

# FINANCING GREEN FUTURES THROUGH DLT INNOVATION



# Table of content

<b>EXECUTIVE SUMMARY</b> .....	4
<b>PURPOSE AND SCOPE</b> .....	4
<b>STRUCTURE OF THE PAPER</b> .....	4
<b>1 - KEY POINTS</b> .....	5
1.1 Sustainable Finance Presents Many Challenges .....	5
1.2 What is DLT.....	5
1.3 The DLT Solution for Sustainable Finance .....	5
1.4 Challenges for Adoption .....	5
1.5 Empowering Sustainability Practices .....	6
1.6 DLT Driving Growth in Sustainable Finance .....	6
<b>2 - CURRENT TRENDS AND CHALLENGES</b> .....	7
2.1 Traditional Finance.....	7
2.2 Sustainable Finance.....	7-8
<b>3 - A PRIMER ON DISTRIBUTED LEDGER TECHNOLOGIES</b> .....	9
<b>(DLT)</b>	
3.1 Key Features of DLT.....	9
3.2 How DLT Works.....	9-11
<b>4 - THE DLT OPPORTUNITY IN SUSTAINABLE FINANCE</b> .....	12
4.1 DLT vs Standard/AI Optimisation.....	12-13
4.2 Democratising Validation.....	14
4.3 The Benefits and Challenges of Smart Contracts.....	15-16
4.4 Real-Time Tracking and Automated Compliance.....	16-17
4.5 Traceability of Sustainable Practices .....	18
<b>5 - REGULATORY AND LEGAL CONSIDERATIONS</b> .....	19
5.1 EU Taxonomy Regulation.....	19
5.2 Sustainable Finance Disclosure Regulation (SFDR).....	19
5.3 Digital Operational Resilience Act (DORA).....	19
5.4 Corporate Sustainability Reporting Directive (CSRD).....	19
5.5 Markets in Crypto-Assets (MiCA) Regulation .....	19-20
5.6 Updates of the SFDR Annexes.....	20-21
5.7 Greenwashing .....	21-22
5.8 DLT Regulatory Solutions .....	22-24
<b>6 - CHALLENGES AND RISKS OF DLT</b> .....	25
6.1 Technical and Operational Challenges .....	25

<b>7 - THE CASE OF GREEN BONDS INFRASTRUCTURE</b> .....	26
7.1 Issuance of Green Bonds and its Tokenisation Process.....	26-27
7.2 Tamper-Proof Audit Trail.....	28
7.3 Automation of Compliance and Operations.....	28
7.4 Implications for Market Participants .....	28
7.5 Green vs DLT – Energy Consumption .....	30-32
<b>8 - DLT AS A DRIVER OF SUSTAINABLE FINANCE</b> .....	33
8.1 ESG Funds.....	33
8.2 Impact Investing.....	33-34
8.3 Microfinance.....	34
8.4 Carbon Credits.....	35
8.5 Carbon-Linked Green Bonds.....	35-37
8.6 Corporate Reporting .....	37-39
<b>9 - RECOMMENDATIONS</b> .....	40
9.1 For Financial Institutions.....	40
9.2 For Policymakers/Regulators.....	40-41
9.3 For Technology Firms.....	41
<b>CONCLUSION</b> .....	42-43
<b>GLOSSARY</b> .....	44-45
<b>REFERENCES</b> .....	46
<b>APPENDIX I : EXPLORATION OF BFT IN THE CONTEXT OF SUSTAINABLE FINANCE</b> .....	47-48
<b>APPENDIX II : MEET THE DOERS</b> .....	48
<b>MONIFLO</b> .....	49-51
<b>EVERCITY</b> .....	52-54
<b>IMPACT</b> .....	55-56
<b>AUTHORS</b> .....	57
<b>ACKNOWLEDGEMENTS</b> .....	58
<b>CONTRIBUTORS</b> .....	58



## Executive Summary

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This white paper explores the transformative potential of Distributed Ledger Technology (DLT) in advancing sustainable finance, offering a fresh perspective on how DLT can tackle the key challenges presented in this white paper, by significantly enhancing transparency, efficiency, and accountability in the sector. The paper addresses issues such as current technological limitations, operational inefficiencies, regulatory hurdles and cost barriers.

Despite criticisms regarding its energy consumption, DLT offers unparalleled capabilities in terms of data integrity and traceability – key attributes that are essential for the credibility of green finance initiatives. By embedding project data directly into financial instruments, DLT not only bolsters the credibility and accountability of sustainable investments but also enhances investor confidence and participation, driving the growth of sustainable finance forward.

## Purpose and Scope

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Our main objective is to explore the application of DLT in sustainable finance, facilitating a consensus on best practices and standards. This involves examining the technical, regulatory, and operational challenges and identifying solutions that align with the evolving landscape of sustainable finance. Engaging stakeholders across the financial sector, regulatory bodies, and technology providers, the white paper aims to raise awareness and promote the widespread adoption of DLT in sustainable finance, ensuring it meets the highest standards of transparency, efficiency, and impact for both investors and investees.

## Structure of the Paper

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The paper is divided into sections covering sustainable finance, DLT technology, its applications in sustainable finance, regulatory considerations, challenges, case studies, strategic recommendations, and future outlook.





# 1 - KEY POINTS

## 1.1 SUSTAINABLE FINANCE PRESENTS MANY CHALLENGES

Sustainable finance seeks to integrate environmental, social, and governance (ESG) factors into financial decision-making, aiming to promote projects that benefit both the environment and society. Notwithstanding the efforts made, it remains that Financial Institutions tend, especially in the sustainability field, to lack transparency, as highlighted by the European Central Bank in its report published in 2023 titled “The importance of being transparent - A review of climate-related and environmental risks disclosures practices and trends”<sup>1</sup>. The process of disclosure is made largely on a manual basis, using external studies as well as management boards. These processes are frequently inefficient, slow and lacking access to some sources of data, all of which can hinder the progress and effectiveness of sustainable finance initiatives.

## 1.2 WHAT IS DLT

DLT, more commonly known as blockchain, offers a secure, transparent, and efficient platform for sustainable finance. By ensuring data integrity and providing real-time access, DLT addresses critical issues such as transparency and efficiency. Additionally, it reduces the need for intermediaries, further streamlining financial processes and enhancing the overall effectiveness of sustainable finance initiatives.

## 1.3 THE DLT SOLUTION FOR SUSTAINABLE FINANCE

DLT holds significant potential in transforming sustainable finance through various applications. For instance, in the realm of green bonds, DLT enhances the issuance, management, and tracking processes, ensuring greater transparency and reducing the risks associated with greenwashing. Additionally, the use of smart contracts can automate compliance and operational tasks, ensuring that funds are used as intended and mitigating the risk of fraud. Moreover, DLT improves the traceability and authenticity of sustainability claims in carbon credits and impact investing, making these processes more reliable and trustworthy.

## 1.4 CHALLENGES FOR ADOPTION

Recent advancements have made significant strides in addressing the challenges of DLT. One major concern, energy consumption, has been mitigated by innovations such as Ethereum’s shift to Proof of Stake (PoS), which drastically reduces the energy required. Additionally, overcoming technical and regulatory barriers necessitates collaboration between financial institutions, regulators, and technology providers. This cooperative effort is essential for ensuring seamless integration and compliance, paving the way for the broader adoption of DLT in sustainable finance.

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<sup>1</sup> The importance of being transparent - A review of climate-related and environmental risks disclosures practices and trends, European Central Bank, April 2023





### 1.5 EMPOWERING SUSTAINABILITY PRACTICES

DLT plays a crucial role in supporting compliance with regulations such as the Sustainable Finance Disclosure Regulation (SFDR) and the EU Taxonomy by providing secure, immutable records of sustainability-related data. This automation enhances stakeholder trust and facilitates real-time tracking and automated compliance, making it easier for organisations to adhere to regulatory requirements and demonstrate their commitment to sustainable practices.

### 1.6 DLT DRIVING GROWTH IN SUSTAINABLE FINANCE

DLT's role in sustainable finance is anticipated to expand significantly, with applications reaching beyond green bonds to encompass ESG funds, impact investing, microfinance, and more. Continuous innovation and education are essential to fully realising DLT's potential, ensuring it meets the highest standards of transparency, efficiency, and impact. As the technology evolves, it will likely become an integral part of a broader range of sustainable finance initiatives, driving positive change across various sectors.





## 2 - CURRENT TRENDS AND CHALLENGES

Legacy financial infrastructure faces significant pressures to evolve in light of rapid technological advancements and increasing demands for transparency and efficiency. Meanwhile, the sustainable finance sector, despite its noble intentions and growing prominence, encounters its own set of hurdles, including greenwashing, inadequate transparency, and the complexities of verifying sustainable investments.

### 2.1 TRADITIONAL FINANCE

The financial system, characterized by its complex and often cumbersome processes, is increasingly ill-suited to meet the demands of modern stakeholders. Legacy systems that underpin these financial operations are plagued by inefficiencies, including slow and convoluted processes that involve numerous intermediaries. The lack of transparency within these systems impedes the ability to track transactions and verify data, creating silos that isolate crucial information. Manual operations, which are still prevalent, not only increase the risk of human errors but also heighten the potential for fraudulent activities. Moreover, the high costs associated with maintaining and upgrading outdated infrastructure pose significant financial and resource constraints, while the limited accessibility of these systems stifles broader participation and hinders innovation, such as that within the sustainable finance sector.

- **Complex Processes:** Legacy systems often involve multiple intermediaries, leading to slow and complicated processes.
- **Lack of Transparency:** Information is often siloed and not easily accessible, making it difficult to track transactions and verify data.
- **Manual Operations:** Many operations require manual intervention, increasing the risk of errors and fraud (“fat finger” errors)
- **High Costs:** Maintaining and upgrading old systems can be expensive and resource intensive.
- **Limited Accessibility:** These systems are not easily accessible to all stakeholders, limiting participation and innovation.

### 2.2 SUSTAINABLE FINANCE

The sustainable sector faces unique challenges that stem from its mission to promote environmental and social governance (ESG) principles. One of the most pressing issues is greenwashing, where misleading claims about the sustainability of products and services undermine trust and accountability. The absence of standardized criteria and robust verification processes makes it difficult to distinguish genuine sustainable initiatives from those that are merely deceptive. This sector also contends with transparency issues, as there is limited visibility into the true environmental and social impacts of investments. Inconsistent reporting standards and the challenges in tracking fund allocation in green projects further complicate efforts to ensure transparency and accountability. Lastly, the efficient verification of sustainable investments remains a critical challenge. Traditional methods of verification are not only costly and complex but also heavily reliant on manual processes that are prone to errors and fraud.







### **Greenwashing Entails:**

- Misleading claims about the sustainability of products and services.
- Lack of standardised criteria and verification processes.
- Difficulty in distinguishing genuine sustainable initiatives from deceptive ones.
- Regulatory scrutiny and the need for robust mechanisms to ensure transparency and authenticity.

### **Transparency Issues Cover:**

- Limited visibility into the actual environmental and social impact of investments.
- Challenges in tracking the allocation and use of funds in green projects.
- Inconsistent reporting standards and practices across different regions and institutions.
- Difficulty in accessing reliable and real-time data on sustainability metrics.

### **Efficient Verification of Sustainable Investments:**

- Need for accurate and timely verification of sustainability claims.
- High costs and complexity associated with traditional verification methods.
- Reliance on manual processes is prone to errors and fraud.







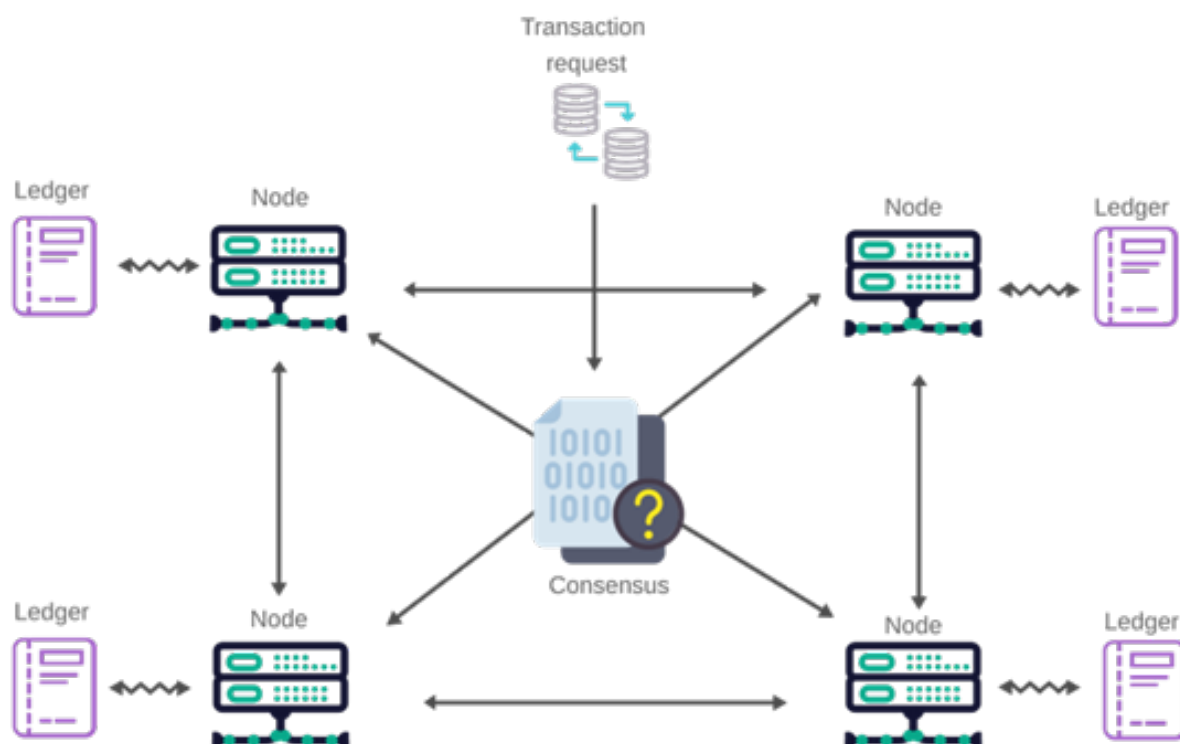
## 3 - A PRIMER ON DISTRIBUTED LEDGER TECHNOLOGIES (DLT)

Distributed Ledger Technology (DLT) is a digital system for recording the transaction of assets in which the transactions and their details are recorded in multiple places at the same time. Unlike traditional databases, DLT has no central data store or administration functionality. This decentralisation enhances security and transparency.

### 3.1 KEY FEATURES OF DLT

- **Decentralisation:** Unlike traditional databases controlled by a single entity, a distributed ledger is maintained by multiple nodes (computers) across a network.
- **Transparency:** Based on the type of DLT, access to the ledger can be managed to allow everyone or a selection of participants (such as the authorities), ensuring transparency of transactions.
- **Immutability:** Once recorded, data in the distributed ledger cannot be altered retroactively, ensuring data integrity and trust.
- **Security:** Advanced cryptographic techniques secure the data, making it tamper-proof and resistant to fraud.

### 3.2 HOW DLT WORKS





## A. NODES AND NETWORK

A DLT network is made up of multiple nodes. Each node has a copy of the entire ledger and participates in the network's consensus process.

## B. TRANSACTIONS

A transaction is any transfer of value or data that is recorded on the ledger. For example, this could be a transfer of cryptocurrency, a change in ownership of an asset, or recording a contract agreement. All information related to the transaction and the one prior are included in the recording, ensuring the traceability of the information and its immutability.

## C. CONSENSUS MECHANISM

- **Proof of Work (PoW):** Nodes (miners) compete to solve complex mathematical problems. The first to solve it gets to validate the transaction and add it to the ledger. This process is energy intensive.
- **Proof of Stake (PoS):** Validators are chosen based on the number of tokens they hold and are willing to “stake” as collateral. This method is more energy-efficient than PoW.
- **Byzantine Fault Tolerance (BFT):** Ensures the system reaches consensus even if some nodes act maliciously or fail.

## D. VALIDATION AND RECORDING

When a transaction is initiated, it is broadcasted to the network. Nodes validate the transaction based on the consensus mechanism associated. Once validated, the transaction is either stored on a block, alone (in the case of blockchain) or grouped with other transactions (Hashgraph) to save storage and energy to be included in the ledger.

## E. THE SPECIFIC CASE OF BLOCKCHAIN

Blockchain, a type of DLT, uses a system of “blocks” linked by a “hash” chain:

- **Blocks:** A block contains a list of transactions and a unique reference associated to the transaction.
- **Hash:** The transaction reference is called a hash. Each block is linked to the previous one, forming a chain and ensuring its immutability and traceability.

## F. LEDGER UPDATE

Once the block is validated and added to the chain, it is distributed across all nodes. Each node updates its copy of the ledger, ensuring synchronisation across the network.

## G. APPLICATIONS OF DLT IN TRADITIONAL FINANCE

DLT is revolutionising financial services for various purposes, by introducing enhanced data integrity, reducing the need for intermediaries, and





significantly boosting operational efficiency. The decentralised nature of DLT ensures that data is securely and transparently recorded across a network of computers, thereby reducing risks associated with central points of failure and enhancing the robustness of financial systems.

Examples of use cases :

- **Cryptocurrencies:** Bitcoin and other digital currencies use DLT to ensure secure and transparent transactions.
- **Supply Chain Management:** Enhances traceability of products by tracking production data and certification, ensuring authenticity and reducing fraud. DLT can be used to track the journey of produce from farm to table, providing consumers with assurance about the origin and quality of their food. In industries prone to counterfeiting, such as luxury goods and pharmaceuticals, DLT helps to verify product authenticity and prevents fraud.
- **Smart Contracts:** Self-executing contracts with the terms and conditions directly written into code that resides on a blockchain or other DLT framework. These contracts automatically execute and enforce themselves when pre-defined conditions are met, for example, for automating payments, derivatives and insurance claims.
- **Clearing and Settlement:** DLT streamlines clearing and settlement processes by providing a shared ledger that records and verifies transactions in real time. This lowers risk of default and frees up capital that would otherwise be tied up in pending transactions.





## 4 - THE DLT OPPORTUNITY IN SUSTAINABLE FINANCE

By building a robust DLT infrastructure, the full potential of sustainable finance can be unlocked. Increased transparency, streamlined processes, and wider investor access will accelerate the flow of capital towards environmentally responsible projects. This, in turn, will contribute to achieving the ambitious sustainability goals outlined in the Paris Agreement, as emphasised in a 2019 study by the Grantham Research Institute on Climate Change and the Environment<sup>2</sup>. DLT has the potential to be a vital bridge to a more sustainable future.

### 4.1 DLT VS STANDARD/AI OPTIMISATION

Financial actors face the challenge of evolving their systems to meet stringent regulatory requirements while ensuring efficiency and transparency. As noted in the ESMA Final Reports<sup>3</sup> on Greenwashing in the financial sector, the use of SupTech tools is limited and remains the exception. To promote quality data and reporting, it is essential to compare the benefits of available technology in sustainable finance against the current standard optimisation approach.

#### A. CURRENT LANDSCAPE : STANDARD OPTIMISATION

Standard optimisation of legacy systems often focuses on incremental improvements to enhance efficiency, data integrity, and compliance with regulations. This approach involves:

- **Modular Upgrades:** Integrating advanced data management tools, reporting modules, and analytics capabilities.
- **APIs and Middleware:** Facilitating better data exchange and integration, reducing data silos.
- **Cloud Migration:** Enhancing scalability and security.
- **Advanced Analytics and AI:** Enabling more efficient and dynamic reporting.
- **Process Automation (RPA):** A subset of process automation focusing on increasing efficiency and reducing manual errors by automating routine tasks.
- **Cybersecurity Measures:** Including advanced encryption and regular audits to protect data integrity.
- **Training and Change Management:** Ensuring smooth adaptation to new tools and procedures.
- **Adherence to Standards:** Meeting external reporting requirements and stakeholder expectations.

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<sup>2</sup> <https://www.lse.ac.uk/granthaminstitute/events/landing-the-paris-climate-agreement-how-it-happened-why-it-matters-and-what-comes-next/>

<sup>3</sup> <https://www.esma.europa.eu/press-news/esma-news/esas-call-enhanced-supervision-and-improved-market-practice-sustainability>





## B. A TRANSFORMATIVE APPROACH WITH DLT

DLT fundamentally redefines how data is stored, shared, and verified across a decentralised network. This technology ensures :

- **Unparalleled Data Integrity:** Providing data immutability and transparency.
- **Real-Time Data Access:** Facilitating immediate data sharing and verification.
- **Reduction of Intermediaries:** Enhancing efficiency and trust among stakeholders.
- **Long-Term Savings:** Increased efficiency and reduced reliance on intermediaries.
- **Strategic Consideration:** Requiring extensive system overhaul and new operational settings.

	STANDARD OPTIMISATION	DLT
BENEFITS	Immediate efficiency and compliance, minimal operational disruptions, cost-effective in the short term.	Significant long-term savings, greater efficiency, and trust, potential for industry-wide adoption.
CHALLENGES	May not achieve the highest standard of data integrity and transparency, operationally risky.	Substantial upfront costs, lengthy implementation timeframe, extensive system overhaul.

Choosing between standard optimisation and DLT requires a careful gap and cost/benefit analysis. While standard optimisation addresses immediate needs, DLT offers a long-term strategic advantage in achieving unparalleled data integrity and transparency. Financial actors must weigh their organisational readiness, regulatory compliance urgency, and potential for industry-wide adoption when making this decision.





## 4.2 DEMOCRATISING VALIDATION

DLT's decentralised nature democratises the validation process; The absence of a central authority in DLT systems means that no single entity can manipulate the ledger to their advantage. This decentralisation allows for a more equitable and open verification process, where multiple stakeholders can independently assess the authenticity and impact of sustainable projects. The core functionality relies on the consensus mechanism that underpins DLT. A consensus mechanism acts as the backbone for trust and security. It ensures all participants in the network agree on the validity of transactions and the current state of the ledger. This is crucial for sustainable finance applications, where transparency and immutability of data are paramount. There are over 70 consensus mechanisms, each with distinct characteristics impacting energy consumption, transaction speed, and overall network resilience. Choosing the most suitable mechanism is vital for fostering a sustainable and efficient DLT platform for financing green initiatives.

Out of all these existing consensus mechanisms, we can distinguish three main categories :

- **Proof of Work (PoW)** : PoW utilises a competition among miners to solve complex mathematical puzzles. The winner validates a block of transactions and earns rewards. While securing the network, PoW requires significant computational power, leading to high energy consumption. This raises concerns about its environmental footprint.
- **Proof of Stake (PoS)** : PoS offers a more sustainable alternative. Instead of computation, validators are chosen based on their stake – the amount of cryptocurrency they hold in the network. This financial investment incentivises validators to act honestly, as misconduct could result in lost stake. However, becoming a full validator with significant rewards can be expensive for individual users.
- **Delegated Proof of Stake (DPoS)** : DPoS builds upon PoS by introducing a voting system. Network participants elect a limited number of validators to secure the network. This reduces the computational resources needed compared to PoW, improving energy efficiency. Additionally, DPoS can be considered more democratic as it allows for community participation in validator selection. However, the concentration of validation power in a smaller group raises potential centralisation concerns.

Choosing a consensus mechanism impacts factors like :

- **Security**: The mechanism should be resistant to attacks.
- **Scalability**: The network should handle a growing number of transactions.
- **Efficiency**: The validation process should be fast and use minimal resources.

By considering these factors, DLT can optimise validation for their specific use cases.





### 4.3 THE BENEFITS AND CHALLENGES OF SMART CONTRACTS

Some DLTs enable the use of smart contracts, which are self-executing contracts with the terms of the agreement directly written into code. These smart contracts automate the enforcement and execution of agreements, ensuring that funds allocated for sustainable initiatives are used as intended, without the need for intermediaries; this level of automation not only simplifies processes but also significantly reduces the risk of fraud and misallocation of resources.

Smart contracts present various advantages :

- **Automation** of data collection, processing, and reporting tasks, reducing manual efforts and the risk of errors.
- **Predefined criteria** can be encoded by developers, with clear, measurable sustainability criteria aligned with the European Sustainability Reporting Standards (ESRS)<sup>4</sup> and other recognised standards such as the Global Reporting Initiative (GRI) or specific project requirements, into smart contracts using language compatible with the chosen DLT platform.
- **Execution** of actions automatically with the use of triggers, for example, validation of prerequisite compliance, when certain conditions are met - all without the need for intermediary verification.

This process uses conditional logic (if-then statements) to assess whether the incoming data from investee companies' activities meet the specified sustainability requirements - for example, a product's manufacturing process' certain carbon footprint threshold.

To enable this validation, reliable data sources must be integrated into the process, involving IoT devices capturing real-time environmental data, supply chain tracking systems, and potential third-party sustainability databases. These sources feed information directly into the ledger, where it becomes immutable and available for smart contract access. The Materials Impact Explorer (MIE)<sup>5</sup>, developed via a partnership between Google, WWF, and Stella McCartney, is a real-world example of an open-source tool which leverages on a digital ledger.

All validations conducted by the smart contract are recorded on the DLT, offering a transparent and tamper-proof audit trail accessible to authorised parties.

While smart contracts enable the collection of information with a limited risk of error, precautions are necessary. As with all programs, there is an inherent risk associated with the code. Once executed, smart contract transactions cannot be reversed. Therefore, they should be used with caution. Establishing best practices is essential, including the recommendation to audit smart contracts before deployment. This provides a minimum level of assurance regarding the contract's performance and security.

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<sup>4</sup> The European Parliament approved a 2-year delay for adopting sector-specific and non-EU companies' ESRS, allowing more time to focus on implementing the first set of general ESRS and develop quality standards .

Source: "Sustainability reporting updates – February 2024" A&L Goodbody  
<https://www.algoodbody.com/insights-publications/sustainability-reporting-updates-february-2024>

<sup>5</sup> "The Materials Impact Explorer (MIE) examines the location-specific impacts of raw materials." Textile Exchange

<https://textileexchange.org/materials-impact-explorer/>







In summary, the application of DLT in sustainable finance extends beyond mere data integrity, drastically improving the way sustainable practices are recorded, shared, and verified. DLT creates a more informed and reliable ecosystem for sustainable investments by enabling the secure and efficient aggregation of data on green initiatives. These qualities of transparency and accountability pave the way for more effective and genuine sustainable finance practices, moving us closer to achieving global environmental goals.

#### 4.4 REAL-TIME TRACKING AND AUTOMATED COMPLIANCE

DLT enables real-time tracking - used in conjunction with other SuperTech (such as AI) to feed DLT with data - and automated compliance with the SFDR and EU Taxonomy requirements by embedding smart contracts that can execute predefined rules ensuring that sustainability criteria are met. This not only enhances the efficiency of the compliance process but also minimises the risk of errors and fraud. The transparency and traceability inherent in DLT provide stakeholders, including investors and regulators, with the ability to verify the authenticity and accuracy of reported sustainability information in real-time. The technology can validate that investments are green by certifying the data and limiting the risk of greenwashing.

The convergence of DLT with Internet of Things (IoT) technologies can revolutionise the collection and monitoring of accurate, real-time data on sustainable practices. IoT devices can automatically gather data on environmental parameters such as energy consumption, carbon emissions, and waste management. Once recorded on a DLT platform, this data offers tamper-proof evidence of compliance with sustainability criteria, ensuring the integrity and reliability of sustainability reporting.

The challenges identified with the implementation of DLT are pervasive and affect the technology as a whole. Regarding privacy concerns, particularly in relation to the General Data Protection Regulation (GDPR), it must be - in the case of reporting - carefully managed to ensure that personal data is protected without compromising the transparency required for effective sustainability reporting required by the various frameworks.

#### 4.4 TRACEABILITY OF SUSTAINABLE PRACTICES

DLT enables an immutable recording of transactions and data at each step of the supply chain, ensuring the accuracy and verifiability of sustainability claims. This includes, but is not limited to, the capture of raw material sourcing, energy consumption, greenhouse gas emissions, labour practices, and other key supply chain/production data.

Through DLT, all stakeholders, including investors, regulators, and clients, can access a transparent and unalterable history of the products and practices of investee companies, a feature building trust and driving investor preference towards sustainable options.





Consumers are growing more environmentally conscious. In 2021, a Bazaarvoice survey<sup>6</sup> revealed significant consumer interest in ecological and sustainable products. The difficulty lies in distinguishing genuine sustainability efforts from misleading practices. Falsified claims and the stretching of green truths has led to scepticism from consumers and hinders progress towards environmental goals<sup>7</sup>.

Conversely, in reaction to the backlash against greenwashing, a countertrend known as “greenhushing” has emerged within the market. Greenhushing refers to the practice where companies, wary of being accused of greenwashing, choose to understate or completely withhold information about their genuine sustainability efforts<sup>8</sup>. This tendency arises from a fear of scrutiny and criticism, where businesses prefer to remain silent on their environmental initiatives rather than risk the accusation of overstating their green credentials.

Greenhushing, however, presents its own set of challenges and leads to :

- **Lack of transparency in the market:** making it even more difficult for consumers, investors, and stakeholders to identify and support truly sustainable practices.
- **Scarcity of data and case studies:** leading to limited guidance and inspiration for other organisations in their sustainability efforts.

To counteract the above challenges, there is a growing need for clear, standardised reporting frameworks that can provide a trustworthy basis for communication. DLT can play a significant role in enhancing the authenticity and transparency of eco-friendly claims by investee companies, by offering a comprehensive and transparent tracking system for the entire lifecycle of targeted products, from raw materials sourcing to end-of-life disposal. Predefined environmental standards and certifications in smart contracts can also help with automation of compliance verification.

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<sup>6</sup> Haley Campbell-Gross (August 3, 2022) “A complete guide to authentic sustainable branding” <https://www.bazaarvoice.com/blog/a-complete-guide-to-authentic-sustainable-branding/>

<sup>7</sup> SG Analytics (Feb 23, 2024) “Authenticity Over Greenwashing: How Brands Are Engaging with Customers and Building Trust?” (last accessed: 07 Mars 2024) <https://us.sganalytics.com/blog/authenticity-over-greenwashing-how-brands-are-engaging-with-customers-and-building-trust/>

<sup>8</sup> “Net Zero and Beyond - South Pole’s 2022 net zero report” <https://www.southpole.com/publications/net-zero-and-beyond>





#### 4.5 TRACEABILITY OF SUSTAINABLE PRACTICES

While DLT offers a secure and transparent foundation for sustainable finance, the quality of data feeding into the system remains paramount. Dirty data in, dirty data out – even with DLT’s immutability, ensuring the initial data’s accuracy is crucial for trusted information. Here’s where Artificial Intelligence (AI) steps in as a powerful ally. AI can analyse vast datasets within DLT systems, identifying patterns, anomalies, and potential inconsistencies. This allows for data cleansing and verification, further strengthening the trustworthiness of information. Furthermore, AI’s predictive capabilities can unlock valuable insights from DLT data. By analysing trends and modelling future scenarios, AI can guide sustainable investment decisions, pinpointing areas with the greatest environmental and social impact. In essence, DLT and AI operate synergistically. DLT provides a secure platform for data, while AI analyses it to extract valuable insights, ultimately contributing to a more informed and impactful approach to sustainable finance. Data is playing a key role in our current society, even if DLT brings transparency and immutability, the initial quality of data is essential in ensuring trusted information in the systems. The use of adjoined technology such as Artificial Intelligence can level up the information transmitted and provide even more efficiency by providing predictability, patterns, and modelling - giving new insights as to where to invest now for the future.





## 5 - REGULATORY AND LEGAL CONSIDERATIONS

### 5.1 EU TAXONOMY REGULATION

The EU Taxonomy Regulation<sup>9</sup> establishes a classification system for sustainable economic activities, providing a framework for determining which investments are environmentally sustainable. It aims to prevent greenwashing and enhance investor confidence by setting clear criteria for sustainable activities.

### 5.2 SUSTAINABLE FINANCE DISCLOSURE REGULATION (SFDR)

The SFDR<sup>10</sup> requires financial market participants and advisors to disclose how they integrate ESG factors into their investment decisions and advisory processes. It aims to increase transparency and ensure that sustainability risks are consistently considered across the financial sector.

### 5.3 DIGITAL OPERATIONAL RESILIENCE ACT (DORA) :

DORA aims to ensure that all participants in the financial system have the necessary safeguards to mitigate cyber risks and ensure operational resilience. It covers ICT risk management, incident reporting, and third-party risk management, crucial for integrating DLT into financial systems.

### 5.4 CORPORATE SUSTAINABILITY REPORTING DIRECTIVE (CSRD) :

In the European Union, large companies, listed small and medium enterprises (SMEs) and certain non-EU companies with significant operations in the EU must disclose certain information under the Corporate Sustainability Reporting Directive (CSRD)<sup>11</sup>, including how they address social and environmental challenges and how their activities impact people and the environment. This reporting obligation covers climate change, biodiversity, human rights, and governance. A mandatory materiality assessment allows these companies to determine which sustainability-related topics are significant enough to report on, considering both the companies' financial impact and their impact on the environment and society. The resulting sustainability disclosure must be audited by an independent third party before being submitted to the relevant authorities; the CSRD emphasises the importance of the digitalisation of this reporting.

### 5.5 MARKETS IN CRYPTO-ASSETS (MICA) REGULATION :

The Markets in Crypto-Assets (MiCA)<sup>12</sup> regulation represents a significant step towards increased transparency and regulatory clarity within the realm of crypto-assets. This text is particularly relevant for tokens that either represent or are linked to sustainable finance

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<sup>9</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R0852>

<sup>10</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R2088>

<sup>11</sup> "Corporate sustainability reporting"

[https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting\\_en](https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en)

<sup>12</sup> European crypto-assets regulation (MiCA) <https://eur-lex.europa.eu/EN/legal-content/summary/european-crypto-assets-regulation-mica.html>





assets, where enhanced transparency is a must to bolster trust among investors and stakeholders.

MiCA fosters the growth of digital assets that adhere to certain standards regarding sustainability and environmental performance. This is achieved by requesting issuers to provide transparent information about the environmental impact of their assets with regards to the consensus mechanisms used.<sup>13</sup>

This increased transparency and standardisation offered by DLT can make it easier to verify the environmental contributions of investments, significantly contributing to more effective green financing. As mentioned before, DLT can effectively support this by ensuring the accurate and immutable recording of such data on a distributed ledger, enhancing trust and efficiency in green financing processes.

## 5.6 UPDATES OF THE SFDR ANNEXES

Recent proposals<sup>14</sup> by the European Supervisory Authorities (ESAs) aim to refine the Regulatory Technical Standards (RTS) under SFDR, encompassing a variety of areas—including the simplification of SFDR Annexes, the introduction of a dashboard for key information, and specific disclosure requirements tailored to different financial product categories.

A significant proposal is the incorporation of the Do Not Significant Harm (DNSH) principle into website disclosures, as mandated by article 10 SFDR. This would involve setting clear thresholds and criteria for the Principal Adverse Impact (PAI) indicators to ensure sustainable investments adhere to the DNSH principle.

The proposals further suggest the introduction of new mandatory and optional social PAI indicators, covering a range of areas from tax jurisdictions to employee wages, alongside technical adjustments to some existing indicators. Further changes to the PAI reporting framework are suggested, including the disclosure requirements regarding the share of PAI based on data from investee companies and estimations or reasonable assumptions, accompanied by adjustments in the formulae for calculating PAI.

New rules are set to be introduced for financial products with GHG emissions reduction targets as their investment objective. These will detail the requirements for reporting, commitment progress, and information on GHG emissions reduction targets for various types of financial products.

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<sup>13</sup> Article 66.5 of the Regulation: "Crypto-asset service providers shall make publicly available, in a prominent place on their website, information related to the principal adverse impacts on the climate and other environment-related adverse impacts of the consensus mechanism used to issue each crypto-asset in relation to which they provide services. That information may be obtained from the crypto-asset white papers."

<sup>14</sup> Tara O'Reilly, Kevin Murphy and Ian Dillon (31/01/2024) "Proposed Changes to SFDR Annexes and Other Proposals from the ESAs' Amendments to the SFDR RTS" Arthur Cox <https://www.arthurcox.com/knowledge/proposed-changes-to-sfdr-annexes-and-other-proposals-from-the-esas-amendments-to-the-sfdr-rts/>





The proposed amendments to the SFDR RTS are anticipated to become law no earlier than Q4 2024, with an effective date in 2025, pending validation by the European Commission, European Parliament, and Council. As the regulatory landscape evolves, DLT platforms can be designed to quickly integrate new requirements and standards, providing an agile and scalable reporting solution.

## 5.7 GREENWASHING

Greenwashing, as per the latest definition provided by ESMA<sup>15</sup>, refers to a practice where sustainability-related statements, declarations, actions, or communications do not clearly and fairly reflect the underlying sustainability profile of an entity, a financial product, or financial services.

The rise of greenwashing in the financial services sector highlights the need for robust mechanisms to ensure transparency and deter misleading claims. Regulatory bodies and consumer groups are increasingly vigilant, challenging dubious statements through regulatory complaints, lawsuits, and media scrutiny. In response, asset management sectors are being closely monitored to ensure that ESG funds genuinely represent their green and sustainable credentials, with regulatory authorities like the Competition and Markets Authority (CMA) and the Securities and Exchange Commission (SEC) intensifying their focus on preventing greenwashing<sup>16</sup>.

In the European Union (EU), the European Securities and Markets Authority (ESMA) reported that banks, insurers, and investment firms have been making misleading claims about their sustainability credentials, in key aspects such as ESG governance and resources. Cases ranged from cherry-picking information, omission, ambiguity, and empty claims to misleading use of reporting terminology. In addition, such misleading claims could have a substantial impact on insurance and pension consumers, according to the European Insurance and Occupational Pensions Authority (EIOPA). In March 2022, the European Commission proposed to update EU consumer rules to support the green transition. In September 2023, Parliament and Council reached a provisional agreement on the updated rules. Members of the European Parliament approved the agreement in January 2024, followed by the Council the following month. Recently, the ESAs (European Banking Authority (EBA), ESMA and EIOPA) published their Final Report on Greenwashing<sup>17</sup>, emphasising that greenwashing involves misleading sustainability-related statements, actions, or communications that do not reflect the true sustainability profile, thereby posing significant financial risks, including reputational, operational, and litigation risks. The ESAs highlights the need for adherence to EU regulatory frameworks to mitigate these risks, ensuring that sustainability claims are accurate and substantiated. The report recommends best practices such as robust governance, internal

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<sup>15</sup> <https://www.esma.europa.eu/document/final-report-greenwashing>

<sup>16</sup> "ESG: Addressing greenwashing in financial services. What is it, why greenwashing matters and how do you avoid it?" by Justine Sacarello for KPMG UK <https://kpmg.com/uk/en/home/insights/2022/03/esg-addressing-greenwashing-in-financial-services.html>

<sup>17</sup> Greenwashing Monitoring and Supervision Final Report - EBA/REP/2024/09 <https://www.eba.europa.eu/sites/default/files/2024-05/a12e5087-8fd2-451f-8005-6d45dc838ffd/Report%20on%20greenwashing%20monitoring%20and%20supervision.pdf>





processes, and external verification of ESG data to enhance transparency and reliability. It also stresses the importance of clear and honest sustainability information to maintain investor and consumer trust in sustainable finance products and services.

Within Germany's financial sector, enforcement actions were undertaken in 2022 against DWS Group and its principal stakeholder, Deutsche Bank AG. The operations, conducted by local law enforcement in collaboration with BaFin, Germany's financial regulatory authority, focused on the Frankfurt premises of these institutions. This intervention was part of a broader inquiry into accusations that the asset management firm may have provided misleading information to its clientele regarding its sustainable investment practices<sup>18</sup>.

Internationally, key actions have been taken by governments to prevent greenwashing. For example, in India, the Central Consumer Protection Authority released its draft Guidelines for Prevention and Regulation of Greenwashing. In the UK, under the UK SDR proposal - UK funds, sold or marketed to retail investors in the UK (likely to be expanded to non-UK funds), the FCA anti-greenwashing rules are applied to funds targeted at UK professionals only.

In September 2023 in the US, the Security and Exchange Commission specified rules targeting misleading practices by US investment funds, including greenwashing. And finally, in Asia, Singapore Central Bank and Monetary Authority of Singapore have implemented new rules regarding green claims and sustainability disclosures of funds and listed companies.

## 5.8 DLT REGULATORY SOLUTIONS

The proposed introduction of a dashboard for key sustainability information aligns with DLT's inherent capabilities. A DLT-based dashboard can indeed automate the aggregation and display of real-time sustainability data from various sources, ensuring the information is always current, accurate and easily accessible to investors and other stakeholders. Additionally, this simplifies the process of comparing and assessing the sustainability performance of different financial products.

DLT enables sustainability data to be securely recorded and stored on a distributed ledger, guaranteeing stakeholders that the information is accurate, tamper-proof and verifiable. By ensuring the integrity and transparency of sustainability data, DLT can play a crucial role in building trust in the DNSH claims of financial products backed by low PAI tolerance.

Further, DLT can facilitate the verification of the proposed social PAI indicators by using smart contracts and automating their collection, calculation, and reporting. This automation can reduce the back-office burden on financial institutions and increase the reliability of the data reported.

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<sup>18</sup> "Banks face mounting risk of fines, regulatory probes over sustainability claims", by Sanne Wass for S&P Global Market Intelligence  
<https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/banks-face-mounting-risk-of-fines-regulatory-probes-over-sustainability-claims-74385257>







DLT can offer a robust solution for tracking and reporting towards GHG emissions targets by recording emissions data and reduction efforts on a distributed ledger, providing transparent and indisputable evidence of the product's performance.

### A. A SHIELD AGAINST GREENWASHING

DLT provides a shield against greenwashing as it facilitates the creation of an “immutable truth<sup>19</sup>” across the lifecycle of sustainable finance products, ensuring that all stakeholders have access to the same, unalterable data in real-time. By guaranteeing the origin and integrity of ESG data, this shared repository promotes trust among investors and stakeholders. The technology also enables real-time data visibility and automated workflows, streamlining processes and making them more transparent and efficient.

### B. EVOLVING SUSTAINABILITY STANDARDS

The ESAs<sup>20</sup> are consistently updating SFDR RTS, indicating a shift towards more rigorous sustainability criteria and transparency. As climate change increasingly influences asset values, evident in scenarios such as coastal properties at greater flood risk, the need for regulatory frameworks that are both adaptable and visionary is crucial. In this sense, DLT technology provides an unmatched potential to meet the sustainability benchmarks of the future :

- **Enhanced Transparency:** Ensures that sustainability claims can be verified and trusted.
- **Data Integrity and Security:** Secure but also tamper-proof data is critical for maintaining the integrity of sustainability data and avoid greenwashing.
- **Real-time Data Access:** Crucial for adaptive regulatory frameworks, this capability allows for timely and accurate reporting of sustainability metrics.
- **Global Standardisation:** Supported by the inherent interoperability of DLT systems, key for multinational corporations and financial institutions that operate in multiple regulatory environments.

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<sup>19</sup> “Sustainable finance: Blockchain offers a powerful new approach to the challenges of the rapidly growing green bond market”, GFT

<https://www.gft.com/us/en/solutions/landingpage/green-bonds-management#pov-the-immutable-green>

<sup>20</sup> See the section: “Current and upcoming regulations: potential challenges and solutions - Updates of the SFDR Annexes” p. 19





With the momentum from COP28, discussions about sustainable finance are leaning more towards blending tailored sustainable finance solutions into broader financial structures. This requires a refined grasp of sustainable finance nuances, such as green, social and sustainability-linked bonds, in addition to transition bonds aligned with UN development objectives. The pivotal change lies in perceiving sustainable finance not as an isolated niche but as a core element of the broader energy transition, underscoring the need to fund initiatives that genuinely align with sustainability standards<sup>21</sup>.

Looking ahead, the evolution of sustainable finance is expected to shift the focus on the social aspect, covering factors like workers' rights, the effects on communities, and the promotion of diversity and inclusiveness – per the United Nations Sustainable Development Goals (SDGs)<sup>22</sup>. DLT has indeed the potential to transform the way these factors are tracked, disclosed, and confirmed, with a clear and unchangeable account of a firm's initiatives and results regarding their social stance and impact.

In the same way, the governance dimension of reporting might require more comprehensive and regular insights into social performance. DLT provides a secure and immutable framework for collecting and verifying the required data, ensuring its authenticity and accuracy, which in turn enhances the integrity of the reporting process and offers stakeholders real-time, reliable information.

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<sup>21</sup>Jonathan Lee, Bianca Bustamante & Manuel Araujo (December 11, 2023) "Navigating the evolution of sustainable finance", HATCH <https://www.hatch.com/About-Us/Publications/Blogs/2023/12/Navigating-the-evolution-of-sustainable-finance>

<sup>22</sup> United Nations, Department of Economic and Social Affairs – Sustainable Development "The17 Goals" <https://sdgs.un.org/goals>





## 6 - CHALLENGES AND RISKS OF DLT

### 6.1 TECHNICAL AND OPERATIONAL CHALLENGES

#### Scalability

- **Transaction Throughput:** Current DLT systems often struggle to handle large volumes of transactions simultaneously, leading to slow processing times. This is a significant hurdle for widespread adoption, particularly in high-frequency trading environments and large-scale financial systems.
- **Network Congestion:** As more participants join a DLT network, the potential for congestion increases. High transaction volumes can overwhelm the network, causing delays and reducing efficiency.

#### Interoperability

- **Multiple DLT Platforms:** There are numerous DLT platforms, each with different protocols and standards. Ensuring these disparate systems can communicate and work together seamlessly is a major challenge.

#### Integration with Existing Systems

- **Data Migration:** Moving data from traditional databases to a DLT can be complex, requiring careful planning to ensure data integrity and continuity.
- **Compatibility Issues:** Ensuring that DLT can work alongside and complement existing IT infrastructures without causing disruptions is crucial. This includes integrating with current financial software, regulatory compliance systems, and other operational tools.
- **Legacy Systems:** Financial institutions have existing legacy systems that are often not designed to interact with DLT. Bridging this gap requires significant technical effort and can involve complex middleware solutions.





## 7 - THE CASE OF GREEN BONDS INFRASTRUCTURE

Green bonds have emerged as a powerful tool within the European financial system, integrating environmental, social, and governance (ESG) considerations to raise capital specifically for sustainability-linked projects. By investing in green bonds, investors directly contribute to initiatives aligned with the EU's sustainability goals, such as renewable energy development, clean transportation, and green buildings.

However, the current infrastructure for green bonds often lacks transparency. Tracking the use of funds and measuring environmental impact can be difficult, which hinders investor confidence. A 2022 study by the Cambridge Institute for Sustainable Finance<sup>23</sup> found a positive correlation between green bond transparency and investor demand. DLT can address these issues by embedding project data directly into the bond itself, creating an immutable record that allows investors to trace the impact of their investments. Standardisation is another crucial element for widespread adoption. The EU supports the EU Green Bond Standard, leveraging the detailed criteria of the EU Taxonomy to precisely define green projects. This creates a transparent and harmonised framework, fostering investor confidence in the green bond market. Green bonds thus serve as a vital tool for channelling capital towards a more sustainable European future, directly linking sustainable finance principles with tangible environmental action.

The use of DLT in green bonds represents a pivotal innovation in sustainable finance, offering a transformative approach throughout the entire lifecycle of green bonds, including issuance, management, and monitoring. This ensures that green bonds effectively contribute to environmental sustainability by maintaining transparency and accountability at every stage.

### 7.1 ISSUANCE OF GREEN BONDS AND ITS TOKENISATION PROCESS

DLT may be leveraged to enhance the green bond issuance process by embedding comprehensive data about the bond's characteristics and ensuring all parties have access to the same data, at the same time. We observe an explosion of data available, due to the proliferation of digital technologies and advanced analytics, which generate and collect vast amounts of information in real-time; but quantity does not necessarily mean quality. By providing an immutable ledger and ensuring accuracy and authenticity, DLT helps ensure that the data can be relied upon, and that it can be trusted. In addition to information about a green bond's issuance, environmental objectives, anticipated impacts, and financial returns, can also be directly inscribed directly onto a secure and immutable ledger. This integration facilitates a flawless and transparent flow of information, enabling all stakeholders, including issuers, investors, and regulators, to access real-time, unalterable data. By providing a single Golden Source of Truth, provided the data is valid and trustworthy, DLT effectively counters the risk of greenwashing, bolstering investor confidence and trust in the authenticity of green initiatives.

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<sup>23</sup> <https://www.emerald.com/insight/content/doi/10.1108/MEDAR-06-2020-0926/full/html>





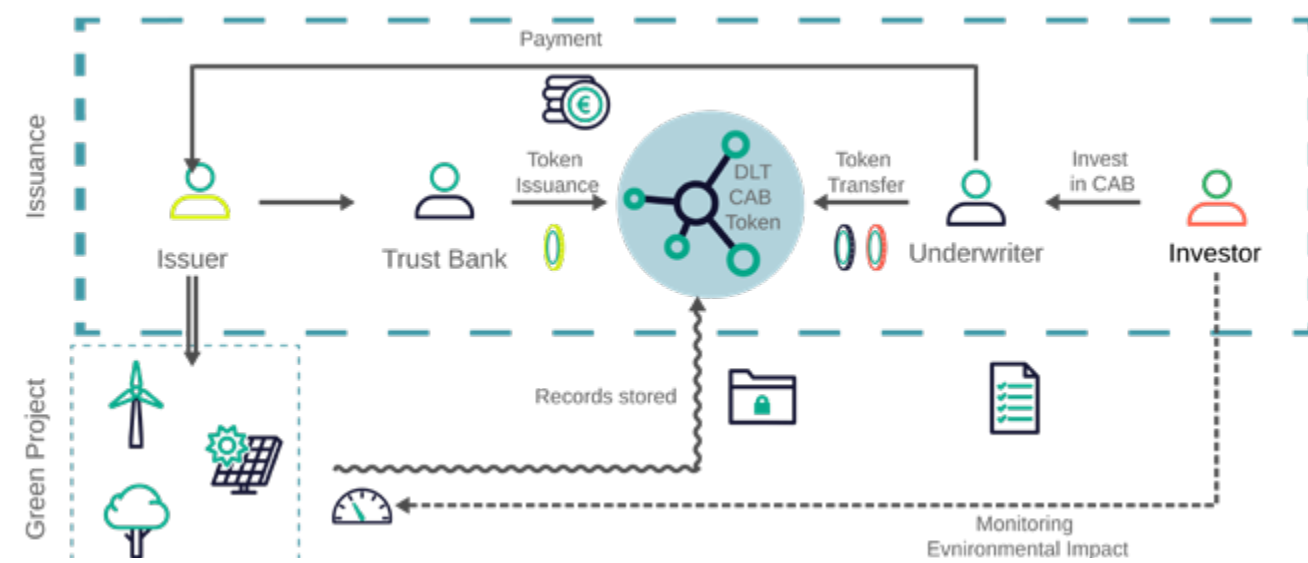
Extending over the trust and immutable capabilities, DLT can be used to tokenise green bonds, creating a secure and efficient digital representation of the bond on a shared ledger. This can lead to several benefits:

- **Enhanced Transparency and Traceability:** DLT allows for the embedding of vital information directly into the bond itself. This can include data related to the underlying green project, its environmental impact, and how the funds are being used. This fosters greater trust and transparency for investors.
- **Streamlined Issuance and Settlement:** DLT can automate many manual processes involved in issuing and settling green bonds, reducing costs and speeding up transactions.
- **Increased Liquidity and Accessibility:** Tokenised green bonds can be easily fragmented into smaller units, potentially opening the market to a wider range of investors, including retail investors.
- **Interoperability:** DLT can ensure that various solutions can seamlessly communicate with each other<sup>24</sup>, supporting global integration and enhancing cost-effectiveness, making it easier for diverse systems and platforms to work together efficiently.

By harnessing the power of DLT, the European green bond market can become even more efficient, transparent, and accessible, further accelerating the flow of capital towards sustainable projects and a greener future.

The tokenisation of green bonds has significantly advanced in recent years, characterised by numerous experiments and innovations. Tokenising green bonds using DLT involves creating a digital representation of the bond on a shared ledger that holds all essential information, such as ownership, value, maturity date, and, crucially, a link to the underlying green project's data. This process allows for the creation of smaller fractional tokens, potentially broadening the market to include retail investors. Consequently, tokenisation via DLT leads to a more efficient, transparent, and accessible green bond market, attracting greater capital towards sustainable projects.

### THE ISSUANCE OF TOKENISED CLIMATE AWARENESS BONDS (CAB)



<sup>24</sup> DLT achieves this by using standardized protocols and APIs, allowing different systems to share and verify data across a common, secure network.





## 7.2 TAMPER-PROOF AUDIT TRAIL

The adoption of DLT in green bond issuance establishes a robust and tamper-proof audit trail that spans the entire lifecycle of a bond, from its inception and issuance to the allocation of proceeds and the reporting of outcomes. This comprehensive auditability not only enhances transparency but also ensures full accountability for the deployment of funds towards genuine green projects. The immutable nature of DLT records guarantees that every transaction and allocation is accurately captured and permanently recorded, making it an invaluable tool for tracking the environmental impact of green bond investments.

## 7.3 AUTOMATION OF COMPLIANCE AND OPERATIONS

DLT introduces automated workflows and smart contracts, significantly streamlining the bond issuance process. These technologies standardise various aspects of bond issuance, from preparation and origination to settlement, thereby increasing efficiency and reducing the potential for errors or fraud. Moreover, DLT's capability for real-time tracking and reporting simplifies compliance with the European Green Bond Standard<sup>25</sup> and international principles<sup>26</sup>, enhancing the efficiency of labelling and verification processes. The tokenisation of bonds, whether native digital assets or non-native security tokens, further refines the process by facilitating direct interactions between issuers and investors, thereby eliminating unnecessary intermediaries and paperwork.

## 7.4 IMPLICATIONS FOR MARKET PARTICIPANTS

### A. BENEFITS

- **Streamlined Operations:** For bonds issued as native digital assets, DLT redefines the execution, clearing, safekeeping, and other key functions currently managed by trading venues, clearing systems, depositories, and other intermediaries<sup>27</sup>. This evolution towards a more streamlined and efficient system has the potential to significantly lower transaction costs and enhance market liquidity, making green bonds more accessible and attractive to a broader range of investors.
- **Market Adaptation:** There is a real shift occurring in the asset management industry as captured in the survey by the Luxembourg Sustainable Finance Initiative and PwC<sup>28</sup>. Investors are inclined to be active in impact investing, and this should be seen as an opportunity by

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<sup>25</sup> European Parliament Briefings "European green bonds - A standard for Europe, open to the world"  
[https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698870/EPRS\\_BRI\(2022\)698870\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698870/EPRS_BRI(2022)698870_EN.pdf)

<sup>26</sup> International Market Capital Association "Green Bond Principles - Voluntary Process Guidelines for Issuing Green Bonds"  
<https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Green-Bond-Principles-June-2021-100621.pdf>

<sup>27</sup> International Market Capital Association "Frequently Asked Questions on DLT and blockchain in bond markets"  
<https://www.icmagroup.org/market-practice-and-regulatory-policy/fintech-and-digitalisation/distributed-ledger-technology-dlt/faqs-on-dlt-and-blockchain-in-bond-markets/11-how-might-dlt-bonds-change-the-issuance-and-lifecycle-process/?showiframe=true>

<sup>28</sup> <https://lsfi.lu/wp-content/uploads/2022/12/Sustainable-Finance-in-Luxembourg.pdf>





the market to create new products and adapt the process to facilitate investments. More than a trend, it is a willpower to ensure sustainability in all fields.

## B. CHALLENGES

- **Initial Investment:** Implementing DLT-based systems requires an initial investment in new infrastructure to allow digital assets to be issued and traded. While essential for ensuring the liquidity of these assets, this can be costly.
- **Interoperability and Infrastructure:** Transactions must be settled between various financial institutions, necessitating either a common infrastructure or interoperability of diverse infrastructures. Introducing new infrastructure for all market participants involves significant costs and integration timescales. The use of diverse infrastructures may provide more flexibility for market participants, but the interoperability challenge becomes paramount and poses operational risks.
- **Technology Selection:** There are a wide range of available DLT technologies - how can firms and infrastructure providers choose between them? Ensuring the chosen technology will be maintained over the long term is crucial. There is still a lack of skills in the finance sector related to DLT that can adequately conduct thorough due diligence and justify decisions on DLT<sup>29</sup>.
- **Integration with Legacy Systems:** Many financial institutions have deeply entrenched legacy systems, and ensuring seamless integration with new DLT infrastructure can be complex and resource-intensive. Creating a true network is key to the success of the implementation given the decentralised nature of the technology; indeed, volumes are needed to make it effective and validate the use case.
- **Data Privacy and GDPR Compliance:** The decentralised nature of DLT poses challenges in ensuring that data privacy regulations are met. Ensuring that the technology adheres to stringent data protection laws while maintaining transparency and traceability is a delicate balance that needs careful consideration.

In summary, while the tokenisation of green bonds and other digital assets holds great potential, addressing these challenges is crucial for the successful adoption and long-term viability of DLT in the financial sector.

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<sup>29</sup> Uses of DLT in the EU banking and payments sector: EBA innovation monitoring and convergence work (last accessed: 19 June 2024) <https://www.eba.europa.eu/sites/default/files/2024-04/69001f7d-be44-456e-a40a-2d2f0e5a84f4/factsheet%20on%20uses%20of%20DLT%20in%20the%20EU%20banking%20and%20payments%20sector.pdf>

<sup>30</sup> <https://forexsuggest.com/global-impact-of-crypto-trading/>







## 7.5 GREEN VS DLT – ENERGY CONSUMPTION

Often criticised for its energy consumption, the technology is frequently labelled as unsustainable. In 2022, the report on the Global Impact of Crypto Trading by Forex Suggest<sup>30</sup> pointed out the considerable energy consumption of the cryptocurrency industry. Ethereum, still relying on PoW in 2021, ranked second behind Bitcoin in terms of energy intensiveness and environmental impact, with an overall energy consumption of 62.56 kWh per transaction and 22 million tons of CO<sub>2</sub> emissions<sup>31</sup>. Removing a year's worth of Ethereum 1.0 transactions from the atmosphere would require planting 109.8 million trees. Critics argue that without a comprehensive and widespread adoption of greener technologies, the environmental benefits of DLT may be overshadowed by its substantial energy demands<sup>32</sup>. This ongoing debate highlights the need for continuous innovation and regulatory support to ensure that DLT can achieve its full potential in a truly sustainable manner.



Source: <https://ccaf.io/cbnsi/cbeci/ghg/comparisons>, GHG emissions comparison for Bitcoin

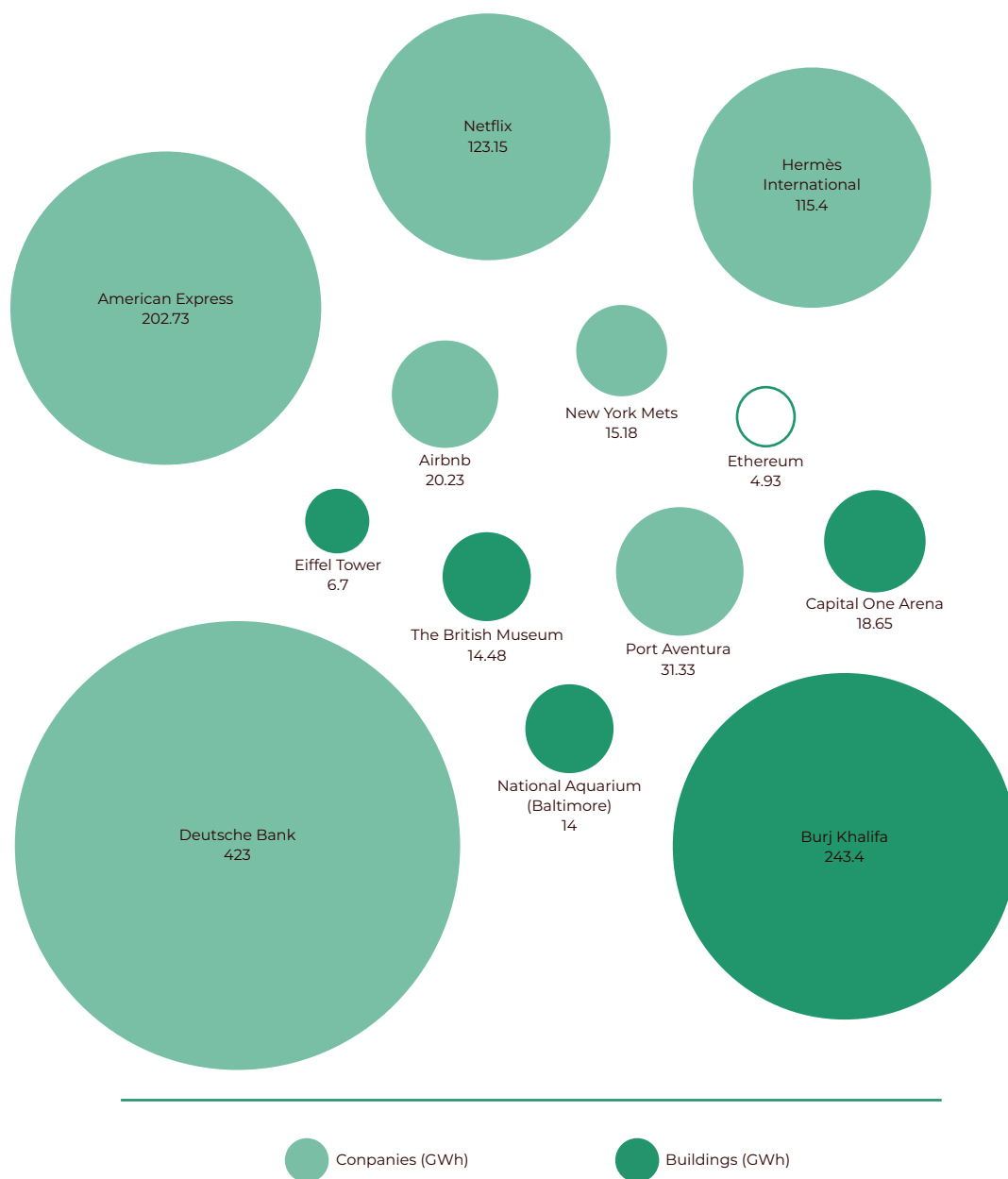
<sup>31</sup> More information: Oriane Kaesmann (10/01/2023) "The Age of Sustainable cryptos?" LHoFT <https://lhoft.com/bloockchain/the-age-of-sustainable-cryptos/>

<sup>32</sup> For more information: <https://ccaf.io/cbnsi/ethereum/comparisons>





Recent advancements have significantly improved its energy efficiency, making it a viable option for achieving sustainable goals. It is important to note that not all DLT networks have the same energy requirements. Some newer DLT platforms are exploring alternative consensus mechanisms, such as proof-of-stake (PoS), which consume significantly less energy. To illustrate this, on September 15, 2022, the two DLT algorithms of Ethereum merged, marking the end of PoW and helping energy consumption drop by an estimated 99.95%<sup>33</sup>.



Source: <https://ccaf.io/cbnsi/ethereum/comparisons>, energy consumption comparison with Ethereum 2.0

<sup>33</sup> The Merge – Ethereum.org com <https://ethereum.org/en/upgrades/merge/>





Various consensus mechanisms exist and continue to be developed to provide new functionalities as well as enhance sustainability. A comprehensive comparison<sup>34</sup> demonstrates that the latest iteration of Ethereum, which transitioned from Proof of Work (PoW) to Proof of Stake (PoS), is now more sustainable, with reduced energy consumption and emissions. Another noteworthy technology in the sustainability context is Hedera Hashgraph. It utilises a gossip-based Byzantine Fault Tolerance (BFT)<sup>35</sup> algorithm instead of PoW, significantly reducing energy consumption. Each transaction on the Hedera network uses only 0.00017 kWh<sup>36</sup>, a fraction of the energy required by traditional payment methods, making it a powerful and secure platform for environmentally conscious solutions. We will provide more insights into this consensus in the next part of the white paper.

There are ongoing discussions and research on developing more energy-efficient consensus algorithms. However, recent years have seen the emergence of innovative eco-friendly alternatives. One such example is Hedera, mentioned earlier in the report. Worth mentioning Chia Network as well<sup>37</sup>, which utilises storage space on external hard drives instead of computational power for its Proof-of-Space and Time (PoST) consensus mechanism. This significantly reduces energy consumption compared to PoW. Another innovative approach is exemplified by Green Mining DAO<sup>38</sup>, which harnesses waste heat from a fruit drying factory to power their servers for Bitcoin mining. This approach not only minimises the environmental footprint of their mining operations but also facilitates sustainable production processes within the factory itself. These examples highlight the ongoing advancements in environmentally friendly consensus mechanisms, paving the way for a more sustainable future for DLT technology.

While DLT often faces scrutiny, studies reveal that other technologies, such as AI image generation, emails, and spam, also contribute significantly to greenhouse gas emissions and energy use<sup>39</sup>. The World Economic Forum indicates that AI developments could lead to a surge in power demand of up to 1000 times. Hence some consideration on how to reduce the impact and potential measures to take<sup>40</sup>. Developing more efficient codes and infrastructures seem to be the key in ensuring a sustainable technology development.

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<sup>34</sup> <https://ccaf.io/cbnsi/ethereum/comparisons>

<sup>35</sup> See Appendix I for more information about this consensus

<sup>36</sup> <https://hedera.com/learning/sustainability/is-crypto-bad-for-the-environment>

<sup>37</sup> <https://www.chia.net/>

<sup>38</sup> <https://www.greenminingdao.io/>

<sup>39</sup> <https://www.iea.org/reports/electricity-2024>

<sup>40</sup> <https://www.weforum.org/agenda/2024/04/how-to-manage-ais-energy-demand-today-tomorrow-and-in-the-future/>





## 8 - DLT AS A DRIVER OF SUSTAINABLE FINANCE

The potential of DLT in sustainable finance extends far beyond the tokenisation of green bonds. Numerous inefficiencies are identified in the sustainability spectrum and DLT solutions are being developed to answer these needs.

### 8.1 ESG FUNDS

Traditional ESG funds have become popular investment vehicles for those seeking to align their portfolios with environmental, social, and governance principles. While these funds offer a way to invest ethically, they often face challenges related to data accuracy, transparency, and verification.

TRADITIONAL ESG FUNDS	ESG FUNDS WITH DLT
Data collection is processed by Robot Process Automation or manual reporting. Some data cannot be collected and are left out. This data processing can be opaque and susceptible to greenwashing.	Collection of data is performed either automatically via smart contracts and related technologies. Secure embedding of ESG metrics directly into the structure of the fund itself.
Investors rely on the information collected with limited means to verify the sustainable parameters.	The immutability offered by the DLT, as validated by research from the International Sustainability Standards Board (ISSB) in 2021, allows investors to verify the ESG performance of the fund and hold managers accountable for their sustainability claims.
Investment decisions is based on available information.	Increased trust as the information available is the closest possible to the reality. It guarantees the investors to make informed decisions aligned with their values.

### 8.2 IMPACT INVESTING

Impact investing goes beyond financial returns, aiming to generate measurable positive social and environmental impact. However, tracking the real-world impact of investments can be challenging.





IMPACT INVESTING	IMPACT INVESTING WITH DLT
<p>The outcomes of impact investing are known when the report is published, relying on the information shared by the investment company.</p>	<p>Creation of a secure and transparent impact data layer which can be linked to individual investments within the DLT infrastructure, allowing for real-time tracking of social and environmental outcomes achieved.</p>
<p>By aligning financial returns with positive societal impact, impact investing appeals to a growing segment of investors who prioritize ethical considerations in their investment decisions.</p>	<ul style="list-style-type: none"> <li>• Allows investors to measure the effectiveness of their contributions and hold fund managers accountable for delivering on their impact goals.</li> <li>• Democratize access to impact investment opportunities by reducing barriers to entry. Tokenization of assets and fractional ownership can attract a broader range of investors, including smaller investors who can participate in high-impact projects without the need for large capital investments.</li> </ul>

### 8.3 MICROFINANCE

Microfinance provides financial services to low-income individuals and entrepreneurs, often in developing countries, who lack access to traditional banking systems. A 2020 study by the World Bank<sup>41</sup> highlights the potential of digital identity solutions to promote financial inclusion.

TRADITIONAL MICROFINANCE	MICROFINANCE WITH DLT
<p>Relying on the physical documentation, while numerous individuals lack official identity documents.</p>	<p>Creating secure and transparent digital identities for unbanked populations.</p>
<p>With limited access to the file and history of the individuals, the risks associated are difficult to predict. It can prevent small lenders to benefit from microfinance.</p>	<p>Unlock economic opportunities and contribute to poverty reduction by covering a larger number of individuals. It facilitates secure and efficient loan applications, approvals, and repayments, streamlining the entire microfinance process.</p>

<sup>41</sup> <https://documents1.worldbank.org/curated/en/710151588785681400/pdf/Smart-Contract-Technology-and-Financial-Inclusion.pdf>





## 8.4 CARBON CREDITS

The carbon credit market allows companies and individuals to offset their carbon footprint by purchasing credits representing verified emission reductions elsewhere. However, the current market suffers from a lack of transparency and potential for double counting. The International Emissions Trading Association (IETA) launched a Task Group to examine the new trends in digital carbon markets and recommend steps to ensure integrity in this growing field. Demonstrating the success of carbon credit markets, and how DLT offers a powerful tool to achieve these goals<sup>42</sup>.

TRADITIONAL CARBON CREDITS	TOKENIZED CARBON CREDITS
Physical or digital certificate representing the right to emit a certain amount of carbon dioxide or other greenhouse gases.	Conversion of traditional carbon credits into digital tokens using DLT. Creation of a secure and transparent registry: <ul style="list-style-type: none"> <li>• Tracks ownership of carbon credits throughout their lifecycle</li> <li>• Prevents double-counting</li> <li>• Legitimacy of offsets</li> </ul>
Transaction costs linked to: <ul style="list-style-type: none"> <li>• Regulatory compliance</li> <li>• Verification</li> <li>• Transfer</li> <li>• Tracking of credits</li> </ul> It is complex, time-consuming and requires intermediaries.	Reduce the costs of: <ul style="list-style-type: none"> <li>• Verification</li> <li>• Transfer</li> <li>• Tracking</li> </ul> Smart contracts are used to automate processes, reducing the administrative and regulatory cost.
Difficulty to assess the lifecycle of the carbon credit, resulting in potential double counting or misuse of the carbon credits.	Immutability and transparency avoid double counting or fraud, lowering the related costs.
Market tends to be less transparent, resulting in high search and information costs.	As a result: <ul style="list-style-type: none"> <li>• Fosters trust in the system</li> <li>• Facilitates efficient trading of carbon credits</li> <li>• Accelerates efforts to mitigate climate change</li> </ul>

## 8.5 CARBON-LINKED GREEN BONDS

Carbon-linked green bonds represent a groundbreaking financial instrument that merges the established benefits of green bonds with the burgeoning carbon credit market. This innovative structure creates a compelling proposition for both investors seeking to support climate projects and issuers working towards a sustainable future.

<sup>42</sup> <https://www.ieta.org/ieta-launches-task-group-on-integrity-in-digital-climate-markets/>





This approach offers a win-win scenario. Green bond proceeds are used to finance the issuance of carbon credits, while the carbon credits themselves provide an additional revenue stream for investors and a tangible measure of the project's environmental impact. These credits can be sold on the market to generate further returns or even used by the issuer to negotiate lower interest rates on the bond itself.

The structure of carbon-linked green bonds is designed to be particularly attractive to investors. They benefit from increased liquidity, the potential for higher returns through carbon credits, and access to a transparent and verifiable investment using stablecoins. Issuers can leverage this structure to raise capital at potentially lower interest rates due to the additional revenue stream from carbon credits. This allows them to finance climate projects with “cheaper money,” ultimately accelerating progress towards environmental goals.

The process unfolds in several key stages. First, a bond framework is developed that adheres to a chosen green bond standard and is verified by a third-party opinion provider. All relevant parameters and conditions are recorded on a public distributed ledger for complete transparency. Following this, the green bond is issued. To incentivise investor participation, issuers can offer lower interest rates while compensating investors with future returns generated from the carbon credits produced by the financed projects. The use of stablecoins for bond purchases ensures transparency in how the proceeds are used.

To bridge the gap until the carbon credits are effectively issued, the issuer can offer carbon forwards to investors. These forwards serve as concrete proof of the issuer's commitment to delivering the credits and can be traded on exchanges or placed in liquidity pools, generating immediate value for investors.

Once the projects funded by the bond demonstrably reduce carbon emissions, verified emission reductions lead to the issuance of carbon credits. These credits are then delivered to the holders of the carbon forwards. Finally, upon reaching maturity, the issuer repays the principal amount to bondholders, concluding the bond's term.

Carbon-linked green bonds offer a promising solution to several challenges in climate finance. Traditionally, green bonds, while environmentally beneficial, may not be as attractive to mainstream investors seeking competitive returns. Carbon-linked bonds address this concern by offering a clear financial incentive alongside the environmental benefits, making them more appealing to a wider range of investors.

For issuers, the ability to raise capital at potentially lower interest rates due to the additional revenue stream from carbon credits is a significant advantage. Carbon-linked bonds further enhance the appeal by introducing additional financial incentives, ultimately increasing issuers' access to climate finance.

Looking ahead, Web3 and Decentralised Finance (DeFi) mechanisms offer exciting possibilities for enhancing liquidity and yields. Investors or issuers can leverage these mechanisms to place carbon forwards in liquidity pools, generating additional yield while waiting for the carbon credits to be issued.







However, ensuring transparency and credibility remains paramount. Issuers must comply with established verification and reporting standards to guarantee that the environmental benefits associated with the projects are demonstrably achieved. Third-party verification adds an essential layer of credibility to the entire process.

In conclusion, carbon-linked green bonds offer a promising path towards mobilising the significant funds needed to achieve international climate goals like the Paris Agreement and the Sustainable Development Goals (SDGs). This innovative approach fosters a win-win scenario for investors seeking financial returns and issuers working towards a more sustainable future.

## 8.6 CORPORATE REPORTING

Data plays a pivotal role in Environmental, Social, and Governance (ESG) investing, serving as the foundation for informed decision-making and risk management in sustainable finance. High-quality ESG data enables investors to assess the sustainability performance of companies, identify potential risks and opportunities, and align investments with their values and objectives.

A recent report<sup>43</sup> published by the Luxembourg Sustainable Finance Institute highlights the challenges faced in the space of ESG data and the need for the development of:

- Robust data management practices
- A commitment to enhancing data quality and transparency in the ESG space.

ESG REPORTING	ESG REPORTING WITH DLT
<p>Reliability of the data:</p> <ul style="list-style-type: none"> <li>• Complexity of measurement</li> <li>• Multiple estimations in the reporting process</li> <li>• Shortage of skills required (assessment, reporting and verification).</li> </ul>	<p>An ally for maintaining an immutable record of reported data:</p> <ul style="list-style-type: none"> <li>• Assurance of data integrity and auditability.</li> <li>• The inability to tamper with information fosters trust and prevents greenwashing.</li> </ul>
<p>Companies are self-reporting data.</p> <p>Although the CSRD will enhance this by imposing limited assurance on sustainability reports, the challenge of estimation within reported data will persist.</p>	<p>Facilitates access for regulators and supervisory bodies, enabling them:</p> <ul style="list-style-type: none"> <li>• to access information and ensure compliance with existing regulations.</li> <li>• secure and permissioned data sharing between the parties.</li> <li>• to monitor progress and hold companies accountable for their environmental and social impact.</li> </ul>

<sup>43</sup> <https://lsfi.lu/outcome-report-lsfi-esg-data-working-group/>





<p>Measurement complexity:</p> <ul style="list-style-type: none"><li>• Lack of reliable data sources (incomplete data are accessible manually)</li><li>• Data quality: validation processes, update frequency, scope and coverage, transparency in data aggregation.</li></ul>	<p>Data collected can be tracked throughout the entire value chain, allowing for better decision-making and targeted sustainability initiatives.</p> <p>Furthermore, when coupled with AI and the Internet of Things (IoT), DLT can capture information in a unique setting.</p> <p>This eliminates the need for manual data collection and reconciliation, reducing administrative burdens and streamlining the reporting process.</p>
<p>A lack of standardisation and consistency in data reporting is observed.</p>	<p>Homogeneity in the reporting:</p> <ul style="list-style-type: none"><li>• Trigger automated reporting processes based on predefined rules aligned with the regulatory framework.</li><li>• Reduced human error</li><li>• Timely reporting</li><li>• Simplifying compliance for businesses</li></ul>
<p>The rapid evolution of ESG regulations and reporting standards poses challenges for private equity markets to remain compliant.</p> <p>This dynamic environment may lead to compliance gaps, uncertainties, and increased complexity in managing ESG data.</p> <p>The lack of regulatory requirements has led to the emergence of various initiatives, resulting in confusion and scalability issues. Data requirements vary depending on the framework and objectives of the invested instrument, leading to partial disclosure adoption and availability across the spectrum.</p>	<p>The technology enables businesses to:</p> <ul style="list-style-type: none"><li>• Track</li><li>• Measure</li><li>• Harmonise the information collected</li><li>• Adapt the data based on the evolution of the regulation in a seamless way</li><li>• Improve their impact on the environment and society by focusing on investing in the right companies, projects</li><li>• Empowers companies to comply with evolving sustainability regulations in the EU.</li></ul>





The lack of uniformity in measurement methodologies hinders the accessibility of comparable ESG data for analysis and decision-making.

Different definitions and the absence of standard reporting practices further compound this issue.

The level of data obtained and reported allows the investors to be reassured they are genuinely investing in products aligned with their convictions.





## 9 - RECOMMENDATIONS

### 9.1 FOR FINANCIAL INSTITUTIONS

Financial institutions have a significant opportunity to leverage DLT to transform their operations and investment strategies in relation to sustainable finance. Institutions should:

- 1. Conduct Comprehensive Assessments:** Begin with a thorough evaluation of existing systems to identify areas where DLT can provide the greatest value. Key focus areas might include streamlining trade settlements, enhancing ESG data traceability, and improving overall operational efficiency.
- 2. Pilot High-Impact Projects:** Initiate pilot projects in sectors where DLT can offer immediate benefits, such as the issuance and reporting of green bonds or the tracking of sustainability metrics. These pilot projects will serve as valuable learning experiences and can be scaled up based on initial successes, setting a precedent for broader implementation.
- 3. Develop ESG-Focused Financial Products:** Leverage DLT's capabilities to create and manage ESG-oriented financial products. DLT's ability to maintain immutable records and facilitate real-time tracking ensures transparency and verifiability of sustainability claims, thereby boosting investor confidence.
- 4. Collaborate with Stakeholders:** Engage in active collaboration with technology providers, regulators, and industry bodies to ensure compliance with emerging standards and to address potential challenges. This will also facilitate the integration of best practices and innovative solutions across the sector.
- 5. Build Internal Expertise:** Invest in training and development to build a workforce proficient in DLT technologies. Recruitment of DLT specialists and the establishment of dedicated teams will help in overseeing the implementation and management of DLT projects.
- 6. Establish Robust Governance Frameworks:** Develop governance structures that align DLT projects with the institution's strategic objectives and ensure that these initiatives are managed effectively. This will help mitigate risks and maximize the potential benefits of DLT adoption.

### 9.2 FOR POLICYMAKERS/REGULATORS

To facilitate the adoption of DLT while safeguarding investor interests, policymakers and regulators must develop a supportive and balanced regulatory framework. Key actions include:

- 1. Develop Clear and Consistent Guidelines:** Establish comprehensive and consistent guidelines that define the permissible uses and applications of DLT across financial services. Clear regulations on data privacy, security, and interoperability will provide a stable environment for DLT development and implementation.
- 2. Promote Transparency and Accountability:** Mandate disclosures and audit requirements to ensure transparency in DLT applications. This will help mitigate risks such as fraud and misuse, protecting investors and maintaining market integrity.





3. **Foster Collaboration and Engagement:** Encourage active collaboration between regulators, financial institutions, tech firms, and academia by forming dedicated working groups and advisory committees. Such engagement will help regulators stay informed about technological advancements and ensure that regulatory frameworks remain adaptive and relevant.
4. **Introduce Regulatory Sandboxes:** Implement regulatory sandboxes to allow businesses to experiment with new DLT applications in a controlled environment. This approach will encourage innovation while managing risks and ensuring compliance with regulatory standards.
5. **Support Standardisation Efforts:** Lead initiatives to develop international standards for DLT applications in finance, which will facilitate cross-border interoperability and trust. This will enable financial institutions to adopt DLT solutions with confidence, knowing they comply with global best practices.

### 9.3 FOR TECHNOLOGY FIRMS

Technology firms are uniquely positioned to create tailored DLT solutions that address the specific needs of the financial sector, particularly in sustainable finance. Key recommendations include:

1. **Develop Customized DLT Platforms:** Design DLT systems that cater specifically to the requirements of sustainable finance. For example, platforms that facilitate the issuance and management of green bonds can enhance transparency and traceability, thereby building investor trust and promoting capital flow into sustainable projects.
2. **Integrate with Emerging Technologies:** Focus on integrating DLT with other technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI). IoT sensors can provide real-time data on environmental metrics, which, when recorded on a DLT, ensure data accuracy and immutability. AI can analyse this data to identify trends and predict impacts, offering valuable insights for investors and regulators.
3. **Enhance Ecosystem Collaboration:** Work closely with financial institutions and regulators to ensure that DLT solutions meet industry needs and comply with regulatory requirements. Collaborative efforts can lead to the development of robust, scalable, and compliant solutions that drive the adoption of sustainable finance practices.
4. **Focus on Interoperability:** Develop solutions that are interoperable with existing financial systems and other DLT platforms. This will enable seamless integration and data exchange, enhancing the overall efficiency and utility of DLT applications in finance.
5. **Support Transparent Reporting and Verification:** Create systems that enable detailed and verifiable reporting on the environmental and social impacts of investments. This will help prevent greenwashing and ensure that sustainability claims are backed by reliable data.





## Conclusion

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Is the future of sustainable finance bright with the integration of DLT? The evidence suggests that it is, provided we continue to explore and innovate within this dynamic space. From tokenised green bonds to real-time compliance and automated reporting, DLT has the potential to revolutionise the way we finance and manage sustainable projects, fostering a more transparent, efficient, and inclusive financial system that supports our global sustainability goals.

The immutable and transparent nature of DLT addresses critical challenges such as opacity and inefficiencies in tracking the allocation and use of funds for green projects. By embedding data directly into financial instruments, DLT ensures the credibility and accountability of sustainable investments, thereby enhancing investor confidence and participation. Tokenizing green bonds, for example, illustrates how a secure, transparent, and efficient platform can revolutionize the green finance market. This approach simplifies the issuance and management of green bonds, providing real-time tracking and verification of environmental impacts, and effectively tackling the issue of greenwashing.

The successful application of DLT in the green bond market highlights its broader potential to transform various aspects of sustainable finance. However, realising DLT's full potential in sustainable finance requires a concerted effort in research, collaboration, and implementation. Developing a cohesive framework that supports widespread DLT adoption while adhering to the highest standards of transparency, efficiency, and impact, is critical. Stakeholders across the financial sector, including regulatory bodies and technology providers, must work together to address the technical, regulatory, and operational challenges associated with DLT integration.

Standardisation is another crucial component for the widespread adoption of DLT. Establishing common standards and best practices will ensure interoperability between different systems, facilitating a seamless and efficient flow of information. For the transition to DLT to occur, talent is required, and education and training are vital. Stakeholders at all levels need to understand the benefits and challenges of DLT in sustainable finance. Promoting a deeper understanding of DLT's capabilities and applications will help build a knowledgeable and engaged community that supports and drives the adoption of this transformative technology.





Critically, regulatory frameworks must evolve to accommodate DLT's unique features, providing clear guidelines that encourage innovation while ensuring investor protection and market integrity. The journey toward integrating DLT into sustainable finance is just beginning. The potential benefits are immense but achieving them will require a collective effort from all stakeholders involved. This transformation promises to not only enhance the integrity and efficiency of sustainable finance but also to help us meet our environmental and social objectives, driving positive change for all.





## Glossary

- **Distributed Ledger Technology (DLT):** Technological infrastructure and protocols that allow simultaneous access, validation, and record updating across a networked database. DLT is the technology blockchains are created from. It allows users to view any changes and who made them (transparency and immutability), reducing the need to audit data (auditability), ensures data is reliable, and only provides access to those that need it (security).
- **Greenwashing:** Misleading claims about the environmental benefits of a product, service, or company practices to appear more environmentally friendly than they are.
- **Sustainable Finance:** Financial services that integrate environmental, social, and governance (ESG) criteria into business or investment decisions for the lasting benefit of both clients and society at large.
- **Smart Contracts:** Self-executing contracts with the terms of the agreement directly written into code, enabling automatic and trustworthy execution.
- **Consensus Mechanism:** A fault-tolerant mechanism used in DLT systems to achieve the necessary agreement on a single data value or a single state of the network among distributed processes or systems.
- **Proof of Work (PoW):** A consensus mechanism where nodes (miners) compete to solve complex mathematical problems. The complex calculations require powerful infrastructure, leading to high energy consumption. Once validated, it is added to the ledger.
- **Proof of Stake (PoS):** A consensus mechanism where validators are chosen based on the number of tokens they hold and are willing to “stake” as collateral. It is more energy-efficient than PoW.
- **Byzantine Fault Tolerance (BFT):** A consensus mechanism that ensures the system reaches consensus even if some nodes act maliciously or fail.
- **Green Bonds:** Bonds specifically earmarked to be used for climate and environmental projects. They are typically asset-linked and backed by the issuer’s balance sheet.
- **EU Taxonomy Regulation:** A classification system establishing a list of environmentally sustainable economic activities to prevent greenwashing and help investors make informed decisions.
- **Sustainable Finance Disclosure Regulation (SFDR):** A regulation requiring financial market participants and advisors to disclose how they integrate ESG factors into their investment decisions and advisory processes.
- **Digital Operational Resilience Act (DORA):** An act ensuring that all participants in the financial system have the necessary safeguards to mitigate cyber risks and ensure operational resilience.
- **Markets in Crypto-Assets (MiCA) Regulation:** Regulation aiming to







increase transparency and regulatory clarity within the realm of crypto-assets, fostering growth and ensuring environmental standards.

- **Principal Adverse Impact (PAI):** Indicators that measure the negative impact of investment decisions on sustainability factors.
- **Do Not Significant Harm (DNSH) Principle:** A principle ensuring that financial activities or investments do not significantly harm environmental or social objectives.
- **SupTech Tools:** Solutions leveraging the latest advanced technologies available. They are used to enhance data quality, accuracy, and reporting. Key examples include AI and ML, blockchain and DLT, and IoT.





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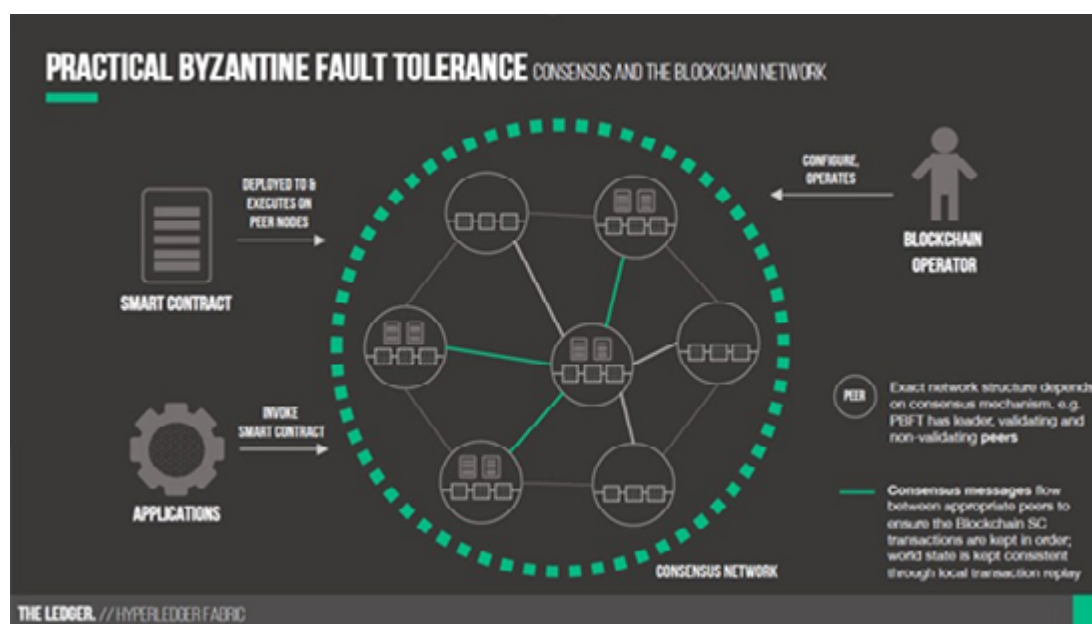
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## Appendix I: Exploration of BFT in the Context of Sustainable Finance



Source: The Ledger

If we want to ensure the veracity of the data and trust while being conscious in terms of the environment, a mechanism of interest is the Byzantine Fault Tolerance (BFT). In this specific case, validators use voting systems to reach consensus even if some nodes (computers on the network) malfunction or exhibit malicious behaviour. This enables operation in complex scenarios.

While not directly impacting energy consumption, BFT can contribute to a more sustainable DLT ecosystem in two ways:

- **Reduced Downtime and Resource Waste:** BFT systems can continue operating even with faulty nodes. This minimises system downtime and prevents wasted resources due to restarts or recovery efforts.
- **Enhanced Security and Trust:** BFT helps maintain data integrity and prevents manipulation by malicious actors. This fosters trust in the system, reducing the need for redundant security measures that might consume additional resources.

However, BFT protocols can be computationally expensive compared to simpler consensus mechanisms. While not a direct energy concern like PoW, it's worth considering the trade-off between security and resource usage when selecting a BFT implementation for a sustainable DLT application.



In conclusion, BFT plays a crucial role in building robust and secure DLT systems that can operate reliably even in challenging environments. While it may not directly contribute to reduced energy consumption, it indirectly supports sustainability by minimising resource waste and enhancing system trust.

## Appendix II: Sustainable Finance Fintech

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The numerous benefits of DLT technology have been discussed throughout this document. To showcase tangible examples, we sought to engage with entrepreneurs in sustainable finance, those dedicated to fostering a financial system that is sustainable, eco-friendly, and supports socially impactful projects. To this end, we explored various local and international solutions, including Moniflo, Evercity, and Arkadia. They are the future of green finance; give them the support they deserve.





# Moniflo



Moniflo, founded in 2020, is an investing platform for the critical and the conscious. It gives values-driven people the tools and data they need to build wealth while making an impact.

## **Which problem or issue are you trying to solve with your solution?**

Investing should not be complex and costly. The high costs and lack of transparency make it difficult to see the real impact of people`s investments. We need a simpler, more affordable, and transparent way to invest.

At Moniflo we empower individuals to invest in financial products that align with their own values. Investing is personal, but it also has the potential to make a real difference to the world we live in. We truly believe in the power of each individual to contribute to a more sustainable future through conscientious investing decisions. We have developed the Moniflo app using DLT to make investing safer, cheaper and more transparent. Moniflo helps to make your money matter!

## **Why do you use DLT and what does it help to solve/what does it bring that makes it a value-added solution?**

We believe in Green goes Digital and Digital goes Green.

Impact investing requires digital solutions to become fully relevant. A major part of investing is maintaining accurate records of ownership safely at best possible price: investors need to know what they own in a way that is secure and legally enforceable. DLT is an exciting technology that has many advantages over conventional approaches. It allows for a dramatic cost reduction for investors when transacting, so that everybody is able to give its money a voice. On top it uses only one third of the energy that is required in a traditional financial transaction. So when Green impact investing goes Digital, Digital DLT transacting saves energy and thereby goes green.

To achieve this, our solution includes the participation of multiple actors in the transaction signing process to improve governance and traceability. DLT opens up exciting new ways to implement multi-party signing models which we believe are more secure and provide stronger oversight.

We are convinced that DLT will become the future for robust financial record-keeping and will make many of the existing solutions obsolete. The benefits for investors are clear: Moniflo allows faster, safer, cheaper and more transparent investing.

## **What are the primary technical and regulatory challenges your company faces when integrating DLT for sustainable finance into the existing financial infrastructure?**





The ultimate measure of trust and adoption is when DLT and digital asset integrations of all kinds simply flow seamlessly together with established business processes, delivering measurable improvements. We have developed our solution along this principle.

DLT poses both technical and regulatory challenges. There are learning curves to integrate DLT and strong key management solutions into existing back-office streams. At Moniflo, we have a team of finance experts and DLT engineers that have experience in building DLT solutions which has enabled us to build a fully functioning financial platform on top of a public DLT. We have also partnered with one of the world's largest DLT key custodians to make sure we have the highest levels of security for our customers.

There are also important regulatory considerations about using DLT and the legal protections for investors. The use of DLT technology is also a new approach for regulators and they have to make efforts to achieve sufficient levels of comfort. We are very proud to have obtained regulatory approval in Luxembourg which allows us to deliver our services across the EU. This is very important as it requires regulated companies to put in place robust mechanisms and governance models to ensure DLT becomes mainstream and make sure customers always have the protections they deserve.

**How does your company address concerns around the energy consumption of DLT, and what measures are in place to ensure the sustainability of your DLT operations?**

A major criticism of some DLT solutions is the amount of energy used to implement the underlying trust-building algorithms in the network. This was a significant issue for us at Moniflo because we believe in sustainable investing, and that includes the energy footprint of the DLT platform. We spent a long time looking at different DLT solutions before choosing the Stellar DLT. Stellar uses a proof-of-ownership model to implement the consensus building, instead of using the proof-of-work solutions we usually see in DLT networks. This has an enormous impact on the energy consumption which means Stellar is much more energy efficient than other chains but also the traditional finance operations. We operate the Moniflo platform as a native cloud solution instead of using our own data centres which would be more costly and less efficient.

**How does your DLT solution help prevent greenwashing and ensure the authenticity of sustainability claims made by companies and projects?**

We only offer investment funds on our platform that are article 8 and 9 SFDR compliant, which means the products make efforts to comply with EU transparency requirements. Greenwashing can be best avoided giving investors the information as well as the tools and filters they need to make





informed choices. Our foremost aim is to show the investor what their money does and how this impacts the world we live in. We have partnered with a leading independent reference data provider that specialises in analysing financial products and produces sustainability metrics. Users can use filters to make the best possible choice when it comes to impact, exclusions and sustainability, so to say tailor-made to their vision of Green.





## Evercity



Evercity, founded in 2021, combines DLT with monitoring tools to increase data transparency avoiding greenwashing and enabling the issuance of fully traceable green digital assets: green and sustainability-linked debt instruments, carbon credits and forwards. Evercity also develops an open-source sustainable finance protocol, which serves as a global common good infrastructure.

Evercity aims to make green finance faster, cheaper, and more transparent, traceable, and accessible to SMEs, investors, and service providers.

### Which problem or issue are you trying to solve with your solution?

Our mission is to increase access to climate finance in developing countries by solving the following barriers:

- **Complex Climate Finance Origination:** The multitude of global standards and frameworks (e.g. green bond frameworks, project idea notes and design documents) create a significant knowledge barrier for new market entrants.
- **High Costs and Upfront Expenses:** Companies face substantial upfront costs for service providers (auditors, registries, project developers). The reliance on manual practices makes the process lengthy and labour-intensive, requiring hiring skilled workforce.
- **Trust Issues:** Investors (corporates, banks, funds) only invest in third-party verified, labelled assets, and lack access to transparent and reliable ESG impact/risk data.

Evercity streamlines the issuance of climate finance instruments, cutting origination time & consulting costs, ensuring transparency using blockchain & digital MRV.

### Why do you use DLT and what does it help to solve/what does it bring that makes it a value-added solution?

There is clear consensus among the UN bodies, international players and regulators that blockchain provides significant value along the climate finance value chain.

In the origination stage, it ensures traceability by recording project documentation and key stakeholder actions such as third-party verification in the most transparent and immutable manner. It creates a trust chain that can provide reliable data at any stage of the climate financing process.







During issuance, blockchain facilitates the creation of digital tokens representing climate finance assets like carbon forwards, carbon credits and green bonds, making them easily tradable. Blockchain broadens market access, allowing issuers to reach a global pool of investors, including those not accessible through traditional finance channels. It also reduces issuance costs by automating processes and eliminating intermediaries.

At the post-issuance stage, blockchain paired with monitoring tools (drones, satellites, AI models, IoT sensors) enables real-time monitoring of funds and project performance, ensuring transparency and accountability. Its immutable records secure all transactions and updates, easing audits and compliance checks. Automated data collection and smart contracts allow for accurate verification of environmental impacts, ensuring projects deliver on their promised outcomes.

**What are the primary technical and regulatory challenges your company faces when integrating DLT for sustainable finance into the existing financial infrastructure of your clients?**

One of the main technical challenges we encounter is interoperability - it's challenging to connect blockchain systems with existing, older financial systems, and ensure they can share data smoothly. There is also a need to protect sensitive data and prevent cyberattacks, which requires robust security measures. Lastly, working with blockchain requires specialised skills and knowledge from both tech companies and their clients.

One of the biggest regulatory challenges is keeping up with the constantly changing rules and regulations for both blockchain and climate finance. These rules can vary greatly from one country to another, making it difficult to stay compliant across different jurisdictions. Many legal issues arise due to different laws and the acceptance of not only cryptocurrencies, smart contracts, web3 mechanisms or tokenisation of securities, but also such instruments like green bonds and carbon credits. In both the blockchain and climate finance industries there is a lack of common standards. Thus, gaining the trust of the market and regulators is crucial.

**How does your company address concerns around the energy consumption of DLT, and what measures are in place to ensure the sustainability of your blockchain operations?**

Evercity has been choosing the underlying blockchain technology from the point of efficiency and sustainability. We are building on Hedera Hashgraph, a public ledger that uses a technology called the leaderless, asynchronous Byzantine Fault Tolerance (aBFT) hashgraph consensus algorithm. This algorithm ensures that transactions are processed quickly and securely, without the need for energy-intensive mining processes used by some





other blockchain technologies. It makes Hedera extremely efficient and sustainable, capable of handling many transactions with minimal energy consumption of only 0.000003 kWh per transaction.

**How does your DLT solution help prevent greenwashing and ensure the authenticity of sustainability claims made by companies and projects?**

Evercity is contributing to the development of a blockchain framework called Guardian- it is an open-source solution that uses Hedera's network to simplify the creation and verification of digital environmental assets. It has already digitised 50+ carbon offset methodologies (like CDM and VERRA) and aims to digitise over 100 more, automating the measurement of greenhouse gas (GHG) reductions and removals along the projects' lifecycle. It also includes automating the calculation of expected GHG reductions and removals for projects, validating Project Design Documents (PDD) and issuing fully traceable carbon forwards (carbon credits with future delivery) and green bonds.





# Impact

Founded in 2023, in Singapore

## **Which problem or issue are you trying to solve with your solution?**

We are developing a token-based crowdfunding platform as a new innovative way to fund green infrastructure projects through community participation. This modern web3 solution enables individuals and organisations to invest in and support sustainable initiatives.

## **Why do you use DLT and what does it help to solve/what does it bring that makes it a value-added solution?**

We use blockchain technology to tokenise assets. Each token represents a share or a stake in a green infrastructure project. Tokens can be bought, sold, or traded on the platform, offering liquidity to investors. Projects can be listed with detailed descriptions, goals, financial requirements, timelines, and expected environmental impact. Projects undergo a vetting process to ensure feasibility and alignment with sustainability goals. Users can purchase tokens using fiat currency or cryptocurrencies. Funding rounds can be structured similarly to traditional crowdfunding with tiers of rewards based on the amount invested. Investors can participate in decision-making processes for projects they have invested in through voting mechanisms. Regular updates and reports on project progress and impact. Besides, Blockchain ensures transparency in transactions and project funding. Smart contracts automate and enforce the terms of agreements, reducing the need for intermediaries.

## **What are the primary technical and regulatory challenges your company faces when integrating DLT for sustainable finance into the existing financial infrastructure of your clients?**

Regulations in many countries remain unclear about tokenisation. Depending on the technical interpretation of Singapore Financial Act, Token could fall within the definition of “debenture” or “derivative contract”. which are capital market products. Dealing in CMP (including offers to trade) requires a Capital Markets Services (CMS) License therefore the need of a Capital Market Service licence

## **How does your company address concerns around the energy consumption of DLT, and what measures are in place to ensure the sustainability of your blockchain operations?**

Not an issue as we don't expect huge transaction numbers at that stage.





Besides, we use Hedera Hashgraph which is one of the greenest Blockchains in the market (<https://hedera.com/ucl-blockchain-energy>). We don't have a massive number of transactions to date, therefore our related consumption is negligible.

### **How does your DLT solution help prevent greenwashing and ensure the authenticity of sustainability claims made by companies and projects?**

Token-based crowdfunding platforms, leveraging blockchain technology, smart contracts, and community governance, can create a robust system that ensures the authenticity of sustainability claims and prevents greenwashing. By providing transparency, third-party verification, and continuous monitoring, these platforms can build trust and support genuine green initiatives.

- **Blockchain Ledger:** The use of blockchain technology ensures that all transactions and project updates are recorded on an immutable ledger. This transparency makes it difficult for companies to manipulate data or make false claims about their sustainability efforts.
- **Audit Trails:** Every action and transaction is logged and can be audited by investors and third-party organisations, providing a clear trail of how funds are used and the progress of sustainability initiatives.
- **Automated Enforcement:** Smart contracts can be programmed to enforce specific sustainability criteria automatically. For example, funds can be released in stages only when predefined environmental goals are met and verified.
- **Conditional Funding:** Investments can be contingent on the achievement of certain milestones, which are verified through third-party audits embedded in the smart contract logic.
- **Verified Claims:** Projects can be required to obtain certifications from recognised environmental organisations or undergo third-party audits before being listed on the platform. These verifications can be recorded on the blockchain.
- **Ongoing Monitoring:** Continuous monitoring by third-party auditors can be integrated, with reports uploaded to the blockchain to provide ongoing verification of a project's sustainability claims.



## Authors

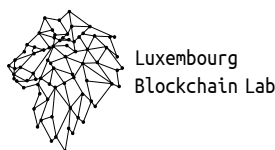
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**Emilie Allaert**

Emilie Allaert is an innovation passionate who aims to implement impactful solutions. She is renowned for her DLT and tokenization expertise associated with her in-depth knowledge of the financial industry challenges and is convinced technology and innovation are the paths to follow to maintain one's business competitiveness. Renowned for her expertise in Distributed Ledger Technology (DLT) and tokenization, Emilie possesses a deep understanding of the industry's challenges.

She believes dissemination of knowledge is key to adoption and gives lectures on digital innovation and DLT technology. She is active in a number of initiatives including as the co-chairman of ALFI's working group dedicated to blockchain and cryptoassets or as a member of ERC3643 Association

Impact investing and climate initiatives also rank high in her interests' list.



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**Oriane Kaesmann**

Oriane Kaesmann began her academic journey with a strong passion for literature and psychology.

However, her fascination with new technologies led her to pursue an LL.M. in Space Law at Luxembourg University. She gained valuable experience by interning at the Luxembourg Space Agency and subsequently joined an energy provider focused on the circular Moon economy, and sustainable electricity production with zero carbon impact.

Motivated by her dedication to sustainability, Oriane ventured into the financial sector. She specialized in sustainable finance, working for an international bank, a renowned Big 4 firm, and a consultancy firm, also focusing on compliance and AML/KYC. In search of cutting-edge developments in the financial industry, Oriane then joined the LHoFT, where she dedicates her time to research and crafting insightful articles and reports on transformative fields such as artificial intelligence, cryptocurrencies and blockchain, Fintech, Regtech, and inclusive finance.



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