

Heinrichs, Sven; Isselstein, Franz

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"Leveraging blockchain-based financing mechanisms for carbon sequestration and biodiversity enhancement." A feasibility study

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“Leveraging Blockchain-Based Financing Mechanisms for Carbon Sequestration and Biodiversity Enhancement.”

A Feasibility Study

Sven Heinrichs

Prof. Dr. Franz Isselstein

IU Internationale Hochschule

Main Campus: Erfurt
Juri-Gagarin-Ring 152
99084 Erfurt

Telefon: +49 421.166985.23
Fax: +49 2224.9605.115
Kontakt/Contact: kerstin.janson@iu.org

Autorenkontakt/Contact to the author(s):
Sven Heinrichs
Prof. Dr. Franz Isselstein
ORCID-ID: 0009-0006-0116-2791

IU Internationale Hochschule - Campus Bad Honnef
Mülheimer Str. 38
53604 Bad Honnef

Telefon: +49 02224 123060
E-Mail: Lis@iubh.de

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“Leveraging Blockchain-Based Financing Mechanisms for Carbon Sequestration and Biodiversity Enhancement”

A FEASIBILITY STUDY

Sven Heinrichs

Prof. Dr. Franz Isselstein

Abstract

Climate change exists and poses a great threat to all living beings on our planet. Any further delay in global action on mitigation will make it more difficult to secure a liveable and sustainable future for all. In this exploratory study, an inductive approach based on qualitative evidence from expert interviews as well as literature is applied to assess the economic feasibility of ecologically enhancing unused land with an initial focus in Germany and using the so far limited financing potential of blockchain token to incentivize project participation and let investors earn sustainable returns from carbon sequestration and probable future biodiversity rewards. Security token offerings can be a valuable alternative for business and project financing. Tokenization reduces transaction costs through automation and disintermediation, supporting transparency and liquidity. The creation of agroforestry systems can serve as an effective way to benefit the environment as well as agriculture. Private funding initiatives are highly demanded for such activities as government subsidies diminish. Financial modelling shows that under the given assumptions the project can be economically feasible, providing returns comparable to benchmarks for agriculture investments and a positive Net Present Value. However, the expert interviews show, that the lease model / user right schematic should not be neglected and needs to be investigated further as it promises highly promising results.

KEY WORDS: *Carbon Sequestration, Security Token, Security Token Offering, Blockchain, climate finance, HedgeToken*

JEL: Q57, Q52, Q58, G23, O31, Q01

Authors



Sven Heinrichs completed his bachelor's degree (B.A.) in International Management with a specialization in Finance & Accounting at IU International University in Bad Honnef in 2022. During his studies, Mr Heinrichs worked for Rockethome GmbH. He started at the Cologne-based software company for IoT solutions in spring 2020 and is still working for the company in the areas of project management, sales, and business development. At Rockethome, he is responsible for the acquisition and implementation of numerous projects in the housing industry, was significantly involved in the implementation of a new CRM system and leads the submission of funding applications to support the company's R&D activities.



Dr. Franz Isselstein has been a Professor of Corporate Finance and Accounting at IU(BH) since 2013. His main research interest is in fundamental stock valuation, tactical asset allocation and FinTech. He is the inventor of the ValueSimulator research platform providing financial models and intelligence for 30.000 companies worldwide that is delivered as a 3rd party service to investment professionals and Bloomberg Terminal users. He is a member of EuroIRP (European Association of Independent Research Providers) and advisor to Cannonball Capital GmbH, an independent investment office based in Munich. Franz is an active investor and mentor in FinTech companies and has participated in several successful funding rounds. Earlier he worked for more than 10 years in senior investment banking positions in Corporate Finance and Corporate Strategy.

Disclaimer

This discussion paper is designed to spark interest and highlight key research findings. However, it is important to note that the underlying academic work offers a much more in-depth exploration of the subject. The original paper addresses a broader range of topics, providing a comprehensive analysis from multiple perspectives. The following sections will offer a brief review of the relevant literature, an overview of the research methodology, and a summary of the main findings.

Introduction

Climate change is an undeniable global threat, urgently requiring innovative solutions. The EU's Green Deal emphasizes that achieving climate neutrality by 2050 demands more than just reducing greenhouse gas emissions; it necessitates the creation of carbon sinks to offset unavoidable emissions. This research introduces the HedgeToken project, a pioneering initiative in Germany focused on combating climate change and biodiversity loss by enhancing marginal land through hedgerow cultivation. The project explores advanced blockchain technology and tokenization as innovative funding mechanisms to acquire and manage land for environmental restoration. HedgeToken aims to not only sequester carbon and restore ecosystems but also offer investors sustainable returns through carbon credits and potential biodiversity rewards. By merging academic research, cutting-edge technology, and public engagement, this study seeks to pave the way for future environmental financing and sustainable land management, potentially setting a new standard in climate action.

Blockchain

Blockchain is widely regarded as a disruptive core technology, fundamentally transforming how transactions are recorded and verified (Xu et al., 2019). Introduced in 2008 by Satoshi Nakamoto, blockchain combines cryptography with a decentralized, open ledger to create secure, immutable records of transactions without needing a central authority (Nakamoto, 2008). Blockchain operates through a peer-to-peer (P2P) network where transactions are verified by consensus and recorded in blocks, making data tampering nearly impossible (Kumar et al., 2021). This decentralization eliminates intermediaries, reducing risks of failure and enabling transparent, direct transactions (Biscontinini, 2020). However, blockchain faces challenges like high energy consumption and inefficiency in processing power due to the need for widespread consensus (Biscontinini, 2020). Despite these drawbacks, platforms like Ethereum remain central to blockchain applications, particularly in areas like Non-Fungible Tokens (NFTs) and smart contracts (Wang et al., 2021).

Token

The concept of a "token" in blockchain is broadly defined as a digital unit designed for utility within a larger crypto-economic system (CoinMarketCap, n.d.-b). More specifically, tokens are digital representations of assets based on Distributed Ledger Technology (DLT), characterized by their immutability, traceability, and transferability (Deloitte, 2019; Benedetti & Rodríguez-Garnica, 2021).

Historically, tokens have been used in various forms, such as in loyalty programs or as alternative currencies (Oliveira et al., 2018; Bussac, 2019). With blockchain, tokens now serve to represent assets, utility, or claims within a blockchain project, making them integral to the digital economy (Pilkington, 2016; Chen, 2018).

Tokenization, the process of converting rights to an asset into digital tokens, allows for fractional ownership and investment, which is particularly significant for assets like real estate or art that are difficult to divide physically (Sazandrishvili, 2020; Swan et al., 2019). This digital transformation of assets, supported by blockchain's decentralization and security, is expanding rapidly across various sectors, offering new opportunities for trade and investment (Sazandrishvili, 2020; Benedetti & Rodríguez-Garnica, 2021).

Blockchain technology has introduced various digital assets, with security tokens being one notable application. Security tokens are defined as digital, blockchain-based representations of securities, offering features like automatic payments, transparent ownership records, and immutable histories (Smith et al., 2019). These tokens operate within the blockchain environment and are programmable, allowing for unique functionalities based on their pre-defined features (Benedetti & Rodríguez-Garnica, 2021). Due to their nature as financial securities, security tokens are subject to stringent regulatory compliance and must adhere to federal securities regulations (Benedetti & Rodríguez-Garnica, 2021).

In the context of entrepreneurial finance, Lambert et al. (2021) describe security tokens as digital representations of investment products, regulated under securities laws, and highlight their role in financing ventures through Security Token Offerings (STOs). These tokens can grant economic stakes similar to traditional securities, such as rights to receive cash or vote in company decisions, but with the added benefit of being governed by smart contracts and traded on blockchain exchanges (EFRAG, 2020; Omlor & Link, 2021). Lambert et al. (2021) also note that while security tokens can offer fixed-income payments, dividends, or control rights, they are predominantly used by start-ups rather than established companies.

Security Token Offering

In this section of the literature review, recent developments in security token offerings (STOs) are critically examined. STOs are broadly defined as the process of issuing tokenized securities—digital representations of securities on a blockchain platform (Schletz et al., 2020). According to CoinMarketCap, STOs involve selling tokenized digital securities, known as security tokens, on cryptocurrency or security token exchanges (coinmarketcap.com, n.d.-a). PwC (2020) emphasizes that STOs are regulated sales of tokens with features akin to traditional securities.

Heinzle (2022) identifies key success factors for STOs, including asset quality, transparent communication, user-friendly investment processes, market developments, and competent ecosystem partners. Heinzle suggests that having a thorough understanding of the target investor group is crucial for a successful STO, recommending the development or use of digital platforms for issuing security tokens.

Pazos (2019) proposes a new valuation method for equity-based STOs, particularly for start-ups, highlighting STOs as a viable and economically beneficial capital-raising method. Kondova and

Simonella (2019) compare STOs with traditional funding methods and note their growth in Switzerland, the USA, and Singapore, citing increased volumes from \$22 million in 2017 to \$442 million in 2018. PwC (2019, 2020) also reports fluctuating growth trends, with significant increases in market capitalization observed in 2020.

Lambert et al. (2021) provide a comprehensive overview of the STO process, identifying six phases: preparation, advisor appointments, technology selection, financial service provider selection, capital raising, and listing. They emphasize that the STO process typically spans 24-56 weeks, with costs ranging from \$180,000 to \$750,000. Their findings indicate that modern STO platforms are increasingly offering integrated services, reducing the need for numerous partners (Lambert et al., 2021; Tokeny.com).

HedgeToken Project Description

The HedgeToken project represents a Germany-wide initiative aimed at addressing global warming, climate change, and biodiversity loss. By enhancing marginal and unused land through ecological measures, such as establishing agroforestry systems and hedgerows, the project seeks to improve carbon sequestration and biodiversity. HedgeToken will acquire land or secure long-term user rights and utilize blockchain technology to finance the initiative through innovative mechanisms, including security tokens.

The project aims to democratize investment by leveraging blockchain-based funding methods. Unlike traditional high-value assets typically associated with NFTs, HedgeToken intends to use these digital assets to create granular and accessible investment opportunities in environmental projects. Investors in HedgeToken will have the chance to contribute to environmental sustainability while potentially benefiting from increases in land value, carbon credits, and biodiversity rewards.

HedgeToken's multidisciplinary approach includes ecological, legal, technological, and economic research. This paper focuses on the economic feasibility of the project, analyzing data to evaluate costs, financial viability, and overall feasibility. The project's tokens, representing ownership interests or user rights, will be available directly to ordinary investors. Investment funds will be reinvested into the project, and returns will be distributed based on the project's performance.

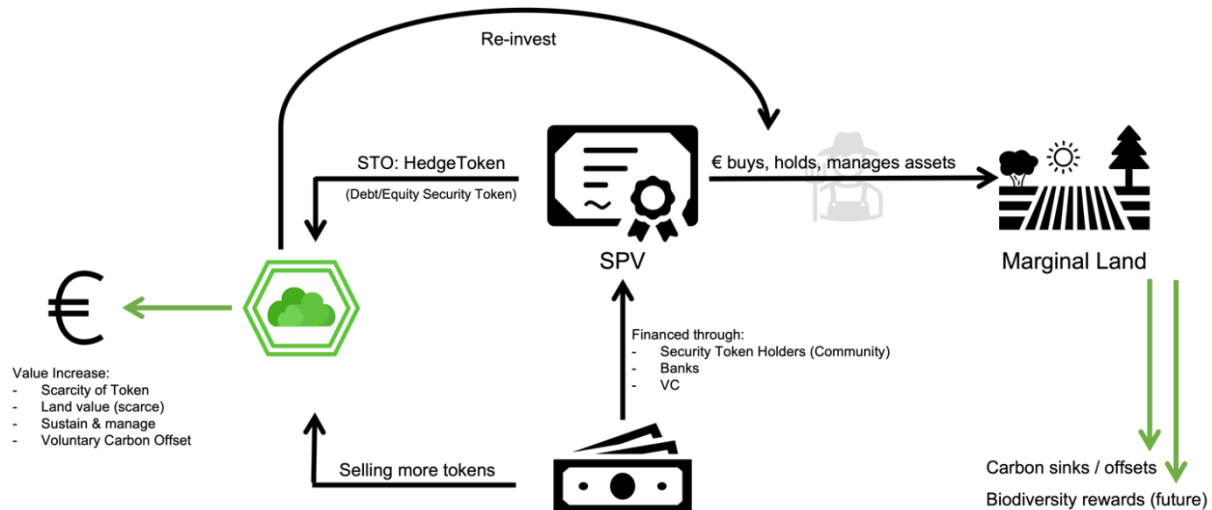
Project Schematics

Two preliminary tokenization schemes have been proposed for HedgeToken, each with its own considerations related to technology providers and negotiations with landowners. These schemes are designed to ensure practical feasibility and effective implementation of the project.

Special Purpose Vehicle / Purchase Schematic

A key challenge in tokenizing real estate is avoiding the impracticality of fractional ownership where many individuals hold direct property rights, which can limit the flexibility and tradeability of tokens (Stobox Technologies Inc., 2021). Instead, the HedgeToken project will use a Special Purpose Vehicle (SPV) structure. An SPV, a type of company, will own or claim the property, and investors will hold

shares in the SPV, represented as tokens. This method allows for a more manageable and flexible approach to tokenization.



Source: HedgeToken, own elaboration

Academia suggests that leveraging proven structures, such as limited liability companies (LLCs), partnerships, or trusts, is beneficial for fractional investments. Baum (2020) supports this approach, noting that such structures provide certainty, risk control, and regulatory compliance. The intermediate structure of an SPV ensures the fractionalization process aligns with established investment frameworks and regulatory standards.

Baum (2020) also highlights the advantage of debt tokens in the security tokenization space. Debt tokens offer lower pricing uncertainty compared to equity tokens, as they are based on standardized contracts between lenders and borrowers. The HedgeToken project will evaluate both equity and debt token options during the STO process to determine the most suitable design for their objectives.

Methodology

This study assesses the economic feasibility of the HedgeToken project through a pragmatic, inductive research approach. Pragmatism focuses on practical outcomes and real-world impact, aligning with the study's goal to explore a new and under-researched area. The inductive approach allows for generating insights from qualitative data, which is crucial given the pioneering nature of the topic.

Research Technique

Semi-structured interviews were employed to gather qualitative data. This method provided flexibility, allowing for in-depth exploration of expert opinions. Two key interviews were conducted: one with a soil protection expert from Brandenburg's technische Universität, assessing ecological measures and

land acquisition, and another with an expert from DB Real Estate on environmental protection and land rights.

Data Collection: The study combined secondary data (literature on blockchain and tokenization) with primary data from interviews and industry sources. Secondary data provided a theoretical foundation, while primary data included confidential commercial information and expert insights. The mixed-methods approach ensures a comprehensive analysis of the project's feasibility.

Research Results

Addressing research objective 1:

Objective: Review concepts of tokens, tokenization, Security Token Offerings (STOs), and their advantages and challenges.

Key Findings:

- Blockchain technology supports various tokens (e.g., NFTs, security tokens).
- NFTs are mainly used for digital assets but face regulatory challenges.
- Security tokens, backed by securities laws, are more regulated and suitable for financing.
- STOs offer faster, more transparent financing but come with risks like regulatory uncertainty and operational risks.
- STOs have seen growth in jurisdictions with innovative securities laws (e.g., Switzerland, the US, Singapore).
- Successful STOs depend on asset quality, clear communication, and competent networks (Appendix).

Addressing research Objective 2:

Objective: Evaluate the suitability of derelict railway land from DB for the HedgeToken project.

Key Findings:

- DB has a moratorium on selling railway land due to ecological and regulatory requirements.
- DB prefers to use fallow land for compensation measures, which complicates land acquisition.
- DB's land includes 116,100 hectares, with 9,300 hectares classified as fallow land (Interview with Mr. Roy).
- Alternative options include negotiating rights of use rather than land acquisition (Appendix).

Addressing research objective 3:

Objective: Investigate the cost-effective establishment of hedgerows or agroforestry systems and assess alternatives to DB land.

Key Findings:

- Establishing hedgerows or agroforestry systems on DB land might be costly and complicated due to contamination issues.
- Using farmland from large-scale landowners or farmers' fields could be an alternative but faces challenges like planning uncertainty and investment costs (Interview with Mr. Böhm).
- Agroforestry systems might be more feasible due to their dual use of land and potential for ecosystem service benefits (Appendix).

Addressing research objective 4:

Objective: Develop a financial model to test the economic feasibility of the HedgeToken project.

Key Findings:

- Initial costs are high (€412,251.66) due to setup expenses, leading to a pre-tax loss in the first period.
- Revenue from carbon offsets begins in the first year, with an expected annual revenue of €76,592.32.
- The model shows profitability in subsequent years with increasing revenues from wood sales and carbon offsetting.
- Income tax is first incurred in period 5, with a projected net income of €436,336.98 by that period (Appendix).

Cash Flow Statement Summary

Initial Investment:

Negative result and land acquisition (€1.00/square meter for 200 hectares, totalling €2 million) recorded under investment activities.

Equity Issuance:

Equity security tokens issued in period 0, raising €4.9 million from 4,900 tokens at €1,000 each, recorded under financing cash flow.

Ending Cash Balance:

After-tax loss and land investment result in a closing cash balance of €2,487,748.34 in period 0.

Land Sale:

Land sold in periods 10 and 15, assumed to appreciate at 2% p.a. Value gain/loss from the sale recorded in the income statement.

Free Cash Flow:

Initially negative in period 0 due to investment, becomes positive in subsequent years. Used to calculate NPV and IRR for both 10-year and 15-year scenarios.

Result Monitor Summary

Y10 Scenario:

Project NPV: €119,138.92

Project IRR: 4.58%

Investor NPV: -€806,862.62

Investor IRR: 2.15%

EPS: €236.50

Capital Return per Token: €1,236.50

Land Value in Year 10: €2,437,988.84

Y15 Scenario:

Project NPV: €283,388.47

Project IRR: 4.98%

Investor NPV: -€1,096,455.15

Investor IRR: 2.26%

EPS: €397.85

Capital Return per Token: €1,397.95

Land Value in Year 15: €2,691,736.68

Conclusion:

The study concludes that the HedgeToken project is economically feasible. Security tokens are found to be a better choice than NFTs due to their regulatory advantages and greater flexibility. Acquiring land from DB is not viable due to sales restrictions and contamination issues. The establishment of agroforestry systems, particularly with fast-growing poplars, shows potential for enhancing biodiversity and generating timber, though cost estimates need further refinement. Financial analysis reveals positive NPVs in both 10-year and 15-year scenarios, with the latter offering a higher IRR. Investor returns appear promising, but potential biodiversity rewards could further increase the project's value. Ongoing validation of assumptions and cost evaluations is recommended.

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Appendix:

(see next page)

Appendix 1: Assumptions

Assumptions List: Acquisition of fallow Land for eco-enhancing measures

Optimistic Case

Input Boxes
(optional) Calculatory Boxes
Result Boxes

Comp. Info	HedgeToken SPV	
	Company Type	GmbH / LLC
	Equity	Issued Security Token
	Accounting principle	Going concern
	Investment per Token	1.000,00 €
	No. of Tokens Issued	4.900,00
	Funding received / Equity: used as capital to invest	4.900.000,00 €
Item	Land Acquisition Calc.	
	Land size (ha)	200
	Land size (sq m)	2.000.000
	Cost of the land per hectare	10.000,00 €
	Cost of the land per square meter	1,00 €
	Assesed value	2.000.000,00 €
	Additional Acquisition Cost	10%
	Total Land Acquisition Cost	2.200.000,00 €
P&L	Hedges or Agroforestry Est.	
	Cost of one poplar seedling	0,15 €
	Approximate number of seedlings required per ha	493
	Cost of seedlings per hectare	73,95 €
	Cost of seedlings for total land size (approx)	14.790,00 €
	Tokenisation and STO	
	Legal Consulting	39.000,00 €
	Security token issuance & management platform (CAPEX)	25.000,00 €
	Security token issuance & management platform (OPEX, based on 1y operation)	31.500,00 €
	Human Resources for ongoing management of agroforestry system	
	1 Full time equivalent (hrs) ±	2.080,00
	Annual salary 1 FTE (17€ per hr)	35.500,00 €
	FTE assessment base	1,50
	Hours needed per year	3120,00
	Annual salary of FTE needed for project	53.250,00 €
	Human Resource General Management	
	1 Full time equivalent (hrs) ±	2.080,00
	Annual salary 1 FTE (GM)	100.000,00 €
	FTE needed per year in the project	0,25
	Hours needed per year	520,00
	Annual salary of FTE needed for project	25.000,00 €

Detailed Explanation
Goal to stay below the 5 million mark in order to avoid prospectus requirement
cf. Interview Christian Böhm
Based on Interview with Böhm; Böhm et al. (2020); healthy agroforestry system
For a detailed breakdown of the costs, see sheet "Detailed Cost line items".
Based on commercial talk with STO-Legal Consulting Firm. Disclosed information. Available on request.
Based on commercial talks with firm that provides an enterprise-grade infrastructure to allow companies and financial actors to compliantly issue, transfer, and manage assets on blockchain. Disclosed information. Available on request.
Based on commercial talks with firm that provides an enterprise-grade infrastructure to allow companies and financial actors to compliantly issue, transfer, and manage assets on blockchain. Disclosed information. Available on request.
We assume that most of the personnel costs are incurred at the time the system is established (Y0) and at the time of harvesting (Y 5; 10; 15).
Based on Böhm et al. 2020; "The salary of the workers was set at 17 €/hour (LELF 2020a)."
In the intervening years, the agroforestry system grows, which is why no personnel costs are incurred. Due to the comparatively high costs of establishment and harvesting, the personnel costs will be at 1.5 FTE at the times mentioned.
General HedgeToken Management

Variable machinery costs €/ha and year			<p>We assume that most of the machinery costs are incurred at the time the system is established (Y0) and at the time of harvesting (Y 5; 10; 15). Cf. Böhm et al. (2020)</p> <p>In the intervening years, the agroforestry system grows, which is why no machinery costs are incurred. As the costs are based on Böhm et al. 2020, and already measured per hectare, a multiplier of 2 is only applied in the year of harvesting, due to the extra efforts connected to harvesting.</p> <p>cf. https://globalgoals.goldstandard.org/fees/</p> <p>40€ as a reasonable and defensible price for a german agriculture-based offset project, aiming to be certified by Gold Standard.</p> <p>Based on annual averages for 2019-2021. Source: C.A.R.M.E.N. e.V. - Central Agricultural Commodity Marketing and Energy Network e.V.: https://www.carmen-ev.de/service/marktueberblick/marktpreise-energieholz/marktpreise-hackschnitzel/</p> <p>No sound data available at the time of research. However, policy and EU in specific debates for a long time. For best practice examples see Australia. Cf. also https://www.lmbc.nsw.gov.au/offsetpaycalc</p> <p>LLC / GmbH</p> <p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
Establishment (Cultivation, year 0)	110,00 €	per ha and year	
Phase I (years 1-7)	115,00 €	per ha and year	
Phase II (years 8-15)	93,00 €	per ha and year	
Verification with Gold Standard - Carbon Project			<p>Based on annual averages for 2019-2021. Source: C.A.R.M.E.N. e.V. - Central Agricultural Commodity Marketing and Energy Network e.V.: https://www.carmen-ev.de/service/marktueberblick/marktpreise-energieholz/marktpreise-hackschnitzel/</p> <p>No sound data available at the time of research. However, policy and EU in specific debates for a long time. For best practice examples see Australia. Cf. also https://www.lmbc.nsw.gov.au/offsetpaycalc</p> <p>LLC / GmbH</p> <p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
Set-up & Registration Cost	711,66 €		
Annual Registry Account Fee	1.000,00 €	p.a.	
Revenues			<p>Based on annual averages for 2019-2021. Source: C.A.R.M.E.N. e.V. - Central Agricultural Commodity Marketing and Energy Network e.V.: https://www.carmen-ev.de/service/marktueberblick/marktpreise-energieholz/marktpreise-hackschnitzel/</p> <p>No sound data available at the time of research. However, policy and EU in specific debates for a long time. For best practice examples see Australia. Cf. also https://www.lmbc.nsw.gov.au/offsetpaycalc</p> <p>LLC / GmbH</p> <p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
(Voluntary) Carbon Offset (per metric ton of carbon dioxide equivalent)	40,00 €		
Timber harvest (€/ton)	119,12 €		
Probable biodiversity reward (future)	0,00 €		
Tax			<p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
Income tax	16%		
Expected increase in the value of the land			<p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
Growth p.a.	2%		
Discount rate			<p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
r	4%		
Agroforestry Facts			<p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
Poplar yield per hectare and year in atronnes	10		
Short rotation harvesting (around every X years)	5		
Carbon sequestration (t CO2 per ha woodland area and year; tree species: poplar)	21,7		
Assumed net woodland area on 200 ha	44,12%		<p>Based on Agroforestry System Establishment; Böhm et al. 2020; An exemplary area plan is enclosed, cf. Appendix</p> <p>Atrotonne is the unit of measurement for the mass of one tonne of absolutely dry wood; Source: Interview Böhm</p> <p>cf. Böhm et al. (2020)</p> <p>cf. Böhm et al. (2020)</p>
net woodland area (ha)	88,24	ha	
Total tonnes carbon sequestration on total land per year	1.914,81	t-CO2 per year	
Timber production per year (atratonnes)	882,4	t per y	
Timber harvest potential in short rotation (every 5 years, in t)	4.412	t	

Appendix 2: Detailed Cost Line Items

Legal Consulting - STO Service		
CAPEX	optional	standard included
STO Blueprint Phase (3 Sessions à 90 mins, conception, elaboration and presentation)		
		4.000,00 €

Cost Legal Consulting - STO Service		
OPEX (monthly invoicing is limited to the estimated duration for each phase)	optional	standard included
STO Design (+/- 3 month)		
Project & Token Economics	2.000,00 €	
Sales, Marketing & Liquidity	1.000,00 €	
Legal & Regulatory	2.000,00 €	
Technology & Operation	1.000,00 €	
Project Coordination & Management		3.000,00 €
Estimated fee range: 3-9k per mont		
STO Setup (+/- 3 month)		
Sales, Marketing & Liquidity	2.000,00 €	
Legal & Regulatory	4.000,00 €	
Technology & Operation	2.000,00 €	
Project Coordination & Management		4.000,00 €
Estimated fee range: 4-12k per mont		
Token Sale (manage operations 2 month, tbd)		
Sales, Marketing & Liquidity	2.000,00 €	

Business Case Legal Consulting: cost assesment based on duration of each phase				
	Optimistic (2 months)	Neutral (3 months)	Pessimistic (4 months)	
	Duration of each phase			
Position	2 Months	3 Months	4 Months	
CAPEX (upfront payment)				
Blueprint exercise	4.000,00 €	4.000,00 €	4.000,00 €	
Design: Project Coordination & Management	3.000,00 €	3.000,00 €	3.000,00 €	
Setup: Project Coordination & Management	4.000,00 €	4.000,00 €	4.000,00 €	
OPEX (monthly): Design Phase				
Project & Token Economics	4.000,00 €	6.000,00 €	8.000,00 €	
Sales, Marketing & Liquidity	2.000,00 €	3.000,00 €	4.000,00 €	
Legal & Regulatory	4.000,00 €	6.000,00 €	8.000,00 €	
Technology & Operation	2.000,00 €	3.000,00 €	4.000,00 €	
OPEX (monthly): Setup Phase				
Sales, Marketing & Liquidity	4.000,00 €	6.000,00 €	8.000,00 €	
Legal & Regulatory	8.000,00 €	12.000,00 €	16.000,00 €	
Technology & Operation	4.000,00 €	6.000,00 €	8.000,00 €	
Sum Costs Value 2140	39.000,00 €	53.000,00 €	67.000,00 €	
Professional Fees - Token Issuance Platform				
T-Rex Platform	Set up (CAPEX)	Monthly License (OPEX)	Commitment and billing	Sum OPEX for min. Commitment
General Fees				
Access Fee	20.000,00 €	-	-	
Marketplace	3.000,00 €	1.000,00 €	12 months	12.000,00 €
Per token fees				
Smart contracts (ERC3643)	-	-	-	
Servicing	-	1.000,00 €	12 months	12.000,00 €
Option: Custodial Wallet Agent	1.000,00 €	500,00 €	12 months	6.000,00 €
Investor Portal	-	500,00 €	3 months	1.500,00 €
Option: Custodial Wallet Investors	1.000,00 €	500,00 €	3 months	1.500,00 €
Qualification	1.000,00 €	500,00 €	3 months	1.500,00 €
Subscription	1.000,00 €	500,00 €	3 months	1.500,00 €
Billboard	-	500,00 €	3 months	1.500,00 €
DINO	-	500,00 €	3 months	1.500,00 €
Sum Capex (n/Options)	25.000,00 €	Sum OPEX (min. Commitment, 1 year, n options)		31.500,00 €
Sum Capex (w/Options)	27.000,00 €	Sum OPEX (min. Commitment, 1 year, w options)		39.000,00 €

CAPEX + OPEX for 1 year Operation (no options)	56.500,00 €
CAPEX + OPEX for 1 year Operation (with options)	66.000,00 €

Cost Gold Standard Verification		
Amount of tonnes CO₂e sequestered:	1914,81	
Registry Fees	one time payment	yearly
Annual Registry Account Fee		1.000,00 €
Certification Review Fees		
Microscale Carbon: Preliminary Review	500,00 €	
Microscale Carbon: Performance Review	650,00 €	
Fees for First Year of Issuance		
Carbon: Gold Standard VER	-362,78 €	
Subsequent Issuances		
Carbon: Gold Standard VER	-75,56 €	
Sum Total Set-up Cost	711,66 €	

Appendix 3: Income Statement and Cash Flow Statement – Y10 Scenario

Income Statement Y10

YEARS		0	1	2	3	4	5	6	7	8	9	10
Revenue	Voluntary Carbon Offset	0,00	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32
	Biodiversity reward (future)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Timber harvest (sale of wood)	0,00	0,00	0,00	0,00	0,00	525.557,44	0,00	0,00	0,00	0,00	525.557,44
	Gain / Loss from sale of land	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	437.988,84
	Total revenue	0,00	76.592,32	76.592,32	76.592,32	76.592,32	602.149,76	76.592,32	76.592,32	76.592,32	76.592,32	1.040.138,60
Expenditure	Additional Acquisition Cost	-200.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Agroforestry Establishment	-14.790,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Legal Consulting (STO)	-39.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Security token issuance & management platform (up-front)	-25.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Security token issuance & management platform (recurr.)	-31.500,00	-13.500,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Employee General Management	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00
	Variable Machinery Cost	-22.000,00	0,00	0,00	0,00	0,00	-46.000,00	0,00	0,00	0,00	0,00	-37.200,00
	Employee Agroforestry Management	-53.250,00	0,00	0,00	0,00	0,00	-53.250,00	0,00	0,00	0,00	0,00	-53.250,00
	Gold Standard - Set Up	-711,66	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Gold Standard - Annual Registry Account Fee	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00
	Total expenditures	-412.251,66	-39.500,00	-26.000,00	-26.000,00	-26.000,00	-125.250,00	-26.000,00	-26.000,00	-26.000,00	-26.000,00	-116.450,00
Earnings before tax (EBT)		-412.251,66 €	37.092,32 €	50.592,32 €	50.592,32 €	50.592,32 €	476.899,76 €	50.592,32 €	50.592,32 €	50.592,32 €	50.592,32 €	923.688,60 €
Tax Loss Carry Forward		-412.251,66 €	-375.159,34 €	-324.567,02 €	-273.974,70 €	-223.382,38 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Assessment basis (taxable amount)		-412.251,66 €	-375.159,34 €	-324.567,02 €	-273.974,70 €	-223.382,38 €	253.517,38 €	50.592,32 €	50.592,32 €	50.592,32 €	50.592,32 €	923.688,60 €
Income Tax		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	-40.562,78 €	-8.094,77 €	-8.094,77 €	-8.094,77 €	-8.094,77 €	-147.790,18 €
Earnings after tax (EAT)		-412.251,66 €	37.092,32 €	50.592,32 €	50.592,32 €	50.592,32 €	436.336,98 €	42.497,55 €	42.497,55 €	42.497,55 €	42.497,55 €	775.898,42 €

Cash Flow Statement Y10

YEARS	0	1	2	3	4	5	6	7	8	9	10
Operating Cash Flow											
Earnings after tax	-412.251,66	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	775.898,42
Cash from Operations	-412.251,66	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	775.898,42
Investing Cash Flow											
Investments in Property & Equipment	2.000.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-2.000.000,00
Cash from Investing	2.000.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-2.000.000,00
Financing Cashflow											
Issuance (repayment) of equity	4.900.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cash from Financing	4.900.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Net Increase (decrease) in Cash	2.487.748,34	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	2.775.898,42
Opening Cash Balance	0,00	2.487.748,34	2.524.840,66	2.575.432,98	2.626.025,30	2.676.617,62	3.112.954,60	3.155.452,14	3.197.949,69	3.240.447,24	3.282.944,79
Closing Cash Balance (Cash Flows)	2.487.748,34	2.524.840,66	2.575.432,98	2.626.025,30	2.676.617,62	3.112.954,60	3.155.452,14	3.197.949,69	3.240.447,24	3.282.944,79	6.058.843,22
Free Cash Flow	-2.412.251,66	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	2.775.898,42
Project Free Cash Flow Discounted	-2.412.251,66 €	35.665,69 €	46.775,44 €	44.976,39 €	43.246,53 €	358.637,19 €	33.586,43 €	32.294,64 €	31.052,54 €	29.858,21 €	1.875.297,51 €
Investor Cash Flow	-4.900.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	6.058.843,22 €
Property value in the respective year (growth p.a.)	2.000.000,00	2.040.000,00	2.080.800,00	2.122.416,00	2.164.864,32	2.208.161,61	2.252.324,84	2.297.371,34	2.343.318,76	2.390.185,14	2.437.988,84

Appendix 4: Income Statement and Cash Flow Statement – Y15 Scenario**Income Statement Y15****Cash Flow Statement Y15**

YEARS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenue																
Voluntary Carbon Offset	0,00	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32	76.592,32
Biodiversity reward (future)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Timber harvest (sale of wood)	0,00	0,00	0,00	0,00	0,00	525.557,44	0,00	0,00	0,00	0,00	525.557,44	0,00	0,00	0,00	0,00	525.557,44
Gain / Loss from sale of land	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	691.736,68
Total revenue	0,00	76.592,32	76.592,32	76.592,32	76.592,32	602.149,76	76.592,32	76.592,32	76.592,32	76.592,32	602.149,76	76.592,32	76.592,32	76.592,32	76.592,32	1.293.886,44
Expenditure																
Additional Acquisition Cost	-200.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Agroforestry Establishment	-14.790,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Legal Consulting (STO)	-39.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Security token issuance & management platform (up-front)	-25.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Security token issuance & management platform (recurr.)	-31.500,00	-13.500,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Employee General Management	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00	-25.000,00
Variable Machinery Cost	-22.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-37.200,00	0,00	0,00	0,00	0,00	-37.200,00
Employee Agroforestry Management	-53.250,00	0,00	0,00	0,00	0,00	-53.250,00	0,00	0,00	0,00	0,00	-53.250,00	0,00	0,00	0,00	0,00	-53.250,00
Gold Standard - Set Up	-711,66	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Gold Standard - Annual Registry Account Fee	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00	-1.000,00
Total expenditures	-412.251,66	-39.500,00	-26.000,00	-26.000,00	-26.000,00	-125.250,00	-26.000,00	-26.000,00	-26.000,00	-26.000,00	-116.450,00	-26.000,00	-26.000,00	-26.000,00	-26.000,00	-116.450,00
Earnings before tax (EBT)	-412.251,66 €	37.092,32 €	50.592,32 €	50.592,32 €	50.592,32 €	476.899,76 €	50.592,32 €	50.592,32 €	50.592,32 €	50.592,32 €	485.699,76 €	50.592,32 €	50.592,32 €	50.592,32 €	50.592,32 €	1.177.436,44 €
Tax Loss Carry Forward	-412.251,66 €	-375.159,34 €	-324.567,02 €	-273.974,70 €	-223.382,38 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Assessment basis (taxable amount)	-412.251,66 €	-375.159,34 €	-324.567,02 €	-273.974,70 €	-223.382,38 €	253.517,38 €	50.592,32 €	50.592,32 €	50.592,32 €	50.592,32 €	485.699,76 €	50.592,32 €	50.592,32 €	50.592,32 €	50.592,32 €	1.177.436,44 €
Income Tax	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	-40.562,78 €	-8.094,77 €	-8.094,77 €	-8.094,77 €	-8.094,77 €	-77.711,96 €	-8.094,77 €	-8.094,77 €	-8.094,77 €	-8.094,77 €	-188.389,83 €
Earnings after tax (EAT)	-412.251,66 €	37.092,32 €	50.592,32 €	50.592,32 €	50.592,32 €	436.336,98 €	42.497,55 €	42.497,55 €	42.497,55 €	42.497,55 €	407.987,80 €	42.497,55 €	42.497,55 €	42.497,55 €	42.497,55 €	989.046,61 €

Cash Flow Statement Y15

YEARS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operating Cash Flow																
Earnings after tax	-412.251,66	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	407.987,80	42.497,55	42.497,55	42.497,55	42.497,55	989.046,61
Cash from Operations	-412.251,66	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	407.987,80	42.497,55	42.497,55	42.497,55	42.497,55	989.046,61
Investing Cash Flow																
Investments in Property & Equipment	2.000.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-2.000.000,00
Cash from Investing	2.000.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-2.000.000,00
Financing Cash Flow																
Issuance (repayment) of equity	4.900.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cash from Financing	4.900.000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Net Increase (decrease) in Cash	2.487.748,34	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	407.987,80	42.497,55	42.497,55	42.497,55	42.497,55	2.989.046,61
Opening Cash Balance	0,00	2.487.748,34	2.524.840,66	2.575.432,98	2.626.025,30	2.676.617,62	3.112.954,60	3.155.452,14	3.197.949,69	3.240.447,24	3.282.944,79	3.690.932,59	3.733.430,14	3.775.927,69	3.818.425,24	3.860.922,78
Closing Cash Balance (Cash Flows)	2.487.748,34	2.524.840,66	2.575.432,98	2.626.025,30	2.676.617,62	3.112.954,60	3.155.452,14	3.197.949,69	3.240.447,24	3.282.944,79	3.690.932,59	3.733.430,14	3.775.927,69	3.818.425,24	3.860.922,78	6.849.969,39
Free Cash Flow	-2.412.251,66	37.092,32	50.592,32	50.592,32	50.592,32	436.336,98	42.497,55	42.497,55	42.497,55	42.497,55	407.987,80	42.497,55	42.497,55	42.497,55	42.497,55	2.989.046,61
Project Free Cash Flow Discounted	-2.412.251,66 €	35.665,69 €	46.775,44 €	44.976,39 €	43.246,53 €	358.637,19 €	33.586,43 €	32.294,64 €	31.052,54 €	29.858,21 €	275.621,94 €	27.605,60 €	26.543,84 €	25.522,93 €	24.541,28 €	1.659.711,48 €
Investor Cash Flow	-4.900.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	6.849.969,39 €
Property value in the respective year (growth p.a.)	2.000.000,00	2.040.000,00	2.080.800,00	2.122.416,00	2.164.864,32	2.208.161,61	2.252.324,84	2.297.371,34	2.343.318,76	2.390.185,14	2.437.988,84	2.486.748,62	2.536.483,59	2.587.213,26	2.638.957,53	2.691.736,68

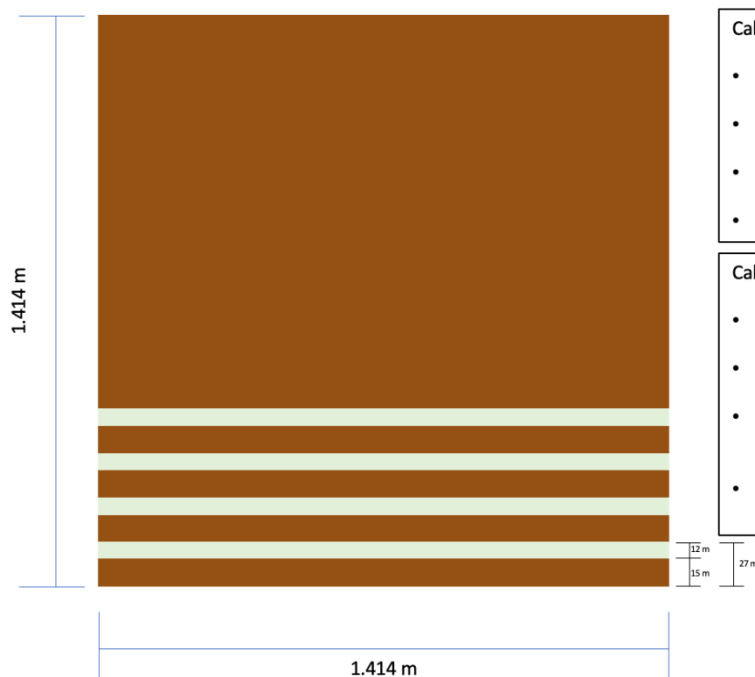
Appendix 5: Result Monitor

<u>Result Monitor: HedgeToken Project - Base Case Scenario</u>		
	Sale of Land after 10 Years	Sale of Land after 15 Years
Project Net Present Value	119.138,92 €	283.388,47 €
Project Internal Rate of Return	4,58%	4,98%
Investor Net Present Value	-806.862,62 €	-1.096.455,15 €
Investor Internal Rate of Return	2,15%	2,26%
ROI		
EPS	236,50 €	397,95 €
Repayment of Capital	1.236,50 €	1.397,95 €
Land Value Y0	2.000.000,00 €	2.000.000,00 €
Land Value Y10	2.437.988,84 €	2.437.988,84 €
Land Value Y15		2.691.736,68 €

Appendix 6: Exemplary Planning Agroforestry System

Establishment Plan Agroforestry System with Side Calculation

Given	
Area (A) =	2.000.000 sqm
Carbon sequestration (t CO ₂ -equivalents per ha agroforestry woodland area and year); for Fast-growing woody plants, managed in short rotation periods (approx. 5 years); 12 m wide strips , (tree species: poplar)	21,7 t CO₂-equivalents per ha and year



Calculations:

- $1.414\text{m} / 27\text{m} = 52$ times row + space in between
- $1414\text{m} / 3\text{m} = 471$ Rows of trees per strip
- $\rightarrow 4$ Bäume $\rightarrow 471 \times 4 = 1885$ trees per 12m strip
- $1885 \times 52 = 98.037$ Trees

Calculations:

- $12\text{m} \times 1.414\text{m} = 16.968$ sqm
- 16.968 sqm $\times 52 = 882.336$ sqm $\rightarrow 88,24$ ha
- $\rightarrow 1.914$ t CO₂ equivalents on the whole area per year
- $\rightarrow 15\text{€}$ per ton = 28.722 €