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Foresight Case Study

Climate Foresight: Transforming the Voluntary Carbon Markets

by Roger Spitz and James Balzer

Disruptive Futures Institute

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Contextual Note

LuxCS Rainforest Summit. Atlantic Forest (Mata Atlântica), Brazil. Photo GrupoVex

In collaboration with climate foresight practice Techistential and the Disruptive Futures Institute, LuxCS has spent years exploring pathways to transform the VCM landscape. This effort focuses on improving the perception and the effectiveness of carbon offset programs using cultural, technical, and regulatory levers. Through a commitment to conservation, performance, quality assurance, and rigorous monitoring, LuxCS intends to strengthen market integrity while democratizing market access, ensuring that these systems work for all stakeholders - from local landowners to global buyers.

A key milestone in this journey is Brazil's Law 15.042/2024, pivotal legislation that represents a significant shift in the regulatory framework for carbon markets. The law enacted back in December 2024, introduces stricter requirements for carbon credit integrity and additionality. These principles align directly with the standards that LuxCS has been advocating in its vision -

a powerful step toward ensuring that Brazil's carbon credits meet the highest standards of environmental integrity.

LuxCS' vision, combined with Brazil's evolving regulatory landscape, positions the country to play a leading role in global carbon markets. But realizing this vision will require concerted agency and continued collective action to drive a virtuous tipping point. Law 15.042/2024 is just one part of the levers to transforming the global carbon markets - one where narratives, foresight, and systems innovation must converge to create sustainable futures of higher integrity and broader participation.

Abstract

Voluntary Carbon Markets (VCMs) are a growing market-based mechanism to support decarbonization by creating carbon credits via carbon offsets. VCMs have many promising aspects, but they do not constitute direct emissions reduction. While VCMs create new market-based incentive structures for carbon abatement, their integrity is often critiqued as lackluster, untransparent, and poorly verified.

Solving complex issues like climate change requires transformative systems-level change, not point solutions. Systems innovations are instrumental to enabling widespread change across complex systems. In complex systems, no path can be established in advance and relied upon with certainty. The carbon crisis and energy transition are wicked problems; they exist in dynamic, nonlinear environments where solutions don't emerge from pre-established answers.

Effective carbon offsetting requires a nuanced understanding of complexity, with many possible solutions and uncertain outcomes. Addressing such complex challenges necessitates integrating climate foresight - moving from silos to systems and rethinking structures that incentivize outcomes. For a successful energy transition, businesses and investors must consider multiple stakeholders and complex ecosystem interactions.

This article uses Brazilian climate-tech startup Lux Carbon Standard (LuxCS) as a case study to evaluate the role of anticipatory governance - a growing futures concept - in transforming VCMs. LuxCS is using systems innovations within the Brazilian VCM ecosystem, including blockchain, satellite monitoring, and innovative biodiversity calculation methods, to verify the integrity of carbon credits. Applying climate foresight and futures intelligence, they're building a democratized, transparent, and effective carbon credit market, initially adapted to Brazil and its biomes.

LuxCS is driving systemic change in VCMs, as their standards can be scaled globally. However, while the opportunities are great, we also explore foresight exercises that reveal how LuxCS' strategy could result in perverse outcomes for VCMs and the energy transition as a whole.

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Climate Foresight: Transforming the Voluntary Carbon Markets

Introduction

The energy transition from fossil fuels to renewables is a global, radical transformation that will see major shifts in societal values, business models, and public perception (Christensen et al. 2021). Organizations face unprecedented scrutiny regarding the effectiveness of their climate actions. Organizations which are seen to deliver sustainable futures are increasingly reaping benefits, while those which neglect the environment will be exposed to value erosion, stakeholder scrutiny, shareholder criticism, and litigation (Alsayegh et al. 2022; Gomez-Bezares et al. 2016). An essential feature of effective governance is ensuring sustainable futures, which are futures that can be maintained for the long-term without compromising the systems they're within, or jeopardizing the needs of future generations (Slaughter 2020).

Prioritizing sustainable futures requires robust long-term thinking within organizations, and a strong grasp of **futures intelligence** (decision-making informed by anticipatory thinking and future-related insights) and **climate foresight** (understanding, anticipating, measuring, disclosing, and monitoring climate-related risk to support resilient climate-aligned decisions).

However, leadership pathologies often stifle proper long-term, systemic thinking, stymieing futures intelligence and climate foresight (Boin 2014; Jacobs 2011). Boin (2014) and Cairney (2012a) identify how path dependence, risk aversion, and top-down management models traditionally maintain a business-as-usual mentality (also see McConnell and 't Hart 2019; Kingdon 2011).

The carbon crisis and energy transition are wicked problems; they exist in dynamic, nonlinear environments where solutions don't emerge from pre-established answers. Addressing them

requires climate foresight, anticipatory governance, moving from silos to systems innovations, and rethinking incentive structures (Spitz and Zuin 2021). Specifically, anticipatory governance involves practices that seek to analyze and address uncertainties and their broader implications *ex ante* by adopting a systems-thinking approach. Establishing proactive governance systems (including through policies and regulations) can in turn drive long-term transformational change, not short-term, isolated point solutions (see Spitz and Zuin 2021; Kahane 2018).

Inertia and path dependence can cause organizations to avoid taking responsibility for problems or developing solutions. Conflicting short-term interests can frame challenges and responses in competing fashions, leading to inaction and parochial understandings of complex issues - exacerbating short-termism (Roberts 2000; McHugh et al. 2021; Feduzi et al. 2022).

Because of the rapidly changing landscape of climate change and Environmental, Social, and Governance (ESG) oversight, traditional short-termist risk management must be disrupted to enable long-term systems thinking that is conducive with sustainability outcomes (Slaughter 2020). This requires stronger climate foresight in organizations and individuals, especially in the context of complex issues (see Snowden and Boone 2007). Something is complex when it has unknown unknowns, multi-source causality, and co-dependent variables (Page 2009). Complex systems generate emergent properties unexpected at the outset. The whole is not merely different from the sum of its parts - the whole lacks a clear relationship to the parts' sum (Page 2009; Snowden and Boone 2007).

The Role of Voluntary Carbon Markets in the Energy Transition

Voluntary Carbon Markets (VCMs) are a growing market-based mechanism to achieve decarbonization by creating carbon credits via offset methods (SBTi 2024a;SBTi 2024b). VCMs are markets where firms can abate carbon emissions to generate carbon credits for purchase - often by large institutional actors. Purchasers of carbon credits often use them as a form of carbon offset, which supports the net zero agenda of many modern companies (Berg et al. 2021). We consider VCMs to be a complex solution to the energy transition due to their dynamic interplay between environmental, economic, social, and cultural dimensions. This interplay makes them subject to scrutiny and mismanagement (Kim et al. 2024). For VCMs to operate with integrity, and to minimize adverse outcomes, correct incentive structures and transparency

are paramount (Kim et al. 2024). With the heightened scrutiny of corporate ESG ratings, transparent and credible carbon credit verification methods are critical (Berg et al. 2021).

Given the scrutiny from shareholders and consumers, companies have an increasing incentive to undertake ESG practices (Kim et al. 2024; Christensen 2021). Additionally, organizations face substantial carbon transition risk as global markets move to a low-carbon future (Bolton and Kacperczyk 2023). In this context, companies have a perverse incentive to greenwash and obscure their sustainability practices, particularly in the field of VCMs (Kim et al. 2024; Christensen et al. 2021). The integrity of VCMs has become undermined by issues of integrity, particularly regarding the legitimacy of their carbon abatement claims, and equity, with regard to which they further entrench institutional power asymmetries in carbon markets and lock-out less powerful stakeholders (Christensen et al. 2021).

Despite challenges in ensuring additionality and issues with liquidity and pricing, the carbon credit market could surge in importance due to upcoming regulations that require decarbonization targets and aim to incentivize emissions reductions. According to Morgan Stanley (2023), the voluntary carbon-offset market is projected to expand from $2 billion in 2020 to around $100 billion in 2030 and approximately $250 billion by 2050. Morgan Stanley (2023) also asserts that the world must remove at least one billion tons (one gigaton) of carbon dioxide annually by 2030 to meet various national and corporate targets and forthcoming regulatory requirements. Avoidance or reduction credits could total up to 10 gigatons per year (Morgan Stanley 2023), although there is continued debate regarding how to define scientifically-sound carbon credit verification (SBTi 2024c).

To establish demonstrably sustainable incentive structures and transparency in VCMs, climate foresight is necessary locally, regionally, and globally. This is essential to overcome the current shortcomings of the market - underpinned by narrow-minded, transactional understandings of VCMs that do not have an orientation for long-term effectiveness. In turn, a lack of climate foresight is exacerbating the crisis of credibility and trust in VCMs (see Spitz 2023).

This article explores avenues for promoting actionable futures intelligence through climate foresight within organizations, particularly in the context of VCMs. Specifically, it interrogates

how the systemic, long-termist ethos of climate foresight can overcome current issues of integrity and equity in VCMs, through the **four levers for transformative change** necessary for futures intelligence and climate foresight (Spitz and Zuin 2021):

1. AAA Framework
2. Effective Systemic Change
3. Transformation vs. Point Solutions
4. Virtuous Inflection Points

Spitz and Zuin (2021) developed these four levers to generate a suite of heuristics that enable systems change as applied to complex challenges such as climate, technology and social entrepreneurship. This is an antidote to linear and parochial thinking.

These are outlined in Figure 1.

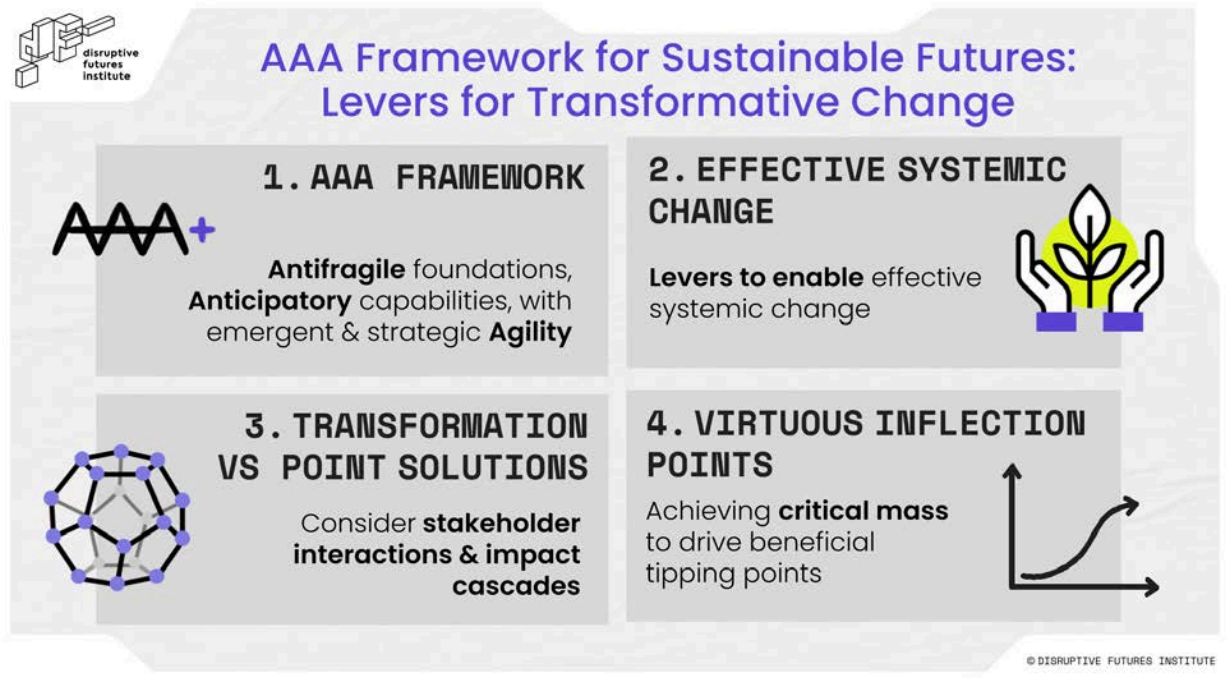

Figure 1 - The 4 Levers for Transformative Change (Spitz and Zuin 2021)

To achieve sustainable futures, we build on the AAA Framework's capabilities and foundations. We then focus on enacting effective leverage points to drive transformative change while recognizing the positive potential of inflection points.

1. AAA Framework

The AAA framework introduced by Spitz (2020) explores the role of **Antifragile, Anticipatory,** and **Agile** principles in facilitating robust futures intelligence.

Spitz (2020) and Spitz and Zuin (2021) argue that the AAA framework is necessary to achieve sustainable value creation, including systems innovations in climate technology (see Figure 1 and Figure 2):

- **Antifragile:** Antifragile foundations can support innovative mindsets and systems that thrive in uncertainty and complexity, benefiting from shocks, randomness, and volatility. Spitz (2020) borrows the term “antifragile” from Nassim Nicholas Taleb (Taleb 2012, 6).
- **Anticipatory:** Anticipatory thinking can embed climate foresight among commercial and policy actors, driving sustainable futures by preparing for next-order implications, unexpected consequences, and opportunities.
- **Agility:** Actors can develop adaptive decision-making through feedback loops that reconcile the short-term discovery process of emergent solutions with longer-term complex challenges and visioning.

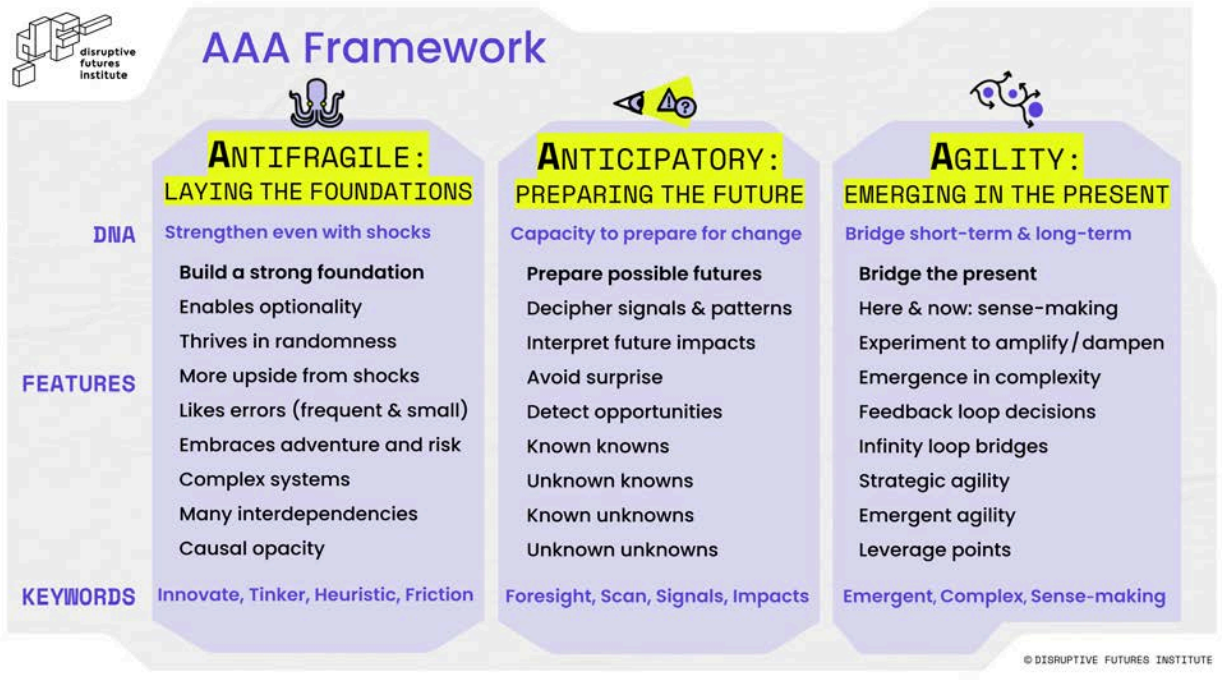

Figure 2 - The Role of the AAA Framework in Futures Intelligence (see Spitz and Zuin 2021)

While the AAA framework has merit, it does not provide all the answers for how to achieve longer-term manifestations of transformative climate foresight. Although the AAA framework provides robust foundations for climate foresight, “transformative” and sustainable change requires a deeper understanding of systems-level change. (Spitz and Zuin 2021, 17) (see Figure 3).

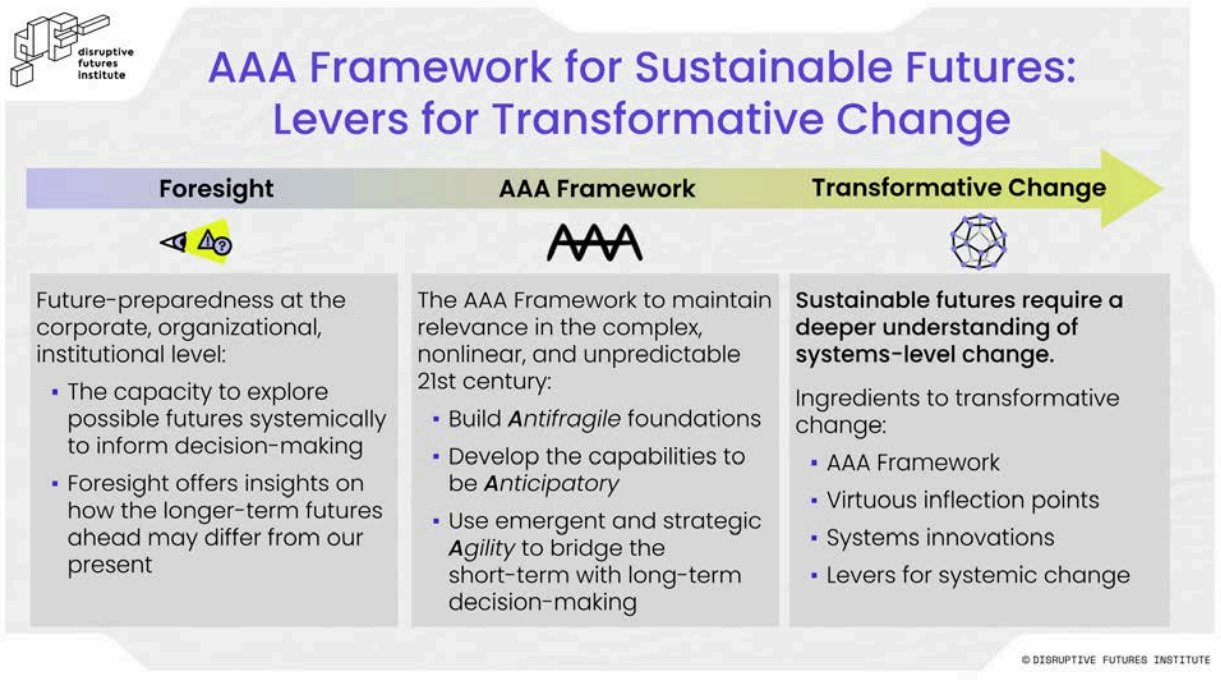

Figure 3 - The Evolution and Connection Between Foresight, the AAA Framework, and Transformative Change (Spitz and Zuin 2021)

2. Effective Systemic Change

The world's most critical challenges are complex (Snowden and Boone 2007): climate change, societal paradigm shifts, and frontier technologies. Unlocking these requires systems-level change, not point solutions, and systems innovation is necessary to achieve long-term change (Wright and Meadows 2009).

In the context of VCMs, deeper systemic appreciation of the environmental and social integrity of carbon credits is critical (Kim et al. 2024). Proper regulatory structures and governance practices are necessary to rein in perverse incentives, promote transparency, and generate trust in carbon markets. However, many investors and corporations still have a short-termist, parochial understanding of carbon markets, driven by profit incentives (Berg et al. 2021). These approaches can be counterproductive if they generate a lack of trust and credibility. Transforming VCMs through anticipatory governance, including a focus on conservation,

performance, quality, and monitoring, can enhance trust, which benefits market participants and the environment (Spitz 2024).

Transformational change must be addressed systemically, acknowledging varying degrees of impact and interconnections (Meadows 1999). Donella Meadows proposes intervention levels in a system to overcome endemic short-termism. In increasing order of effectiveness (also see Figure 4):

- **Surface events**: These easily observed interventions rely on straightforward linear responses. While simple, they offer the lowest leverage as they are less integrated in the system. Surface events are often devoid of enablers for systemic transformational change.
- **Patterns and trends:** By monitoring trends and their feedback loops, change can be observed. Consistent, comparable, reliable, clear, efficient, and transparent disclosure can reinforce accountability and trust, while anticipating what might arise to plan ahead.
- **Structures**: Incentive structures, the regulatory environment, and governance arrangements can support, drive, and generate patterns of change, or produce adverse behaviors. Changing and disrupting structures can be highly effective to establish what change arises.
- **Foresight:** Organizations and governments that embrace foresight understand how long-term orientation can build shared visions and challenge short-term mindsets.
- **Mental models**: Mental models are perceptions of the system, including how these drive the structures, patterns, and events. Influential stakeholders can challenge the mental models that sustain our beliefs, values, or assumptions.

Accordingly, changing structures and mental models results in larger changes throughout the system (Meadows 1999), as with integrating foresight. Such transformations are crucial to incentivising participation in VCMs. This argument is complemented by the Causal Layered Analysis framework, proposed by Inayatullah (2008) (Figure 5). Inayatullah (2008) argues that worldviews, values, and culture underpin complex subject matter, and therefore, shifting worldviews is key to long-term systemic change.

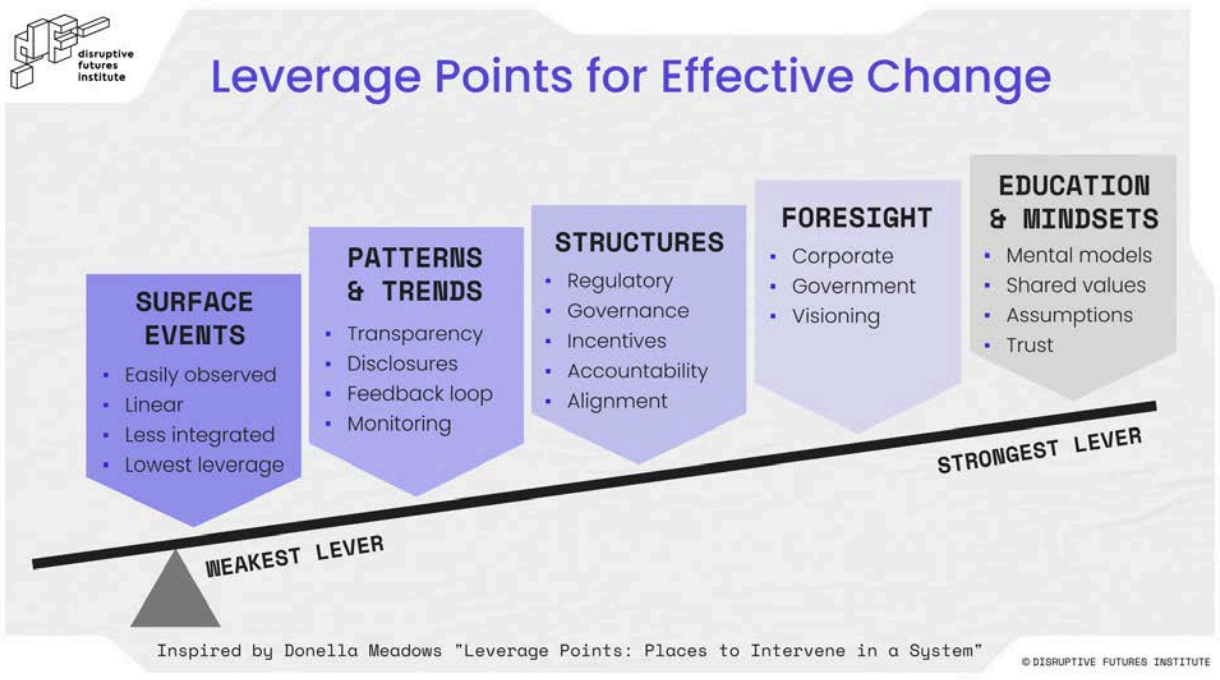

Figure 4 - Leverage Points for Effective Change, as argued in Meadows (1999) (Figure from Spitz and Zuin 2023)

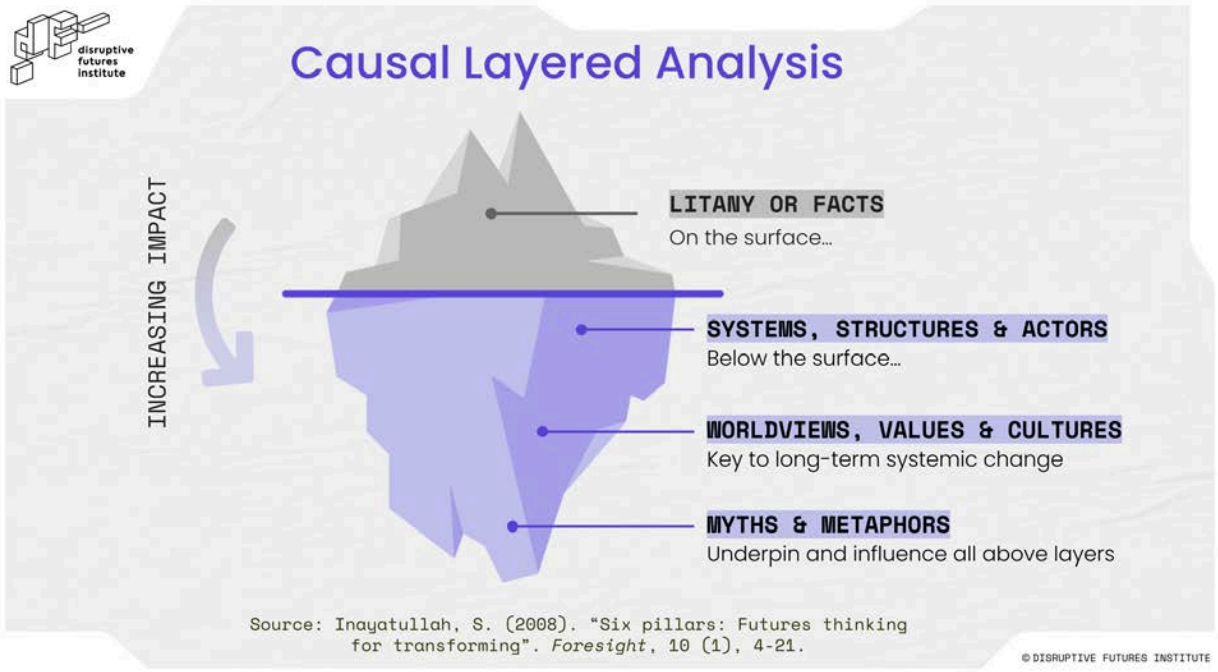

Figure 5 - Causal Layered Analysis (Inayatullah 2008)

Climate issues are inherently complex, with many possible mitigants and unintended consequences (Slaughter 2020; Wright and Meadows 2009). Environmental remedies are not straightforward financial mechanisms with clear supply-demand dynamics. As a market-based solution, VCMs must account for this. In this sense, Meadows (1999) posits the need for systems change to create a "pattern disruption" (Cairney 2012a, 31) - disrupting path dependence, which is a symptom of organizational and systemic inertia and short-termism (Boulton 2010). To achieve this, environmental remedies require systems change (Wright and Meadows 2009).

O'Brien (2018) also promotes the role of leverage points in achieving pattern disruption and systems change. O'Brien (2018) frames these leverage points as a series of **practical, political,** and **personal** levers that, in aggregate, can promote systems change for climate action. Similar to Meadows (1999), O'Brien (2018) emphasizes that personal factors, including personal worldviews and beliefs towards VCMs, have the most leverage for systems change.

For VCMs to act with effectiveness and integrity, a mix of these influences are required, at all scales of operation, as shown in Figure 6 and Figure 7.

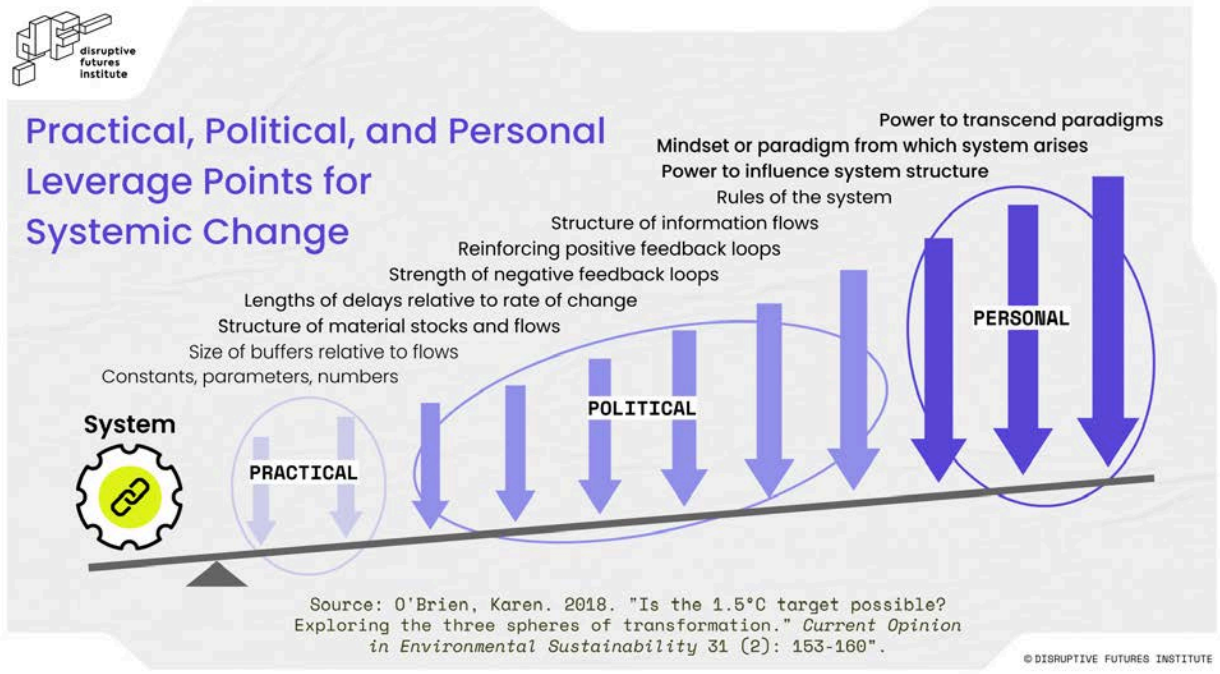

Figure 6 - Practical, Political, and Personal Leverage Points for Systemic Change, According to O'Brien (2018)

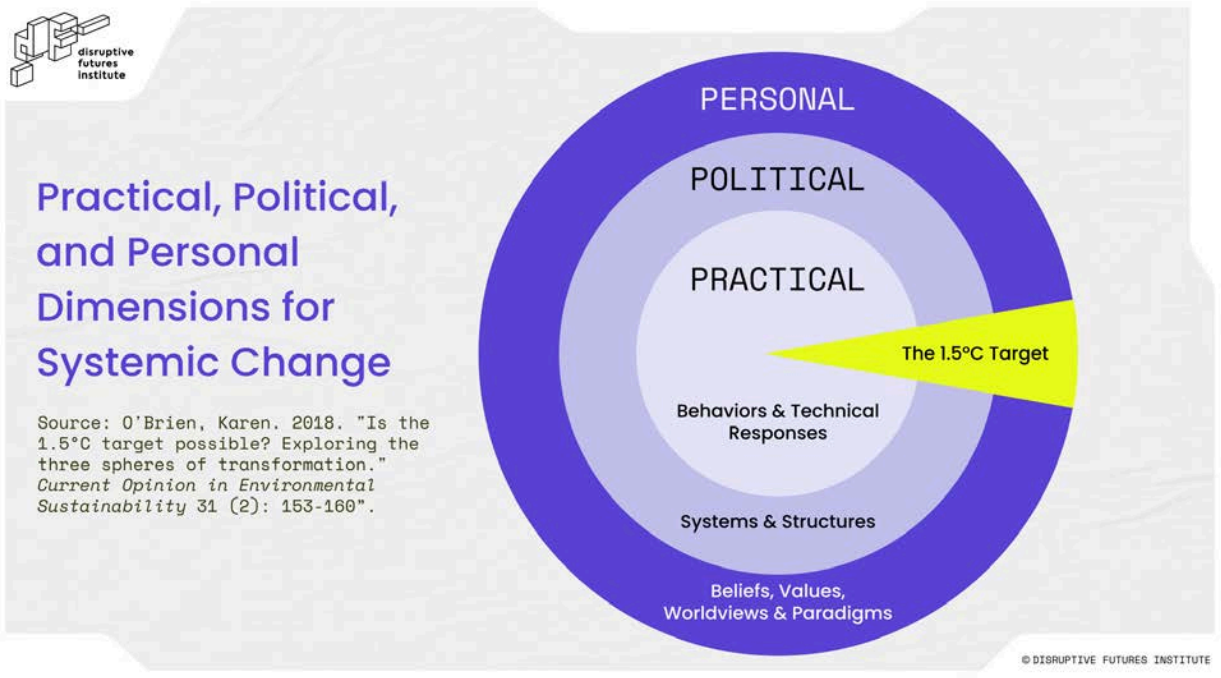

Figure 7 - Practical, Political and Personal Dimensions for Systemic Change, According to O'Brien (2018)

3. Transformation vs. Point Solutions

Achieving long-term, systemic change requires strong systems thinking, which holistically analyzes the intersecting components of systems, instead of point solutions.

Kahane (2018) explores the need for systems-wide, holistic change in complex environments to drive impactful shifts. Kahane (2018, 15) emphasizes the necessity to mobilize "autonomous system forces" in the form of "self-organizing networks" to operate in a decentralized, agile, and responsive fashion. This is particularly important in complex environments experiencing much change, which necessitates agile, decentralized networks that promote innovation in such environments (Boulton 2010).

Therefore, addressing the climate crisis as a whole requires systemic change, not isolated solutions. For a successful energy transition, businesses and investors must consider a broad set of stakeholders, partners, and complex ecosystem interactions, raising the bar for viability.

To understand stakeholder dynamics, including power imbalances and incentives, the Stakeholder Analysis Matrix by Cairns and Wright (2018) can be used (see Figure 8). By analyzing these stakeholder dynamics, we can better understand who has the most to gain - or the most to lose - in certain outcomes (Cains and Wright 2018).

In VCMs, interactions between stakeholders shape the system's effectiveness. Within the environment established by context setters, players hold interest and power. Although subjects such as local communities lack immediate power, the matrix is helpful for tracking changes over time; a bystander or subject can transform into a player or context setter under the right conditions.

This has been demonstrated by discourse exploring indigenous-led carbon credit projects (see Evans 2023). Indigenous perspectives are tailored to the biodiversity characteristics of the land they inhabit and sequester carbon on (Lee 2022; Evans 2023). Indigenous worldviews respect the land as a provider; an antithesis to the extractive mentality of large financiers and carbon offset providers actively participating in VCMs. Despite being "low power", they are certainly "high interest", making them "subjects" as defined by Cains and Wright (2018).

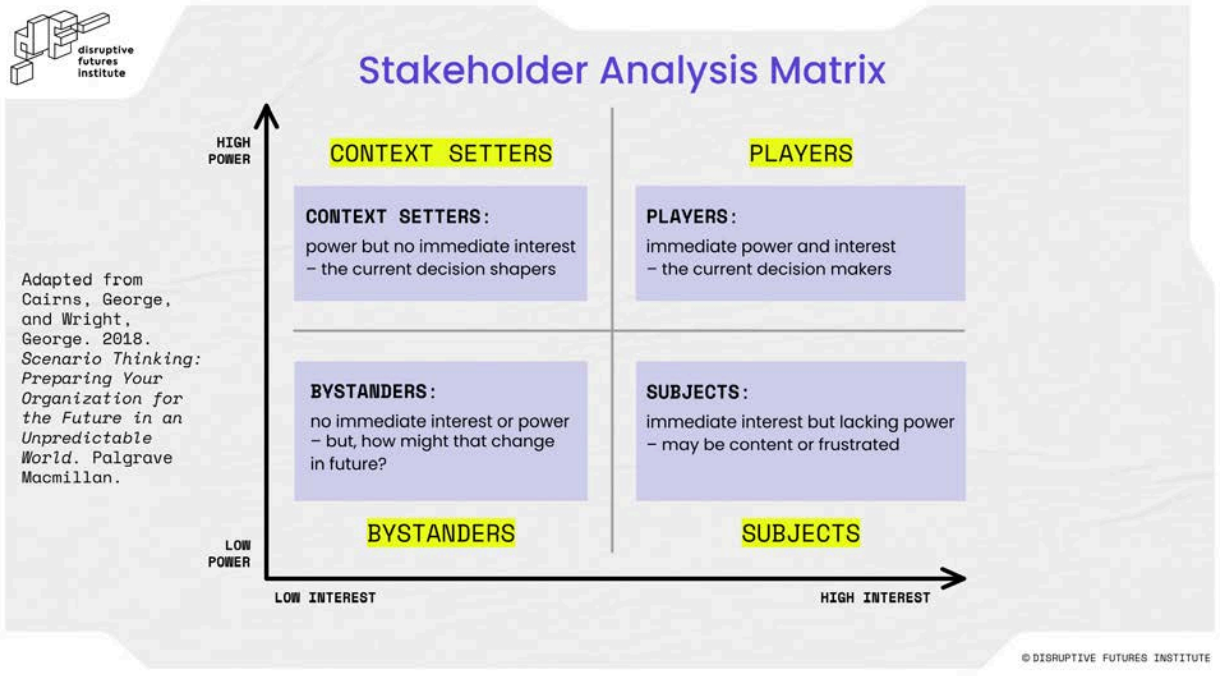

Figure 8 - Stakeholder Analysis Matrix (adapted from Cairns and Wright 2018)

Kahane (2018) posits that robust systems thinking allows relevant stakeholders to transform in four ways:

- **New Understandings** provide insight into methods, problems, and solutions.
- **Relationships** cohere innovative networks to achieve sustainable development.
- New understandings and relationships shift actors' **Intentions** about their own actions in systems.
- The preceding three evolutions enable actors to transform their **Actions** and, thereby, their situation.

The Futures Wheel (Glenn 1972) is useful for visualizing the consequences of changes within a system, which can contribute to systems-level change (see Figure 9). The sources of unintended consequences include ignorance, errors, and short-termism (Merton 1936). Using the Futures Wheel with the Stakeholder Analysis Matrix can facilitate holistic thinking for VCM

participants, leading to transformative solutions. Some emergent VCM actors, including Sylvera and LuxCS, are beginning to build on these principles to authenticate carbon offsets and credits. Both the Futures Wheel and Stakeholder Analysis Matrix are applied to the LuxCS case study later in this article.

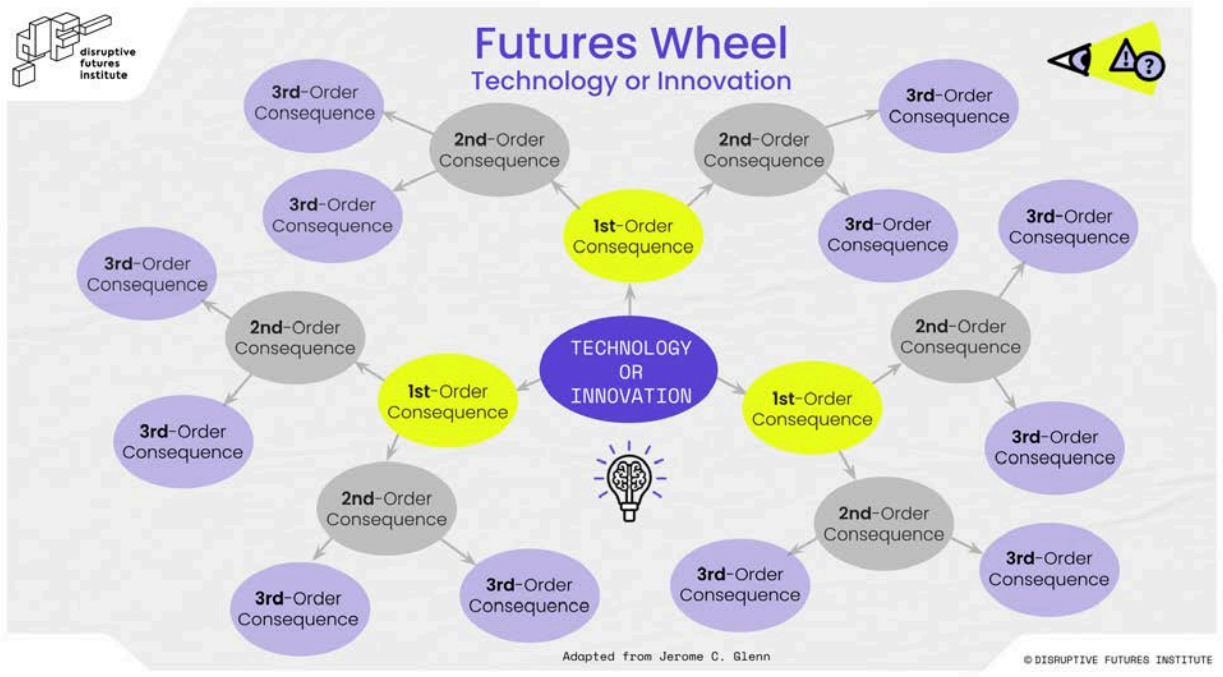

Figure 9 - Futures Wheel, as proposed by Glenn (1972)

When considering stakeholders and systems, we must also emphasize the associated dangers of technology. Technology can support sustainable practices and systems-level solutions, but only with appropriate safeguards (see Kahane 2018) and appropriate incentive structures as proposed by Meadows (1999).

4. Virtuous Inflection Points

Innovations, especially in climate technology, often go unnoticed or underappreciated until they reach a key “inflection point” in their capabilities (Diamandis and Kotler 2012, 21). In the carbon credit discourse, innovations in verification and democratization have been slow, but are beginning to emerge in a disruptive manner.

Cairney (2012b, 122) explores the Punctuated Equilibrium Theory as a model demonstrating such phenomena. Issues remain in “stasis” for long periods of time, before a stimulant event instigates a “revolution”. Enough instances of “revolution” promote a “gradualism” of change over time (see Figure 10).

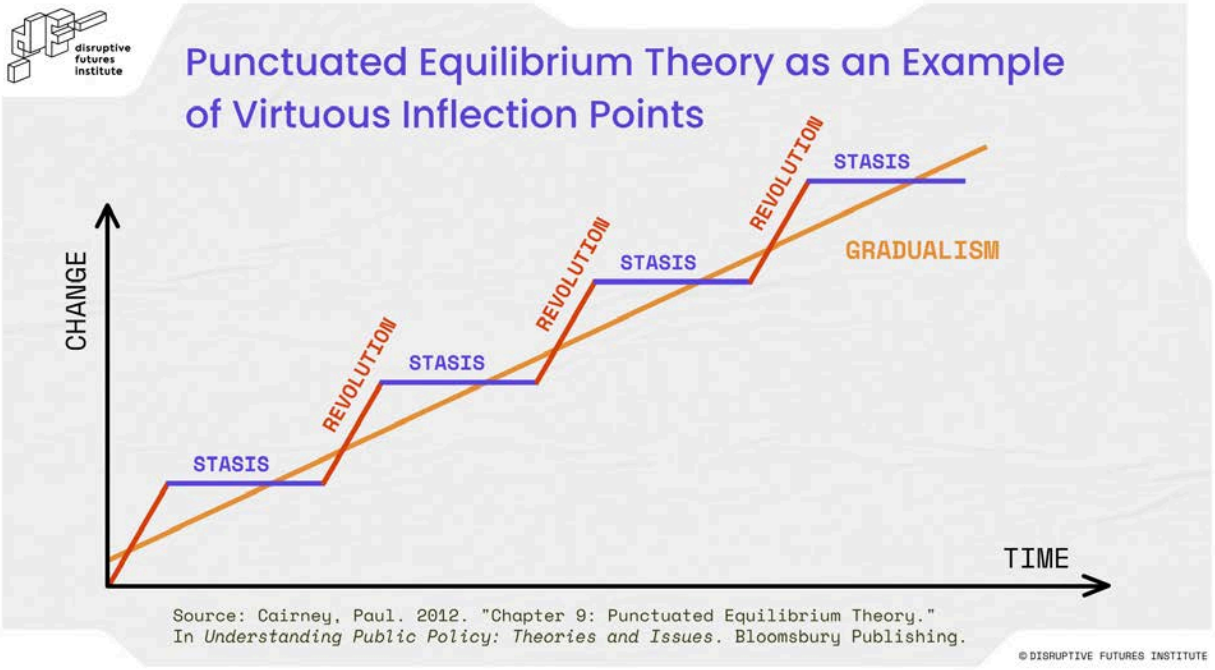

Figure 10 - Punctuated Equilibrium Theory as an Example of Virtuous Inflection Points, as discussed in Cairney (2012b)

Levin et al. (2012, 134-136) also highlight avenues for achieving long-term systemic change via virtuous inflection points - being points of precipitous change that disrupt the inertia of the status quo. Levin et al. (2012) argue that long term systems change requires **“Stickiness”**, or “lock-in” after which trajectories are difficult to alter; **“Entrenchment”**, embedding support, which results from changing mindsets, values, and norms (see O’Brien 2018 and Meadows 1999); and **“Expansion”**, long-term shifts in practical, political, and personal factors, which drive inflection points.

To promote more effective incentives and transparency from VCMs, it is necessary to overcome path dependence through virtuous inflection points. Such inflection points can shift traditional hindrances for VCMs, such as questionable transparency and perverse incentives that lead to greenwashing and carbon credit portfolio mismanagement (Christensen et al. 2021; Berg et al. 2021).

VCMs are still largely captured by established market actors, leaving out low-influence stakeholders as defined by Cains and Wright (2018). Despite the growth of VCMs, carbon credit verification methods are mixed and frequently lackluster, often overlooking the nuanced biodiversity and carbon abatement characteristics of emissions reduction projects (Christensen et al. 2021; Kim et al. 2024). Remedying these verification methodologies necessitates a disruption to the status quo, resulting in new verification methods that become **“Entrenched”** and **“Expanded”** as common practice, as per the argument of Levin et al. (2012, 135-136). This should result in a virtuous inflection point for disrupting verification processes for VCMs.

Next, the article explores the development of the VCMs in Brazil through a detailed case study of how to transform VCMs through the four levers for transformative change.

Case Study: Brazil and the Voluntary Carbon Markets

Introduction

To explore the pathways for step change to transform VCMs, we will investigate Brazil, using Lux Carbon Standard (LuxCS), Brazil’s first carbon credit issuer, as an example in real-world innovation. We will investigate the levers for transformative change, including how LuxCS is democratizing, legitimizing, and scaling a higher-quality carbon credit market. Its activities intend to change attitudes - and eventually worldviews - towards carbon credits from a variety of interconnected stakeholders. LuxCS applies climate foresight through demonstrating a distinct level of systems thinking and long-termism in its carbon credit verification processes. This supports transformative change, which is increasingly important in an era of dangerous climate change, the mainstreaming of net-zero, and scrutiny towards ESG (Kim et al. 2024).

Brazil has significant potential in the carbon credit market due to its vast size and diverse biomes. According to BloombergNEF, Brazil could become the world's largest country in carbon reduction, offsetting an equivalent cumulative total of 30.5 billion metric tons of carbon dioxide by 2050 through avoided deforestation, reforestation, and sustainable agriculture (Millard and Amat 2024). As the first Brazilian certifier in this market, LuxCS is uniquely positioned to benefit from the region's developments.

Brazil has made significant strides in the carbon market. In 2021, the Green Rural Product Note (CPR Verde) was established by Presidential Decree, providing an alternative for rural producers to obtain resources from financial institutions, backed by the carbon stock of their property. This means landholders demonstrating more carbon abatement activities on their land are eligible to receive more credit. This potentially reduces climate transition risk for the national agribusiness sector, while allowing the sector to embrace the opportunities (Sintropica 2021).

In the Brazilian Congress, several proposals were under discussion in the early 2020s to establish a regulated carbon market. Previously, there was a carbon market regulation bill draft that suggested 20% of the total credits for emission offsetting must come from the voluntary market, creating a positive outlook for voluntary projects (see Brazilian Senate Bill No. 412/2022). However, when the bill was forwarded to the Chamber of Deputies, it was replaced by another bill (Bill No. 182/2024), enacted as Law 15.042/2024. The recently enacted Law 15.042/2024 establishes comprehensive interoperability between Brazil's voluntary and regulated carbon markets. This integration mechanism operates through the accreditation of methodologies by the governing body of the Brazilian Greenhouse Gas Emissions Trading System (SBCE), provided they comply with either the law's stipulated requirements or future regulations issued by the SBCE. Consequently, any voluntary market credits certified under these approved standards become eligible for submission and conversion within Brazil's compliance market, creating synergistic acceleration across both market segments while maintaining rigorous environmental integrity standards. This legislative framework positions Brazil at the forefront of carbon market innovation by bridging voluntary action with regulated climate obligations.

While investigations into misleading carbon credit programs have affected the global VCM industry, there may be an inflection point approaching in Brazil. As the Brazilian market matures with local ecosystem players, certain stakeholders could establish and maintain VCM credibility. While Brazil's VCM has historically relied almost entirely on global certifiers such as Verra, Gold Standard, American Carbon Registry, and Climate Action Reserve, new domestic certifiers are emerging. Emerging certifiers seek to address the local specificities of Brazil, and to rebuild trust, transparency, and sustainable integrity of VCMs.

LuxCS' Protocol and Accreditation

LuxCS' verification process is called the Triple C Protocol (Certificacao de Créditos de Carbono Protocol), a nature-based standard designed to ensure the measurable impact of carbon projects. The protocol defines the criteria for eligibility, validation and verification of carbon credit certification processes. It establishes a reference scenario, ensuring that projects create genuine, rather than assumed, emissions reduction. The protocol is underpinned by principles that ensure the effectiveness of certified carbon credits - focused on accuracy, credibility, legitimacy, simplicity and transparency. The Protocol can operate in different Brazilian biomes, taking advantage of geographic and cultural proximity to reduce project certification costs, and allowing projects in drier regions to participate. This makes certification more accessible, promoting projects that reduce emissions, strengthen communities, and protect biodiversity. The Triple C Protocol's ability to measure carbon in this manner is distinctive, and gives it a particular advantage over established carbon verification methods, which are typically based on avoided emissions.

The Protocol covers activities like agriculture, orcharding, reforestation, and native forest conservation. These combined efforts aim to increase VCM participation in Brazil, accelerate positive environmental impact, and enhance the credibility of the market. LuxCS aims to follow the guidance of key organizations like Science Based Targets initiative (SBTi), the Integrity Council for the Voluntary Carbon Market (ICVCM), and the Voluntary Carbon Markets Integrity Initiative (VCMII).

LuxCS also follows a high standard of corporate governance, based on the ICROA Code of Best Practice (ICROA 2024), the ICVCM Fundamental Carbon Principles (ICVCM 2024), and the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019).

The Triple C Protocol is more efficient and affordable than conventional carbon measurement processes, as it focuses on biodiversity proxy information rather than time-intensive carbon measurement processes. Most carbon credit programs seek to avoid emissions, which requires burdensome baseline data collection. Instead, the reliance on biodiversity characteristics measures the carbon that has already been absorbed in the land, precluding resource-intensive baselines. As another differentiator, LuxCS covers both avoided deforestation, similar to REDD+ (Reducing Emissions from Deforestation and forest Degradation in Developing countries), and afforestation, reforestation, and restoration (ARR) conservation practices.

Explaining LuxCS' Verification Process

Figure 11 outlines the LuxCS carbon credit verification process.

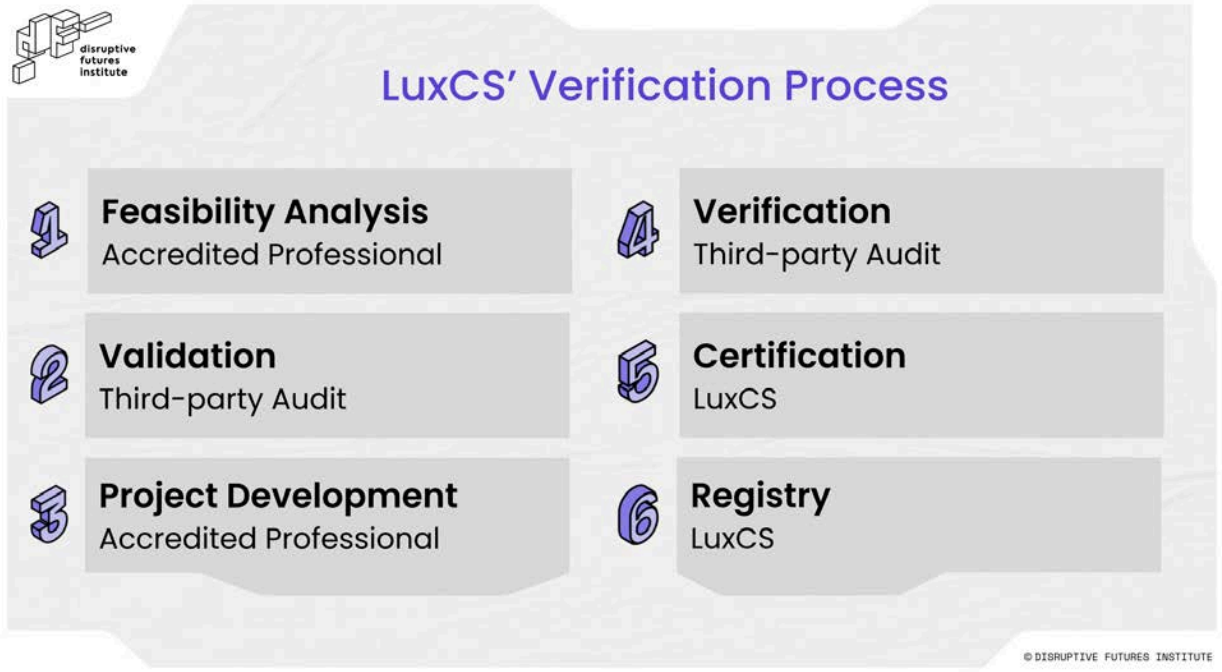

Figure 11 - LuxCS' Verification Process

The Protocol begins with a technical feasibility analysis of the site, carried out by an independent professional. After a positive technical analysis, an independent third-party audit verifies that the proposed methodology is suitable.

The third phase is the Project Development itself, where the developer expands soil sampling and the forest inventory and performs calculations according to the validated methodology.

Finally, after measuring the carbon in the area, the project undergoes verification by an independent third party.

Unlike other protocols, LuxCS uses a hybrid blockchain architecture to model their blockchain network for development and information. This digital architecture allows stakeholders to verify the impact of their certified credits as well as track them, which enables transparency and integrity.

After generation, credits can be retired immediately to offset a company's emissions. Alternatively, credits can be traded until a company or individual acquires them for offsetting purposes.

LuxCS' Unique Qualities and Impact

LuxCS aims to ensure accountability through the use of immutable blockchain technology, and has the ability to address systemic environmental issues at the intersection of biodiversity and carbon.

Carbon markets have long been largely inaccessible to low socio-economic landholders, particularly in the Global South. There is a perception that carbon markets are a top-down, impositional, and low-integrity initiative, with adverse socio-ecological outcomes for the global poor (Kim et al. 2024; Christensen et al. 2021). Consequently, these low socio-economic landholders have perceived carbon markets as a negative practice. This has promoted an

inequitable governance culture among carbon market actors that have neglected less powerful actors and their communities.

However, the increasing democratization of blockchain and tokenization technologies are increasing access to carbon markets, and can shift the worldviews of such landholders towards carbon markets (UNEP 2022). This can lead them to appreciate and manifest the economic, social, and environmental value of carbon markets (UNEP 2022).

LuxCS and the AAA Framework: How Does It Align?

Antifragile

LuxCS pursues antifragile principles by demonstrating the following:

1. **Vulnerabilities as opportunities**: By adopting LuxCS protocols, landowners can benefit by creating sustainable value in the face of climate change.
2. **Conservation**: LuxCS' metrics are underpinned by nature-based solutions, which offer pathways to *conservation*. This enables LuxCS to understand the impact of carbon credit investment on ecosystem improvements and carbon abatement, as opposed to traditional carbon offsetting methods (or *preservation* approaches), which rely on estimates of avoided deforestation.
3. **Embracing complex systems:** LuxCS translates project-level climate complexity into anticipatory climate action by providing open access to voluntary carbon markets. By blurring the lines between carbon markets, the natural environment, and local landholders, LuxCS enables less established actors to participate and reinforces the diversity of ecosystem interactions.
4. **Building climate resilience**: Resilience, or the ability to respond to and recover from shocks, is a prerequisite to antifragility (Taleb 2012). LuxCS is rethinking VCMs for both ***mitigation*** of climate change (financing renewable energy installations, verifiable carbon reduction, encouraging sustainable practices) and ***adaptation*** (supporting resilient infrastructure, nature-based solutions - mangroves or wetlands - that restore ecosystems). Resilient infrastructure and nature-based solutions can fortify resilience to

climate impacts, sequester carbon, and generate social benefits that improve community adaptive capacity (IPCC 2022).

5. **Integrity and reducing single points of failure**: The LuxCS rating system, administered by independent, reputable organizations, classifies carbon credits on a per-project basis. This process enhances market integrity and provides additional security by scrutinizing each project, ensuring that any failures are isolated, mitigating risk for other projects.

Anticipatory

LuxCS demonstrates anticipatory principles through the following:

1. **Climate foresight and futures intelligence**: A precondition to managing risk is to measure risk. LuxCS offers comprehensive and accessible data for landholders, enabling monitoring and evaluation capacity.
2. **Climate-related monitoring:** Enhanced carbon credit disclosures support greater VCM transparency, informed investment decisions, and increased quality. LuxCS' insights promote comprehensive disclosure.
3. **Anticipatory governance**: Recognizing the intensifying outside scrutiny of VCMs, progressive players like LuxCS go beyond mere adherence to best practices. Instead, they rethink the traditional VCM practices, considering systemic and long-term climate impacts. Proactive, not reactive, LuxCS collaborates with stakeholders, regulators, and market players to continuously push for higher-integrity VCMs in Brazil.

Agile

LuxCS demonstrates agile principles through the following:

1. **Sense-making**: LuxCS proposes to offer localized insights from large datasets. The carbon and biodiversity data enabled by LuxCS intends to provide high quality and quantity of localized data. Likewise, its use of biodiversity data to more expeditiously measure carbon enables sense-making, adapted to specific Brazilian biomes.

2. **Feedback loop decisions**: LuxCS leverages real-time insights from technology, including remote sensors, satellites, and AI, to measure, monitor, and verify carbon evolutions.
3. **Diverse perspectives to enable emergence**: Various cultures, experiences, environments, and fields will pick up different signals before the future emerges. Diversity enables a broader, richer set of signals. These allow you to challenge stale assumptions (Spitz and Zuin 2022). LuxCS harnesses diverse perspectives from a broad set of constituents, including indigenous populations and locals to Brazil's diverse biomes, allowing for different responses from multiple and diverging points of view (Page 2009).

In addition to the AAA Framework, the other three avenues for transformative change explored in this article also align with LuxCS' strategy, and will be explained subsequently.

The Virtuous Inflection Point offered by Blockchain and Democratized Climate Intelligence

LuxCS uses blockchain to create a public ledger that verifies and evaluates the true carbon abatement of carbon credits, which leads to transparent and cost-effective ways of achieving high-integrity carbon markets. As a result of this and other cost-reducing strategies, LuxCS' carbon credit verification methodology is much more accessible than traditional carbon credit verification methods.

Insights offered by LuxCS have historically only been accessible to those with deep climate data sets. As we reach an inflection point in our relationship with the climate, democratizing climate intelligence can help achieve systems-level success through virtuous inflection points.

In democratizing climate foresight, LuxCS disrupts the **"Stickiness"** of path dependence as an early adopter challenging the status quo of carbon markets, as explored by Levin et al. (2012, 134). The widespread democratization of climate intelligence is leading to **"Entrenchment"** and longer term disruptive **"Expansion"** of carbon markets access, as expressed in Levin et al. (2012, 135-136). This may become particularly apparent as LuxCS enters into the "early

majority” market of customers in Brazil (lower-middle-class to middle-class consumers).

Leverage Points for Effective Change Demonstrated by LuxCS

In addition to the virtuous inflection point presented by blockchain and democratized climate foresight, LuxCS’ model presents an important shift in mindsets towards climate foresight. This aligns with the arguments of Meadows (1999), O’Brien (2018) and Inayatullah (2008), who emphasize the role of shifting mental models and understandings of systems in order to drive longer-term systemic change (see Figure 4, Figure 5, and Figure 6).

Access to carbon markets shares the burden of climate responsibility with low-influence actors, overcoming the perception that only high-influence actors can mitigate carbon emissions. Per the argument of Meadows (1999), there is much power in shifting mental models as an avenue for mitigating carbon emissions.

Other levers for change driven by LuxCS include observable patterns and trends such as greater transparency and disclosures. In turn, this promotes accountability, trust, and alignment through the power of blockchain, all demonstrated as levers of change in Figure 5 (see Meadows 1999).

Per the argument of O’Brien (2018), democratized technology such as blockchain offers practical, political, and personal avenues for decarbonization. The LuxCS protocol helps overcome the administrative burden of verifying carbon credits through its more cost effective methods. Furthermore, LuxCS promotes a more streamlined and clear structure of information flows on the political dimension, reducing information asymmetries present in less democratized carbon markets.

LuxCS: Moving Beyond Point Solutions

To understand how LuxCS could be a catalyst to systems-level change, a Stakeholder Analysis Matrix was performed using the Cairns and Wright (2018) framework (Figure 12).

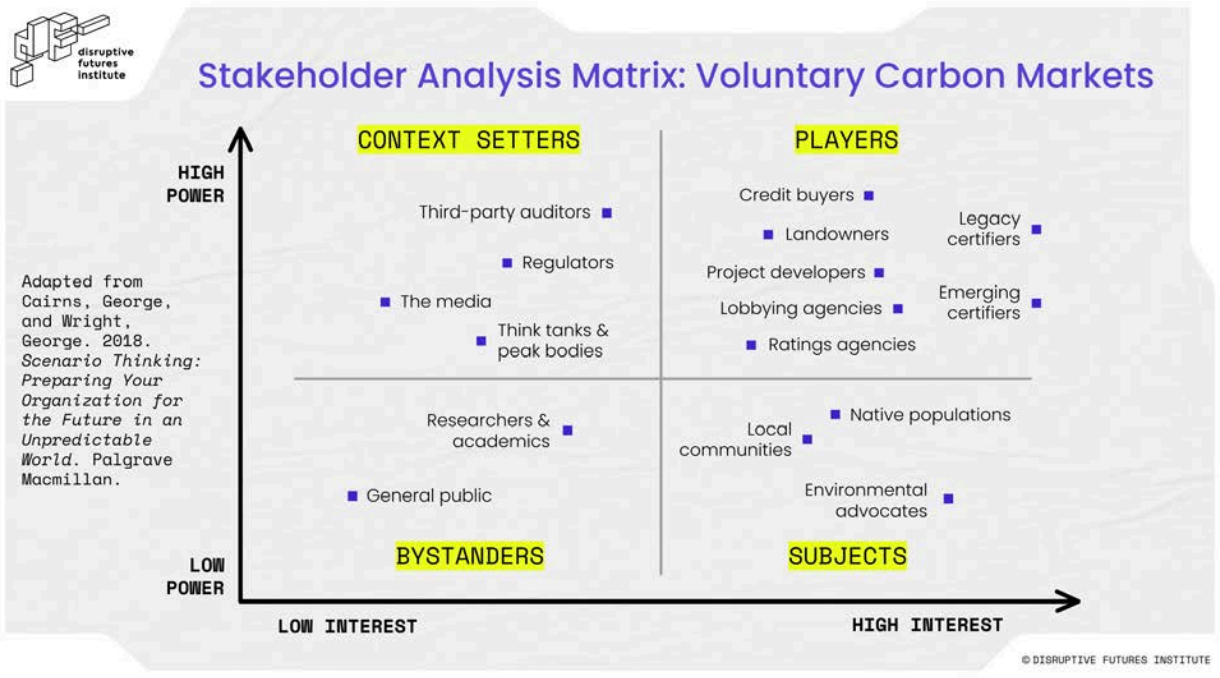

Figure 12 - Stakeholder Analysis Matrix: Voluntary Carbon Markets

As a certifier, LuxCS can leverage relationships with currently low-power but high-interest stakeholders to enable their interests to be enacted, potentially adding legitimacy, and moving those actors from the subject quadrant into the player quadrant. By transforming subjects and bystanders into allies, LuxCS can increase its power and influence while achieving virtuous interests. As carbon markets are facing unprecedented scrutiny, beneficial alignments with marginalized stakeholders can mitigate reputational risk.

To understand the next-order implications of LuxCS' operation, we performed a Futures Wheel exercise (see Glenn 1972) to identify future impacts following the successful adaptation of the company's protocol.

To generate these, the initial source of change was chosen as "LuxCS scales and its standards become so pervasive that every VCM adopts such approaches."

From this point, the strongest first-order impacts of this change were explored. After that, second-order effects created by the first-order consequences were identified, considering

unexpected, counterintuitive, and even perverse results. The process was then repeated to create a full Futures Wheel.

The full results of the impact cascades exercise can be found below in Figure 13. We will summarize three of these “branches” here:

- **First, we explored the “ideal” scenario for LuxCS.** Here, LuxCS’ approach to anticipatory governance becomes the built-in standard for VCMs. The resulting carbon credit values could then incentivize investment in renewable energy projects. Following that, R&D could increase for carbon sequestration technologies, which could then result in a long-term overall reduction in greenhouse gasses.
- **However, perverse outcomes were also imagined.** Consider that LuxCS’ approach to anticipatory governance still becomes the standard. The resulting carbon credits would incentivize renewable projects. However, imagine that the monetary incentives are so strong that the value of farmland skyrockets, leading to a land-grabbing frenzy as developers rush to capitalize on carbon credits. As land becomes more dedicated to carbon projects, agriculture could be pushed out, leading to increased food prices. Here, indigenous peoples could also be priced out of their homeland.
- **Finally, a third branch highlights scenarios in which LuxCS’ protocol undermined the energy transition.** Even if carbon projects proceed with full transparency, they may not need VCM incentives to do so. In this scenario, there would be no additional emissions reduction (i.e., zero additionality) as a result of LuxCS’ protocol. Therefore, true carbon sequestration would not increase. Sustained emissions by institutions that bought carbon credits would persist, enabled by VCMs despite their transparency. Consequently, this could undermine the global energy transition as a whole.

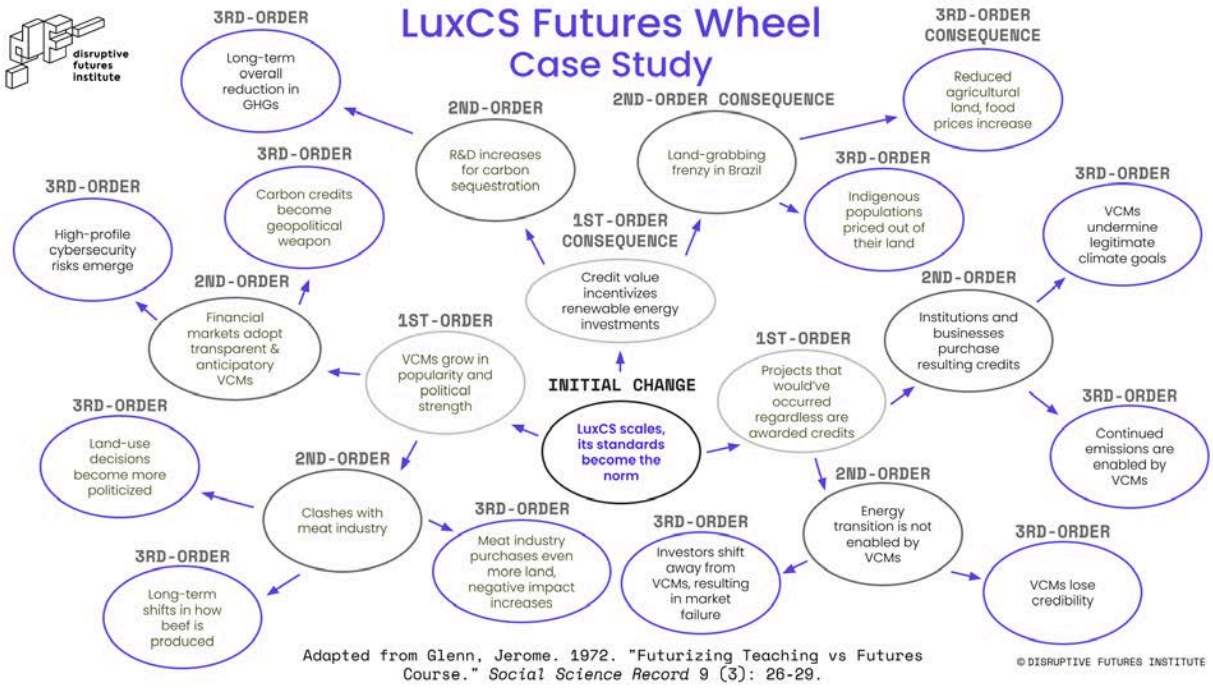

Figure 13 - LuxCS Futures Wheel

In addition to initiatives derived from stakeholder analysis, LuxCS' commitment to systems-level change is further evidenced by its certification of credits for reducing greenhouse gas emissions through the UnCarbonize Program within the Triple C Protocol. The UnCarbonize Program assesses a whole-of-production chain of emissions, encouraging environmental and biodiversity conservation of the land and sectors where carbon is being abated. This overcomes a common issue in carbon markets: an overfocus on carbon abatement at the expense of broader sustainability characteristics of land and ecosystems (Kim et al. 2024).

UnCarbonize reflects the remarks of Kahane (2018) - the need for holistic change in complex environments to drive impact. Doing so should enable a shift in the **understandings, relations, intentions, and actions** of stakeholders involved in LuxCS, as proposed by Kahane (2018):

- With a stronger appreciation of the complex interaction of the land's biodiversity, carbon, and potential value, **understandings** should change.
- Landholders' **relations** to their land should change, as they can appreciate their land's economic value in a new sustainable way.

- Then, **intentions** and **actions** should shift, as landholders change how they treat their land based on the climate intelligence enabled by LuxCS.

Conclusion

While VCMs present a market-driven avenue to decarbonization, they are subject to skepticism regarding their integrity and equity. This is largely due to their opacity and suboptimal verification procedures, and occasionally intentional fraud and lapses in integrity regarding the carbon abatement potential of VCM projects (Kim et al. 2024).

Addressing the complexities of climate change necessitates holistic, systemic transformations rather than siloed approaches (Kahane 2018). VCMs are a complex phenomena, existing at the interface of social, economic, and environmental domains (Kim et al. 2024). Given the unpredictable nature of complex systems, a nuanced comprehension of complexity is essential for effective VCMs.

Enterprises are encountering unparalleled scrutiny of their climate initiatives and ESG practices (Christensen et al. 2021). This enormous shift in corporate practice and scrutiny is already leading to changes in corporate ESG strategies as entities perceived as champions of sustainable futures can gain a competitive advantage (Berg et al. 2021). Any proficient ESG practice must illuminate effective pathways to sustainable futures through climate foresight.

Consequently, to facilitate a successful energy transition, it is imperative for businesses and investors to recognize the diverse array of stakeholders involved and intricate ecosystem interactions (Spitz 2024).

The case of Brazil and its first carbon credit certifier, Lux Carbon Standard (LuxCS), demonstrates potential pathways for anticipatory governance to reshape VCMs. LuxCS showcases the significance of systemic innovations by employing technologies like blockchain and satellite monitoring, alongside pioneering biodiversity calculation methods. Their initiatives not only improve perceptions of carbon credits among stakeholders, but also drive systemic transformations within VCMs, offering possibilities for global scalability.

By following LuxCS' protocols and standards, more VCM verification stakeholders can understand what best-practice climate foresight looks like, and seek to emulate it. It is possible the practices of LuxCS will become more commonplace, and potentially inspire more robust regulations based on competent climate foresight.

About Lux Carbon Standard

Lux Carbon Standard (LuxCS) is a Brazilian certification entity that operates in the voluntary carbon credit market. It offers a set of guidelines and methodologies, as well as a proprietary protocol for measuring and certifying greenhouse gas emissions reductions or removals. LuxCS actively seeks to promote global sustainability and address social and environmental issues through its operations.

LuxCS brings together a multidisciplinary group of professionals specializing in fields as diverse as forestry engineering, information technology, business administration, law, and communications. This diversity of talents and experiences allows the company to approach the complexity of the carbon credits market in a holistic and innovative way.

LuxCS is the only company in Brazil that operates under the trinomial of Validation, Verification, and Certification. It provides comprehensive technical, legal, and economic support and carries out prospecting for suitable carbon credit generation areas. The company follows strict corporate governance rules, and its projects are audited by third parties to guarantee the integrity, transparency, and credibility of the credits generated.

Pedro Kraus (LuxCS Founder), Roger Spitz (Chair Disruptive Futures Institute), and Thiago Müller (LuxCS CEO). Atlantic Forest (Mata Atlântica), Brazil. Photo GrupoVex

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