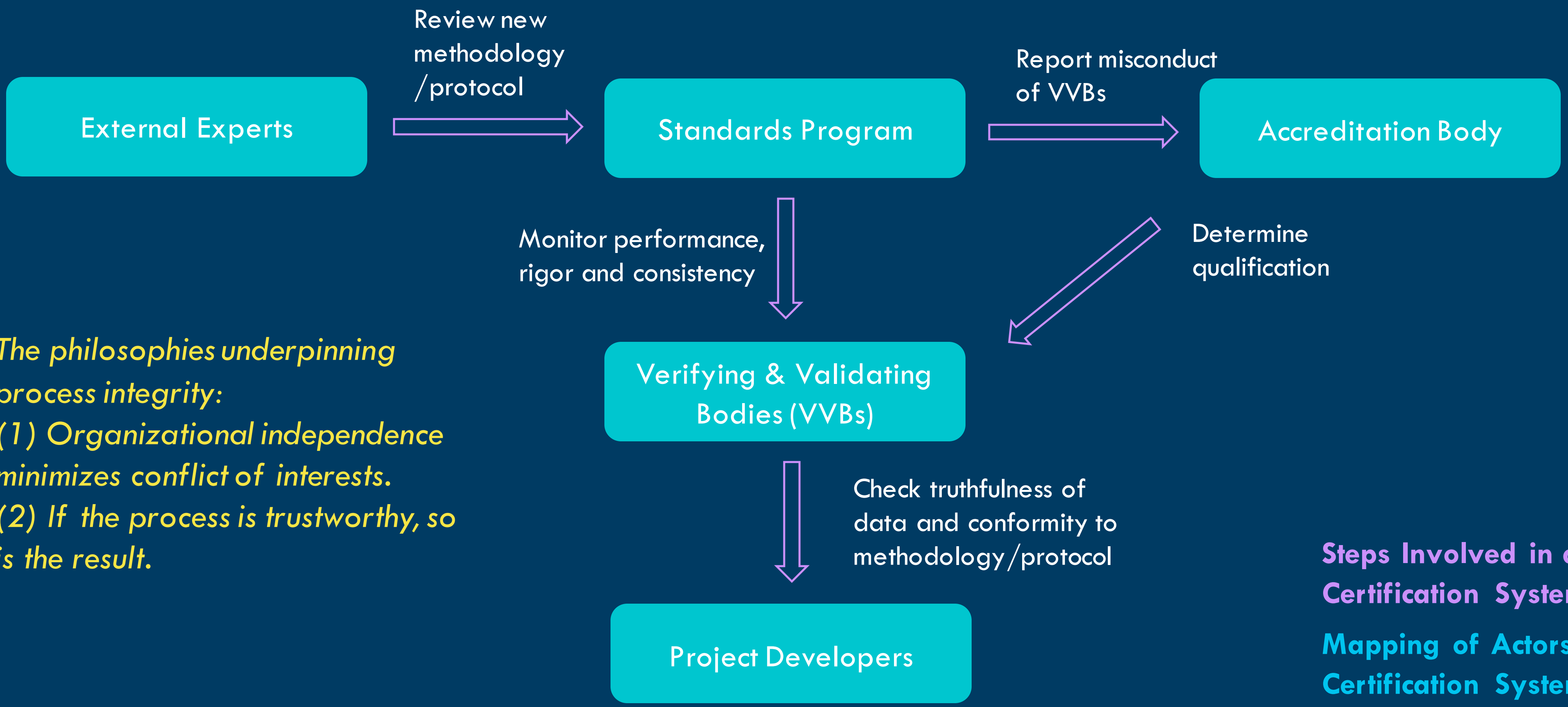
SECTION DEEP DIVE

Deep Dive Into the Supply Side

PART A

Current State of Play for Process Integrity

Traditionally, the VCM has Put Trust in the Process to Assure Quality; Process Integrity is Foundational to Developing a Carbon Credit Today



The philosophies underpinning process integrity:
(1) Organizational independence minimizes conflict of interests.
(2) If the process is trustworthy, so is the result.

Steps Involved in an Established Certification System

Mapping of Actors in the Legacy Certification System

These Steps Have Been Widely Applied to Develop Various Project Types Under the Process Integrity Model

AGRICULTURE

AGRICULTURE	Bundled Compost Production	Feed Additives	Improved Irrigation Management	Manure Methane Digester	Nitrogen Management	Rice Emission Reductions	Solid Waste Separation	Sustainable Agriculture
VCS	0	309	247,682	1,546,005		720,000	222,592	325,825
GS		0	148,822	592,318		0		0
CAR				8,546,035	3			0
ACR	0			1,730,651	72	597		0

FORESTRY & LAND USE

FORESTRY & LAND USE	Afforestation/Reforestation	Avoided Forest Conversion	Avoided Grassland Conversion	Improved Forest Management	REDD+	Sustainable Grassland Management	Wetland Restoration
VCS	35,882,231			10,567,708	397,959,455	4,645,888	1,272,852
GS	5,144,130						
CAR	0	1,964,711	179,863	84,063,805			
ACR	9,960,382	7,888,863	166,197	122,169,420			59,552

HOUSEHOLD & COMMUNITY

HOUSEHOLD & COMMUNITY	Biodigesters	Bundled Energy Efficiency	Clean Water	Community Boreholes	Cookstoves	Lighting	Weatherization
VCS	0	500,000	0		4,497,444	516,651	8,004
GS	18,691,029	3,467,283	2,617,745	4,677,889	43,053,148	23,982	260,920
CAR							
ACR		0					

RENEWABLE ENERGY

RENEWABLE ENERGY	Biomass	Geothermal	Hydropower	RE Bundled	Solar - Centralized	Solar - Distributed	Solar Cookers	Solar Lighting	Solar Water Heaters	Wind
VCS	24,148,818	2,994,507	148,526,856	6,544,928	49,784,211	3,729,732	783,054	0	65,471	153,802,793
GS	5,751,113	1,758,510	4,157,478	0	9,880,523	1,175,756	4,183,919	124,658	397,319	66,192,365
CAR										
ACR	0		673,609			4,082				931,614

WASTE MANAGEMENT

WASTE MANAGEMENT	Composting	Landfill Methane	Methane Recovery in Wastewater	Waste Diversion	Waste Incineration	Waste Recycling
VCS	627,768	15,099,131	7,985,473		1,789,272	0
GS	1,073,402	22,120,881	2,347,313	0	0	62,903
CAR	662,261	36,595,541				
ACR	0	6,291,221	100,000			

Source: Berkeley Carbon Trading Project*

Issuance Volume Low High

Each standards body has its specialized area of greater involvement

- **Verified Carbon Standard (VCS):** REDD+, Afforestation and reforestation, Hydropower, Solar and Wind
- **Gold Standard (GS):** Cookstove and Wind
- **Climate Action Reserve (CAR) and American Carbon Registry (ACR):** Improved Forestry Management

Emerging standards bodies

- **Puro:** Biochar, Carbonated Building Materials, Enhanced Rock Weathering, Geologically Removed Carbon, Woody Biomass
- **C-Sink:** Biochar

Most credits are issued from a few pathways

REDD+, Improved Forest Management, Hydropower, Wind and Centralized Solar are the most widely used

*Cumulative issuance of major sectors from big four registries from 1996 through March 31, 2022
Carbon Capture & Storage, Chemicals, Industrial Manufacturing, and Transportation are excluded

First Step to Assure Quality Under this Model: Create a Methodology to Define Quantification Method and Project Design Parameters

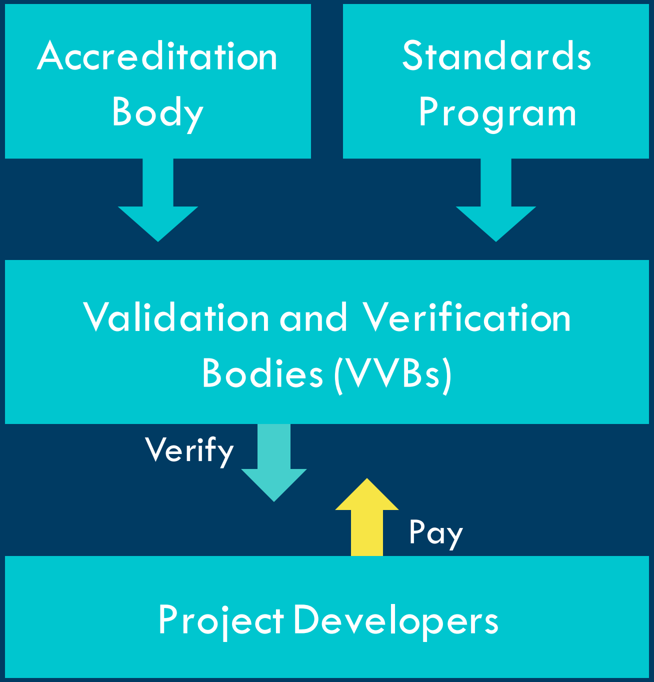
Certification Body	Author	Public Consultation	Check 1	Public Consultation	Check 2
Verra	External proponent	Public Consultation	VVBs		Verra
Gold Standard	External proponent		Two experts named by proponent, two members from technical advisory committee	Public Consultation	Technical advisory committee
Climate Action Reserve	Standards program		Work group	Public Consultation	Board of directors
American Carbon Registry	External proponent	Public Consultation	Blind peer review		
Puro	Standards program	Public Consultation	Work group		Technical advisory board
Australian Emission Reduction Fund	Standards program			Public Consultation	Expert committee
Alberta Climate Change Office	External proponent	Public Consultation	Technical review expert and 3rd auditor named by proponent		Department

This process involves

1 Public consultation

2 Expert reviewers

Second Step to Assure Quality Under this Model: Third-Party Validation and Verification to Independently Check Progress and Make Determinations

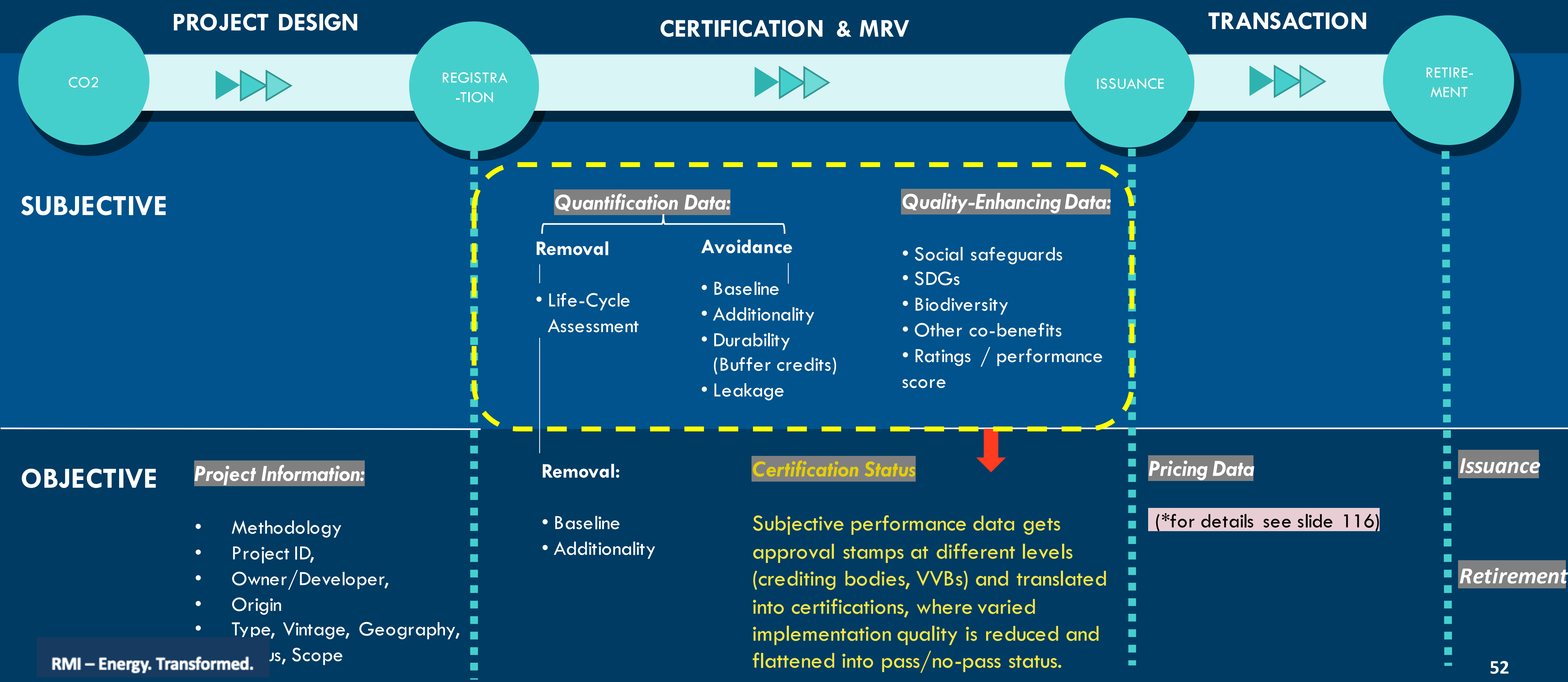


Checkpoints for VVBs to conduct inspection	Validation	First Verification	Ongoing Verification(s)
Site visits			
Conformity to procedures and standards	✓		
Facility checks/site baseline checks	✓		
Documents checks			
Assess the appropriateness of assumptions	✓	✓	✓
Spot deviation from quantification methods and assess its impact	✓	✓	✓
Record the data and source	✓	✓	✓
Assess the sufficiency of data quality and reliability	✓	✓	✓

Designed according to the ideal of organizational independence, but may present conflict of interest since VVBs, who are essential to the process, are paid by project developers

This process involves extensive judgement calls on tradeoffs between local realities vs. data quality and implementation stringency

Process Integrity is a Critical Step in the Credit Lifecycle Where Subjective Data is Translated into Binary Certification Status



Shortcomings of Methodology Creation in the Process Integrity Model

Lack of Independence

- The author (i.e., the methodology proponent or the standard itself) can select the expert reviewers in working groups and third-party auditors
- At times, the standard is creating methodologies and taking funding from future beneficiaries

Lack of Transparency

- Creating methodologies involves tradeoffs between data availability and rigor, business models, and local realities.
- Meeting minutes or explanations of decisions are often not disclosed.

Lack of Resources

- Experts participate on a voluntary basis and have limited time, bandwidth, and information.
- The dense inputs raised in public consultations can be quite challenging to digest within resource constraints.

Lack of Sufficient Expertise

- The standards don't agree on who qualifies as an expert or on how many are needed in the review process.
- Ideally, experts bring a range of expertise in carbon markets, industry, science, and IPLC groups.

Shortcomings of Third-Party Validation and Verification in the Process Integrity Model

Lack of Reliability

- Data required to audit a credit is complex, subjective, and prone to human-induced errors
- Audited data is usually not public
- Third-party VVBs are paid by project developers, hence why audited data needs to be accessible

Lack of Transparency

- Most MRV data is disclosed in pdf formats – usually as verification and validation reports.
- PDF format and length of reports make it hard to duplicate, augment, or disprove the VVB analysis.

Lack of Affordability

- Qualified VVBs are rare or hard to find in the global south.
- Hiring international VVBs adds to the burden and costs for developers.
- VVBs report receiving low compensation for their hard technical work.

Lack of Communication

- No communication among different standards on misconduct or non-compliance of VVB
- If VVBs are sanctioned by one standard, they often switch to another.

Recent Improvements in Process Integrity Model for Methodology Creation

Independence

- Blind peer-review (when the author is external proponent)
- Peer-elected technical committee (when the author is the standard)
- A group convened by third-party entity such as buyers

Resource

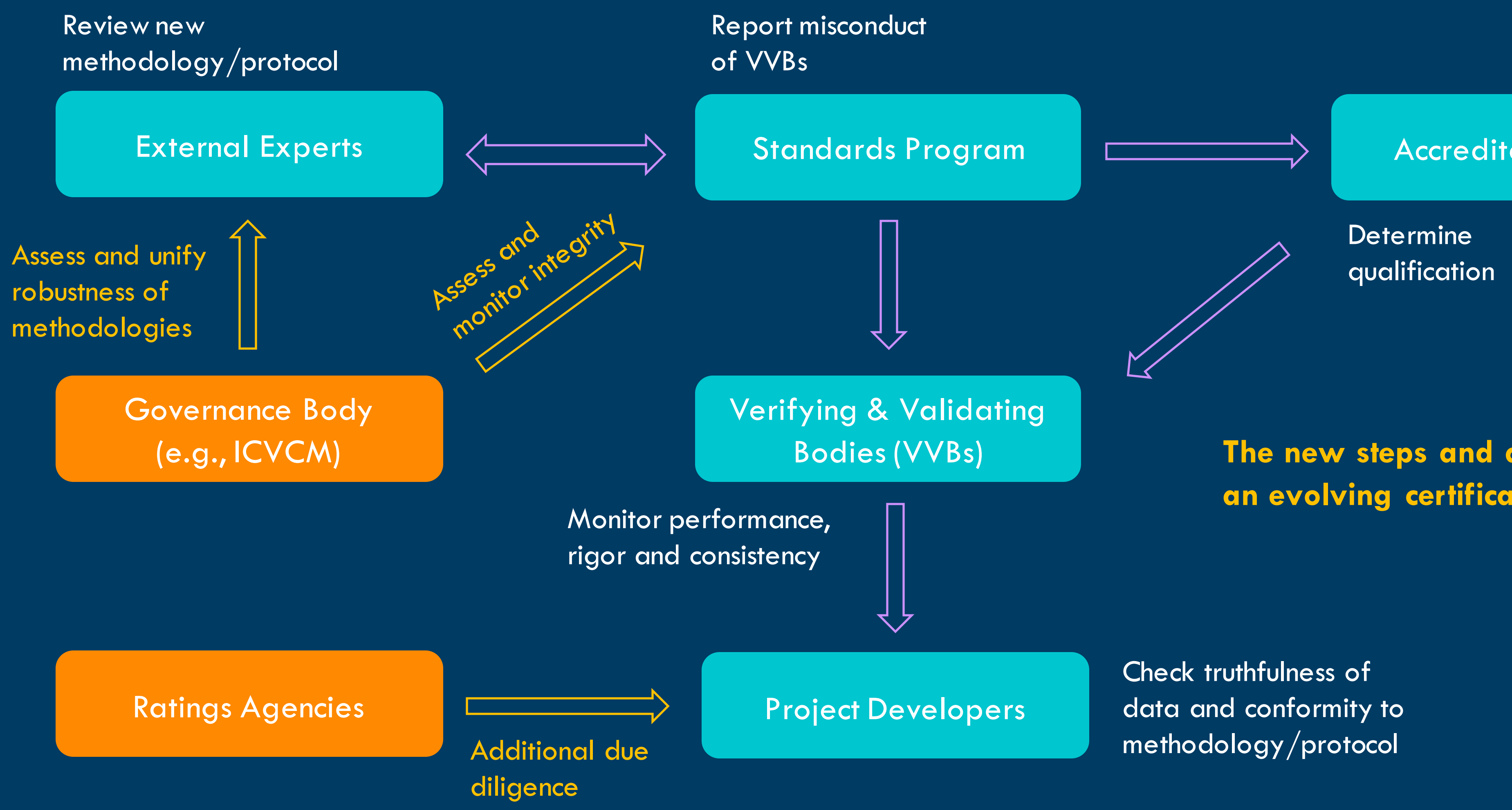
- Some crediting programs have started to compensate the experts who sit on advisory boards
- One requires the chair of the technical committee to be a full-time member

Improved Expertise

- More participation and involvement of the scientific and academia community in methodology creation
- Clearer guidance on the requirements of experts' qualifications

These improvements come from both established standards programs and emerging self-certifying entities

Recently, New Actors are Enhancing the Process Integrity Model Through Additional Guidance, Monitoring and Due Diligence



The new steps and actors involved in an evolving certification system

New/Emerging Actors
Legacy System

Despite Improvements, the Current State of Process Integrity Falls Short in Addressing Five Pain Points that Trap it in a Vicious Cycle

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Under existing methodologies, available data and technologies are inadequate to accurately and cost-effectively capture complex local realities.

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Centralized bodies trying to make methodologies applicable across ecosystems, geographies, and timescales. To accommodate, data requirements are flexible

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VVB findings simplify the complexity of the data tradeoffs inherent in credit design into binary results (pass/no pass) and creates barriers for others to access raw data.

04 Data and quality literacy

Complex nature of data, varied data quality, and inaccessibility to raw data make it extremely difficult to compare credits across methodologies.

05 Lack of clear buyers' guidance

The market lacks a nuanced or harmonized definition of data quality, so struggles to incentivize incumbents to collect and share data.

PART B

Embracing Digital Technologies and Data Integrity to Complement Process Integrity

Digital Tools and Technologies Can Improve the Robustness of The Data Attached to a Carbon Credit

DATA TYPES	Data Collection	Data Storage	Data Production	Data Processing	Data Contextualization
Evidence data	✓	✓	✓	✓	✓
Non-evidence data	✓				✓
	Use of remote sensing technologies, in addition to field surveys, national inventories, etc. to capture environmental factors	Data received from technologies are stored in specific formats (documents, videos, photos) in data storage systems	Large batches of raw data is cleaned, structured, and indexed to enable interpretation and data distribution	Service providers use custom algorithmic-trained models to analyze relationships and patterns and convert raw data to useful output	Insights are combined from different data sources and types by experts and analysts and designed for use by external audiences

DATA VALUE CHAIN

Data Collection → Data Storage → Data Production → Data Processing → Data Contextualization

TECHNOLOGIES THAT HAVE SIGNIFICANT POTENTIAL TO IMPROVE THE VCM

D-MRV (Remote Sensing, Machine Learning, Artificial Intelligence)

Web 3 (Blockchain, Artificial Intelligence)

Data Integrity Needs Multiple Types of Digital Tools and Technologies to Work in Tandem

DATA VALUE CHAIN	Data Collection	Data Storage	Data Production	Data Processing	Data Contextualization
TECHNOLOGY TYPES: D-MRV	✓		✓	✓	
TECHNOLOGY TYPES: Web3		✓		✓	✓
WHERE WE SEE THE MOST POTENTIAL FOR TECHNOLOGICAL IMPROVEMENT	**Remote sensing** technologies (e.g., satellites, drones, sensors) make *data collection* more accurate and less resource intensive – especially for MRV	**Web3 technologies** enable *secure and trusted data storage* of the full lifecycle of carbon credits: more local and inclusive data collection and MRV processes, standardized legal documents, and more transparent transaction and retirement process	Many public **remote sensing** datasets are accessible and applicable to baseline calculations and subsequent *MRV approaches*	**Machine Learning** and **Artificial Intelligence** enable automation of essential *data processing* steps, particularly during the MRV cycle: baseline modelling and emission reduction monitoring	**Web3** public platforms *enables better access* to price and transaction data. **Blockchain** technologies can also introduce *better linkages* between underlying MRV data and prices

Innovations in Measurement Can Alleviate Subjectivity in Data, but Still Faces Challenges of Adoption

Quality Criteria (data variable)	Innovations on the Data Integrity Side	Innovations on the Process Integrity side	Limitations of Technologies
Additionality	• Remote sensing and similar technologies are enabling post-implementation assessments of additionality (e.g., Pachama's dynamic baselines)		• Post-implementation assessments of additionality introduce uncertainties in projected revenues of a project and thus face backlashes • Forecasted additionality can be undone by changes in external conditions (i.e., policy changes or market fluctuations)
Baseline Setting	• Push for independent actors to do more baseline setting (e.g., third-party modelling developed by scientists and calibrated by ground-truth data) • For forestry credits, remote sensing can help randomly select control groups or compute uncertainty (piloted by Sylvera, Renoster, and Pachama) • Post-implementation accuracy assessment of the initial baseline (piloted by Pachama)	• Verra's new consolidated REDD+ methodology will have more standardized components built upon remote sensing	• Ex-ante counterfactuals are inherently subjective and difficult constructs • Independent datasets are not always available to project developers

Innovations in Measurement Have Potential to Improve Certain Quality Criteria in the Long-Run, but Currently Face Technology Limitations

Quality Criteria (data variable)	Innovations on the Data Integrity Side	Innovations on the Process Integrity side	Limitations of Technologies
Permanence	• Nascent and relatively rare insurance solutions (e.g., those offered by Aon and Revalue Nature), and climate risk quantification	• Verra is beginning to use remote sensing to monitor reversal events after retirement	• Inherently difficult to define, measure, and prove "permanence" in dynamic systems
Leakage			• Very difficult to determine the leakage factor or directly account for its potential impacts in a data-driven and scientific way
Uncertainty	• Preference for conservativeness and thus estimations of all possible uncertainties		• Estimating uncertainties is very resource-intensive. A large amount of field tests are needed for different bioprocesses in open systems

Innovations in Measurement Can Increase the Value of Co-Benefits in Carbon Projects, but Real Impact is Hard to Know and/or Ascertain

Quality Criteria (data variable)	Innovations on the Data Integrity Side	Innovations on the Process Integrity side	Limitations of Technologies
Co-Benefits	• Piloting new payment models using blockchain approaches or Digital Ledger Technologies to distribute revenue to local communities	• Emerging standards programs are introducing new verification requirements (for e.g., technical working groups, third-party expert reviews, and project spot checks)	• Place-based, intangible or non-monetary nature of some co-benefits makes it inherently difficult to measure • To date, there has been limited research to understand and measure the value of co-benefit

PART C

How to Merge Process Integrity and Data Integrity

Best Practices to Strengthen Process Integrity to Move Ahead of Current State of Play

There are sporadic instances where early adopters have start to pilot these best practices, but the entire ecosystem needs to embrace these changes.

Methodology Creation

1. Have a panel of experts (selected independently) with broad, relevant expertise review the methodology
2. Streamline and digitalize public comments in consultation phase for the ease of digestion
3. Transparently disclose the tradeoffs and decisions behind a new methodology on flexibility and rigor

Verification

1. Update and publicize the qualification requirements for third-party VVBs to catch up with digital advancements in the sector of concern
2. Identify data that can be reliably collected and verified by local actors (e.g., video checks for facilities) to reduce verification and validation costs and enable bottom-up governance

Innovations are Starting to Merge Best Practices Between Data and Process Integrity, but Still a Long Way to Go for Large-Scale Adoption

01 Complex local realities

- Align data collection with local priorities and consolidate existing data sources.

02 Centralized methodology

- Develop tools ((e.g., those help ground-truthing for remote sensing data) to connect scientists and local participants to promote the quality and speed of data collection and methodology updates.

03 Lack of accessible data

- Operationalize secure data storage, make contextualized data accessible to all stakeholders (e.g., machine-readable formats & API access), and encourage transparency of processed data (e.g., modelling techniques).
- Registries to implement appropriate data aggregation that protects individual privacy but improves data accessibility.

04 Data & quality literacy

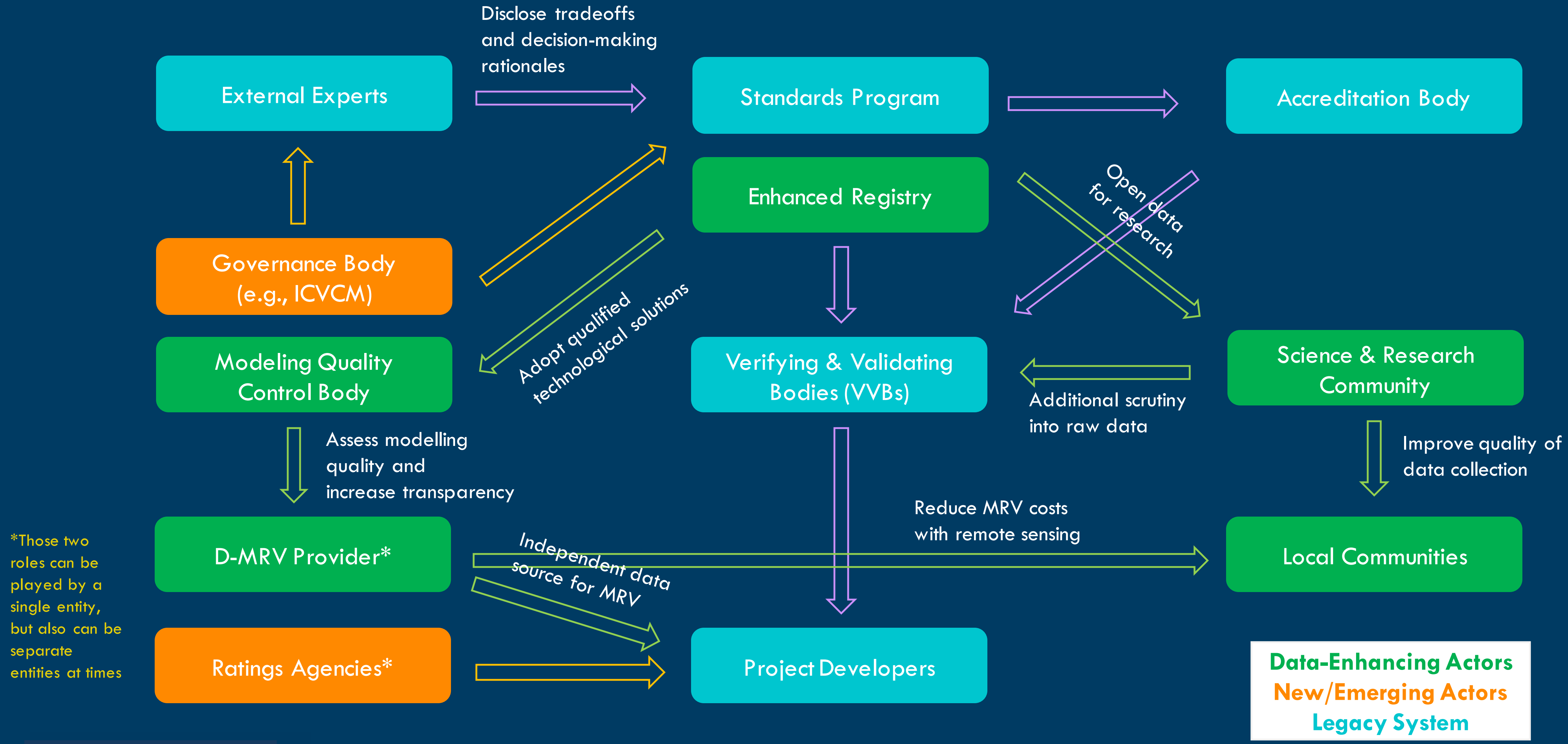
- Resource-intensive, multi-year initiatives (e.g., ICVCM) to uniformly compare & assess methodologies.
- Harmonized framework to assess uncertainties and quality of modelling techniques for data processing.

05 Lack of clear buyers' guidance

- Buyers enabling price premium for credits with high-quality data and provide incentives for landowners and developers to share data.

Action under development
Action yet to happen

Beyond Adoption, Bridging Various Actors is Essential to Create an Ecosystem where Data Integrity and Process Integrity is Connected



SECTION III

Deep Dive Into the Demand Side

How do market stakeholders relate to each other? Where are they transacting credits? What challenges do they face navigating this journey?

KEY TAKEAWAYS

Deep Dive Into the Demand Side

Takeaway 1: The Behavior of Buyers is Driven by Three Motivations -- Openness to Innovation, Reputational Awareness, and Risk Mitigation

Innovation-led buyers purchase credits underpinned by new technologies to accelerate commercialization and bring down costs. They use offtake agreements and advanced market commitments (AMC) to do this. Often focused on removal credits.

Reputation-led buyers purchase credits to build their public reputation. They have invested in removal projects by joining the AMCs started by innovation-led buyers.

Risk mitigation-led buyers purchase credits to manage risk and demonstrate climate leadership in hard-to-abate sectors. They mostly tend to invest in avoidance forestry projects and renewable energy projects.

Selecting high-potential pathways and reliable developers.

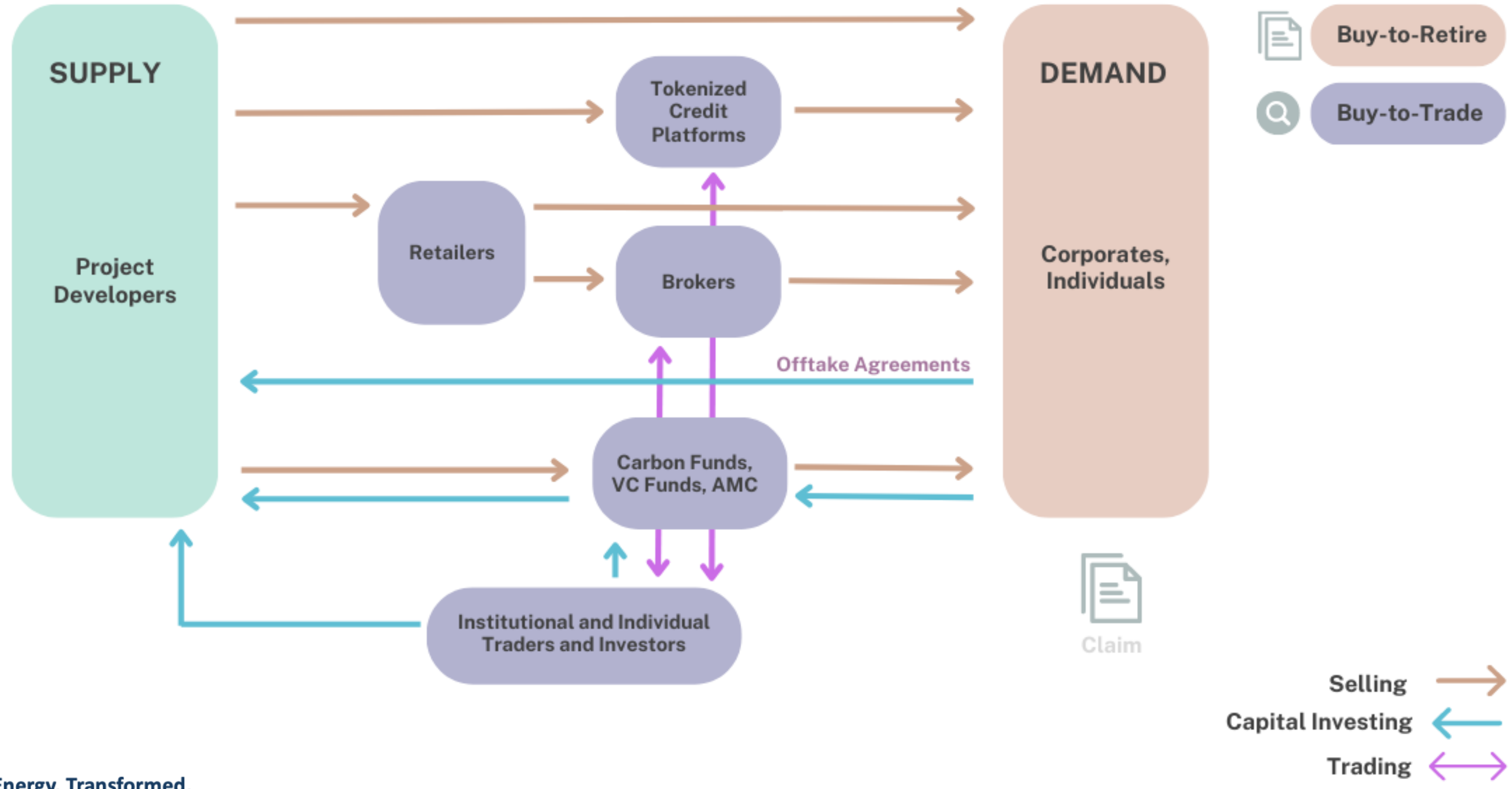
Securing stable, high-quality supply within budget to support credible, future claims.

Limited budget where credits purchased are to manage public reputations.

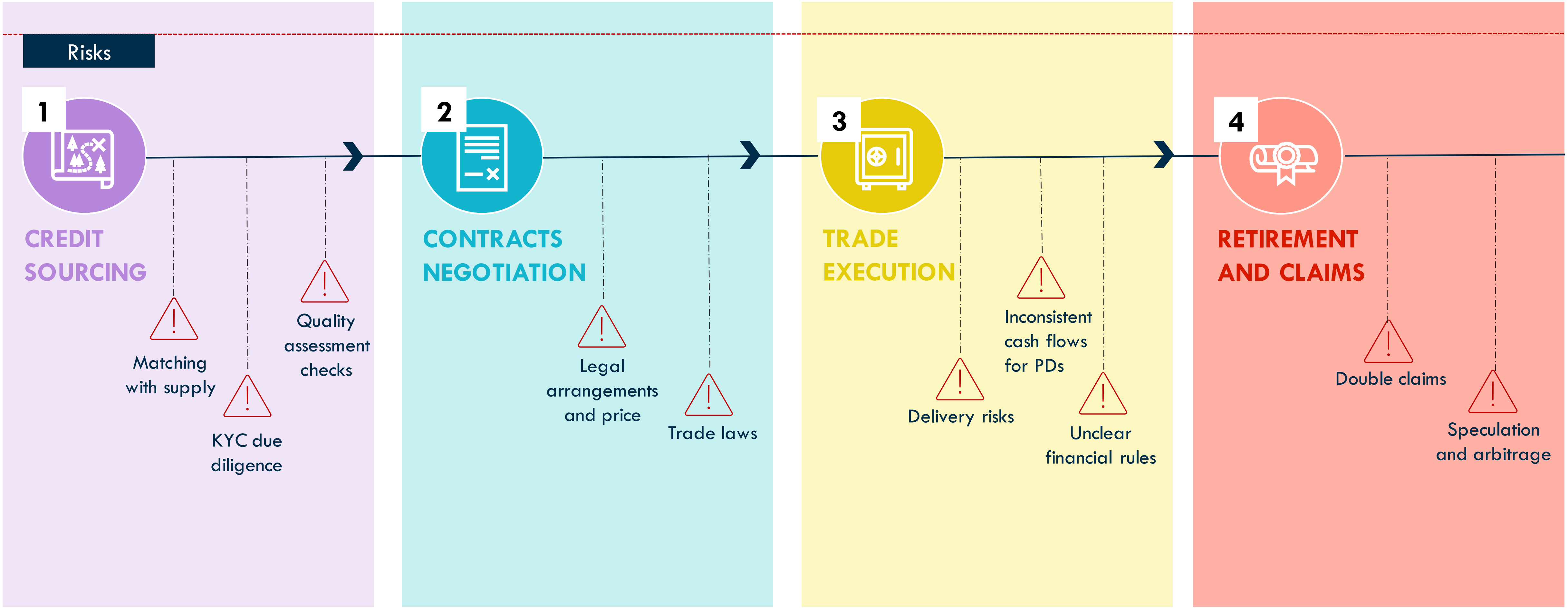
Key Challenge for each type

This visual is inspired to but does not represent an innovation adoption curve for carbon credits buyers. Companies included represent a sample based on information contained in their sustainability reports.

Takeaway 2: Interactions Between Actors on the Supply and Demand Side of the Market are Complex



Takeaway 3: The Procurement Path Involves Multiple Types of Risks for Buyers and Other Purchasing Entities



Takeaway 4: Public Guidance for Buyers Agrees on Transition Strategy but Cannot Reach Consensus on the Definition of High-Quality Carbon Credits

WHERE DOES THE GUIDANCE AGREE?	WHERE DOES THE GUIDANCE DISAGREE OR IS UNCLEAR?
Setting a decarbonization strategy including long-term and interim science-based targets	Interim target requirements differ and tools to measure and track progress are still under development
Prioritizing insetting, e.g., abatement of emissions within supply chain	Sectoral decarbonization guidance is available for most sectors and new guidelines on the role of "beyond value chain mitigation" for corporates
Procure high-quality carbon credits as a complement that does not count towards targets	Definition of high-quality credit varies, has consensus on limited metrics, or is extremely vague
Prioritize avoidance in the short-term, progressively shifting towards removal and permanent removal to achieve net-zero by 2050	Guidance to quantify the proportions of avoidance and removal credits and the timeline for the shift towards permanent removal is unclear

Takeaway 5: Despite Significant Challenges, Buyers Rely on Emerging Market Approaches and Technology-Driven Solutions to Keep Moving

Private Sector Solutions

Microsoft and Carbon Direct published their **'Criteria for High-Quality Carbon Dioxide Removal'** in 2021 to orient developers responding to Microsoft's Request for Proposals. The document includes 7 essential principles:

- Additionality and baselines
- Carbon accounting method
- Harms and benefits
- Durability
- Environmental justice
- Leakage
- MRV

Frontier, Climeworks, Shopify, and Stripe-led Advanced Market Commitment focused on permanent removal all apply a mix of the above criteria in their removal portfolio creation.

Legacy Industry Certifications

Recognized since 2008, **the ICROA certification program** defines and certifies carbon carbon credit standards and project developers in accordance with its Code of Best Practice. ICROA also certifies carbon management service providers more broadly. The VCM standards assessment criteria are defined at a high-level to include:

- Independence
- Governance
- Registry
- Validation/verification
- Carbon crediting principles
- Environmental/ social impacts
- Stakeholder considerations
- Scale

ICROA is supporting the ICVCM in the development of its Core Carbon Principles and related Assessment Procedure.

New Multi-Stakeholder Initiatives

The **ICVCM's '10 Core Carbon Principles (CCPs)** set a market benchmark for high-integrity carbon credits that will form the basis of a two-step assessment procedure. The CCPs are:

- Effective governance
- Tracking
- Transparency
- Robust Independent Third-Party verification
- Additionality
- Permanence
- Robust quantification of emission reductions and removals
- No double counting
- Sustainable development benefits and safeguards
- Contribution toward net zero transition

Data and Technology Services

Statistical tools and technologies such as remote sensing, machine learning and distributed ledger technologies (e.g., blockchain) are enabling improvements in data collection and interoperability, as well as carbon credit quality assessment and traceability:

- Remote sensing and machine learning can enhance the **quality of forest carbon credits** by improving baseline, leakage, and additionality calculations.
- **End-to-end decentralized data ecosystems** are promising to deliver platforms that will aggregate and harmonise carbon credit registry data to enhance communication and transparent accounting.
- Some **blockchain-based platforms** create a digital twin of credits, facilitating traceability of credits all the way to retirement.

SECTION DEEP DIVE

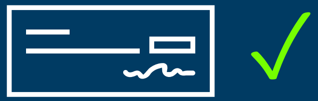
Deep Dive Into the Demand Side

PART A

The Buyer Journey: Archetypes, Stakeholder Mapping and Interactions

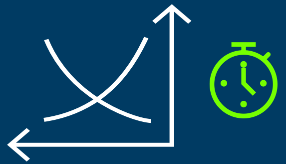
At the Highest Level, Credit Buyers can be Categorized into Two Broad Archetypes

Buy-to-Retire Actors



- Purchase credits to retire immediately and claim the related benefits (for associated emissions reduction and/or removal).
- Individual buyers purchase readily available (already issued) credits.
- Some corporate buyers provide project financing by paying to develop the carbon credit projects that they ultimately intend to retire.

Buy-to-Trade Actors



- Purchase credits to trade and invest for their own accounts or for financial speculation (e.g., traders at hedge funds and trading desks at investment banks).
- Some buyers match other buyers and sellers over the counter, on exchanges (brokers and retailers), or on carbon-to-crypto markets (e.g., tokenized credits platforms).

The Behavior of Buy-to-Retire Actors is Driven by Three Motivations: Openness to Innovation, Reputational Awareness, and Risk Mitigation

Innovation-led buyers purchase credits underpinned by new technologies to accelerate commercialization and bring down costs. They use offtake agreements and advanced market commitments (AMC) to do this. Often focused on removal credits.

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Selecting high-potential pathways and reliable developers.

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Limited budget where credits purchased are to manage public reputations.

Key Challenge for each type

This visual is inspired to but does not represent an innovation adoption curve for carbon credits buyers. Companies included represent a sample based on information contained in their sustainability reports.

Buyers are Interacting with a Range of Stakeholders Performing Different Overlapping Roles Across Supply-Demand Functions

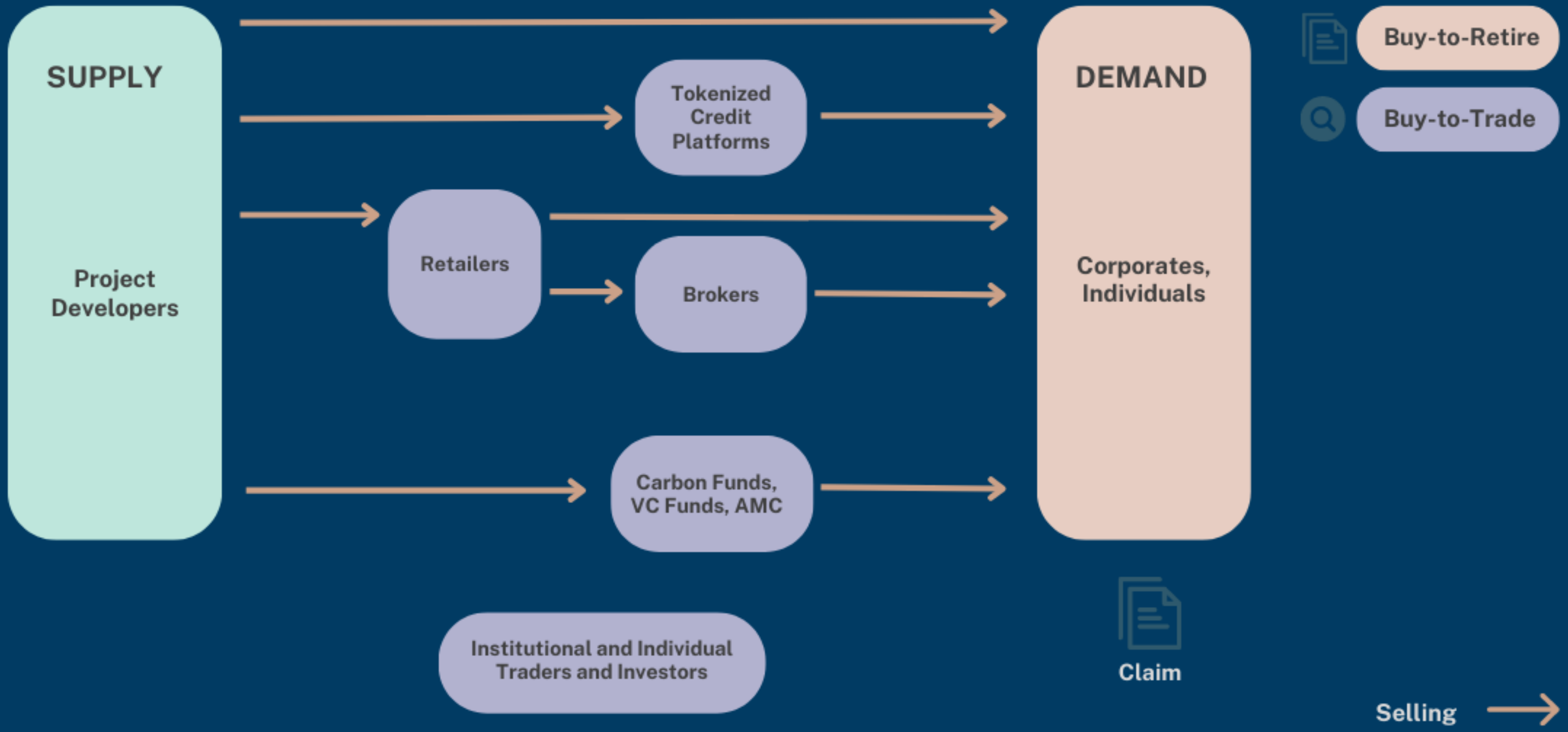
Supplier
Buy-to-Retire
Buy-to-Trade

Overlapping Market Functions

Stakeholders

Functions	Project Developer	Retailer	Broker	Tokenized Credit Platform	Carbon/ VC Fund	Institutional/ Individual Trader	Institutional/ Individual Investor	Advanced Market Commitment	Corporate	Individual Buyer
Selling	✓	✓	✓	✓	✓					
Trading			✓			✓				
Capital Investing					✓		✓	✓	✓	
Purchasing		✓	✓		✓	✓			✓	✓

Interactions Between Project Developers, Buy-to-Retire and Buy-to-Trade Actors are Complex



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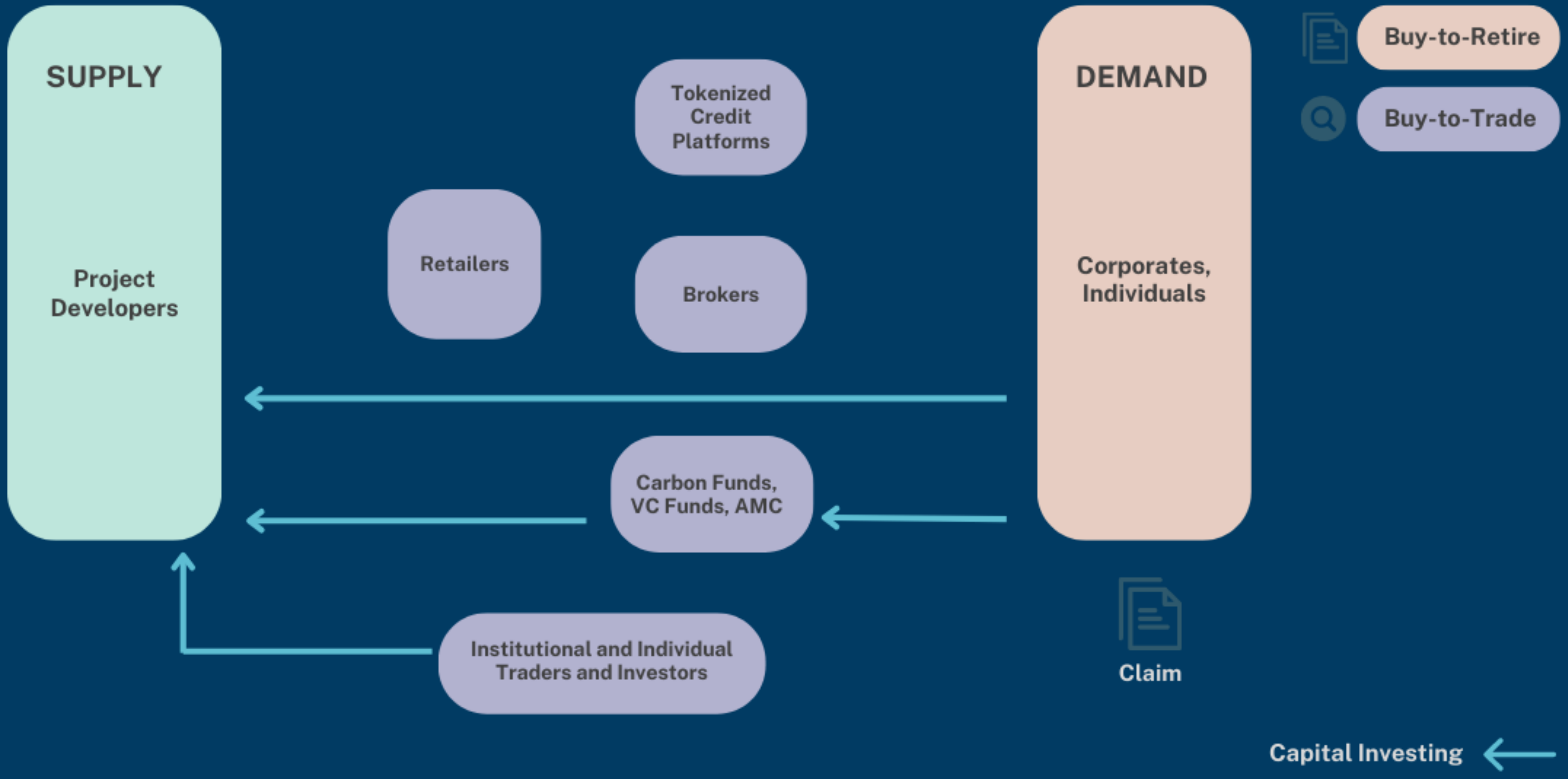

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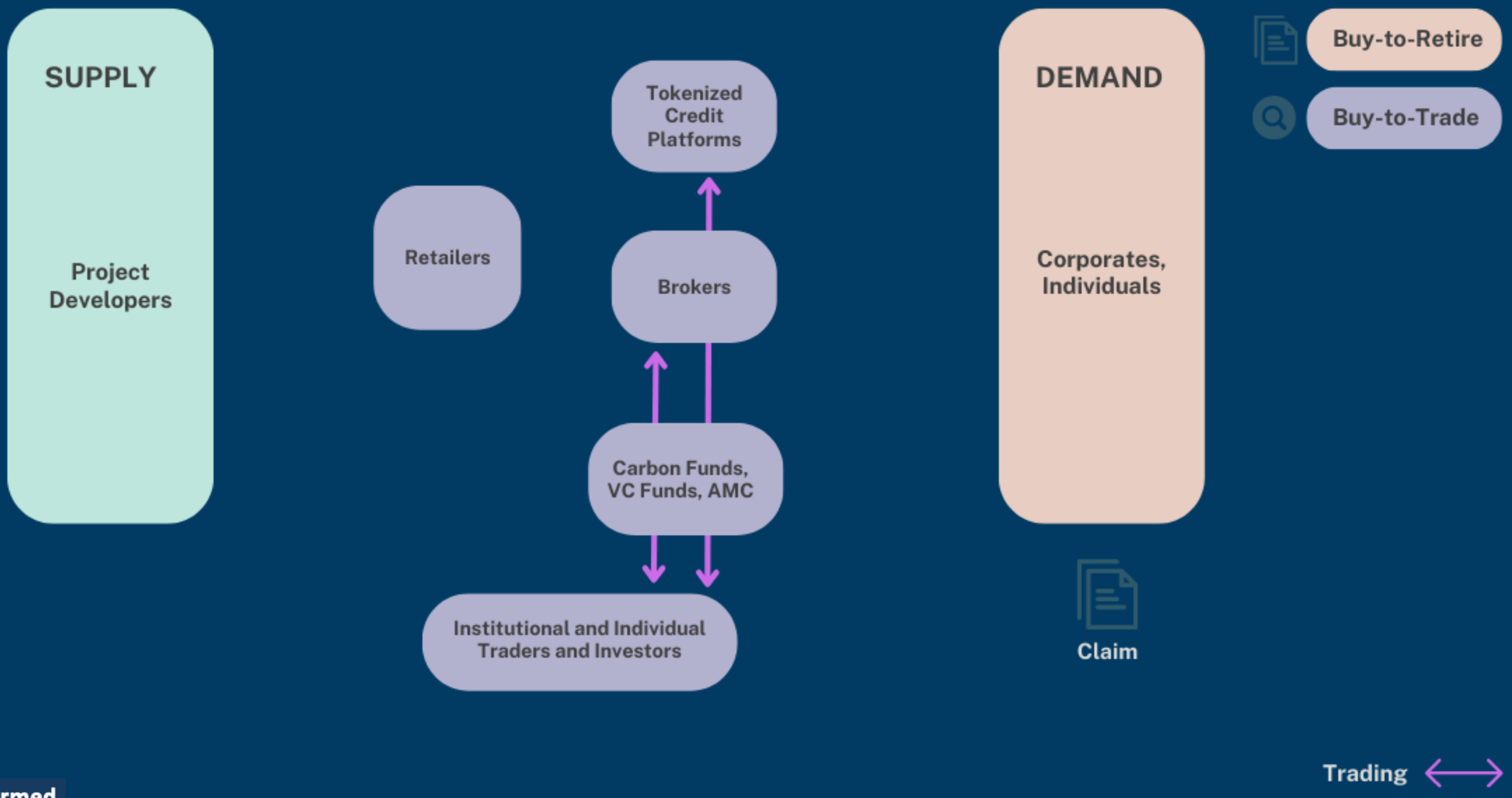
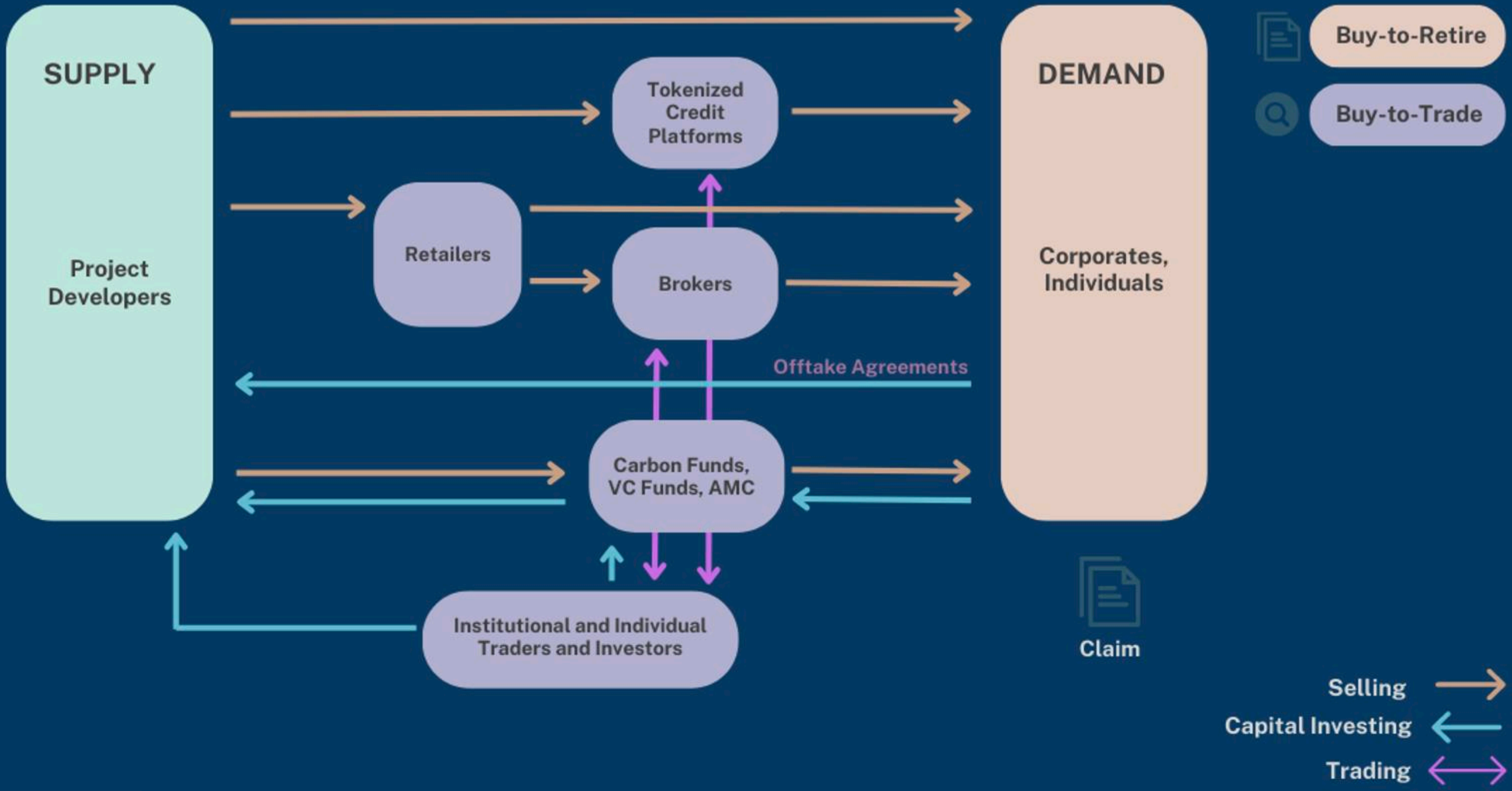
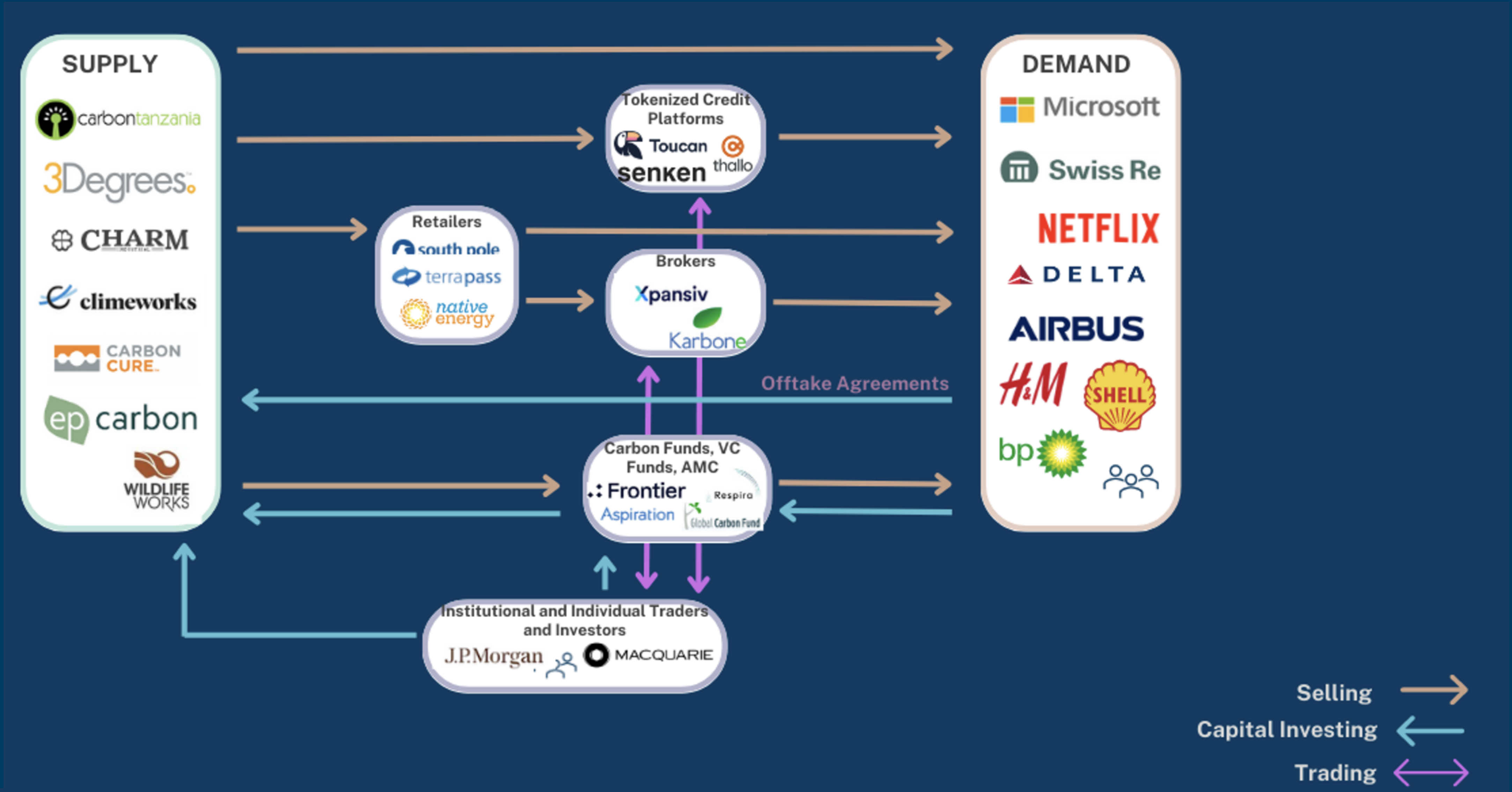


Interactions Between Project Developers, Buy-to-Retire and Buy-to-Trade Actors are Complex



Non-Exhaustive Stakeholder Mapping of the Complex Interactions Between Market Actors



PART B

Transaction Channels: Mechanisms to Purchase Carbon Credits

This slide provides a non-exhaustive illustration of market participants.

Transaction Channels Available to Buyers in Their Procurement Journey

OVER-THE-COUNTER (OTC) MARKETS

BILATERAL TRADING

1:1 BUYER-DEVELOPER

south pole · Wildlife Works (Carbon Offsets – Forest Protection Credits) · indigo · Pachama · 3Degrees

INTERMEDIARY-BUYER

Evolution Markets (an Xpansiv company) · Redshaw advisors ltd. · Karbone · Climate Impact Partners

MARKETPLACES

WEB2 MARKETPLACE

salesforce · south pole · Patch · pledge

WEB3 MARKETPLACE

thallo · Toucan · senken · Atem · Flowcarbon · REGEN NETWORK

EXCHANGES

CENTRALIZED TRADING

BESPOKE AUCTIONS

Climate Impact X · ICE · AirCarbon Exchange · XCHG (Xpansiv | CBL Holding Group)

OTC MARKETPLACE

Climate Impact X · Nasdaq · XCHG (Xpansiv | CBL Holding Group)

STANDARDIZED CONTRACTS

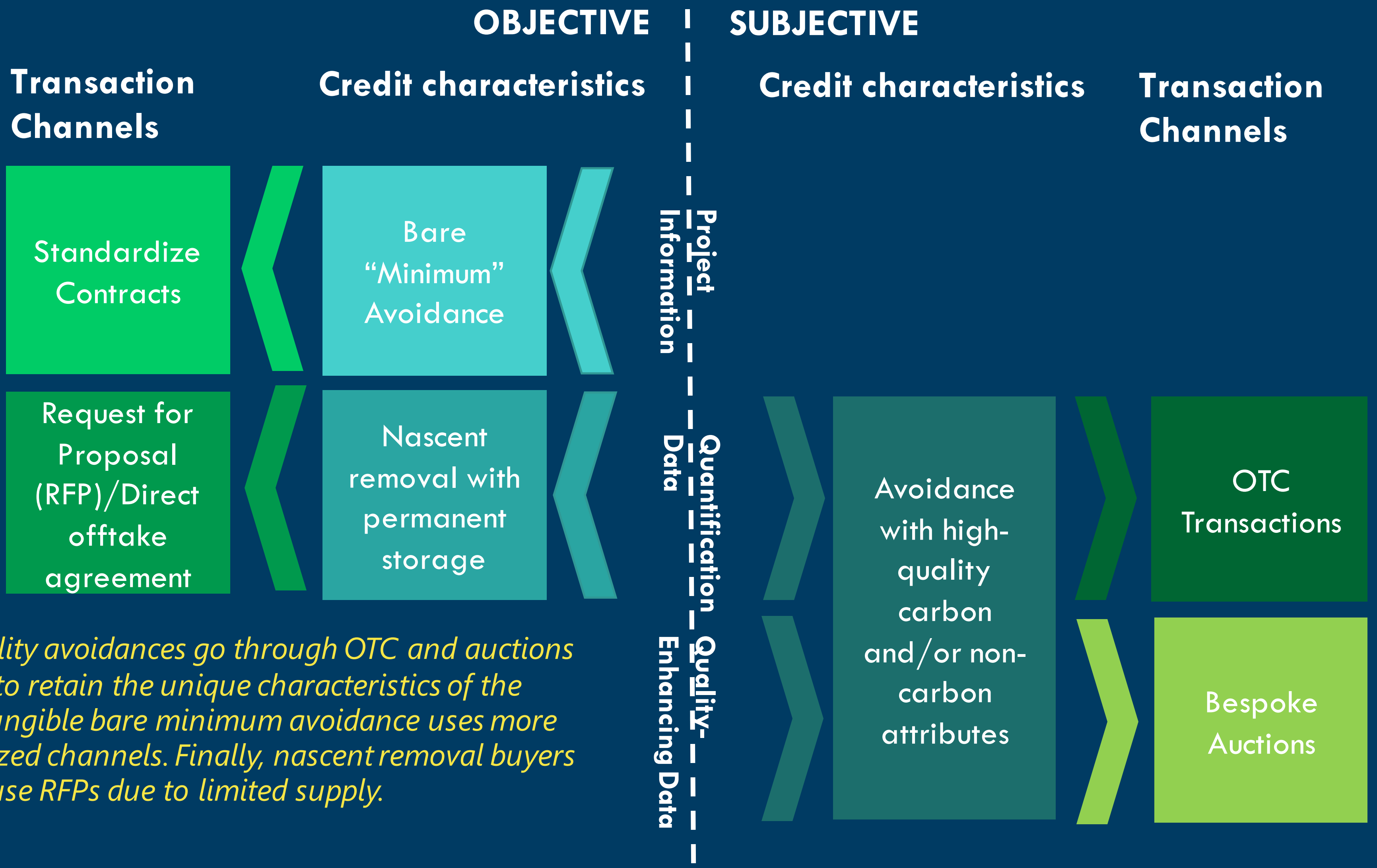
SPOT EXCHANGE

XCHG (Xpansiv | CBL Holding Group) · AirCarbon Exchange · Climate Impact X · NEUTRAL

FUTURES EXCHANGE

Xpansiv · CME Group · ICE

Different Types of Credits Demand Different Transaction Channels



High-quality avoidances go through OTC and auctions channels to retain the unique characteristics of the credits. Fungible bare minimum avoidance uses more standardized channels. Finally, nascent removal buyers typically use RFPs due to limited supply.

PART C
Buyer Issues: Navigating Risks and Uncertainties

Credit Buyers Navigate Two Broad Interconnected Issues in the Buy-Sell Process

Issue 1

RISK

The complicated steps involved in procuring carbon credits, and the risks associated at each step.

Issue 2

UNCERTAINTY

The state of guidance available to buyers as they navigate the complicated world of carbon credits purchase.

The level of uncertainty around how to vet quality reinforces the mitigation strategies available to buyers and the number of risks involved in the buying and selling of carbon credits.

Issue 1: Buyers Navigate a Long and Complex Procurement Path

FUNCTIONS

1

CREDIT SOURCING

Discuss price, volume, and other sourcing priorities with chosen transaction channel.

2

CONTRACTS NEGOTIATION

Draw up a legal contract based on mutually agreed upon terms and length of delivery.

3

TRADE EXECUTION

Initiate transaction and credit transfer process from seller account to buyer account.

4

RETIREMENT & CLAIMS

Ensure claims related to carbon credit use are verified through proof of ownership.

TOUCHPOINTS

DUE DILIGENCE

Verifying entity-level KYC and project-level details.

SOURCING

Using RFPs, carbon brokers, OTC marketplaces, or exchanges to filter or match credit selection criteria.

TERMS ARRANGEMENT

Predetermining the aspects of quality, volume, payment method and delivery date.

CLEARING

Verifying both parties have the resources (funds and tons) to complete the transaction.

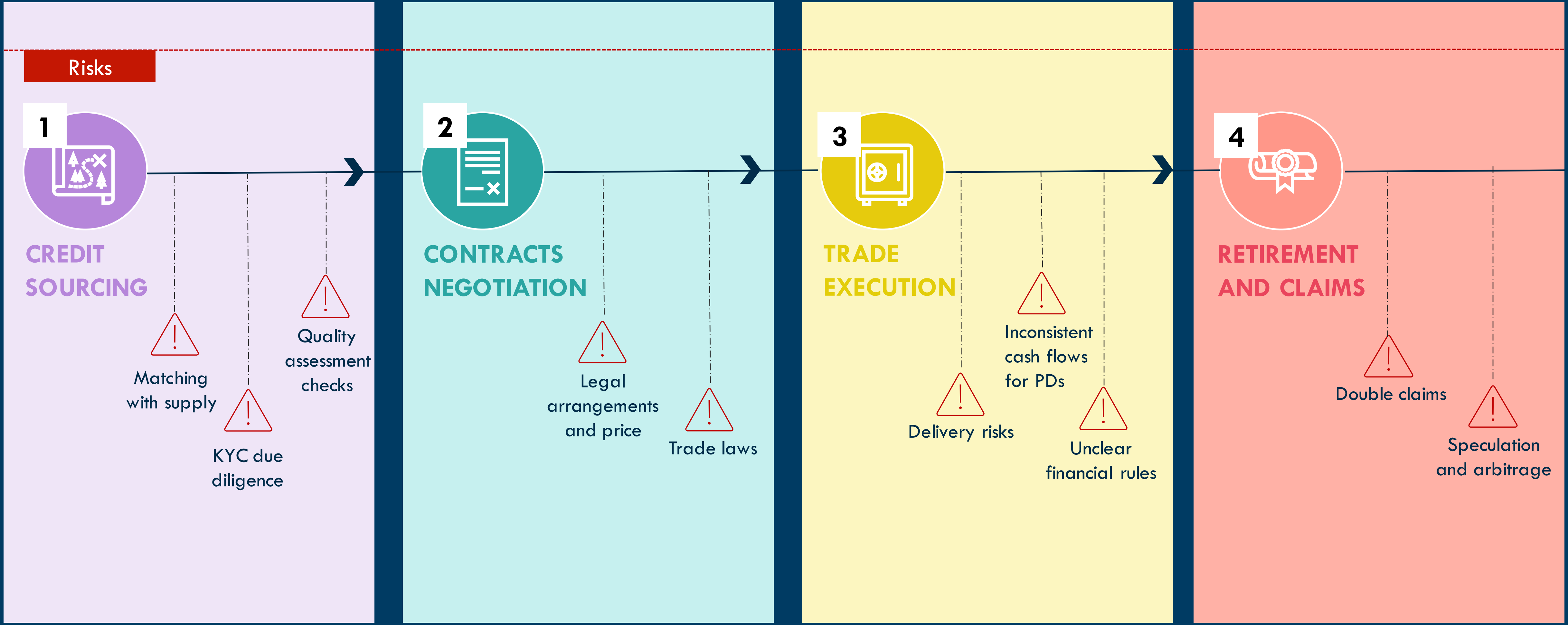
SETTLEMENT

Executing final stage of the financial transaction, which may occur immediately or take several days.

FINAL RECORD

Linking internal transaction database with crediting program registries to correctly reflect the status of ownership.

Issue 1: The Procurement Path Involves Multiple Types of Risks



Issue 1: These Risks Often Make the Process of Transacting Carbon Credits A Messy Experience for Buyers

1 CREDIT SOURCING

- Sourcing involves complex operations and decisions around the availability of desired credits and its quality.
- KYC due diligence of large corporate buyers can take up to a month or two, stressing tight cashflows of developers.

2 CONTRACTS NEGOTIATION

- Carbon credit transactions happen across national boundaries, introducing legal complexities that can add time and costs.
- Contracts need to be designed with flexibility to respond to unknown risks down the line.

3 TRADE EXECUTION

- Project developers often don't have sufficient capital to securely develop projects.
- Today, carbon credit trades are cleared and settled in the absence of clearcut and predictable financial standards, risk controls, and regulatory oversight.
- Manual settlement of trades can take anything from a few weeks to over a month to finalize.

4 RETIREMENT AND CLAIMS

- Brokers, traders, and financial speculators are increasingly holding carbon credits for future use or arbitrage possibilities, complicating the retirement step.
- Many buyers retire their credits through brokers. In the legacy registries, brokers send buyers a retirement certificate in a simple PDF that does not protect against the risk of double claims.

Issue 2: The Available Public Guidance for Buyers Tends to be Inconsistent, Incomplete, and Fragmented

Corporate purchases data is non-exhaustive and scattered

Information can be found across sustainability reports and publicly available databases, but with varying levels of detail. Some corporates publish RFP and investment details, others only mention a few highlights.

Voluntary disclosures can't be easily compared

Corporates voluntarily publish sustainability information, but follow different sustainability standards and frameworks (e.g., GRI, ISSB, CDP), making comparability and completeness of information challenging.

Publicly available databases uncover partial transaction information

The Berkley Carbon Trading Project and CDR.fyi databases contain publicly available information, which does not capture the volume of transactions completed in the market.

Issue 2: Buy-to-Retire Actors Face Three Big Challenges During Their Strategy-Setting and Procurement Process

Net-Zero Strategy Challenge
Uncertainty around why and how much to invest in carbon credits.

Guidance coming from leading organizations does not provide clear incentives to use carbon credits and consistent instructions on how to use avoidance vs. removal credits. This creates ambiguity and risks for buy-to-retire actors looking to the VCM to meet their net-zero targets.

Credit Quality Challenge
Uncertainty around assessing quality and what carbon credits to buy

All buyers navigate market-wide uncertainty about how to define and identify high-quality credits that suit their needs and strategies.

Sourcing and Execution Challenge
Uncertainty around how to source carbon credits and what claims to make

Buyers also face uncertainty and navigate risks when executing their procurement strategies, that often involve several transaction channels. At the end of the procurement process, they face uncertainty on how to claim the benefits related to the purchased credits.

Issue 2: The Long List of Questions* Buyers Have to Ask During Their Strategy-Setting Reveals the Complexity of the Procurement Process

Net-Zero Strategy Challenge

- What science-based targets can we set and achieve by directly reducing emissions in our supply chain?
- Where can we invest inside our supply chain to maximize decarbonization its insetting potential?
- How many tons can we compensate beyond our value chain?
- What role do carbon credits play in broader decarbonization plans?
- How much of that should be avoidance vs. removal credits?

Credit Quality Challenge

- What credits do we need to buy?
- What is a high-quality carbon credit?
- Will the project deliver our desired climate impact?
- What is our tolerance for counterparty risk, price volatility, and market illiquidity?
- How can contractual agreements protect us against violations of international trading rules and legal requirements?
- How can we safeguard against greenwashing accusations and purchasing low quality credits?

Sourcing and Execution Challenge

- How do we plan an order and execute a trade?
- What information do we need to confirm this trade is meeting our goals?
- When will the credit be delivered?
- Do we have in house expertise and resources to purchase credits, or do we need to rely on intermediaries?
- Who do we need to source the credits?
- What are the claims we can make once the credit is retired?

*Illustrative version of a broader set of decisions buyers have to face.

Issue 2: Different Types of Guidance Address the Three Big Challenges at Different Levels

BUYER-ORIENTED GUIDANCE

Addressed specifically to buyers and provides actionable recommendations

At the **corporate level**, organizations such as SBTI and VCMI* provide guidance on how to navigate net-zero strategy setting. They rely on the concept of mitigation hierarchy: avoidance, minimization, and restoration and offsets, while deferring to other organizations to define carbon credit quality.

At the **project level**, guidance for buyers comes from organizations such as WRI and WBCSD* to support them in assessing quality as well as navigating sourcing and execution of credits. It focuses on due diligence, mostly for nature-based solutions.

CREDIT-ORIENTED GUIDANCE

Provides cross-cutting definition of quality, with limited direct applicability for buyers

At the **methodology level**, organizations such as ICVCM* and the Carbon Credit Quality initiative offer guidance aimed at defining credit quality. Although this guidance addresses the quality challenge, it does not orient buyers on what type of credit to purchase or how to make claims, nor on how to conduct due diligence. On the other hand, it aims at establishing a cross-cutting definition of carbon credit quality for the market.

*ICVCM: Integrity Council for the Voluntary Carbon Market; SBTi: Science-Based Targets initiative; VCMI: Voluntary Carbon Market Integrity initiative; WRI: World Resources Institute; WBCSD: World Business Council for Sustainable Development

Issue 2: Guidance for Buyers Agrees on Transition Strategy but Cannot Reach Consensus on the Definition of High-Quality Carbon Credits

WHERE DOES THE GUIDANCE AGREE?	WHERE DOES THE GUIDANCE DISAGREE OR IS UNCLEAR?
Setting a decarbonization strategy including long-term and interim science-based targets	Interim target requirements differ and tools to measure and track progress are still under development
Prioritizing insetting, e.g., abatement of emissions within supply chain	Sectoral decarbonization guidance is available for most sectors , while guidelines on "beyond value chain mitigation" is under development
Procure high-quality carbon credits as a complement that does not count towards targets	Definition of high-quality credit varies, has consensus on limited metrics, or is extremely vague. Cross-cutting definitions are under development
Prioritize avoidance in the short-term, progressively shifting towards removal and permanent removal to achieve net-zero by 2050	Guidance to quantify the proportions of avoidance and removal credits and the timeline for the shift towards permanent removal is unclear

Organizations providing guidance are increasingly working synergistically to minimize confusion for their audience. ICVCM and VCMI announced their plans to join forces in June 2023.

Organizations that provide definition of quality include World Resources Institute, Natural Climate Solutions Alliance, World Business Council for Sustainable Development & World Economic Forum, Carbon Credit Quality initiative, World Wildlife Fund, Environmental Defense Fund, Oeko Institut, and Conservation International.

Issue 2: A Short History of How Guidance has Evolved and the Leading Guidance Providers in the VCM

2020

The **University of Oxford** set the stage with its *Principles for Net-Zero Aligned Carbon Offsetting.*

2021

The **Science-Based Targets Initiative (SBTi)** developed its *Corporate Net-Zero Standard*, with further guidance on the use of carbon credits expected later in 2023.

2023

The **Voluntary Carbon Market Integrity initiative (VCMI)** issued its draft guidance *Claims Code of Practice* on how to use and make claims related to carbon credits.

Oxford University, SBTi and VCMI are the leading guidance providers. Other notable voices include Environmental Defense Fund, World Resources Institute, Energy Transitions Commission, Conservation International, and the Nature Conservancy.

Issue 2: Deep Dive – Oxford University (2020)
A Principles-Based Approach

The Oxford *Principles for Net Zero Aligned Carbon Offsetting* states that companies should:

Principle 1

"Cut emissions, use high quality offsets, and regularly revise offsetting strategy as best practice evolves"

Principal 2

"Shift to carbon removal offsetting"

Principle 3

"Shift to long-lived storage"

Principal 4

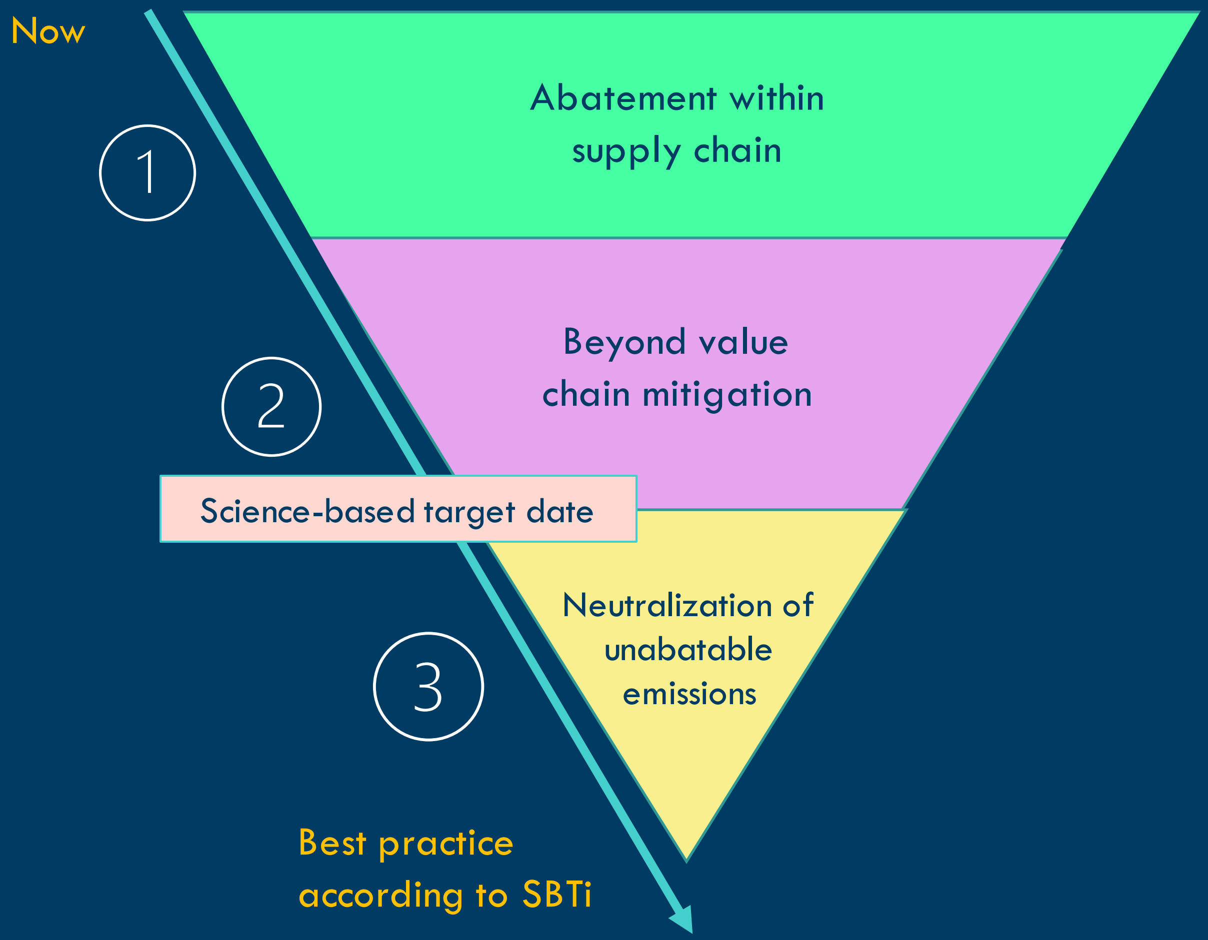
"Support the development of net zero aligned offsetting."

Source: The Oxford Principles for Net Zero Aligned Carbon Offsetting, 2020

Issue 2: Deep Dive – SBTi Net-Zero Standard (2021) A Mitigation Hierarchy-Based Approach

SBTi *Corporate Net-Zero Standard* guidelines states that companies should:

1. **Invest to reduce emissions within their supply chains:** Real emissions reductions count towards achieving science-based targets.
2. **Contribute to societal net-zero by purchasing carbon credits:** Prioritize investment in carbon sinks that avoid emissions. Investment in removal is also encouraged. Neither investment counts towards company's net-zero targets.
3. **Neutralize emissions that cannot be abated through permanent emissions removal:** This should be done when the net-zero target date is reached.



Source: SBTi, 2023

Issue 2: Deep Dive – VCMI (2023) A Claims-Based Approach

The VCMI *Claims Code of Practice* published in June 2023 replaced the 2022 draft guidance. It states that companies should:

Comply with the Foundational Criteria: Companies should maintain and disclose annual GHG emissions inventory; Set and disclose near-term validated targets and commit to net zero no later than 2050, with demonstration of progress; Demonstrate that corporate public policy advocacy activities align with the Paris Agreement.

Select Claims to Make: Companies can select from silver, gold, and platinum claims (see next slide), to be made at the enterprise-wide, brand, product or service-level.

Meet the Required Carbon Credit Use and Quality Thresholds: Companies should purchase ICVCM Core Carbon Principle-Approved carbon credits or CORSIA eligible credits as assessed by ICAO (see slide 107) when assessment of the ICVCM is pending.

Report Information and Obtain Third-party Assurance: Companies should demonstrate compliance with foundational criteria by reporting key information related to carbon credits use. The information should be reported according to the VCMI Monitoring Reporting & Assurance Framework and verified by independent limited assurance providers.

Source: VCMI, 2023

Deep Dive (Cont.): VCMI's Tiered Approach to Link Carbon Credits to Net-Zero Progress

Claim	Carbon Credits Use to Meet Interim Target	Carbon Credits Use to Finance Additional Climate Mitigation Once Progress on Targets is Demonstrated	Amount of High-Quality Carbon Credits
VCMI Platinum	Cannot be used	Required	Equal to 100% or more of 'remaining emissions' of most recent reporting year
VCMI Gold	Cannot be used	Required	Equal to or greater than 60% of 'remaining emissions.' Percentage of credits retired should increase in each subsequent year
VCMI Silver	Cannot be used	Required	Equal to or greater than 20% and less than 60% of 'remaining emissions.' Percentage of credits retired should increase in each subsequent year

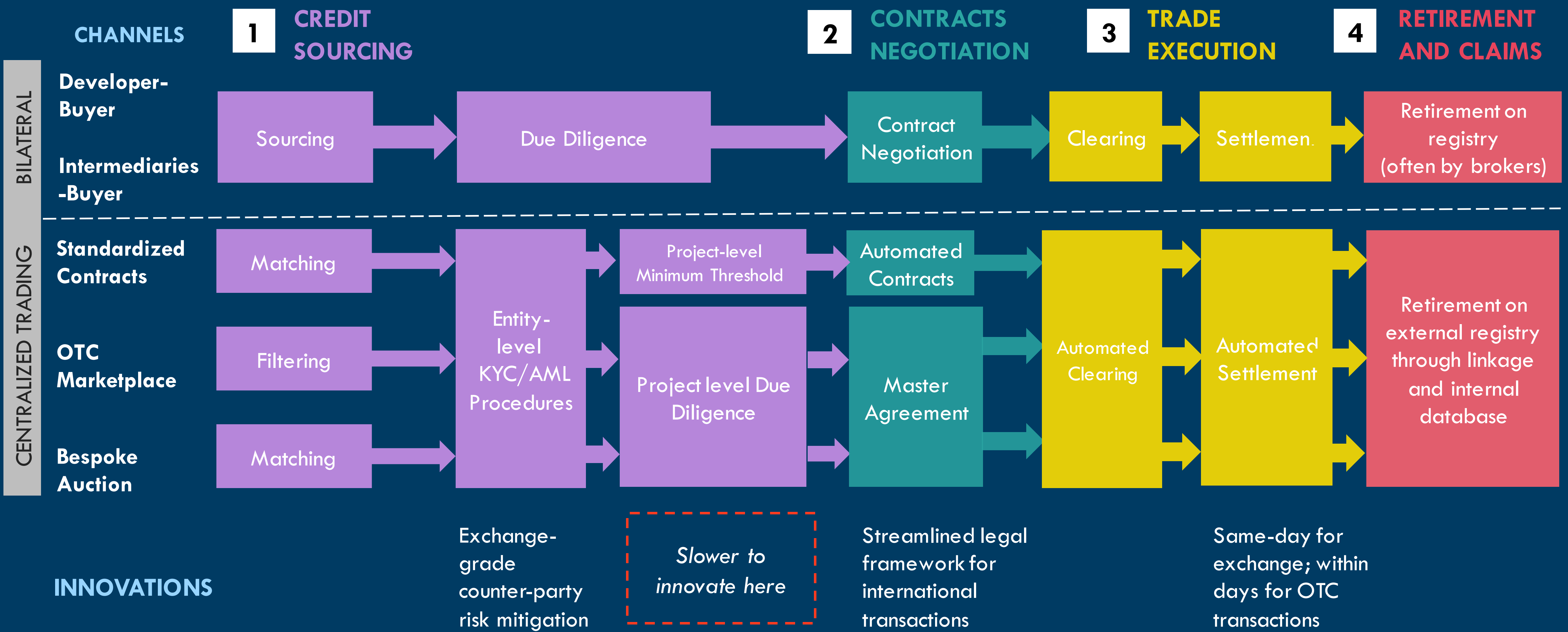
VCMI defines 'remaining emissions' as "emissions that remain in a given year as a company progresses towards the delivery of its near and long-term target."

Source: VCMI Provisional Claims Code of Practice User Guide (2022)

PART D

Market Approaches and Tech-Driven Innovations to Address Buyer Issues

Exchanges are Adopting Digital Advancements to Streamline the Transaction Process



Despite Promising Innovations, Entrenched Data Challenges in the VCM Make the Transaction Process Inherently Complicated

Inherent Structural Barriers Limit Technology-Based Interventions to a Narrower Focus

Technology applications cannot resolve all the intricacies and unique risks at each stage of the transaction process. Barriers driven by entrenched challenges in the VCM (see table) create inherent limitations to technology-based interventions.

Thus, digital tools and technologies have been largely efficiency-focused:

1. Web3 innovations are well suited to address the speed, cost, and operational inefficiencies of purchasing carbon credits
2. Web3 innovations are also driving improvements around the accessibility, traceability, retirement, and exclusivity of carbon credits

	INFORMATION BARRIER	PROCESS BARRIER	CONSENSUS BARRIER
Evidence data	Available Data But Not Accessible	Path Dependency	Subjective Constructs Limitations of Technologies
Non-Evidence Data	Available Data But Not Transparent Available Data But Not Transparent		Subjective Constructs

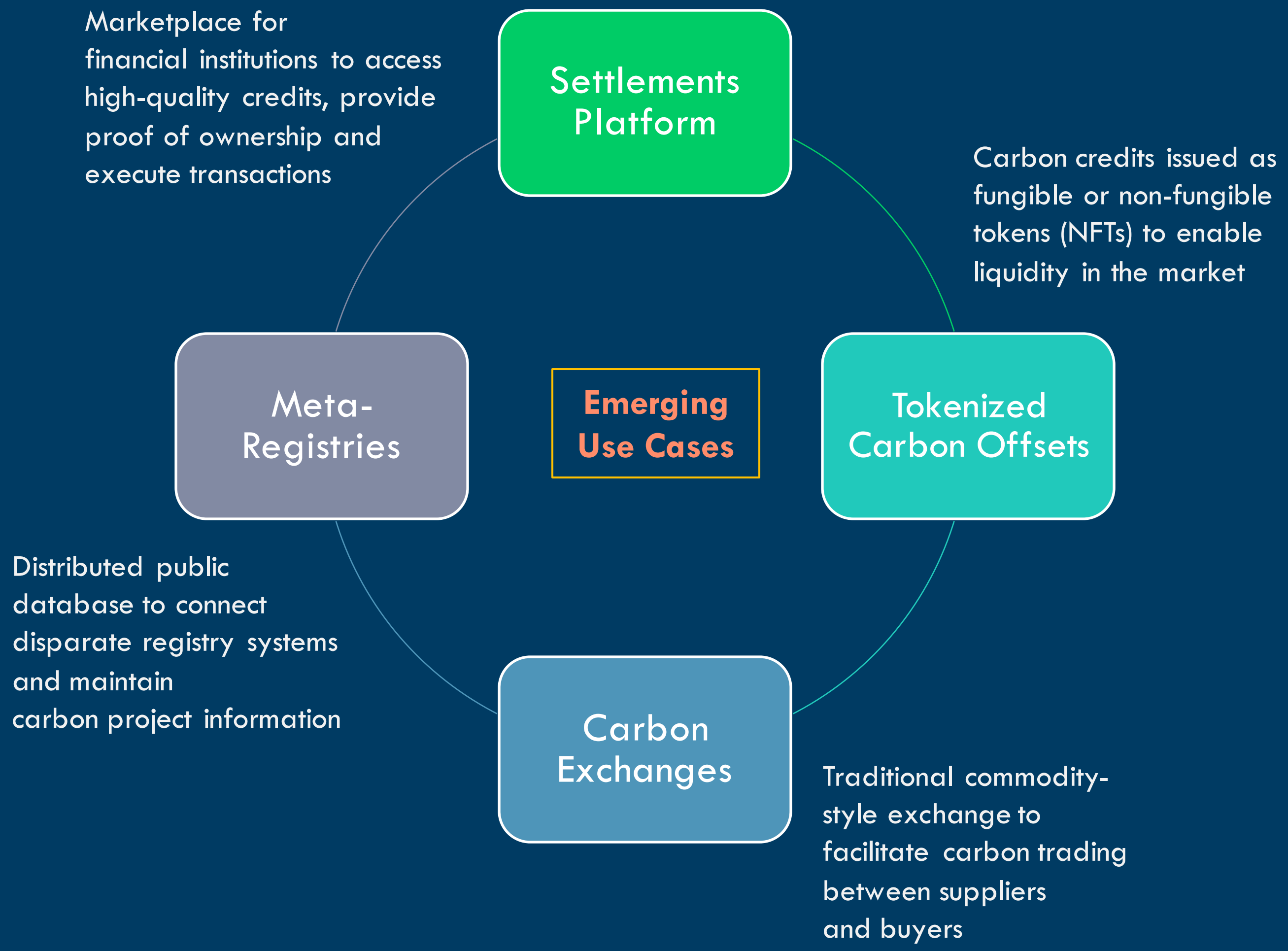
Web3 Technologies are Offering Solutions to Speed up and Simplify the Transaction Process

Web3 Innovations Offer New Ways to Improve Transactional Efficiency

Web3 technologies are introducing opportunities to increase the accessibility and traceability of credits, streamline operations and paperwork, lower transaction costs, and reduce the number of, and reliance on, transaction intermediaries.

Blockchain-based tools provide risk controls for carbon procurement across sourcing, contracts negotiation, trade execution, and retirement and claims. These include:

1. Make carbon credit supply transparent to buyers
2. Implement robust KYC compliance and identity verification
3. Provide near-instantaneous settlements of payments
4. Enhance traceability of credit ownership and retirement



Overcoming Uncertainty: Summary of Private Sector and Industry-Wide Approaches to Tackle Risks and Bridge Existing Gaps in Buyers' Guidance

Private Sector Solutions

In the **absence of industry consensus on quality for emerging removal projects, corporates are filling in the gaps** by developing their own quality criteria. While useful in the short-term, these approaches could prevent coherent progress.

Legacy Industry Certifications

Corporates rely on accreditation programs as an indicator of quality, with the International Carbon Reduction and Offset Alliance (**ICROA**) being the leader in the VCM. ICROA certifies carbon credit developers, VCM standards programs, emissions reduction and offsetting service providers. ICROA has worked closely with the ICVCM in the development of the CCPs.

New Multi-Stakeholder Initiatives

The **Integrity Council for the VCM** (ICVCM) **has developed cross-cutting quality criteria,** the **Core Carbon Principles (CCPs), that inform its assessment procedure.** In their first iteration, the CCPs have been criticized by industry leaders for being too high-level. The ICVCM promised more details and guidance.

Data and Technology Services

Technology is playing a critical role in **advancing quality, transparency, and efficiency** in the VCM. **Remote-sensing and blockchain** technologies have several applications in improving the **monitoring, reporting, and verification (MRV),** as well as enhancing **due diligence checks** of carbon credits.

Overcoming Uncertainty: Detailed Examples of Private Sector and Industry-Wide Approaches to Tackle Risks and Bridge Existing Gaps in Buyers' Guidance

Private Sector Solutions

Microsoft and Carbon Direct published their 'Criteria for High-Quality Carbon Dioxide Removal' in 2021 to orient developers responding to Microsoft's Request for Proposals. The document includes 7 essential principles:

- Additionality and baselines
- Carbon accounting method
- Harms and benefits
- Durability
- Environmental justice
- Leakage
- MRV

Shopify, Climeworks, Stripe, and Frontier, the Advanced Market Commitment focused on permanent removal, all apply a mix of the above criteria in their removal portfolio creation.

Legacy Industry Certifications

Recognized since 2008, the ICROA certification program defines and certifies carbon carbon credit standards and project developers in accordance with its Code of Best Practice. ICROA also certifies carbon management service providers more broadly. The VCM standards assessment criteria are defined at a high-level to include:

- Independence
- Governance
- Registry
- Validation/verification
- Carbon crediting principles
- Environmental/ social impacts
- Stakeholder considerations
- Scale

ICROA is supporting the ICVCM in the development of its Core Carbon Principles and related Assessment Procedure.

New Multi-Stakeholder Initiatives

The ICVCM's 10 Core Carbon Principles (CCPs) set a market benchmark for high-integrity carbon credits that will form the basis of a two-step assessment procedure. The CCPs are:

- Effective governance
- Tracking
- Transparency
- Robust Independent Third-Party verification
- Additionality
- Permanence
- Robust quantification of emission reductions and removals
- No double counting
- Sustainable development benefits and safeguards
- Contribution toward net zero transition

Data and Technology Services

Statistical tools and technologies such as remote sensing, machine learning and distributed ledger technologies (e.g., blockchain) are enabling improvements in data collection and interoperability, as well as carbon credit quality assessment and traceability:

- Remote sensing and machine learning can enhance the quality of forest carbon credits by improving baseline, leakage, and additionality calculations.
- End-to-end decentralized data ecosystems are promising to deliver platforms that will aggregate and harmonise carbon credit registry data to enhance communication and transparent accounting.
- Blockchain-based platforms create a digital twin of credits, facilitating traceability of credits all the way to retirement.

SECTION IV

In Search of Price Discovery

Is credit quality captured by prices in the VCM? How do transaction channels influence pricing?

KEY TAKEAWAYS

In Search of Price Discovery

Takeaway 1: Price is Not Yet a Proxy for Quality; Evidence-based Quality Assessments is the Bridge to Get There

CERTIFICATION & MRV

SUBJECTIVE DATA

Quantification Data

Removal

- Life-Cycle Assessment

Avoidance

- Baseline
- Additionality
- Durability (i.e., buffer credits)
- Leakage

Quality-Enhancing Data

- Social safeguards
- SDGs
- Biodiversity
- Other co-benefits
- Ratings or performance score

Pricing Data Today is NOT a Proxy for Quality, Because:

- Anchored mostly to **project information** and **certification status,** whose binary "pass/no pass" results are not sufficient to capture quality

?

OBJECTIVE DATA

Project Information

- Methodology
- Owner/Developer
- Origin, Type
- Vintage, Geography
- Status, Scope

Removal

- Baseline
- Additionality

Certification Status

Subjective performance data gets approval stamps at different levels (crediting bodies, VVBs) and translated into certifications

Pricing Data Ideally SHOULD Be a Proxy for Quality:

- Will allow the market to capture the total cost of project development, MRV and transaction costs and appropriately capture the true value of desirable subjective data

Issuance

Retirement

SECTION DEEP DIVE

In Search of Price Discovery

The Gap between Price and Quality Impacts How Market Valuation Estimates are Made on Different Types of Credits

OBJECTIVE

Project information and process-integrity status

SUBJECTIVE

Most of carbon and non-carbon attributes

Easier for low-quality avoidance credits to be adequately priced in the market, but more cumbersome for high-quality avoidance credits to receive an appropriate price premium due to the subjective nature of data underpinning their quality attributes.

Bare "Minimum" Avoidance

Project Information

- Methodology, Project ID,
- Owner / Developer,
- Origin
- Type, Vintage, Geography
- SDGs Certification Status
- CORSIA Eligibility

Nascent removal with permanent storage*

Quantification Data

{Removal}
- Baseline
- Additionality
- Permanence (for long-term storage)

- Life-Cycle Assessment
- Permanence (Buffer credits for short-term storage)

{Avoidance}
- Baseline
- Additionality
- Permanence
- Leakage

Quality-Enhancing Data

- Social safeguards
- Benefit sharing
- Biodiversity
- Ratings / performance score

Avoidance with high-quality carbon and/or non-carbon attributes

* Removals tend to have more objective carbon attributes, but their limited supply demands a different type of channel.

Price Benchmarks Available Today are Typically Based on Project Information and Certification Status, but Most Data is Behind Paywalls*

*Moss.earth has the price data of MCO2 public

Standardized Contracts

Entity	Spot/Future	Baseline	Premium						
			Standards	Cookstove with SDGs	AFOLU with Co-benefits	Other	Removal	Vintage	Geography
Xpansiv CBL	Spot	CORSIA-eligible Non-AFOLU	VCS, Gold Standard, EcoRegistry, ACR, CAR	✓	✓ CBS certification	✓ CCP aligned		recent 5 years, single year	Latin America (Eco registry)
CME	Future	CORSIA-eligible Non-AFOLU	VCS, ACR, CAR (CBL's GEO, N-GEO & C-GEO)		✓ CBS certification	✓ CCP aligned		recent 5 years, single year	
Platts	Spot and Future	Renewable energy	CORSIA-Eligible and the same standards as Xpansiv CBL	✓	✓	✓ CCP aligned		recent 5 years, mixed (no separate index for different vintages)	
Viridios Capital	Spot	Benchmarks of S&P commodity assessments		✓	✓ Separate index for soil, REDD, A/R and Blue carbon			current year vintage and delivery	
AirCarbon Exchange	Spot	CORSIA-Eligible Renewable energy	CORSIA-Eligible	✓	✓		✓	every 3 year for benchmark, annual for certified co-benefits	
CIX & Nasdaq	Spot				✓				
ICE	Future		VCS		✓			2016 onwards, every five years	
Moss.earth*	Spot		VCS		✓				

Grey cells mean the standardized contracts offered by that exchange are not differentiated based on such attributes, therefore, price premium for such attributes is not discovered.

Price Discovery for High Quality Avoidance and Removal Credits is Still Largely Lacking in the Market

OTC transactions

Auctions

RFP / Direct Offtake Agreement

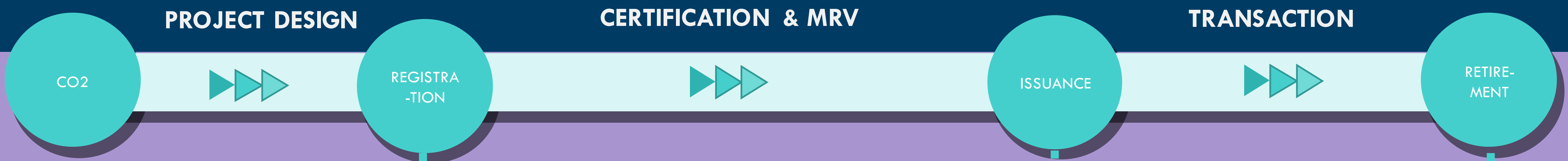
Grey cells mean marketplace services is not designed to enable price discovery for such attributes, e.g., the attribute is not included in the filters.

Entity	Descriptors: Geography, Vintage, Sector, SDG Certification	Additional Digital MRV data	Co-Benefit	New Project Type (Removal & Avoidance)	Removal with Permanent Storage
Xpansiv CBL (Colonial Bourses)	✓ Filtering	✓ Partnered with Sylvera	✓ Auction delayed in Q1		
CME (Chicago Mercantile Exchange)					
Platts					
Viridios Capital	✓ AI-forecast of price				
AirCarbon Exchange	✓ Filtering				
CIX (Climate Impact X) & Nasdaq	✓ Filtering	✓ Partnered with Sylvera		✓ e.g., Blue carbon, TREES HFLD	
ICE (Intercontinental Exchange)					
Microsoft					✓ Only portfolio average price disclosed
Frontier					✓ Price disclosed
Regen Marketplace	✓ Sorting	✓ Registry with MRV data under dev.			
Senken	✓ Filtering with additional rating from BeZero				

Challenges for Price Discovery of High-Quality Avoidance and Removal

- The price benchmarks from exchanges offer little reference for OTC transactions for inherent quality disparity
- Currently, not all buyers on the OTC marketplace rely on independent ratings to improve price discovery
- Simple filtering based on project descriptors provides limited improvement in the price discovery efficiency of OTC channels

Price is Not a Proxy for Quality in Today's VCM Because of Limited Knowledge of and Access to All Data Aspects of Credit Value



SUBJECTIVE

Quantification Data

Removal

- Life-Cycle Assessment

Avoidance

- Baseline
- Additionality
- Durability (i.e., buffer credits)
- Leakage

Quality-Enhancing Data

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Pricing Data Today
NOT proxy for quality, because:

- Anchored mostly to project information and certification status, whose binary "pass/no pass" results are not sufficient to capture variations in quality

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OBJECTIVE

Project Information

- Methodology
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- Status, Scope

Removal

- Baseline
- Additionality

Certification Status

Subjective performance data gets approval stamps at different levels (crediting bodies, VVBs) and translated into certifications

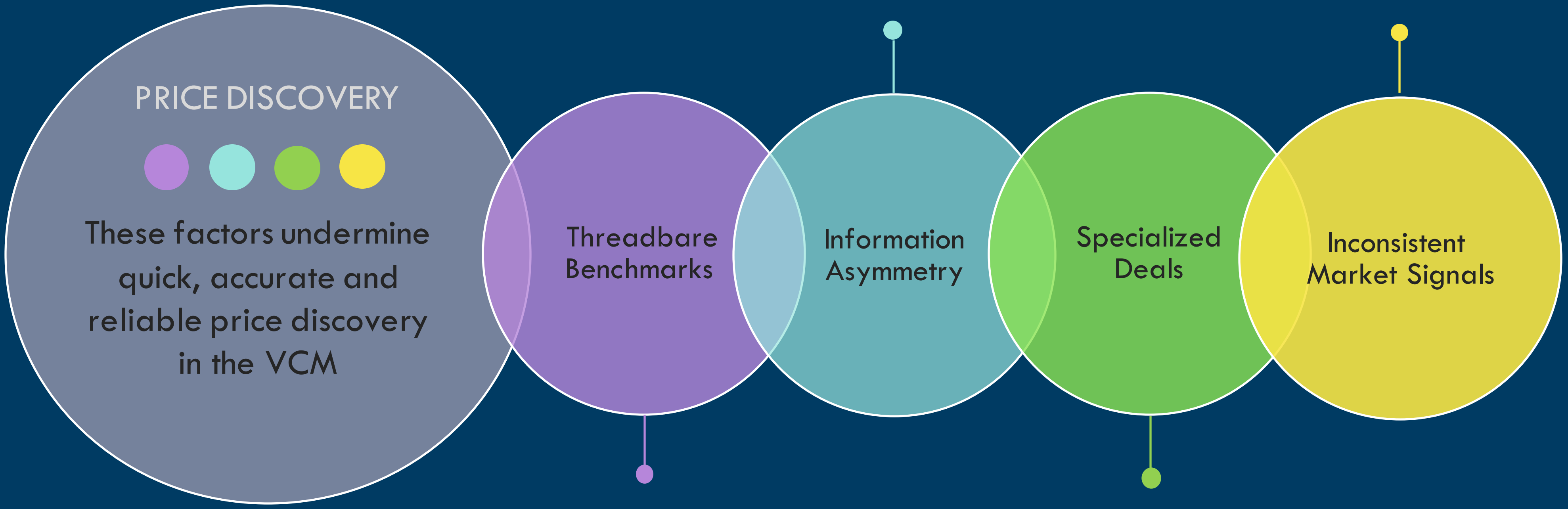
Pricing Data Ideally
SHOULD Be a Proxy for Quality:

- Capture real and total cost of project development, MRV and transaction costs
- Capture actual value of desirable subjective data attributes

Issuance

Retirement

The Disconnect Between Price and Quality has Various Implications on How Buyers and Sellers Meet in the Market to Value Carbon Credits



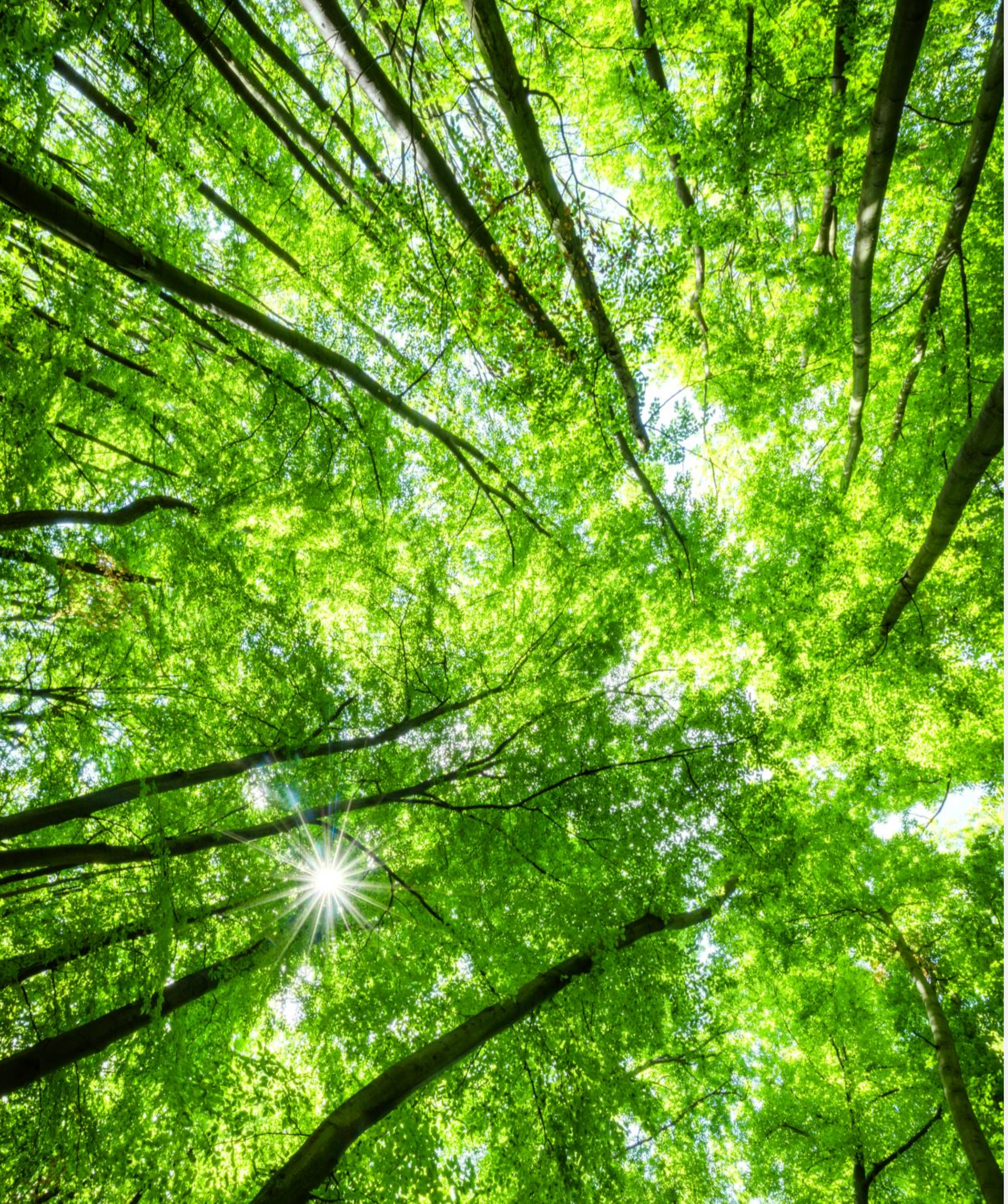
Hard for buyers to gather relevant pricing and performance data

Weak price and demand signals due to unreliable metrics of performance quality

Minimal reliable price history tying details of credit quality to price premiums

Intermediaries offer specialized services (auctions or detailed due diligence) to connect buyers to high-quality projects

CONCLUSION



Strengthening the VCM

What is the current state of play? Where do we go from here? What and do we build a stronger VCM?

The Current VCM is an Imperfect Space with Imperfect Information

01
INFORMATION ASYMMETRY IN AVAILABLE DATA

Despite the maturity of MRV technologies, challenges of collecting data at the local level persist, in addition to entrenched barriers to data transparency and accessibility.

- Lack of transparency
  - Opaque
    - Scarce historical sampling data
    - Bilateral deals, closed-door negotiations
  - Black box
    - Proprietary models
    - Credit ownership and transfer
- Lack of access
  - Paywalls
    - Pricing data
    - Transaction costs
  - PDFs
    - Data formats
    - Readability

02
SLOW EVOLUTION OF CERTIFICATION SYSTEMS

Legacy certification systems have been slow in catching up with state-of-the-art D-MRV technologies and communicating improvements to verifying and validating bodies.

- Local participation
  - Remote video checks
  - Sampling toolkits
- Digital MRV
  - Remote sensing
  - AI
  - ML

03
LACK OF CONSENSUS BUILDING

Nature of the data underpinning a carbon credit forces the market to subjectively map ideal vs. acceptable thresholds of data and link that mapping to quality assessment and price discovery.

- Subjective constructs
  - Modeling
    - Avoidance credits
  - Assumptions
    - Co-benefits
    - Equity benefits
    - SDGs
- Technology limitations
  - Measurements
    - Leakage
    - Estimating uncertainty in open and closed systems
    - Non-permanence or reversal risks related to natural disasters or project mismanagement

These multi-faceted data issues prevent more credit data from being objective

The Objective-Subjective Divide is Entrenched and Impacts the Integrity of the Entire System

Structural Barriers

Evidence Data

Available Data but Not Accessible
Evidence data is often stored in a static format and the raw data is hard to access. Most verification and validation reports are in PDFs (and not machine readable) and most raw data is not disclosed or accessible to stakeholders other than the verifiers.

Available Data but Not Transparent
Most models and raw data sets are withheld as proprietary (to protect intellectual property). This hinders efforts to ground-truth their results, calibrate them to evolving contexts, or verify their accuracy.

Path Dependency
Infrastructure of legacy certification systems are not evolving fast enough to incorporate new ways of data collection or production (e.g., data captured by remote sensing technologies) that can provide more accurate and timely evidence data.

Limitations of Technologies
Uncertainties around the quantification of emission reduction in nature-based open systems (e.g., forest, soil, ocean) are unlikely to ever reach 100% accuracy. Similarly, variables that project future behavior – such as non-permanence risks and leakage – cannot be made perfect by technological innovations.

Subjective Constructs
A significant portion of the data underpinning a carbon credit depends on modeled outputs and assumptions (counterfactual baseline for avoidance credits, indicators of non-carbon metrics, estimates of permanence or leakage).

Non-Evidence Data

Available Data but Not Accessible
Pricing and transaction data is often behind paywalls, and this hinders efforts to build complete information about a credit's value.

Available Data but Not Transparent
Many closed-door negotiations or bilateral deals between project developers, buyers and/or intermediaries where most of the fees or terms are not disclosed.

Subjective Constructs
No consensus on the threshold for a quality credit, leading to varied assessments and valuations of quality (e.g., overall rating scores developed by third-party agencies) and increasing confusion on which attributes project developers should prioritize.

These structural data barriers make it difficult to discern quality, impact the flow of information, and impede credit valuation.

Structural Barriers Introduce Additional Pain Points on the Supply and Demand Side

SUPPLY	DEMAND
Low data collection at the local level	Unclear and inconsistent buyer guidance
State of methodology creation	Uncertainty around definition of quality
Limited access to raw data	Risky and complex procurement process
Over-reliance on process integrity	Reliance on proxies and limited price discovery
Lack of incentives and weak market signals	Information asymmetry and "black boxes"

Today's VCM has Two Main Struggles to Overcome its Manifold Pain Points, Issues and Challenges

01 STRUCTURAL DATA BARRIERS

QUALITY CLAIMS

DATA INTEGRITY

- Available raw data is not accessible
- Available data is not transparent
- Slow uptake of technological advancements
- Lack of consensus on definition of "quality"

PROCESS INTEGRITY

- Gatekeepers holding raw data
- Centralized governance

02 INEFFECTIVE CHANGE LEVERS

The VCM is unable to build and pull change levers across supply and demand that would make data integrity and process integrity more robust.

- Lever 1: Build consensus around quality across the market
- Lever 2: Adopt digital and technology advancements
- Lever 3: Follow best practices for organizational independence
- Lever 4: Promote bottom-up governance

New Data and Technology Innovations are Tackling Pain Points to Address a Range of Issues Undermining the VCM

01	02	03	04
MARKET INFRASTRUCTURE AND TRANSACTIONS	COORDINATION AND COMMUNICATION	DATA, ACCOUNTING AND MRV SYSTEMS	PURCHASE AND PROJECT FINANCING
Introducing new carbon credit trading options to increase liquidity, enabling the market to scale.	Finding compatibility between legacy VCM structures and emerging, technologies.	Addressing inaccessible raw data and quality variance across projects through digital and technological innovations.	Ensuring high-quality credits can be purchased with less risk and bringing more finance options to deliver such credits.
Examples: Standardized contracts; Dynamic pooling	Two-way bridge; On-chain digital twin; API integration software	Modeling techniques; Storage of raw data; citizen science data collection	Advanced market commitments; Carbon funds; Carbon insurance providers

Innovators are Showing a Balance of Risk-Mitigation and Creative Problem-Solving Across Core Functions to Move the VCM Forward

01

MARKET INFRASTRUCTURE AND TRANSACTIONS

While lively activity on the trading side points to growing demand and market maturity in handling transactions, innovators are also aiming to surface credit quality (climate & co-benefits impact).

02

COORDINATION AND COMMUNICATION

Entities are experimenting with how digitally-enabled tools can lower transaction costs and increase trust, but without introducing new risks or hurdles on due diligence, credit quality, and market trust.

03

DATA, ACCOUNTING AND MRV

Standardize and streamline MRV with new data and technologies. New tools make it easier to involve scientists, researchers and local participants in the MRV process.

04

PURCHASE AND PROJECT FINANCING

Experimentation with the incentives, contract structures, technologies, and coalitions that can better finance project developers to develop and deliver high-quality projects across a range of pathways.

Scaling these Innovations and Positive Trends Requires an Integrated Set of Levers to Link Data and Process Integrity

DATA INTEGRITY

More options to pull levers here

Lever 1 — Build consensus around quality across the market

SUPPLY
Accuracy of modeling techniques, measurement complexities, technology limitations

DEMAND
Granular and actionable public guidance for buyers at all levels (corporate, project, methodology)

Lever 2 — Adopt digital and technology advancements

D-MRV
Collection, measurement, calculation, monitoring

WEB3
Efficiency, storage, security, attribution, traceability, interoperability, risk controls

PROCESS INTEGRITY

Limited levers but essential

Lever 3 — Follow best practices for organizational independence

Public consultations, expert reviewers, and third-party auditing

Lever 4 — Promote bottom-up governance

Better data transparency and access will complement process integrity by enhancing public visibility

The Ideal State to Develop High Quality Credits Rests on the Robustness of both the Foundational Pillars of Process and Data Integrity

The quality of any claim depends on the integrity of the underlying carbon credit

Integrity of the data itself (“the what”) as well as the governance and flow of information (“the how”) in a system

DATA INTEGRITY

Carbon, social and environmental data is accurate, reliable, transparent, verifiable and accessible to market participants and public stakeholders

PROCESS INTEGRITY

Independent and separate entities play different functional and structural roles to govern development of credit projects

Ideal state*

Lever 1 — Build consensus around quality across the market

Lever 2 — Adopt digital and technological advancements

Lever 3 — Follow best practices for organizational independence

Lever 4 — Promote bottom-up governance

**Expanded access to and increased transparency around the credibility and granularity of the data underpinning carbon credits can better facilitate the market-linkages between the supply and demand of credits.*

Appendix

Annex A: Glossary of Key Terms

Annex B: Interviews Findings

ANNEX A

Glossary of Key Terms

Glossary: Defining Foundational Concepts

DATA INTEGRITY

Data integrity is the basis on which market participants can reliably measure or judge credit quality using the underlying credit data. Ideally, all data should be accessible, verifiable, accurate, and replicable. This includes information about how the data is collected, the validity and completeness of the data, and how the data is verified and used. A strong evidence base ensures that the stated climate impact of a carbon credit accurately reflects the actual emissions performance of the credit. Data integrity concerns can be approached from two angles:

Evidence Data: quantification data that forms the basis for climate impact claims.

All Other Types of Data: A combination of context information, facts, and insights associated with a carbon credit.

RAW DATA

Any data that helps make the evidence reliable, accurate, and verifiable. This includes any *pre-analysis* data: information that has been collected, stored, and cleaned in a structured way. It does *not* include data that has been processed or interpreted in any way. Raw data files should be retained in their original form before assessments are made to contextualize the data in any analysis, synthesis, insights, ratings, or reviews. Retaining and sharing raw data enables full visibility and independent vetting of all evidence data by market players.

PROCESS INTEGRITY

Process integrity is built on the philosophy that if the process is trustworthy, so is the result. In a trustworthy process, independent and separate entities should play different functions. This independence and separation reduces conflict of interests and produces impartial results that the other market participants can trust. However, due to the complexity and subjective nature of carbon credit data, process integrity is increasingly insufficient to ensure credit quality.

Glossary: Defining Foundational Concepts

MRV

The systematic process to collect, process, record, share, monitor, track, and verify data about a credit's climate performance and additional benefits along the entire credit lifecycle.

Measurement

Measurement or monitoring approaches that quantify the volume of carbon sequestered, avoided, or removed.

Reporting

The access to measurement data in a useful format to record and synthesize information in a structured and transparent way.

Verification

The auditing of measurement data and project information for accuracy and completeness to enable independent auditing and monitoring.

DIGITAL MRV (D-MRV)

The use of any combination of technologies, digital processes and infrastructure, computational modeling, specialized data analytics, and automated datasets to enable MRV across the carbon markets value chain. The suite of D-MRV tools and technologies includes (but is not limited to) remote sensing (e.g., satellite imagery and LiDAR), drones, machine learning (ML), artificial intelligence (AI), cloud computing, distributed ledger technologies (e.g., blockchain), and smart contracts.

WEB3

An evolving term to define the next iteration of internet use that gives users greater autonomy and control over data. The idea of Web3 is premised on reducing reliance on centralized intermediaries, enabling faster flow of information, services and resources, and facilitating trustworthy interactions between participating users. Web3 technologies leverage blockchain, AI, and ML (a subset of AI) to connect data and users across databases, platforms, and transactions.

Glossary: Defining Carbon Attributes

PERMANENCE

The GHG emission reductions or removals shall be enduring (i.e., permanent) or use mitigation measures to compensate for or reduce the risks of reversals.

ADDITIONALITY

The GHG reductions that only occur due to the carbon credit system (can be financial, legal, or regulatory additionality).

BASELINE SETTING

Estimate of the emissions that would have occurred *without* the carbon credit project. Common modelling methods include default values, common practices, or control sites/groups.

LEAKAGE

Unintended increases in GHG emissions outside a project's boundaries (can be activity-shifting leakage or market-driven leakage).

UNCERTAINTY

The expectation that project developers estimate the uncertainties in their measurements of additionality, the baseline, permanence, and leakage.

We provide main debates around each on slide 37.

Glossary: Defining Non-Carbon Attributes

SUSTAINABLE DEVELOPMENT

Carbon credits are recognized as an important vehicle to support a sustainable and just energy transition. The United Nations Sustainable Development Goals (SDGs) is often the default framework recommended to project developers to assess the impact of additional benefits beyond carbon.

CO-BENEFITS

Community, economic, and ecosystem benefits tied to any carbon credit project. Co-benefits are linked to achieving sustainable development targets.

COMMUNITY CO-BENEFITS

Any type of carbon project advancing improvements in community health, benefits sharing, participatory governance (including promoting women's role in decision-making), etc.

ECONOMIC CO-BENEFITS

Any type of carbon project offering opportunities to strengthen the local economy, in the form of jobs creation, increased youth employment, diversifying income opportunities for the community, etc.

ECOSYSTEM CO-BENEFITS

Any type of carbon project tackling biodiversity, sustainable use of natural resources, payments for ecosystem services (such as air, water, and soil protection), etc.

We provide main debates around each on slide 37.

Glossary: Defining Actors on the Supply Side

STANDARDS PROGRAM

The voluntary carbon market (VCM) is largely not under regulation from the governments. Instead, a group of international non-profit organizations play the role of standard setting, credit certifying and registry managing for credits issuance and retirement. The most prominent four standards programs are: Verra, the Gold Standard (GS), Climate Action Reserve (CAR) & American Carbon Registry (ACR). There is a proliferation of new standards programs in recent years, such as those that incorporate latest digital advancement in API and blockchain into their registries (e.g., EcoRegistry, SocialCarbon, Regen Network) or those targeting nascent removal industry (e.g., Puro.earth, C-Sink).

REGISTRY

Registries assign a unique ID to projects certified by a standards program and record public information throughout the credit lifecycle from listing, validation, verification, issuance to retirement. Each standards program must have its own registry, which can be administered by the standards programs themselves (e.g., Verra, ACR), or by private companies (e.g., APX Inc., Markit). Besides, the Climate Action Data Trust is building the first meta-data registry based on blockchain technology.

METHODOLOGY

A methodology prescribes what qualifies as a carbon credit generated from a type of emission reduction activities. It contains several components: eligibility of activities, determination of the accounting boundary, assessment of additionality, rules for the baseline and emission reduction quantification, requirements for ongoing monitoring and reporting. The terms "protocol" and "methodology" are often used interchangeably.

We provide an illustration of interactions of each on slide 56.

Glossary: Defining Actors on the Supply Side

VERIFYING & VALIDATING BODY (VVB)

Third-party auditors are expected to perform ex-ante validation and ex-post verification on projects. Validation checks the conformity to the standards program's normative requirements, the eligibility of project conditions and application of baseline calculations in methodologies. Verification checks the outcomes set up in project design documents have been achieved and the emission reduction has been properly monitored and calculated.

GOVERNANCE BODY

In recently years, two major independent governance bodies emerge in the VCM: The Integrity Council for the Voluntary Carbon Market (IC-VCM) and Voluntary Carbon Markets Integrity Initiative (VCMI). They aim to establish thresholds and codes of best practices, assess and testify adherence and achievement for the supply and demand side of the VCM respectively.

ACCREDITATION BODY

Standards programs set requirements on the qualification of VVBs. Usually, standards programs require the VVBs to be accredited by an accreditation body who recognizes and certifies the competence, impartiality and code of ethics of the VVBs. The VCM has relied on the Clean Development Mechanism's designation in the past. But recently standards programs are shifting to accreditation from the International Accreditation Forum's member organizations.

We provide an illustration of interactions of each on slide 56.

Glossary: Defining Actors on the Demand Side

BUY-TO-RETIRE

Buy-to-retire actors purchase credits for retirement purposes and claim the related emissions reduction and/or removal benefits against their carbon balance or to demonstrate environmental engagement. They purchase credits through bilateral or centralized channels, including directly from developers, through brokers, on exchanges, tokenized credits platforms and other marketplaces.

INDIVIDUALS

Buy carbon credits to compensate personal emissions (e.g., emissions from flying). Individual buyers, unlike corporate buyers, usually purchase readily available credits.

CORPORATES

Purchase credits to demonstrate environmental engagement and make claims against their climate commitments. Corporate buyers sometimes provide finance to develop the carbon credit projects that they ultimately intend to retire, with the intention to bring down costs for the market. This happens mainly through offtake agreements stipulated directly with project developers, by which buyers commit capital upfront and lock prices in early.

We provide an illustration of interactions and examples of each on slide 84.

Glossary: Defining Actors on the Demand Side

BUY-TO-TRADE

Buy-to-trade actors trade and invest for their own accounts for financial speculation (e.g., traders at hedge funds and trading desks at investment banks). They also act as intermediaries by matching buyers and sellers over the counter, on exchanges (brokers and retailers), or on carbon-to-crypto markets (tokenized credits platforms). Buy-to-trade actors include:

RETAILERS

Specialize in the sale of carbon credits. Retailers source large volumes of credits from project developers, while others develop and sell their own projects. Retailers may sell directly to buy-to-retire actors.

BROKERS

Purchase credits from retailers and sell them to buy-to-retire actors. Brokerage usually happens over-the-counter where buyers communicate to brokers the credit characteristics they are looking to procure. Exchanges are emerging as a centralized brokerage service provider. More details on related transaction channels on slide 86.

We provide an illustration of interactions and examples of each on slide 84.

Glossary: Defining Financing Options

CARBON FUNDS

Carbon funds originate and pool capital towards projects. Carbon funds pool and signal demand from corporates and investors, de-risk supply, and bridge the capital gap between project development and credit delivery. They help align developers, buyers, and project financing providers' interests. Fund mandate and investment tools used can vary and change as market gaps and opportunities evolve.

VC FUNDS

VC funds seek private equity stakes in project developers with strong growth potential. They contribute significantly to filling the capital gap between project development and credit delivery, but with very high costs of capital.

ADVANCED MARKET COMMITMENT (AMC)

Agreement aimed at tackling project development issues for projects with high upfront capital costs. An AMC pools demand from corporate buyers and investors, incentivized to invest by the guarantee of delivery of credits. AMCs signal to project developers that demand is committed to projects that meet their specifications.

We provide an illustration of interactions and examples of each on slide 84.

Glossary: Defining Transaction Channels

OVER-THE-COUNTER (OTC)

A carbon credit marketplace in which trades are carried out by brokers on behalf of market participants or by the trading parties themselves.

WEB3 MARKETPLACE/TOKENIZED CARBON CREDIT PLATFORM

A carbon credit marketplace that uses Web3 technologies to enable transparent and traceable trading and retirement of carbon credits. Credits may be tokenized through an automated carbon bridging process that allows a carbon credit to be bridged onto the blockchain by collecting its key metadata and creating its digital twin, which is then considered as ”tokenized credits”.

WEB2 MARKETPLACE

A carbon credit platform enabled by the internet aggregating supply and demand where buyers get access to carbon credits and related project information. Buyers can also get a range of customized services and guidance on credit types and purchase. Different from Web3 marketplaces, a Web2 marketplace does not sell tokenized credits.

We provide examples of each on slide 86.

Glossary: Defining Transaction Channels

EXCHANGE

A platform allowing participants to conduct centralized trading for carbon credits listed on that exchange, which can include standardized contracts, OTC transactions, and auctions. Centralized means the sourcing, contracts negotiation, and trade execution all go through a centralized entity to some degree. The exchange usually brings in benefits like know-your-customer (KYC) procedures, standardized contracts, speedy and secure settlement process, etc.

STANDARDIZED CONTRACT

A spot (immediate delivery) or futures (future delivery) contract listed on the exchange for the settlement and delivery of carbon credits that meet the defined criteria for a group of credits. These contracts are separated and differentiated from other clusters of credits defined by the exchange.

AUCTION

A periodic sale of a defined cluster of carbon credits, usually hosted by an exchange.

We provide examples of each on slide 86.

Glossary: Defining Pricing Terms

PRICE DISCOVERY

The process by which buyers and sellers interact to arrive at a price they're willing to buy and sell for.

PRICE PREMIUM

The spread between a carbon credit's price and that of the benchmark, usually the average prices in the market, as a result of the strengths or attributes of carbon credits.

BARE MINIMUM AVOIDANCE

Avoidance credits that just meet the minimum threshold of passing the certification system in a way that their quality attributes are largely well captured by project information such as methodology, vintage and certification status.

REQUEST FOR PROPOSAL (RFP)

Buyers solicit a business proposal from potential suppliers in order to procure commodity or service they intend to buy, often through bidding.

We provide illustrations of interactions of each on slide 87.

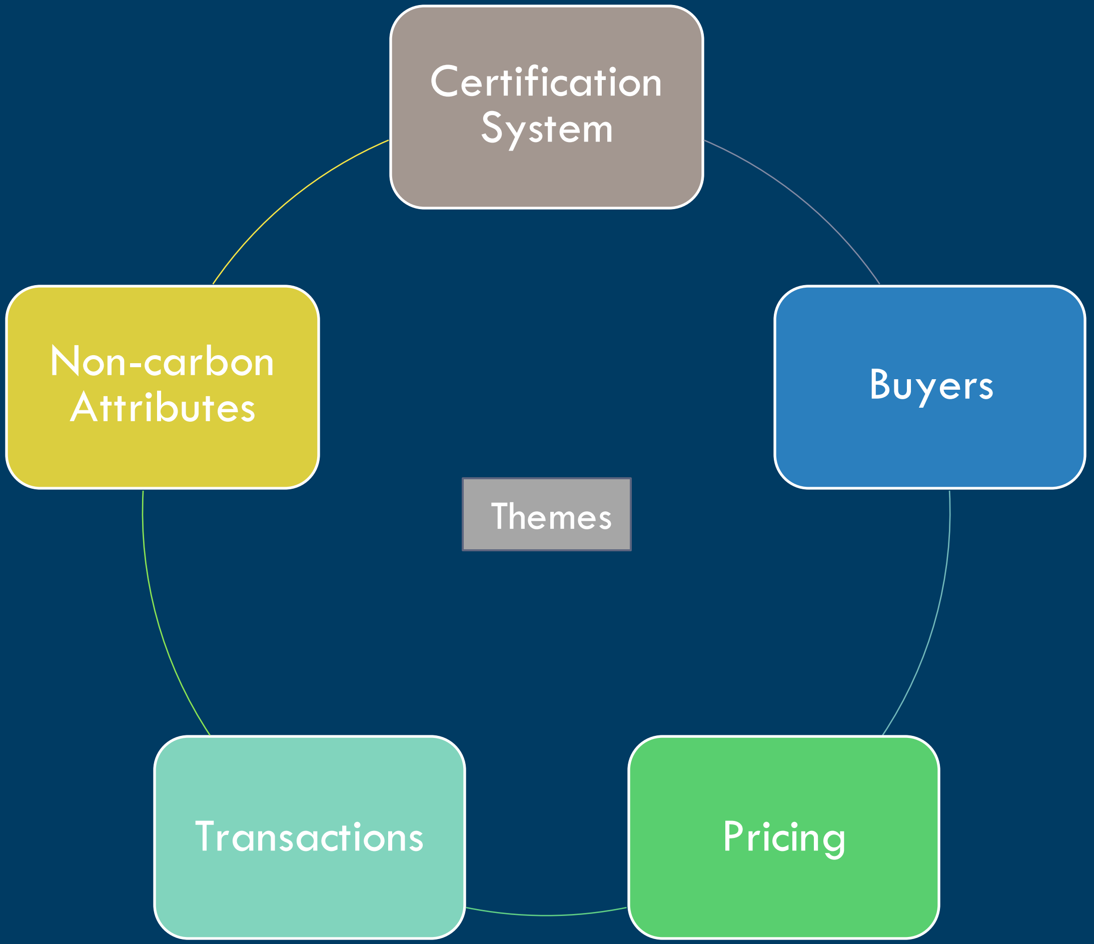
ANNEX B

Interview Findings

Note to Reader

The RMI team conducted 35+ semi-structured interviews with carbon markets policy experts, scientists, standards and methodologies developers, buyers, carbon funders, blockchain and non-blockchain based marketplaces and exchanges.

In this annex B, you will find the insights gained over these interviews that are not fully captured in the main body of this guide. It is organized according to the 5 themes illustrated on the graph on the right.



Theme: Certification System

Methodology

Engaging scientists: As of now, methodologies only incorporate scientific and academia considerations in a limited fashion. It can be challenging for scientists and researchers to understand the complications of commercial and political considerations of carbon credits in the VCM given a limited timeframe. However, scientists are highly enthusiastic about helping create methodologies for carbon credits and see huge potential for open data to better understand climate impacts.

Bandwidth issues

Constrained capacities: All standards face considerable bandwidth issues, and the state is shifting from lack of methodologies towards prioritizing new methodologies, which will address the concerns about quality and scalability.

Scientific updates

The need to catch up with latest science: Widespread recognition that, when they started, the legacy standard entities were creating methodologies using techniques and available data that largely didn't exist – or didn't exist to the caliber it does in 2023. While harsh comments based on today's hindsight was often framed as not fair to the standards, interviewees pointed to the long lag time in updating legacy methodologies as a valid criticism.

Theme: Certification System

MRV

Next step for remote sensing and forestry credits: The forestry sector is ready to move to high-quality data and there are numerous technology companies providing remote sensing services to the market, but their models are kept proprietary, and it is difficult to independently compare or assess the models for accuracy. For legacy registry and buyers to embrace remote sensing, building this independent quality check mechanism is key.

Resource issues

A hassle for both sides: MRV is simply viewed as a box to check and VVBs are paid a minimum compensation, which does not incentivize them to do a good job. On the other hand, project developers in the Global South often have a hard time finding qualified local VVBs and consequently, need to hire expensive fly-in services.

Jurisdictional level

Project-based and jurisdictional approach to forestry: Both are needed to stop deforestation, but policymakers have been slow to align incentives in policy and regulation at a jurisdictional level. We are starting to see momentum on the jurisdictional side and many governments have established digital MRV systems for REDD+. It is important, but unclear, whether the jurisdictional approach will figure out how to align and make use of different legacy systems.

Theme: Buyers

Approach to market

Risk aversion shapes strategy and purchases: The primary concern for most companies is reputational risk attached to buying underperforming, low quality credits.

Lack of trust hinders demand: The lack of trust and transparency in the VCM exposes companies to hard-to-manage reputational risks associated with low quality carbon projects. This can lead corporates to pull back from purchasing carbon credits or participating in carbon markets.

Approach to transactions

Buyer's preferences shape transactions: Different buyers have different preferences and needs, based on their maturity and journey. These preferences shape transactions and largely determine price. Price negotiations usually happen ad-hoc. Buyers are usually willing to pay a premium if projects meet their custom needs, including carbon credit type, carbon pathway, region, and co-benefits.

Approach to channels

Buyer sophistication shapes transactions: Buyers still rely on brokers because they don't have the knowledge or experience to assess credits themselves or to place orders. Only sophisticated buyers are placing and executing orders on exchanges and marketplaces.

Theme: Buyers

Finance-risk calculus

Project financing: Although corporates are becoming more engaged with project development, project developers are primarily funded through venture capital sources. Prospective carbon credit buyers rarely sponsor new methodology development, as it is risky and capacity intensive. Due diligence on credit quality requires technical expertise and is a heavy draw on internal capacity, even for large and well-resourced companies.

Level of engagement

Outsourcing quality criteria development: Quality-forward buyers manage risk and uncertainty by outsourcing methodology development, due diligence, and project feasibility studies to consultancies — for example, Microsoft contracted Carbon Direct to handle its due diligence process.

Removal purchases

Removal purchases are growing, but delivery remains low: Purchases increased 4x in March 2022, compared to the previous month, but total purchases (as tracked by CDR.fyi) only represent 0.0077% of the 10-gigaton 2050 goal. Crucially, only 9.0% of those purchases have been delivered (though this does not necessarily mean that the credit attached to the ton has been retired and claimed). The sales tracked include offtake agreements with no payment today, pre-purchases where all or parts of payment happens now, or sale of ex-post credits.

Theme: Pricing

Approaches to Pricing

Developers/suppliers' approach: We heard a range of factors that help suppliers set their prices. First, the exchanges' price benchmarks are not considered a good reference point. Separately, marketplace prices are determined by suppliers, who review at demand and supply before setting their prices based on how similar projects are being traded. To a certain extent, they will also look at the cost of running the project.

Buyers' approach: Sophistication is a key differentiator for buyers. Buyers who have experienced carbon market teams that can conduct due diligence in house are more comfortable paying higher prices what they deem to be high-quality credits. Building such expertise is very time-consuming and expensive. So, buyers who lack this expertise or confidence are more likely to purchase cheaper credits.

Broker's approach: Many suppliers will go to a broker if they want their quality credits to be sold with a price premium. Brokers provide additional due diligence and connect suppliers to buyers who prioritize the same quality attributes as the credit being developed. However, many brokers are not willing to disclose their fees.

Theme: Pricing

The Consequences of Misaligned Incentives

Low prices impede momentum towards environmental justice: In places where governments have set up land tenure systems to protect indigenous rights, those communities express a lack of enthusiasm towards carbon credits as current market prices (around $5/ton) cannot cover the community's transaction costs for participating in the VCM.

Missing Carrots: With low prices, there is no price discovery, which disincentivizes market participants from sharing relevant data or developing mechanisms to effectively and efficiently identify and market high-quality credits. There are numerous opportunities for cash to exchange hands – but much of that goes to intermediaries.

Different Benchmarks

Mismatch: The price benchmarks from standardized instruments on the exchange does not match with the prices charged in the OTC marketplaces. Some exchanges' business models are based on transaction volume – meaning they cater to traders and financiers rather than corporate buyers and credit suppliers.

Theme: Transactions

Nature of Trade

Transaction channels in the VCM are categorized by two variables: The level of commodification and time to delivery. When entering negotiations, market participants can do so in a bilateral or centralized way, with contracts stipulating immediate or future carbon credit delivery.

Transacting carbon credits is as much a science as an art: Transacting carbon credits is as much a science as an art. Transactions are shaped by factors such as how and where buyers connect in the market. The intangible nature of a carbon credit, the stratification of projects based on vintage and type, and the overlap of functions and trades across the credit value chain requires a balancing act with the terms of a contract.

The VCM is still dominated by OTC transactions: To capture a premium, some developers are inclined to sell through brokers instead of through exchanges. Additionally, OTC platforms are typically willing to negotiate prices on a client-to-client basis. Some OTC marketplaces also attract higher density of buyers because they can help accommodate a variety of buyer needs by creating a custom portfolio of credits.

Theme: Non-Carbon Attributes

Assessment Barriers

Cost of producing relevant data is high: Project developers, local communities, or landowners require upfront capital (which creates a financial barrier) to produce robust data for measurable co-benefit metrics. Temporal monitoring can also be an extensive, costly process because it requires regular, detailed data gathered and reported from the project site.

Willingness-to-Pay

Weak market signal: The market still doesn't show a strong willingness to pay for co-benefits (e.g., biodiversity) because there's no consensus on how to quantify or measure non-carbon impacts and the legacy standards take different approaches to defining and measuring co-benefits. For project developers, incorporating robust co-benefits increases their costs, but they don't have a clear market signal that such efforts will be financially wise.

Theme: Non-Carbon Attributes

Biodiversity

Source-based nature complicates measurement: Biodiversity cannot be constructed as a commodity in the same way as carbon. The basket of metrics differs depending on the species, ecosystems, habitats, and conservation objectives in any given ecoregion (tropical forest vs. coral reef). Biodiversity credits thus cannot be measured, valued, or exchanged independent of where and how they are sourced.

No consensus on unit of measurement: Unlike carbon markets where there is a single quantifiable metric (i.e., carbon emissions), there is no universal unifying biodiversity metric. In addition, biodiversity metrics like species richness and composition or biomass decline overlap into other ecosystem services such as pollination potential, water quality, soil health, air quality.

More research and education: Combining ecosystem carbon and biodiversity benefits is a useful shorthand because it is 'net good' (positive biodiversity change or avoid its loss) for biodiversity. However, biodiversity conservation and biodiversity credits are different things. People need better understanding of how carbon pathways positively or negatively impact biodiversity outcomes.

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