

Blockchain for Biodiversity Finance

An overview of various
blockchain applications
to help increase
biodiversity funding.

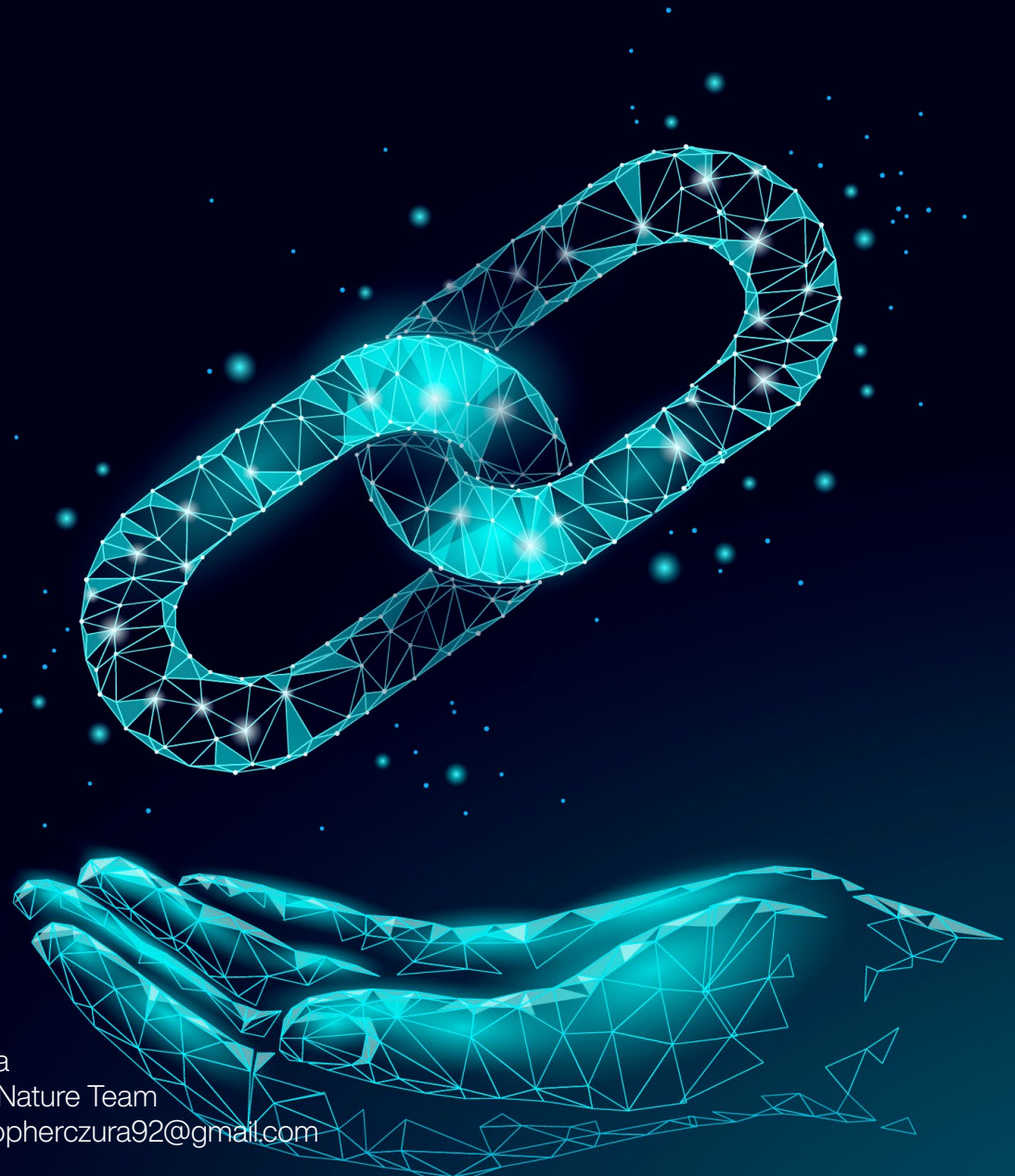


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Introduction

Biodiversity is essential; it provides the crucial life-supporting systems that we all depend on, from the fish in the ocean to the carbon capture trees of the Amazon. As we move forward into the next technological revolution, it is vital to continue to protect the ecosystems services that our economy needs. Blockchain technologies are a revolutionary technology that can apply to a wide array of different projects from digital currencies, decentralized cloud sharing, and even biodiversity data management. Technology is also transforming the ability of biologists, ecologists, and policy-makers to understand nature, and as a result, how we preserve it.

This paper will look at the importance of biodiversity in the economy, why more funding is needed to preserve it, the current green finance vehicles in place, and how blockchain could drive more funding into biodiversity. The purpose of this paper is to provide banks, insurers, and private investors with the knowledge around blockchain and how it can be implemented to reduce risk, create opportunities and improve due diligence into biodiversity assets. While still a relatively new technology, blockchain can have the ability to transform our current financial system and improve the way we finance biodiversity.



Key Recommendations

Below are some key take aways and recommendations for financial institutions regarding blockchain applications into more biodiversity-friendly assets and tools:

1

Implement blockchain data reporting systems:

Utilized a blockchain automated reporting system to harvest recognized metrics to communicate real-time data to investors and improve transparency.

2

Consider implementing blockchain-based biodiversity data sharing tools across or between industries:

create a prototype blockchain built to improve access to critical biodiversity data and improve sharing policies.

3

Piloting of blockchain biodiversity offset credit market:

Utilization of blockchain system to increase cost-efficiency and transparency in biodiversity offsetting programs. FI's can aid in developing a marketplace to trade BioTokens associated with biodiversity, offsetting credits to increase liquidity and stakeholder interaction.

4

Move all steps of Green Bond implementation onto a digital ledger system:

Improve cost-effectiveness and automation of green bond issuance onto a blockchain-based system. Reduce the number of actors involved in the accreditation process and proof of impact using smart contracts.

5

Smaller biodiversity projects should seek to tokenize biodiversity assets:

Projects too small for traditional financing methods should take advantage of blockchain's ability to improve liquidity and access more significant markets.

6

Investment into companies with trackable blockchain-based supply-chain management:

Improve tracking of biodiversity assets and ensure investments into companies in line with biodiversity-friendly sourcing.

The Importance of Biodiversity

Biodiversity is essential for all the economic, human, and cultural elements of life. It plays an integral part in the stock of Natural Capital ¹ and generates the goods and services our economy relies on. Human interaction within biodiverse ecosystems matters tremendously, as many vital benefits are derived from their services. The importance of ecosystems and their services can be divided into four key areas:



Provisional- The products obtained from ecosystems, such as food, fibers, etc.



Regulating- Benefits obtained from the regulation of ecosystems processes, such as climate, pest, or disease regulation.



Cultural- Spiritual, recreational and cultural benefits



Supporting- nutrient cycling, soil formation, and primary production

These services have been under constant threat for decades, and if nothing is done soon, we could be facing a global catastrophe.

Famous 18th-century economist Thomas Malthus once wrote an essay titled “An essay on the principles of population” on population growth philosophies and their impacts. Malthus theorizes that populations continue to expand until growth is stopped or reversed by disease, famine, war, or other global calamities. The theory states that food production will not keep up with growth in the human population; as it grows exponentially, food production remains linear, resulting in a crossing point or point of crisis. One could argue, we are very close to a tipping point on a global scale. The categorization of [The Nine Planetary Boundaries](#) defines the safe operating space for humanity in nine global processes. The planetary ‘boundary’ of biosphere integrity is currently in the ‘Beyond Zone of Uncertainty (high risk).’ The planetary boundaries are also highlighted in Kate Raworth’s [Doughnut Economics](#). This framework combines the planetary boundaries with complementary concepts of social boundaries. The inner circle of social elements is made to ensure that no one is left short on life’s essentials. The ecological outer circle ensures that humanity does not collectively overshoot the planetary boundaries that protect Earth’s life-supporting systems². Between these two circles is the ‘safe space’ for humanity to thrive.

¹A complete list of definitions can be found the [Appendix](#).

²Doughnut Economics Action Lab (2021). [About Doughnut Economics](#)

Furthermore, humanity has found a way to keep up with global demand and avoid this tipping point or breach of planetary boundaries with factory farms, increased mass fishing programs, and GMO foods. However, all these come at extreme biodiversity costs, and if something is not done to change this, we will reach the tipping point, one way or the other.

The Covid-19 pandemic highlights this theory. The WHO conducted a report on the origins of the covid-19 virus and found clear links between biodiversity loss and the zoonotic disease.³ Viruses like Covid-19 are typically isolated from humans through ecosystems that provide a regulatory buffer and disease control. With the constant deforestation of wildlife, these barriers no longer exist and caused a global health crisis. Covid-19 shows the importance of the regulatory ecosystem service that biodiversity can bring and presents just one aspect of preserving it. Unfortunately, the world's ecosystems have been in a massive decline, and the degradation of ecosystem services represents an annual economic loss of at least US\$479 billion per year.⁴ The United Nations collaborative report [Beyond Business as Usual](#) states that recent estimates put more than half of the world's GDP as moderately or highly dependent on these ecosystem services.

Moreover, current biodiversity conservation funding has historically been dominated by the public sector, representing over 80% of the available financial resources⁵. This gap underscores the importance of getting bankers, insurers, and private investors to provide further biodiversity funding. They are dependent on the natural capital biodiversity provides and serve as the biggest drivers of the extreme loss ecosystems are currently facing⁶.

Encouraging the private sector to transition to more biodiverse friendly financing could increase USD 10.1 trillion in annual business value and create more than 395 million jobs by 2030⁷. Blockchain⁸ and other fintech solutions could be implemented to help smooth the transition by reducing costs, increase efficiencies and accelerate transparency.

Before exploring the current biodiversity finance methods and how blockchain could help, it is vital to understand the background around sustainable finance and why financial institutions should diversify their assets into greener and biodiversity-friendly equity.



³Greenpeace International (2021). [WHO Covid-19 report shows clear link between biodiversity loss and zoonotic disease – Greenpeace reaction](#)

⁴UN Environment Programme, UNEP Finance Initiative and Global Canopy (2020). [Beyond 'Business as Usual': Biodiversity Targets and Finance Managing biodiversity risks across business sectors.](#)

⁵Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). [The Little Book of Investing in Nature,](#)

⁶Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). Ibid

⁷Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). [The Little Book of Investing in Nature,](#) citing WEF and AlphaBeta (2020).

⁸A more complete explanation of blockchain can be found in the Appendix

Biodiversity finance background

It is necessary to understand the principles behind sustainable finance and the challenges the current market faces concerning biodiversity and nature. Sustainability has been at the forefront of the international agenda for many governments and businesses over the past few decades. One of the key levers to achieving these sustainable outcomes is the finance and private sector. Banking plays an essential role in aiding this transition to a more sustainable economy by implementing policies that agree to lend or invest in businesses that properly manage biodiversity risks and disclosures.

Traditional finance primarily focuses on financial returns and regards the environment, which it depends on, as separate from them. Sustainable finance considers financial, social, and environmental returns in combination and interconnected within the economic framework⁹. Sustainable finance can help achieve the sustainable development goals set by the United Nations and achieve a net-zero carbon outcome for the economy.

Sustainable finance is an evolving term, and over the last few decades, the focus has been shifting from a short-term profit-driven one to a more long-term value creation-based narrative.¹⁰ Moving from a profit-focused narrative towards one focused on common good value has helped communities, and thus businesses grow together.

Bridging the gap between the old traditional and the new sustainable means creating platforms and organizations that can best convey and guide FI's towards these SDG goals. UNEP FI plays a vital role in this global shift, aimed at helping the private sector achieve sustainable development by implementing key new frameworks and financial guidelines that help drive funding towards ESG and biodiversity goals. Members of UNEP FI are encouraged to follow the multiple sustainability guidelines to improve their business practice and increase profits by utilizing the 'triple bottom line' principle of people, planet, and profit, to create more business value.

Since its creation, UNEP FI has helped in many areas of sustainable finance and continues to help drive change. Several key initiatives include the GRI, the Dow Jones sustainability world index, TCFD, and the TNFD. The constant need for guidance is important as new information surrounding sustainability and government regulation continues to evolve.

⁹Schoenmaker, D (2017). [From Risk to Opportunity: A Framework for Sustainable Finance](#)

¹⁰Schoenmaker, D (2017). Ibid

Banks that fail to transition to the more sustainable model are subject to several risks. These risks are shown in the figure below:



Legal & Regulatory risks:

These are risks that can arise from investing or lending into a business that is non-compliant as regulations become stricter or enforcement of biodiversity protection improves. For example, a business defaulting on debt because of a failure to comply with new regulations.



Market Risks:

This is a risk that can happen because of new market trends and failure to adapt to them—for example, customers seeking more biodiverse-friendly products.



Physical risks:

These are the risk that can arise from the destruction of property or infrastructure. This can affect production lines across the supply chain and thus reduce revenues and returns. For example, increase risks of Tsunami damage from the degradation of coastal mangroves would affect production factories.



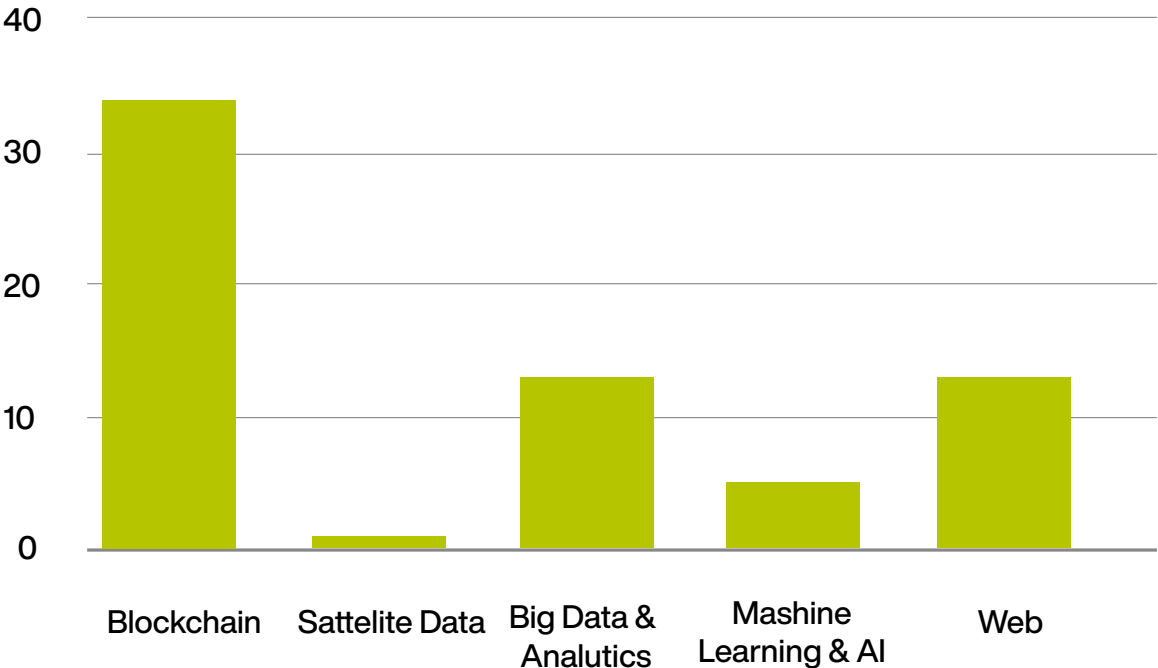
Reputational risks:

These are the risks that can arise from a company's brand perception in the public eye. For example, a company being viewed negatively by the public because of poor biodiversity practices or investment in the destruction of nature, all of which can affect revenues

Financial Institutions can avoid these risks and gain valuable insights from other industry leaders by joining an organization like UNEP FI. They help guide a smoother transition to a greener world. In the financial sector, due diligence is essential when appraising a business or a loan to establish whether it is worth the risk or reward. This is no different in the sustainable finance world. When conducting new investments, businesses must consider the social, economic, and environmental consequences they might create. Organizations like UNEP FI and others have created guidelines about excluding high carbon investments and how to drive more equity into green biodiversity-friendly assets to perform proper due diligence. In tandem with following these beneficial guidelines, FI's can explore how Blockchain technology can also help smooth this transition. A report written by the G DFA (Green Digital Finance Alliance) titled [Fintech for Biodiversity A global landscape](#) examined a total of 60 fintech's around biodiversity to track significant trends and tendencies. They found 55 percent of the fintech solutions identified were blockchain-based, with crypto-assets emerging as the top feature within digital biodiversity finance solutions ¹¹ (See Figure 1).

¹¹Green Digital Finance Alliance (2020). Fintech for Biodiversity A global landscape

Underlying Technology Powering Fintech for Biodiversity



(Figure 1: showing underlying technology powering fintech for biodiversity)

Biodiversity data, offsetting, and blockchain

The following sections explore the current data problems in biodiversity, how blockchain can help it, and biodiversity offsetting measures using blockchain systems.

Current challenges

Tracking and maintaining accurate and available biodiversity data can be challenging. Biodiversity data can refer to the number of species in a specific area to the number of microorganisms in a dirt sample. Biodiversity data sets are unstructured, vastly complex, and can be impossible to study as a whole in real life due to the spatial and temporal scales involved. According to the IUCN red list, 37,400 of the species out of the 134,400 assessed are threatened with extinction¹³, and around 10 percent of the species addressed in the IUCN red list can be classified as data deficient¹⁴.

Furthermore, lack of trust, transparency and proper measurement is impeding growth and investments into biodiversity-friendly initiatives. Another issue is the complex, opaque, fragmented, and geographically dispersed nature of supply chains that can make tracking food and consumer products difficult, significantly affecting the environment. Organizations may be reluctant to share knowledge or disclose data relevant to biodiversity for many reasons. However, generally, it has to do with concerns that someone else will benefit or profit unfairly from it. As a result, data sharing and transparent behavior within the economy are lacking, making proper due diligence difficult. The current data gap can lead to uncertainty about the seriousness of declines and can hamper effective conservation and how we invest in nature. Banks, insurers, and private investors can all benefit from more transparent data collecting policies. MRV of biodiversity impacts for organizations may be further impacted by the lack of data and specific indicators around them. Inaccurate or unreliable data place banks at a regulatory disadvantage and pressure from regulatory bodies like the [CSRD](#) or [SFRD](#).

Blockchain for data management

Blockchain innovation can help alleviate these data challenges in several ways. Precise data sharing among the industry is lacking, and proper verification of biodiversity data is needed. Timely sharing of electronic biodiversity data between industry professionals while ensuring data security and privacy is essential for developing biodiversity research and due diligence in investments. However, most proposed solutions to a blockchain data-sharing system are still in development or at the prototype level. For example, the [Earth Bank of Codes](#) is a solution developed by the World Economic Forum aimed at putting genetic codes of the biodiversity of the Amazon rainforest on the blockchain. Companies that want access to the data will have to buy it using a cryptocurrency, which is programmed to be directly paid to the communities taking care of the rainforest¹⁵.

¹² Green Digital Finance Alliance (2020). [Fintech for Biodiversity A global landscape](#)

¹³ IUCN (2021). [The IUCN Red List of Threatened Species](#)

¹⁴ Kindsvater, H, et al (2018). [Overcoming the Data Crisis in Biodiversity Conservation](#)

¹⁵ Green Digital Finance Alliance (2020). [Fintech for Biodiversity A global landscape](#)

Have a data-sharing platform built on blockchain helps reduce the risk for companies, as each piece of data is spread out onto thousands of different nodes across the ledger. Companies can then have more accessible access to data across the world while ensuring proper accreditation to those doing biodiversity conservation. Continuing conservation of critical biomes like the Amazon, with excellent and fair sharing of the benefits generated from the sequencing of nature with local actors, is needed.¹⁶ Registering the IP (intellectual property) of biological data onto the blockchain will allow for a provenance record and its use. When industry professionals create value into an asset, smart contracts will facilitate the fair sharing of benefits to the custodians of nature for its protection¹⁷.

Registering IP is just one example of utilizing a shared blockchain platform to increase industry data sharing of biodiversity assets. Increasing access and transparency of bio-assets and data will help FI's to have the best information needed to create valuable targets and KPI's, as highlighted in UNEP FI's [Guidance on Biodiversity Target-Setting](#).

Biodiversity offset programs with blockchain implementation

To achieve a net positive outcome for biodiversity, offsetting biodiversity value is sometimes needed. Biodiversity offsetting is based on the 'avoid, minimize, rehabilitate, offset' [mitigation hierarchy](#). FI's can consider using offset programs after first:

1. Considering if the development can avoid negative impact on the environment
2. Next, consider whether development can minimize any negative impacts that cannot be avoided
3. Whether the impact site can be restored or rehabilitated to the original ecosystem that occurred before impacts

Once all these measures have been taking, biodiversity offset measures can be taken to compensate for the adverse impacts and achieve a net positive outcome. According to The Biodiversity Consultancy group, there are two types of biodiversity offsets, 'restoration offsets' that aim to rehabilitate or restore degraded habitat, and 'averted loss offsets' to reduce or stop biodiversity loss (e.g., future habitat degradation) in areas where this is predicted¹⁸.

It is important to note, unlike carbon offsets that are measured in tons of carbon dioxide equivalent and often found as a source of finance for nature through the voluntary carbon market, biodiversity offsets are a last resort to compensate for the biodiversity impacts of a project. Recreating complex natural habits elsewhere is not possible, which is why offsetting for biodiversity should be implemented only after each step of the mitigation hierarchy is followed.

Biodiversity offsets are often complex and expensive; however, implementing and issuing biodiversity offsetting credits on a blockchain system can help in reducing the cost associated with it and track transactions on the marketplace.

¹⁶ World Economic Forum (2018). [Harnessing the Fourth Industrial Revolution for Life on Land](#)

¹⁷ World Economic Forum (2018). Ibid

¹⁸The Biodiversity Consultancy (2021). [Net positive and the Mitigation Hierarchy](#)

New south wales BioTokens

A blockchain prototype has been developed by the Commonwealth Bank of Australia (CBA) and BioDiversity Solutions Australia (BDS), aimed to help boost sustainable development while enabling investment opportunities for landowners, environmental groups, and developers. The prototype enables the creation of tradable digital tokens (BioTokens) within an efficient and transparent digital marketplace powered by blockchain. BioTokens represents biodiversity credits for the New South Wales (NSW) Government's [Biodiversity Offset Scheme](#)¹⁹. A biodiversity credit marketplace can help a broader range of stakeholders participate and make better use of the potential benefits derived from biodiversity offsetting.

Creating a transparent blockchain marketplace for developers and landholders to trade biodiversity offset tokens will help ensure the verifiable delivery of certificates and track transactions. This ensures no fraudulent credits are allowed on the market place increasing the credibility of the program. These blockchain based-solutions allow for cost-efficient and secure distribution of credits while enabling the government to control and manage the schemes with real-time data.

This next section highlights some of the methods FI's can use to increase funding towards biodiversity and how implementing a DLT (Digital Ledger Technology) like blockchain can help accelerate funding, transparency, and efficiency.

¹⁹Poole, B (2019). [Blockchain prototype creates marketplace for biodiversity investment and protection](#)

Current green finance tools/vehicles

The [Little Book of Investing in Nature](#) by Global Canopy goes into depth around the value of biodiversity, the current financing gap, and details current methods to generate biodiversity revenue. Since its creation in 2008, blockchain has primarily linked financial services with cryptocurrencies like Bitcoin. Now enterprises are starting to see the benefits behind blockchain and are venturing into new use cases.

According to a report by the European investment fund, “Globally, VC investments in AI and BC have grown rapidly over the past decade, exceeding \$30 billion in 2019, dominated by the United States and China. In the EU27, these investments grew from \$0.3 billion in 2016 to over \$2 billion in 2019, representing an increase from 3% to 7% of the global total²⁰.” Blockchain interest is growing fast, and below are some of the methods of current biodiversity financing and how blockchain can help FI’s transition.

Green Bonds and Blockchain

One important green finance vehicle first launched by the World Bank in 2008 were green bonds. Green bonds are any bond instrument where the proceeds will be exclusively applied to finance or re-finance in part or in full, new, and/or existing eligible Green Projects aligned with the four core components of the GBP (Green Bond Principles).²¹ According to some experts, the green bond market is expected to double in 2021. Many governments and businesses have sharpened their focus on building back stronger in the aftermath of the coronavirus pandemic. The green bond market has become more prevalent in recent years, with younger generations growing more concerned about how money is invested for their future. The current bond market cap is around 128.3 trillion dollars, and green bonds are the fastest-growing segment²². As of 2019, green bond issuances are the highest in the United States, China, and France, which collectively account for 44% of 2019 global issuances. While this growth is highly encouraging, only 0.5-1.0% of that total capital is being used toward biodiversity²³.

²⁰ The European Commission (2021). [Artificial intelligence, blockchain and the future of Europe: How disruptive technologies create opportunities for a green and digital economy](#)

²¹ The Green Bond Principles (2018). [Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds](#)

²² Miller, A (2021). [How the \\$1 trillion market for 'green' bonds is changing Wall Street](#)

²³ Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). [The Little Book of Investing in Nature](#), citing Deutz et al. (2020)

With such a growing market, it is important to consider how fintech can aid in achieving further funding and help create a more robust, reliable network for investors. Using new disruptive technologies like artificial intelligence or blockchain can create new opportunities for sustainable finance and the green economy. While many biodiversity projects might be too small for the green bond market, it is still possible to bundle them into more considerable investment opportunities .

Green bonds can be issued by various private and public players and agreed upon by standard setters like the [Climate Bond Initiative](#) or the [Green Bond Principles](#).

There are four critical components of the GBP:

1. Use of proceeds
2. Process for project evaluation and selection
3. Management of proceeds
4. Reporting

These four principles help banks, financial institutions, or governments conduct proper due diligence and ensure proceeds and funds of bonds go towards green projects.

Use of proceeds means ensuring project money goes towards environmentally friendly initiatives, such as renewable energy, clean transportation, or climate change adaptation projects. The second phase is clear communication of the bond project to investors. This is how issuers determine how the project fits within the eligible green project categories identified by the world bank. Issuers are encouraged to position this information within the context of the issuer's overarching objectives, strategy, policy, and/or process relating to environmental sustainability²⁵. The GBP encourages this high level of transparency and encourages green bond issuers to process the evaluation with external reviewers. Thirdly, the GBP recommends that net proceeds of the green bond are tracked by the issuer in a formal internal process linked to the issuer's lending and investment operations for Green Projects.

Lastly, issuers should make and keep all the available data and/or information around the green bond up-to-date and on a timely basis. The annual report should include a list of the projects that have received green bond proceeds and describe the project's expected impacts on the environment. Transparency is of particular value when financial institution communicates the expected impacts of their projects. Without transparency or proof of impact, many companies or banks could be accused of greenwashing and not investing in 'green' projects.

After following all these recommended criteria set by the GBP, it is recommended that in connection with the issuance of a green bond, the issuers perform an external review to ensure proper alignment of their bond with the four core components defined.

²⁴ Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). [The Little Book of Investing in Nature](#)

²⁵ The Green Bond Principles (2018). [Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds](#)

The importance of MRV (measuring, reporting, and verification) is apparent when issuing and processing green bonds. Implementing a DLT like Blockchain can help reduce friction and improve reporting standards, costs, and verification. Bonds on the blockchain mean there will be no difference between a 5-dollar or 10-million-dollar investment, which can aid in opening up the Green Bond market to a much broader investor base ²⁶. This is because of the blockchain's ability to digitize trust by using mathematical algorithms (cryptography) to validate transactions. Blockchain can also take over in the role of trust broker, making it easy to reduce the overall costs of bond issuance and impact the minimum coupon size ²⁷.

DLT technology will allow for the simplification of all aspects of green bond issuance and creation. From observing the current criteria to approve a green bond from GBP, we can see how blockchain can aid in each of the four aforementioned steps. DLT allows for the storing of information in a completely secure, fully traceable, and immutable manner. This allows for a quicker expedition of otherwise complex arrangements.

BBVA Blockchain Green Bond

BBVA were a pioneer in the issuance of the first blockchain Green Bond with Mapfre. This was the first green debt security issued to be arranged and negotiated on a blockchain platform. Mapfre invested 35 million euro devoted to sustainable projects in a 6-year term, at a 5-year euro swap. BBVA DLT technology carried out the processes of arrangement, negotiation and issuance all from the blockchain network. BBVA also gave customers the option to host a node of the blockchain, which about half accepted.

This DLT allowed for immutability of the agreements and that the agreed terms are compiled with, while opening the investors to conduct bespoke configuration of their product. However, the verification of the green bond still went through traditional third party validation by DNV GL.

²⁶ HSBC, Sustainable Digital Finance Alliance (2019). [Blockchain: Gateway for sustainability linked bonds](#)

²⁷ HSBC, Sustainable Digital Finance Alliance (2019). Ibid

The focus of DLT for green or sustainable bonds is explored in great detail in a report by UK bank HSBC. The report titled *Blockchain: Gateway for sustainability linked bonds* highlights how blockchain and its encryption algorithms can help boost confidence in the bond market and the opportunity it presents for the emerging green bond market. The report breaks down the relevant subjects around bond issuance as:

- Structuring and distribution
- Transfer of ownership
- Payment and settlement
- Proving the relevant impact of the bond

Firstly, in terms of structuring and distribution, banks that enable blockchain will reduce the time and cost of issuance while creating a stronger relationship between the issuer and investor. The efficiency gains will not only make the distribution of Green Bonds easier but also save on costs. The average US corporate bond carries organizational expenses of 3-6% of funds raised²⁸. A DLT will help in reducing the number of actors by replacing many of the actors in the current system with the blockchain. Using smart contracts for the issuance of green bonds brings greater transparency and reduces the risk for issuers, investors and underwriters. Several parties like brokers and listing agents can be removed from the process²⁹. Third-party oversight will also be removed since cryptographic signatures certify a tamper-proof, anti-fraud check will be written into the smart contracts. In terms of distribution, bonds can be complex, with many different factors to consider, such as coupon rates and credit ratings. Smart contracts can be added to the blockchain allowing for competitive bidding, credit rating approval, and other complexity associated with the bond. This creates opportunities for the fully automated distribution of green bonds.

Small biodiversity project and Blockchain

There are many biodiversity projects that struggle to gain funding due to their size. Lack of transparency has presented reporting challenges for these smaller projects with their many inefficiencies. Blockchain can help improve transparency within proof of impact and traceability of funds within smaller project to aid in credibility. Another bonus, is the cost reductions experienced in blockchain bonds, this creates opportunity to expand the scope of bond issuance to many of these smaller niche projects. Smaller biodiversity assets can also be aggregated into a bond with smart contracts along with proof of impact goals.

²⁸ HSBC, Sustainable Digital Finance Alliance (2019). [Blockchain: Gateway for sustainability linked bonds](#)

²⁹ HSBC, Sustainable Digital Finance Alliance (2019). Ibid

Transfers of ownership of these green bonds will also be provided on smart immutable contracts on the DLT, meaning it will be virtually impossible to receive fake or falsified records. This transparency and ease of transfer are also likely to increase investment in Green Bonds as greater efficiencies tend to lead to a more attractive coupon rate as costs go down.

Payments and settlements will also significantly improve in efficiency through the DLT smart contract platform. The Smart contract system allows for instant transfer of value and assets without the need for a third-party broker or settlement system. This can be done by transferring a digital asset in exchange for a token representing the security ³⁰. For example, a bank can utilize a Stablecoin to move value between investors and the issuer in an automated settlement system. Banks are in a prime position to establish this system of a Stablecoin, as they are a type of cryptocurrency designed to have a relatively stable price, typically through being pegged to a commodity or currency. A Stablecoin ensures management of proceeds is correct (each transaction is registered) and allows for instant settlement of contracts. According to the HSBC report, this can reduce settlement risk by over 99% ³¹.

Perhaps the most significant impact of switching to a blockchain-based green bond system is the vast cost saving it can bring to all parties involved. In partner with the GDFA, HSBC conducted an analysis comparing the cost associated with green bonds on a standard v fully automated blockchain system for a green bond with a value of 100 million USD for a 20-year maturity. The result found that a blockchain-based system was a staggering **10 times more cost-effective** ³².

In short, a blockchain network for Green Bonds will enable FI's to establish a cost-effective, efficient, transparent, and immutable system that will generate greater confidence in the market and increase investments to biodiversity-friendly investments.



³⁰ HSBC, Sustainable Digital Finance Alliance (2019). [Blockchain: Gateway for sustainability linked bonds](#)

³¹ HSBC, Sustainable Digital Finance Alliance (2019). Ibid

³² A more detail look at this analysis provided by the HSBC and GDFA can be found in the Appendix

Tokenization of biodiversity assets

An STO (security token offering)/ tokenized IPO (Initial Price Offering) is a type of public offering in which a tokenized digital security is sold on a cryptocurrency exchange. Tangible financial or biodiversity assets can be traded using the blockchain ledger system to validate transactions securely. Certain aspects of biodiversity investing and data can be tokenized to save on costs, increase transparency for the public, and access a broader array of finance options. STOs combine blockchain technology with the requirements of regulated traditional securities markets, all of which increase the liquidity of the asset.

Some biodiversity-related projects are too small to get funding through traditional finance methods. While green bonds can be used in an aggregated method for smaller projects, an STO or HTO (hybrid token offering) can offer another funding avenue. One barrier to allocating more capital to biodiversity assets is the high transaction cost created by these assets' limited size³³. As mentioned earlier, green bond allocation only drives around 1 percent towards biodiversity. To scale up biodiversity investments and reach the wider capital markets, smaller biodiversity projects can take advantage of the trends of cryptocurrency assets with regulated STOs. While the STO market is still very young, it is expanding quickly, and many new projects are finding refuge in the blockchain.

Note on the regulatory state for blockchain

Currently, the regulatory system has been slow to catch up to blockchain technology. However, Switzerland has evolved as a more crypto-friendly nation and has even regulated security tokens under FINMA, as asset tokens. They are also the first to trade STO's and developed a mature secondary Green Bond Market. This makes Switzerland as prime example for leading the way for Green Blockchain Bonds. Further work is needed and in order to ensure the best outcome, FI's should work with regulators to develop comprehensive and compliant blockchains.

In 2017, 5 STOs raised USD 65.59 million, in 2019, 55 projects raised USD 452.95 million, and some predictions predict the STO market to grow to 2 trillion by 2030.³⁴

Once the relevant regulatory requirements are reached, a biodiversity STO could offer accredited investors a crypto asset associated with a business plan, profit forecasts, and capital requirements. After specific benchmarks are reached, the crypto-token can be listed on secondary market exchanges, reaching a much broader investor base and benefiting from the decentralized blockchain trends.

³³ Green Digital Finance Alliance (2020). [Fintech for Biodiversity A global landscape](#)

³⁴ Green Digital Finance Alliance (2020). Ibid

TreeCycle: A hybrid token offering

TreeCycle is a company that focuses on the sustainable plantation of eucalyptus trees in Paraguay. The Swiss-based company's goal is to encourage investment in trees and their sustainable growth. Through their earned profits, TreeCycle wants to help bridge the gap between biodiversity and the economy. As of June 2021, TreeCycle has sold 820,200 trees, with a goal of 10 million trees. The investment in eucalyptus trees is made with the TREE digital asset. Each TREE asset sold generates 100 currency tokens, of which 70 go to the TREE asset holders. As a hybrid token offering, TreeCycle will offer a maximum supply of 10 million security tokens designated as TREE asset tokens, with a base cost of \$23 each, for a maximum of \$230 million raised. A Treecoin (utility coin) is established as a new payment method and introduced as a currency within local Paraguay farming communities and for other transactions along the supply chain. The aim is to reforest areas of 12,500 hectares with 10 million trees. Investors get 90% of net dividends back, with that 90% being further split into 40% direct dividends and 50% going directly to reinvestment in the TreeCycle Life Reforestation System. This 50% is reinvested by purchasing land and seedlings to grow eucalyptus trees in Paraguay, ensuring TREE is a passive growing asset.

HOW IT WORKS



TreeCycle is unique as it has decided to finance itself using an HTO (hybrid token offering). Before going further, it's important to note some key benefits and disadvantages of using utility tokens, security tokens, and a hybrid method. A more detailed comparison can be found in the appendix. An STO offers regulatory compliance security, is attractive to traditional investors and ensures no misinformation or scams. However, it lacks the advantages of utility tokens regarding the alignment of all stakeholders in an ecosystem/network/marketplace.³⁵ An HTO will allow a company to create a token with a limited supply, allowing it to be traded within a specific network and unlock the benefits from the DLT. An HTO can also allow for equity characteristics such as voting rights, dividends, and equity ownership while maintaining the most critical characteristics of utility tokens, such as stronger volume and usage on the blockchain, leading to a direct increase in the token's price.³⁶

This provides an example of how a biodiversity-related project can integrate blockchain and cryptocurrency to gain wider funding and a larger audience. TreeCycle sells a limited quantity of TREE (a security token) to its investors; this method allows fundraising to be transparent, fast, and much more cost-efficient for all parties.

³⁵Mass, T (2019). [The Case For Hybrid Tokens](#)

³⁶Mass, T (2019). Ibid

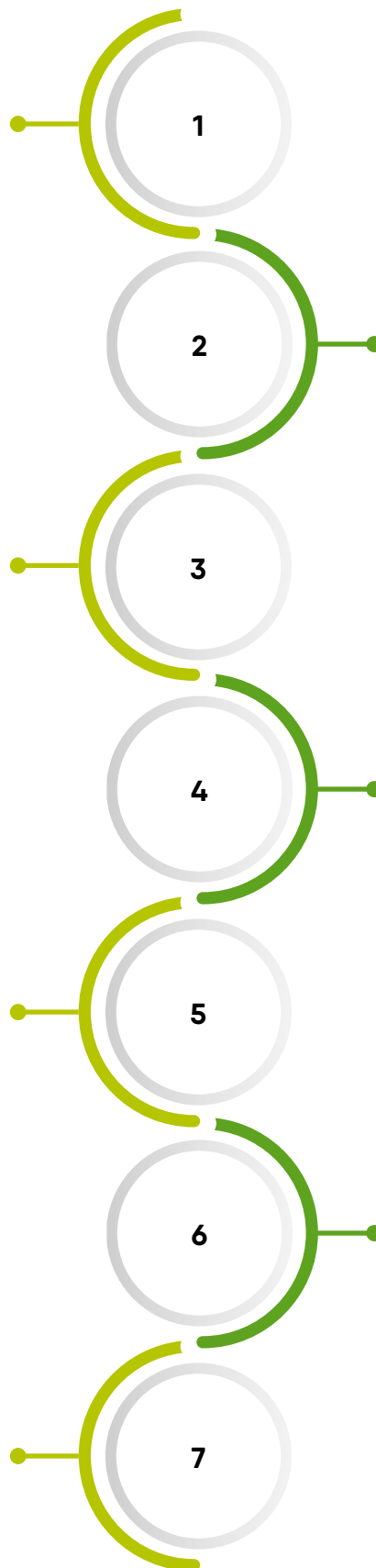
How it all works:

TreeCycle raises money for its specific project for investors who can participate by receiving tokens.

Along with the Security token (TREE), there is also a Paycoin (utility token); called TreeCoin. This is used within the TreeCycle economy.

Investors do not receive any right to claim land, property, or other assets; instead, they receive the profits made by reforestation in Paraguay. Thus, the owner of TREE acquires a right to 40% of the dividends, which, as explained above, is distributed at each cycle from 90% dividends. All distributed profits are paid in TreeCoin. The ticker symbol is TXC.

TREE is only tradable on stock exchanges that are approved for secured tokens. It is also always possible to exchange TreeCoin for the exchange implemented by ARDOR itself for ARDOR & IGNIS (Ardor's Blockchain-Based Token) or others on this blockchain to exchange accessible cryptocurrencies. TreeCoin is transferable as soon as the token is listed on exchanges.



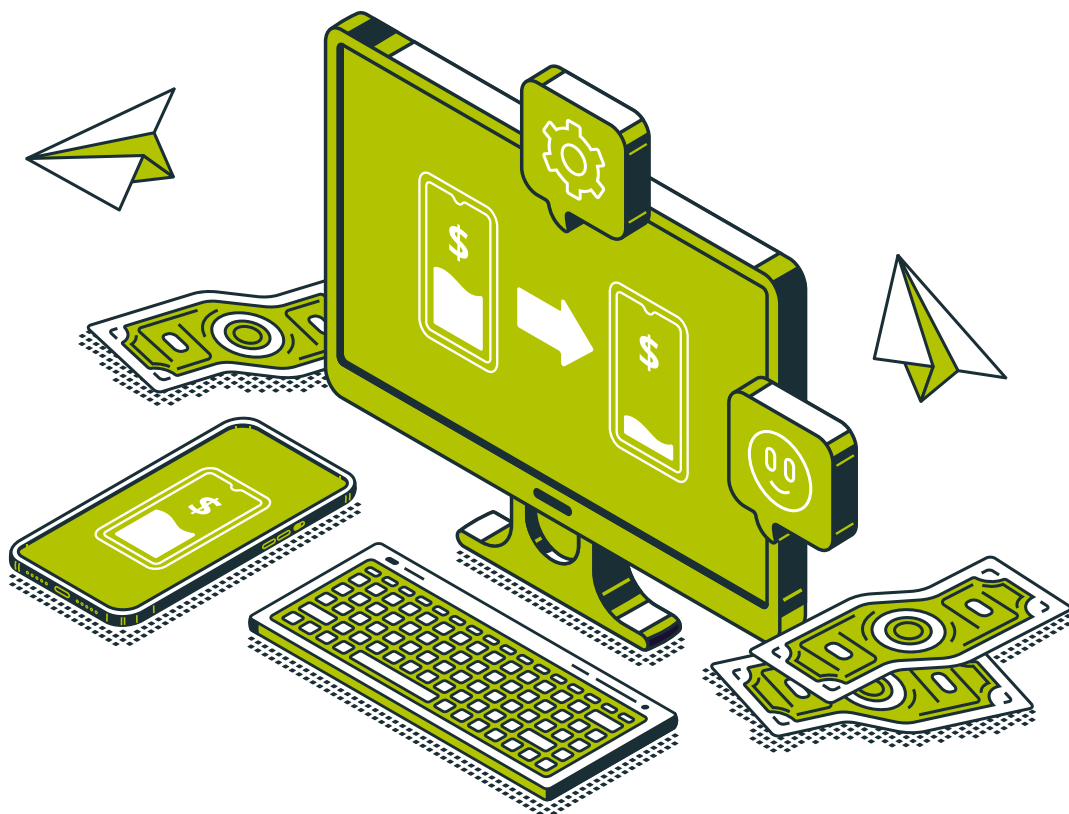
The security token called TREE has the properties of an asset, and it allows the investor to participate in the sale of the eucalyptus tree.

Investors buy TREE, and each one has the value of one tree that has been grown over 22 years. Each TREE has a purchase price of 23 USD, and it has a ratio of 1:100 to the paired payment token TreeCoin.

In addition to the TREE, the investors receive TreeCoins free of charge as a bonus. Investors get an extra 30 TXC tokens on top of their investment as a bonus (they also get a set amount in general - tied to the amount of TREE they purchase). The remaining 50% from the 90% dividends remain to cover plantation workers' salaries and pay.

The use of eucalyptus trees provides valuable economic use while also helping to reforest large areas of land. Through reforestation, TreeCycle can bring back life to fallow land, restoring conditions for the native forest by reclaiming its habitat and re-establishing a healthy and thriving ecosystem. Paraguay has a lot of energy requirements, and proper infrastructure is lacking. Commercial wood is one of the most important uses for reforestation in the area, and TreeCycle can help provide for this demand in a sustainable fashion. Eucalyptus trees can be useful as quick burnable fuel while reducing harmful practices in deforestation.

The combination of both methods has allowed TreeCycle to take advantage of the emerging blockchain and cryptocurrency space. Many biodiversity-related projects that are relatively smaller scale can utilize methods like HTO or STO to generate funding. These methods are cost-effective and provided a great way to track biodiversity assets across supply chains.



Biodiversity finance in supply-chain management

Integrating proper sustainable supply-chain management can be beneficial to both the environment and companies. Establishing the best in CSR management within a business's value chain can help increase capital flows into biodiversity. Historically, global supply chains within biodiversity have been largely negative, contributing to immense land-use changes and unsustainable agriculture, forests, fisheries, and other practices associated with commodities ³⁷. To encourage further investment and funding into biodiversity, transparent supply chain management is needed, as it offers an opportunity to generate revenue from more sustainable means. The sales of more certified sustainable commodities are expected to increase contribution to biodiversity by at least 12-19 billion annually by 2030 ³⁸.

Blockchain technology can help increase the sustainability in supply chains by reducing friction, increasing transparency for end consumers, and reducing costs for companies. The transparent nature of a DLT system will enable companies that are fulfilling sustainable practices to avoid the reputational risk associated with greenwashing. Blockchain-based systems will aid credibility by shifting the validation of proof of impact and transactions from human reviewers to tokenized, data-based automated sensors at each step of the value chain. Secondly, tokenization of capital flows will allow for transparency in the use of proceeds throughout the supply chain, reducing the risks of fraud or tampering. Thirdly, it allows customers to have direct visibility into each phase of the product they are buying, increasing sales and improving customer relationships.

There has been a rise in recent years of customers wanting to know where their food is coming from and wanting it to come from sustainably sourced farms or fisheries. One example of this is aquaculture, an industry that has faced some scrutiny in recent years.



³⁷ Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). [The Little Book of Investing in Nature](#)

³⁸ Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). Ibid

Aquaculture and blockchain supply-chain management

Establishing credibility within the seafood industry is crucial to ensuring sustainable practices continue to be implemented. Seafood producers using aquaculture now account for more than half of all the fish we eat worldwide ³⁹. As populations continue to grow, seafood may be the answer to provide protein more sustainably. Aquaculture can help alleviate the impact on wild fish stocks, which will help reach the goals of SDG 14 (Life Below Water). However, to secure proper sustainable sources and encourage biodiversity, proper management is needed. 90% of the world's fisheries are either harvested up to or beyond their biological limits, and fish farming will be increasingly needed to meet the growing population demand for seafood ⁴⁰.

Meat	Emissions (kg carbon dioxide/kg meat)
Beef	12-16
Pork	4-8
Chicken	3-4
Wild-caught fish (cod, saithe, haddock, herring, mackerel)	1-3
Aquacultured fish (shrimp, tilapia, channel catfish, salmon, blue crab)	2-7 (median = 4)

(Figure 2 ⁴¹, FAO estimates of end energy use in world food systems in 2008)

On average, salmon farms only emit 2.2 kilograms of carbon dioxide for every kilogram of edible fish. That is less than half of any animal raised on land, including 5.1 kilograms of CO₂ per kilogram of chicken or 37.2 kilograms for beef ⁴². However, aquaculture still suffers from low sustainable practices, lack of local regulations, and insufficient proof of quality. Customers will continue to cast doubt on the quality of aquaculture if supply chains are not adequately managed, and with just cause, as some studies have found that nearly 40 percent of fish products from restaurants, markets, and fishmongers are mislabeled ⁴³.

Blockchain can provide a method for all stakeholders across the supply chain to accurately share trusted information about the fish and, most importantly, with the customers in the stores. A DLT solution will help create an unalterable record of every detail of the fish, from egg to the fishmonger's case ⁴⁴. As you move throughout the supply chain, from the hatchery to catching information or even storing conditions, blockchain can capture this data and share it with the customers. Biodiversity damage can be mitigated by improving tracking and reducing mislabeling and IUU (Illegal, unreported, and unregulated) fishing. In the long run, improved tracking may also help protect endangered species, as the sales of legal fish will be tracked and verified. Things like the temperature control of the fish in storage or what type of fish it is, are stored on an easy-to-read QR code for the customers to track.

³⁹ Braathe, E (2020). [Why digital traceability can accelerate the aquacultural revolution](#)

⁴⁰ WWF (2021). [The Future of Responsible Aquaculture](#)

⁴¹ Boyd, C (2013). [Assessing the carbon footprint of aquaculture](#)

⁴² SeaWestNews (2019). [Fish farms carbon footprint among lowest affirms study](#)

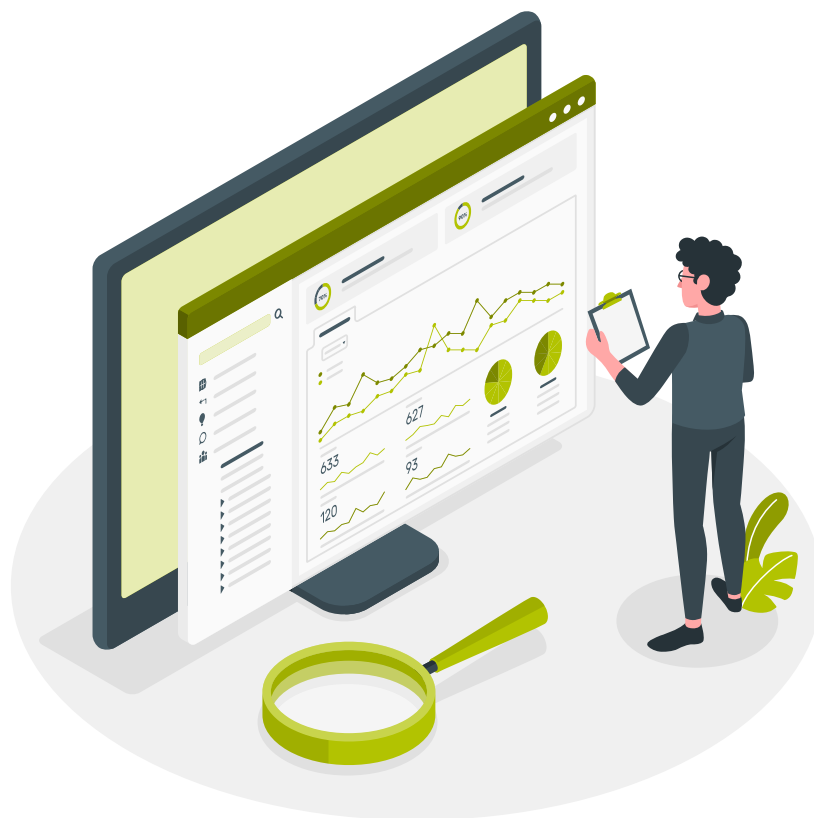
⁴³ Leahy, S (2021). [Revealed: seafood fraud happening on a vast global scale](#)

⁴⁴ Braathe, E (2020). [Why digital traceability can accelerate the aquacultural revolution](#)

The Norwegian Seafood Trust is leading the way, working together with IBM blockchain solutions and Atea. They offer knowledge about all the benefits of the blockchain tracking service. According to the Norwegian Seafood Trust, companies that have implemented this trackability have seen up to 10 percent growth in sales, as clients have more trust in the products they buy. According to an IBM study, up to 70% of consumers indicate that traceability is important to them and are willing to pay a premium for brands that provide it ⁴⁵.

Appropriate record-keeping means regulators can issue licenses of inspection results on the DLT. Farm operators can use it to input vital statistics about the fish (location, type of feed, hatchery location, transportation methods), and grocers can use it to help improve their processes in distribution while reducing inefficiencies and waste ⁴⁶.

Tracing the source on an immutable system; will help increase regulation, reduce fraud in aquaculture, improve sales, and reduce costs. All of this will help bring credibility towards sustainability, which will improve investments in biodiversity. It is hoped that more FI's will seek investments in properly managed biodiverse-friendly companies and move away from financing poor fishing practices.



⁴⁵ Norwegian Seafood Trust AS (2021). Tracking Technology

⁴⁶ Braathe, E (2020). Why digital traceability can accelerate the aquacultural revolution

Challenges and barriers of implementation

As the blockchain system evolves, it is important to remember that it is still a young technology. Only created in 2008, there are still many challenges to overcome in implementing it within our current financial and business system. All industries will face an array of different issues as well as developing some new dependencies.

The most apparent challenge currently facing blockchain is a lack of awareness of the technology and understanding of how the technology works. This has hindered investments and the exploration of new ideas. Companies and FI's must educate themselves to these advancing technologies or risk being taken over by those who do. They must also educate those along their supply chain who will be implementing and inputting valuable biodiversity data onto the blockchain.

Besides awareness, another key challenge is that blockchain works best when an organization sees the value in working together through shared opportunities. The problem is, many organizations are developing their private blockchains and applications. While this might seem counterintuitive, many different chains are being created with different standards in any one sector. This defeats the purpose of a trusted ledger and fails to harness the network effects of decentralization and safe storage of data ⁴⁷.

Changing the culture around technologies is also another challenge within the blockchain. While industries have made changes and adapted to new technologies in the past, blockchain is different. It places authority in a decentralized network rather than in a powerful central institution. This loss of control can be a great barrier for many who might not understand the technology entirely.

Regulation and governance have always struggled to keep up with new technology, and blockchain is no different. The idea of blockchain was that it would reduce oversight. However, it is important when implementing a new blockchain system to understand the current regulation impacts it might have and understand how to work with regulators to bring a new application to the market. Unless careful thought is given to the design of a blockchain, there can be a risk of becoming less resilient to market shocks ⁴⁸. There is a strong argument for blockchain to work within the existing regulatory system, which means all industry regulators have to increase their knowledge of the technology.

Lastly, security and privacy may be of some concern to new users. As mentioned earlier, some blockchains can utilize smart contracts to create indisputable information linked to known identities and information, consequently raising the question around privacy and the security of this information, which can be done on a public ledger available to the public. Transparency within an organization can be a double-edged sword, as public data will be viewable by all, including competitors. This can be mitigated by implementing a private blockchain within an industry, depending on the use case.

⁴⁷Deloitte (2016). [Blockchain: Enigma. Paradox. Opportunity](#)

⁴⁸Deloitte (2016). [Blockchain: Enigma. Paradox. Opportunity](#)

Overall, while there are still barriers to implementing a new technology such as blockchain, however, the benefits it can bring toward the private and public sectors far outweigh them. Biodiversity data and measurements have been a long-standing problem within biodiversity frameworks. Blockchain can help alleviate some of these problems by allowing for more transparent supply chains or helping finance smaller biodiversity operations. The Blockchain system will help reduce the risks of biodiversity impact for business and help generate more opportunities and revenue while maintaining a nature-positive outlook.

References

- Braathe, E (2020). Why digital traceability can accelerate the aquacultural revolution. <https://www.ibm.com/blogs/blockchain/2020/06/why-digital-traceability-can-accelerate-the-aquacultural-revolution/>. Accessed 14 June 2021.
- CBD (2006). Convention on Biological Diversity. Text of the Convention. <https://www.cbd.int/convention/articles/?a=cbd-02>. Accessed 1 July 2021.
- Deloitte (2016). Blockchain: Enigma. Paradox. Opportunity. <https://www2.deloitte.com/uk/en/pages/innovation/articles/blockchain.html>. Accessed 10 June 2021.
- Doughnut Economics Action Lab (2021). About Doughnut Economics. <https://doughnuteconomics.org/about-doughnut-economics>. Accessed 1 July 2021.
- Green Digital Finance Alliance (2020). Fintech for Biodiversity A global landscape. https://www.sustainablefinance.ch/upload/rm/fintech-for-biodiversity-final-30-32020-1.pdf?_id=1612260831000#:~:text=Fintech%20for%20Biodiversity%20acknowledges%20the,overcome%20some%20of%20those%20obstacles. Accessed 14 June 2021.
- Greenpeace International (2021). WHO Covid-19 report shows clear link between biodiversity loss and zoonotic disease – Greenpeace reaction. <https://www.greenpeace.org/international/press-release/47042/who-covid-19-report-clear-link-between-biodiversity-loss-zoonotic-disease/>. Accessed 10 June 2021.
- Hertig (2020). What Are Stablecoins?. <https://www.coindesk.com/what-are-stablecoins>. Accessed 1 July 2021.
- HSBC, Sustainable Digital Finance Alliance (2019). Blockchain: Gateway for sustainability linked bonds. <https://www.sustainablefinance.hsbc.com/mobilising-finance/blockchain-gateway-for-sustainability-linked-bonds>. Accessed 2 June 2021.
- IBM (2021). What are smart contracts on blockchain?. <https://www.ibm.com/topics/smart-contracts>. Accessed 1 July 2021.
- IPBES (2021). Glossary. <https://www.ipbes.net/glossary>. Accessed 1 July 2021.
- IUCN (2021). The IUCN Red List of Threatened Species. <https://www.iucnredlist.org/>. Accessed 28 June 2021.

Kindsvater, H, et al (2018). Overcoming the Data Crisis in Biodiversity Conservation. <https://www.sciencedirect.com/science/article/pii/S0169534718301411#bib0015>. Accessed 8 June 2021.

Leahy, S (2021). Revealed: seafood fraud happening on a vast global scale. <https://www.theguardian.com/environment/2021/mar/15/revealed-seafood-happening-on-a-vast-global-scale>. Accessed 14 June 2021.

Mass, T (2019). The Case For Hybrid Tokens. <https://www.lawandblockchain.eu/the-case-for-hybrid-tokens/>. Accessed 14 June.

Millennium Ecosystem Assessment (2005). Ecosystems and Their Services. <https://www.millenniumassessment.org/documents/document.300.aspx.pdf>. Accessed 1 July 2021.

Miller, A (2021). How the \$1 trillion market for 'green' bonds is changing Wall Street. <https://www.cnbc.com/2021/05/28/how-the-1-trillion-market-for-green-bonds-is-changing-wall-street.html>. Accessed 1 July 2021.

NCFA (2021). What is Natural Capital and why is it important?. <https://naturalcapital.finance/why-is-natural-capital-important/>. Accessed 1 July 2021.

Norwegian Seafood Trust AS (2021). Tracking Technology. <https://norwegianseafoodtrust.no/vart-arbeid/?lang=en>. Accessed 14 June 2021.

Poole, B (2019). Blockchain prototype creates marketplace for biodiversity investment and protection. <https://ctmfile.com/story/blockchain-prototype-creates-marketplace-for-biodiversity-investment-and-pr>. Accessed 10 June 2021.

SBT (2021). Business ambition for 1.5°C. <https://sciencebasedtargets.org/business-ambition-for-1-5c>. Accessed 1 July 2021.

Schoenmaker, D (2017). From Risk to Opportunity: A Framework for Sustainable Finance. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3066210. Accessed 2 June 2021.

SeaWestNews (2019). Fish farms carbon footprint among lowest affirms study. <https://seawestnews.com/fish-farms-carbon-footprint-among-lowest-affirms-study%EF%BB%BF/>. Accessed 14 June 2021.

Stockholm Resilience Centre (2021). The nine planetary boundaries. <https://www.stockholmresilience.org/research/planetary-boundaries/the-nine-planetary-boundaries.html>. Accessed 1 July 2021.

The Biodiversity Consultancy (2021). Net positive and the Mitigation Hierarchy. <https://www.thebiodiversityconsultancy.com/approaches/mitigation-hierarchy/>. Accessed 8 June 2021.

The European Commission (2021). Artificial intelligence, blockchain and the future of Europe: How disruptive technologies create opportunities for a green and digital economy. https://www.eib.org/attachments/thematic/artificial_intelligence_blockchain_and_the_future_of_europe_report_en.pdf. Accessed 1 July 2021.

The Green Bond Principles (2018). Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds. <https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Green-Bonds-Principles-June-2018-270520.pdf>. Accessed 1 July 2021.

The World Bank (2018). World Bank Guide for Green Bond Proceeds Management & Reporting. <https://thedocs.worldbank.org/en/doc/325571540848754637-0340022018/original/WorldBankGreenBondProceedsManagementandReportingpublicWebinar.pdf>. Accessed 1 July 2021.

Tobin-de la Puente, J. and Mitchell, A.W. (eds.) Global Canopy (2021). The Little Book of Investing in Nature. https://globalcanopy.org/wp-content/uploads/2021/01/LBIN_2020_EN.pdf. Accessed 1 June 2021.

TreeCycle (2021). Homepage. <https://treecycle.ch/en/>. Accessed 1 July 2021.

UN Environment Programme, UNEP Finance Initiative, and Global Canopy (2020). Beyond 'Business as Usual: Biodiversity Targets and Finance Managing biodiversity risks across business sectors. <https://www.unepfi.org/wordpress/wp-content/uploads/2020/06/Beyond-Business-As-Usual-Full-Report.pdf>. Accessed 8 June 2021.

World Economic Forum (2018). Harnessing the Fourth Industrial Revolution for Life on Land. http://www3.weforum.org/docs/WEF_Harnessing_4IR_Life_on_Land.pdf. Accessed 8 June 2021.

WWF (2021). Nature Positive. Nature Deal. <https://www.naturepositive.org/>. Accessed 1 July 2021.

WWF (2021). The Future of Responsible Aquaculture. <https://seafoodsustainability.org/aquaculture/>. Accessed 1 July 2021.

Appendix

This appendix will act as a guide to accompany the Blockchain for Biodiversity Finance paper. The following information is cross-referenced in the report and can be used to garner more information about blockchain and biodiversity topics.

Definitions:

Biodiversity: Variety of living organisms from all sources including, terrestrial, marine, and aquatic ecosystems and the ecosystems they are part of. This includes diversity within species, between species and ecosystems. ⁴⁹

Cryptocurrency: Any form of currency that only exists digitally, that usually has no central issuing or regulating authority but instead uses a decentralized system to record transactions and manage the issuance of new units, and that relies on [cryptography](#) to prevent counterfeiting and fraudulent transactions ⁵⁰

Ecosystem Service: Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth. ⁵¹

Ecosystems: A dynamic complex of plant, animal and microorganism communities and their nonliving environment interacting as a functional unit. ⁵²

Fallow land: Arable land not under rotation that is set at rest for a period of time ranging from one to five years before it is cultivated again, or land usually under permanent crops, meadows or pastures, which is not being used for that purpose for a period of at least one year. Arable land which is normally used for the cultivation of temporary crops but which is temporarily used for grazing is included. ⁵³

Natural capital: Natural capital is a way of thinking about nature as a stock that provides a flow of benefits to people and the economy. It consists of natural capital assets – such as water, forests, and clean air. ⁵⁴

Nature Positive: Halting and reversing nature loss from a measured baseline of 2020 through increasing the health, abundance, diversity, and resilience of species, populations, and ecosystems so that by 2030 nature is visibly and measurably on the path of recovery. ⁵⁵

⁴⁹CBD (2006). [Convention on Biological Diversity. Text of the Convention](#)

⁵⁰Merriam-Webster (2021). [Cryptocurrency](#)

⁵¹Millennium Ecosystem Assessment (2005). [Ecosystems and Their Services](#)

⁵²IPBES (2021). Glossary [hyperlink to <https://www.ipbes.net/glossary>]

⁵³European Environment Agency (2021). [Fallow land](#)

⁵⁴NCFA (2021). [What is Natural Capital and why is it important?](#)

⁵⁵WWF (2021). [Nature Positive. Nature Deal](#)

Net-Zero: To hold off some of the worst climate impacts and avoid irreversible damage to our societies, economies, and the natural world, we must hold temperature rise to 1.5°C above pre-industrial levels. This requires halving greenhouse gas emissions by 2030 and hitting net-zero emissions by 2050 .⁵⁶

Smart contracts: Smart contracts are simply programs stored on a blockchain that run when predetermined conditions are met. They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss. They can also automate a workflow, triggering the next action when conditions are met . A more detailed explanation can be found on the IBM website.⁵⁷

Stablecoin: A Stablecoin is a type of cryptocurrency whose value is tied to an outside asset, such as the US dollar or gold, to stabilize the price .⁵⁸

List of acronyms:

BDS- BioDiversity Solutions Australia

CBA- Commonwealth Bank of Australia

CSR- Corporate Social Responsibility

DLT- Digital Ledger Technology

ESG- Environmental, Social and Governance

FI- Financial Institutions

GBP- Green Bond Principles

GDP- Gross Domestic Product

GRI- Global Reporting Initiative

HTO- Hybrid Token Offering

IP- Intellectual property

IPO- Initial Price Offering

IUU- Illegal, unreported, and unregulated

MRV- Measurement, Reporting, and Verification

STO- Security Token Offering

TCFD- Task Force on Climate-related Financial Disclosures

TNFD- Taskforce on Nature-related Financial Disclosures

UNEP FI- The United Nations Environment Programme Finance Initiative

VC- Venture Capital

⁵⁶ SBT (2021). [Business ambition for 1.5°C](#)

⁵⁷ IBM (2021). [What are smart contracts on blockchain?](#)

⁵⁸ Hertig (2020). [What Are Stablecoins?](#)

What is blockchain?

A blockchain is a growing list of records called blocks which are verified using cryptography. Every new block that is created contains what is called a cryptographic hash used to verify the transaction of the person making it. Each transaction has a unique signature attached to it, meaning only the owner of the property or coins can send them, as he is the only one with the cryptographic signature key.

This means transactions cannot be faked, as the whole network is verified by thousands of individuals using their computing power to maintain the record (blockchain). A person that does this is called a miner, and when someone sends a coin, the network records that transaction and all others into a block. Miners running a particular software inscribe these transactions into the greater digital ledger. Increasingly powerful hardware converts these blocks into sequences of code known as a 'hash.' All this is done by thousands upon thousands of computers and individuals. Every time a new hash is created, it's placed at the end of the blockchain, where it is then publicly upgraded and available for all to verify and see what transactions happened. The reason miners maintain the network is because every time a new hash is generated into the blockchain, they are rewarded with the token or coin associated with the system. As mentioned in the Harvard Business Review on blockchain, titled, '*The truth about blockchain*,' they write, "The technology at the heart of bitcoin and other virtual currencies, blockchain is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way .⁵⁹"

Blockchain is an open, decentralized database that allows for bottom-up movement and an increase in grassroots opportunities. Every transaction involving value can be used on it, from money, goods, property, and even votes. It creates a record whose authenticity can be verified by the entire community. The future global economy will move towards one of distributed property and trust. Anyone with access to the internet can get involved in blockchain, and third-party trust organizations may no longer be necessary.

ESG (environmental, social, and governance) goals are crucial in a properly responsible management framework. Proper ethics, communications, trust, sustainability, and resilience to risk are essential factors in making a system work efficiently and sustainably for the long term. The financial crisis of 2008 highlighted how greed resulted in a system susceptible to risk, a system that had poor ethics, and a system that lacked trust. All these factors resulted in the creation of the blockchain system by Mr. Nakamoto. As numerous banks and institutions failed, they had to be bailed out by the government at the taxpayers' expense. This demonstrates the system's fragility where the whole monetary system was reliant on centralized banks that the people trusted with their life savings. Satoshi Nakamoto wanted to create a new digital ledger that could bring the power back to the people in a decentralized virtual currency that isn't controlled by one entity.

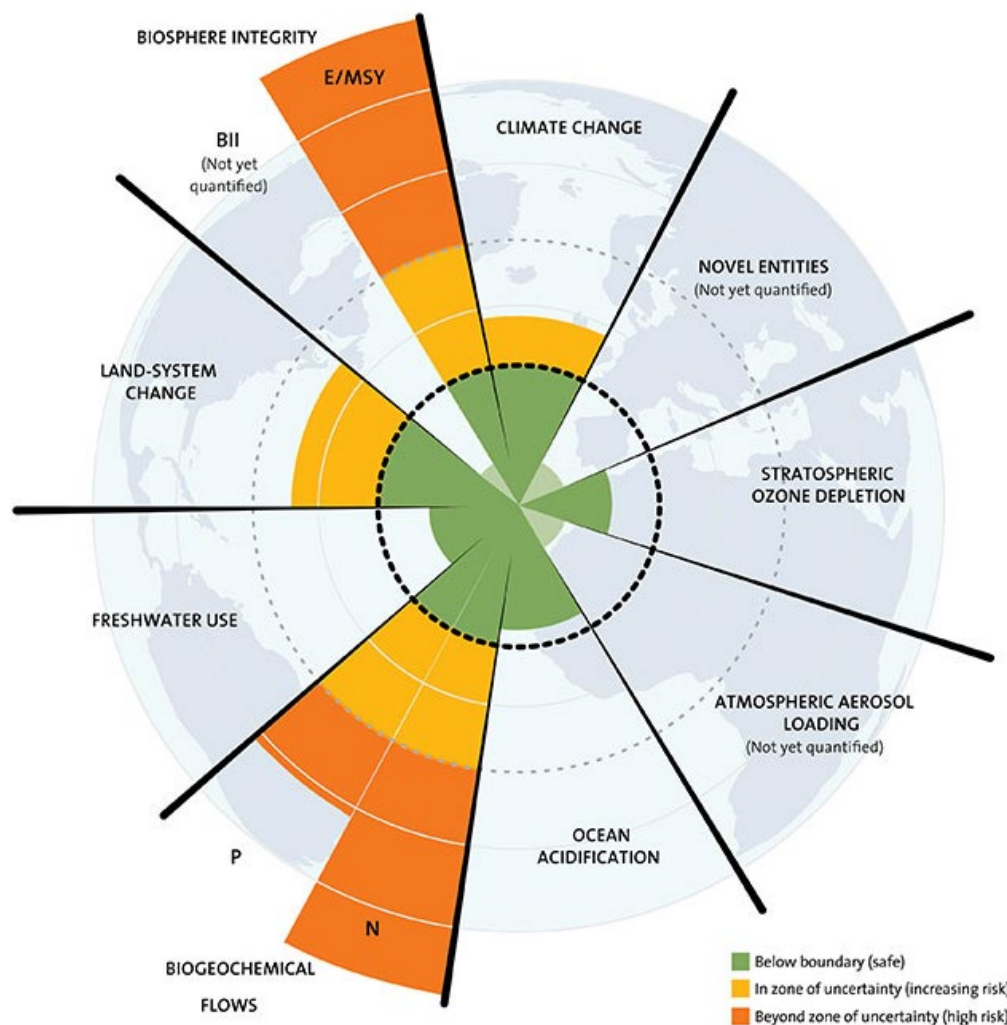
⁵⁹lansiti, M., & Lakhani, K. R (2017). [The Truth About Blockchain](#)

Smart contracts:

IMB states that smart contracts work by following simple 'if, when and then;' statements that are written into code on a blockchain. They are simply programs stored on a blockchain that run when predetermined conditions are met. Smart contracts can have stipulations that have to be satisfied by all participants in order for the information to be released. Smart contracts can be used for various activities on the blockchain, from releasing funds under certain conditions, registering IPs or insurance claims, and resolving disputes of proofs. Once the smart contract conditions are met, the blockchain is updated to reflect this, and a secure record is kept. This means transactions cannot be changed, and only parties who have been granted permission can see the results .⁶⁰

Nine Planetary boundaries⁶¹

The nine Planetary boundaries highlighted the critical earth life support systems and the safe operating spaces we need to be in:



⁶⁰IBM (2021). [What are smart contracts on blockchain?](#)

⁶¹Stockholm Resilience Centre (2021). [The nine planetary boundaries](#) citing Steffen et al. 2015

Difference between regular bond and green bonds ⁶²:

Road Map for issuing green bonds

Issuing a regular bond	Issuing a green bond
<ol style="list-style-type: none">1. Get rated2. Get market intelligence on the currency, tenor and size you're aiming at.3. Decide on underwriters based on the above4. Register with local regulator (i.e., securities and exchange commission)5. Issue prospectus6. Comfort Letter/Due Diligence (if applicable)7. Roadshows and sales effort8. Launch bond9. Price and allocate bond10. Communicate to the capital market11. Monitor secondary market	<ol style="list-style-type: none">1. Identify potential green projects2. Develop Green Bond framework<ul style="list-style-type: none">• Define green bond criteria and project selection process• Set up processes and controls for the use and management of proceeds• Define monitoring and reporting processes3. Get an external review
	<ol style="list-style-type: none">4. Allocate proceeds to the projects5. Monitor use of proceeds and projects6. Undertake post-issuance audit7. Publish impact report

⁶²The World Bank (2018). [World Bank Guide for Green Bond Proceeds Management & Reporting](#)

HSBC and the sustainable green finance alliance

An analysis comparing standard bond process cost with that of a blockchain based system⁶³.

Standard vs Blockchain Cost Estimates Comparison Table










GREEN BOND PROCESS (USD)	STANDARD PROCESS	WITH FULL BLOCKCHAIN AUTOMATION
Structuring, price setting, risk rating	1,000,000	20,000
Legal review	100,000	40,000
Investor whitelisting and matchmaking	500,000	n/a
Internal review and green classification	50,000	20,000
Third party validation and green benchmarking	50,000	5,000
Registration and listing	15,000	n/a (if sold on blockchain exchange)
Brokerage and sales	1,500,000	40,000
Payment and settlement	Opportunity cost: 84,000	0
Custodianship	350,000	2,000 (blockchain dependent)
Data gathering (full lifecycle)	1,200,000	350,000 (includes IoT devices)
Data aggregation (full lifecycle)	400,000	115,000
Reporting (full lifecycle)	1,200,000	100,000
Total	6,449,000	692,000

⁶³HSBC, Sustainable Digital Finance Alliance (2019). [Blockchain: Gateway for sustainability linked bonds](#)

Comparison of utility, security and hybrid tokens ⁶⁴:

COMPARISON REPORT

THE CASE FOR HYBRID TOKENS

		Utility Tokens	Security Tokens	Hybrid Tokens
	Legal Compliance	●	●	●
	Low legal costs	●	●	●
	User Experience	●	●	●
	Inherent value	●	●	●
	Incentive distribution	●	●	●
	Ability to bootstrap network effects	●	●	●
	Secondary market liquidity	●	●	●
	Attractive to more traditional investors	●	●	●
	No scams, misinformation etc.	●	●	●

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⁶⁴Mass, T (2019). [The Case For Hybrid Tokens](#)