



# Vhite Paper



A Technical Introduction to Reneum reneum Technical White Paper

Reneum is for individuals with a cause, companies with a purpose and renewable energy projects with a need.

The energy transition is too slow and too small: according to the April 2022 Intergovernmental Panel on Climate Change (IPCC) report, public and private finance flows for fossil fuels are still significantly greater than those for climate adaptation and mitigation, including renewable energy. Furthermore, global greenhouse gas emissions through 2030 associated with the implementation of current government commitments lock in a disastrous level of warming exceeding 2°C over pre-industrial times.

To achieve the targets set forth by the Paris Agreement that limit warming to sustainable levels, renewable energy needs a capital infusion of greater than 7x current investment rates. Climate finance is one of the mostly widely accepted mechanisms to spur the investment required, with markets like Renewable Energy Certificates acting as integral vehicles to support this growth.

In this document, we aim to illustrate how Reneum's Renewable Energy Certificate solution can help mobilize citizen, corporate and philanthropic action towards the acceleration of renewable energy deployment and access worldwide.

This document is intended to provide an overview of the Reneum solution, including the technical specifications of its native Renewable Energy Certificate, the Renew Record and its correlated blockchain-based token, the RENW, the Reneum platform mechanics, and the tech stack of the Reneum project.

#### **Brianna Welsh**

#### Harib Bakhshi

Reneum Institute contact@reneum.com www.reneum.com





37

41

# **Table of Contents**

1.0 Introduction

**Problem Statement** 

5.0

6

10

21

24

Advantages & Limitations ----- 28

Data Traceability & Immutability

**Global Adoption of Renewables** 

### 2.0

#### **Platform Overview**

The RENW Token

Soul Bound Tokens (SBTs)

Aggregated Soul Bound Tokens

Polygon (MATIC) & The Blockchain

Interplanetary File System (IPFS)

**Transaction History** 

**SCADA Integration** 

Chainlink Integration

Independent Verification

Increased Liquidity

Autonomous Funding

Security & Points of Failure

Challenges & Limitations

#### 6.0

**Token Economics** ----- 34

**RENW Token Price & Funding** 

The RENW Token Distribution

**RENW** Issuance

Artificial Intelligence & Machine Learning

#### 3.0

#### **Process Flows**

**Project Onboarding** 

Funding RECs

**Reserving Multi-Year RECs** 

7.0

#### **Technology Roadmap**

**Delivered Functionality** 

Main Launch Functionality

Phase 2 & Onwards

8.0

**Conclusion** ----- 40

4.0

Use Cases

**Project Verification & Auditing** 

#### 9.0

Smart Contracts

**Reserving Multi-Year RECs** 

**Reserving For 3rd Party Buyers** 

Forward Contracts

Contract Addresses

Roles & Privileges

Audit





# **Definition of Terms**

#### **Artificial Intelligence** - Artificial intelligence is the

simulation of human intelligence processes by machines, especially computer systems. Specific applications of AI include expert systems, natural language processing, speech recognition and machine vision.



created using the Ethereum blockchain. A fungible token is interchangeable with another token.

**Blockchain** - A shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a decentralised network

**Buyer** - An entity that buys RENW tokens within the Reneum platform

**dREC** – Acronym for the market instrument known as a 'digital renewable energy certificate', referring to

**Fungible Token** – Mutually interchangeable, divisible and non-unique crypto tokens. Fungibility is also a feature of fiat currencies, by which, for example, one dollar is always equal in value to another dollar.

**IPFS** - The InterPlanetary File System is a protocol, hypermedia and file sharing peer-to-peer network for storing and sharing data in a distributed file system.

**Issuer** – Reneum, which monitors, verifies and guarantees the generation of clean energy recorded on the Reneum marketplace and issues RENW tokens

RECs that are monitored and issued using entirely digital technologies like blockchain, machine learning and the Internet of Things (IoT). These RECs are broadly considered to be superior in quality to traditional RECs because their data is more reliable. Reneum issues and sells dRECs only. In Reneum's ecosystems, its native dREC is called the RENW token, and may be used interchangeably.

#### Environmental, Social, Governance (ESG) -

Environmental, social and corporate governance is an approach to evaluating the extent to which a corporation works on behalf of social goals that go beyond the role of a corporation to maximize profits

#### to Projects for each MWh produced.

Multi Sig Wallet - A digital wallet that operates with multi-signature addresses. This means that it requires more than one private key to sign and authorize a crypto transaction or, that several different keys can generate a signature.

**MWh** – An acronym for megawatt-hours, referring to the unit of measurement that records the amount of electricity produced from a power plant. It is calculated as the number of megawatts generated per hour.

on behalf of the corporation's shareholders.





# Definition of Terms





identifier that cannot be copied, substituted, or subdivided, that is recorded in a blockchain, and that is used to certify authenticity and ownership.

**Project** - A renewable energy project that is certified by Reneum and supplies MWh to the Platform.

**REC** – Acronym of the term 'Renewable Energy' Certificate, a measurement of the corresponding to the environmental attributes of the production of renewable energies like wind or solar. Environmental attributes are the 'greenness' associated with producing clean energy and can be sold separately from the underlying electricity as a financial instrument. RECs are an instrument to support a cleaner generation mix, to support renewable developers to become competitive in the energy market, and support the acceleration of renewable energy deployment. RECs can directly influence the energy transition.

non-skeuomorphic (ie, digitally-native) REC instrument, whose data is immutable and transparent, enabling the full traceability and proof-of-provenance of the underlying renewable energy project being certified. RENW is the underlying fungible token representing the MWhs within dRECs and referred to more specifically in the technical and tokenomics terminology of Reneum.

**Smart Contract** - A computer program or a transaction protocol that is intended to automatically execute, control or document events and actions according to the terms of a contract or an agreement.

**Soulbound Token (SBT)** – an iteration on the more familiar NFT, the SBT carries all the same data properties, with one primary distinction: it is nontransferrable. This means it is not intended to be sold onwards or profited from, rather is held as a digital credential, or form of publicly-verifiable online reference. Not only can the user not transfer ownership, but the minter also cannot withdraw/ transfer/change ownership as well

**Renew Record** – the green label issued by Reneum to all companies and citizens who fund renewable energy via the purchasing of the SBT. Ownership of a Renew Record ensures that a RENW (or a dREC) has been retired from circulation and possesses at least one SBT. The Renew Record is issued to everyone who owns a retired RENW, irrespective of the volume purchased. It is the master label, representing contribution to renewables by purchasing an SBT (as a retired RENW), and may be connected to the buyer's Reneum profile to reveal each individual SBT connected to projects funded for transparent proofof-impact.



# 1.0 Introduction

### Problem Statement

reneum Technical White Paper

Renewable energy has become a critical component of the global energy mix, with increasing demand for clean energy sources and the need to mitigate the impacts of climate change. But the deployment of renewable energy at scale faces significant financing obstacles compared to their fossil fuel counterparts. The cost structure of renewable development still requires a greater upfront investment with a longer payback horizon than fossil fuels, leaving governments and private financiers with a challenging opportunity cost. Additionally, the fossil fuel sector benefits from greater than 10 times the government subsidies than their renewable counterparts, disincentivizing investors and leaving well-intending developers to fend for themselves. This is further aggravated by power incumbent lobbying for policies to support fossil fuel expansion, as well as existing vested interests crusading against the energy transition.

However, the traditional systems for tracking and trading RECs can be complex and opaque, making it difficult for consumers, businesses and governments to accurately measure their use of renewable energy and to invest in the development of renewable energy projects.

Reneum is a blockchain-based platform designed to revolutionize the way renewable energy is tracked, traded and used. By leveraging blockchain technology, Reneum provides a secure, transparent and immutable record of renewable energy

Market-based instruments operating under the structure of climate finance are available to help rebalance the scales in favor of renewable energy. Tools for private enterprises to step in and support the industry with short-term subsidies or concessional capital, climate finance is considered the most critical generation and consumption, making it possible to track renewable energy certificates from generation to final use.

The platform will enable individuals, businesses, and governments to make informed decisions about the use of renewable energy and to accelerate the transition to a low-carbon economy. Through the use of blockchain and other emerging technologies like machine learning, Reneum will provide an efficient, secure and transparent marketplace for the trading of RECs, enabling all actors to participate in the development of the renewable energy sector and contribute to a sustainable future.

resource in the crusade for a clean energy-powered future. Instruments like Renewable Energy Certificates (RECs) are one variant of climate finance which enable private companies to compensate for institutional and government investment shortcomings.



# 1.0 Introduction

### What are Renewable

reneum Technical White Paper

### **Energy Certificates** (RECs)

Also referred to as Environmental Attribute Certificates (EACs), Renewable Energy Certificates are a type of tradable certificate that represent proof that a specific amount of renewable energy has been generated by a vetted renewable energy project. Purchased by companies and individuals seeking to offset their energy emissions, they act as a private sector-sponsored subsidy to support the operations and development of clean energy. RECs are a mechanism for encouraging the development of renewable energy sources and promoting the use of clean energy in regions where clean energy is not yet available to purchase directly from state grids or is not yet economical to invest in directly. By creating a market for RECs, companies and individuals can purchase credits to offset their energy emissions, thereby supporting the growth of the renewable energy sector and contributing to a

more sustainable future.

Each REC represents the environmental benefits of one megawatt-hour (1 MWh) of renewable energy generation. When a renewable energy project generates electricity, it can sell the associated RECs for additional revenues to buyers who prefer to consume only clean energy, but are presently unable to access it directly from their local grid. These buyers can then claim to have used a certain amount of renewable energy, irrespective of whether they consumed the electricity directly, because they can prove they have paid a premium for the consumption of green energy.



# 10 ntrocuction

### **Issues with Renewable**

Technical White Paper

### **Energy Certificates** (RECS)

The current market of renewable energy certificates (RECs) suffers from several structural issues that have crippled both its effectiveness and access. Some of these challenges are described below:

- Lack of transparency: The current system of tracking and trading RECs requires several private intermediaries with non inter-operational registries storing project data, resulting in opaque and confusing environmental claims. This makes it difficult for buyers to verify the authenticity and environmental impact of each REC.
- Misaligned incentives: The current system of RECs allows for speculative trading which results in multiple broker intermediaries profiting at the expense of the underlying project. This results in a successful financial market but a broadly ineffective environmental impact.
- Conflicts of interest: REC brokers are often owners of renewable energy assets and have a financial interest in artificially propping up prices of these instruments, leading to potential market manipulation.
- Inefficiency: Due to the siloed nature of existing regional registries for REC monitoring, issuance, and brokering, the current process of earning, selling and buying RECs can be slow and cumbersome, with multiple intermediaries involved in each transaction. This can increase the time and cost of transactions.
- Limited accessibility: The current system of RECs is dominated by a small number of large players
- Double counting: As described, neither certifying agents nor private brokers have a centralized system for tracking the trade of RECs. This exposes a risk of double counting the same REC twice, effectively invalidating its environmental impact. This leads to confusion and reduced confidence in the market.

Reneum aims to solve these problems by leveraging blockchain technology to create a decentralized

and is therefore subject to predatory pricing behaviors that leaves it cost-prohibitive for smaller project developers or those in remote regions to participate in the market.

platform that allows for the transparent tracking and verification of RECs. The use of smart contracts and a distributed ledger will increase efficiency and reduce the cost of intermediaries, while also ensuring that the origin and environmental impact of RECs are verifiable and transparent.



# 1.0 Introduction

### **Global Adoption**

reneum Technical White Paper

### of Renewables

In recent years, there has been a significant expansion in the adoption of renewable energy globally<sup>1</sup>. Governments around the world have been increasingly implementing policies aimed at reducing greenhouse gas (GHG) emissions and promoting the use of renewable energy. These policies, such as tax credits, feed-in tariffs, and renewable portfolio standards, have historically helped to drive the growth of the renewable energy sector.

Many companies are also increasingly focused on reducing their carbon footprint and adopting more sustainable business practices. In addition to companies, consumers are also becoming more aware of the environmental impact of energy use and are seeking out more sustainable energy options. This has led to increased demand for renewable energy. The demand for clean energies is only growing. Competing for market penetration and investor interest against heavily subsidized fossil fuel incumbents, renewables are either cancelled or overlooked entirely. Considering that the highupfront-capital requirements for renewables still greatly outweighs hydrocarbons like coal, the long payback period from debt financiers makes it an unattractive loan compared to other forms of energy. This challenge is particularly acute in emerging markets where the climate crisis is most urgent, but the risk profile of these regions due to political

Though while the cost of renewable energy technologies like solar and wind power has dematerialized dramatically in recent years, the economic profile of renewables is still unattractive for many investors and institutions, leaving renewable energy developers stranded without access to the capital required to succeed in development. instability or currency volatility thwarts cautious investors. This means that irrespective of all the progress made in the last decade to advance renewable energy, we are at a major risk of underdeployment without substantial tariffs or buoyant private subsidy markets like RECs.

<sup>1</sup> Publicly accessible data relating to renewable energy adoption can be found on <u>ourworldindata.org</u>





## Platform Overview

Reneum is poised to act as a solution to the barriers faced by the renewable energy industry. Leveraging legacy climate finance mechanisms like RECs, but building new tools to bypass existing failures, Reneum's token-based ecosystem is here to help renewable producers access the capital they need to thrive.

The Reneum platform is a vertically-integrated

The Reneum REC is qualified as a Digital REC, referred to as dREC, which acts as a digitally-native solution to the challenges faced by the REC market. It is a nonskeuomorphic, meaning it is generated entirely online via sophisticated monitoring and data reconciliation technologies like blockchain, and monitored and calculated via Internet of Things devices and machine learning. This combination of technologies allows for greater fidelity of information, assuring all

solution for the REC market, providing services traditionally divided between multiple intermediaries in a more efficient and streamlined manner. Unique to Reneum, it acts as both a Project verifier (quality auditor) and a transaction marketplace (broker), establishing the first unified and open network that facilitates end-to-end quality control. In this way, Reneum acts as a single, unified registry, housing all the relevant project data to help assure buyers of the environmental impact of their claims and facilitating expedient sales on behalf of sellers. Reneum brings RECs onto the blockchain, whereby they are monitored, issued and traded within a set of programmatically-encoded functions. stakeholders of the underlying quality and credibility of renewable energy project data. For more information on the benefits to using a dREC over a REC issued via paper registries, please see the Commercial White Paper.







# Platform Overview



The Reneum platform provides a solution for renewable energy producers to list their projects on the marketplace, which provides instant liquidity and access to purchase RECs for any organization or individual wishing to offset their energy usage. Representing the underlying MWhs produced by verified renewable energy producers, an instrument native to the Reneum platform called the RENW token, is issued on-chain. Because all MWhs are created equally, the RENW is a fungible token following the ERC-20 standards<sup>2</sup>. In the first iteration of the Reneum ecosystem, this RENW token acts only as a unit of measurement by which the REC inventory is monitored, and is not available for public issuance or trading. Accordingly, RENW tokens are held by a Reneum controlled multi-signature treasury and are burnt upon purchase to represent the retirement of a REC to claim for environmental offsetting. The supply of RENW tokens is dynamic, the current supply indicates the total amount of MWh available to fund within the platform.

These RENW tokens comprise the unit of measure available for offsetting within the marketplace. Prospective buyers identify select projects they wish to offset through on the Reneum marketplace, identify the volume of RECs to offset with per project, along with project-specific characteristics like location, technology source and year of issuance, and add to basket for an e-commerce-enabled check-out. Buyers would select a payment method and confirm the transaction. Upon receipt of payment, Reneum's smart contracts automatically burn the RENW tokens to remove them from circulation to avoid double counting. Within a singular transaction, 90% of the funds are sent automatically to the renewable energy producers responsible for the project selected, with Reneum's marketplace fee of 10% deducted concurrently. Immediately following this transaction, the buyer receives a record of the transaction in the form of a Soulbound token (SBT) that stores project provenance data in its metadata and on IPFS. This SBT acts as a non-transferrable credential that verifies their ownership of the underlying REC, and is also issued in the form of a PDF certificate which can be downloaded for environmental claim purposes.

<sup>2</sup> Refer to the EIP for more information on ERC-20





# Platform Overview

### Soulbound Tokens

### (SBTS)

When the retired REC certificate is represented as a Soulbound NFT token (SBT), it is referred to as a Renew Record. The SBTs are non-fungible tokens following the ERC-721 standard<sup>3</sup>, and similarly to the RENW, are non-speculative. They act as an immutable digital receipt for the purchase and burning of the RENW tokens. This process mirrors the legacy system in which RECs are bought and retired for commitment claims, though with Reneum's marketplace, occurs autonomously within the platform whenever a project is funded.

Each SBT has metadata attached which is stored on IPFS<sup>4</sup> to guarantee the authenticity of the REC. The metadata for the individual SBTs all contain a link to the IPFS audit for the project funded, which was created as part of the verification process during the project onboarding. This ensures that each SBT provides a holistic view of the transaction with no further action required from the buyer.

The SBT provides a visual representation of the amount of MWh funded, as well as the location, technology source and year of issuance (vintage). The SBT is intended to be a 'verified green' symbol, akin to the Fair Trade or LEED label, helping thirdparties to recognize the contribution and encouraging a cultural movement towards green energy. To distinguish between various levels of positive environmental impact, the SBT backgrounds will be color-coded to reflect the volume of RENW tokens burned.

<sup>3</sup> Refer to the EIP for more information on <u>ERC-721s</u>

<sup>4</sup> Please visit the <u>IPFS website</u> for more information







# Platform Overview

### Aggregated Soul Bound Tokens

The Aggregated SBTs are non-fungible tokens following the ERC-721 standard, they represent the total amount of MWh funded by a particular buyer. The Aggregated SBT shows a visual representation of the amount of MWh funded, as well as the number of locations, similar to the individual SBTs. The aggregated SBTs also reflect the tiers for determining the background colors. The Aggregated SBT is minted when a buyer completes their first transaction within the Reneum platform. Whenever a new individual SBT is minted, it is updated to include the new total MWh funded. The Aggregated SBTs can be used by both individuals and companies to proudly display the overall contribution they have made.

"name": "SingleEisbaerSBT #61",

```
"description": "This NFT represents what is known as a retired REC in
environmental markets; a green certificate that proves that the owner is
the exclusive holder of the positive environmental attributes of the MWh",
  "image": "ipfs://Qme8o8nyFqpniLcTjrzRT1WqHTE2kTj94w8FpSBXFt7PWS",
  "project": "ipfs://QmX7TEEtXr8hUS9iTuwqKGt2dwMdyjX2DZi9P9YBmDhKkg",
  "attributes": [
      "trait_type": "MWh Funded",
      "value": "1"
    j,
      "trait_type": "Project Vintage",
      "value": "2022"
   50
      "trait_type": "Country Funded",
      "value": "Argentina"
    30
      "trait_type": "Project Source",
      "value": "Solar"
```





14

# Platform Overview

### Polygon (MATIC) & The Blockchain

Both the ERC-20 RENW tokens and the ERC-721 SBTs are minted on Polygon to maintain the environmentally-conscious ethos of Reneum's overall mission. Since the Ethereum merge to proof-of-stake in the fall of 2022, the Ethereum ecosystem, upon which Polygon sits as a Layer 2, has a relatively immaterial environmental footprint. Nonetheless, since Polygon has established itself as the 'green blockchain,' and is on its way to being entirely climatepositive including retroactive emissions, it was selected for its superior climate-centric approach to

The transfer of funds always occurs on the blockchain, producers' wallets can be publicly traced using a Polygon block explorer<sup>5</sup>. To guarantee the safety of the treasury funds, it has been set up using the Gnosis multi-signature wallet which requires signatures from multiple Reneum executives before any withdrawals can occur.

Web3. All fungible and non-fungible tokens minted on Polygon also benefit from lower gas fees than those currently minted on Ethereum.

<sup>5</sup> The most popular <u>block explorer</u> for Polygon is PolygonScan





### Technical White Paper

# Platform Overview

# **Interplanetary File System (IPFS)**

IPFS (InterPlanetary File System) is a decentralized file storage network that can be used in conjunction with the blockchain to improve data storage, retrieval, and management. IPFS operates as a peer-to-peer network where files are stored across many nodes and identified using a hash. When a user wants to retrieve a file, they can search for it by its hash, and IPFS will fetch the data from the closest available node.

By combining IPFS with blockchain technology, a permanent, tamper-proof, and publicly accessible record of a file's hash can be established on the blockchain. This allows the file to be retrieved and verified without the need for a centralized server. The blockchain can also be used to record transactions involving the file, such as changes in ownership or access rights, providing a secure and transparent history of the file's use.

In summary, the combination of IPFS and blockchain technology offers a powerful solution for data management, ensuring that files are stored in a decentralized, secure, and verifiable manner, providing a foundation for new applications and use cases in a variety of industries.

Reneum utilizes IPFS as its primary file storage solution. As projects are audited and approved to be listed on the marketplace, a copy of the audit is uploaded to IPFS with the corresponding hash recorded on the blockchain. During the funding process, the metadata and the corresponding SBT image are uploaded to IPFS. Given the immutable nature of IPFS, it acts as an ideal and highly traceable solution for storing information relating to the ownership & funding of RECs using blockchain.









### Technical White Paper

# Platform Overview

### **Transaction History**

Blockchain transaction histories provide a public, secure, and tamper-proof record of all transactions on the network. The decentralized nature of blockchain technology ensures that all transactions are recorded and stored across multiple nodes in the network, making it difficult for any single entity to manipulate the data. This allows users to easily verify the authenticity and accuracy of transactions, promoting greater transparency and trust. Additionally, the public nature of the transaction history enables regulators, auditors, and other third-party organizations to easily track and monitor the flow of transactions, further

All RECs purchased, whether through direct funding or multi-year reservations, are recorded on the blockchain. The transaction shows the amount of funds paid to the project, the amount of RENW tokens burned, the SBT minted and the Aggregated SBT updated to track the overall contribution made. The immutable record provided by the blockchain allows for absolute traceability and independent verification without reliance on a central entity.

Opolygonscan

MATIC: \$1.23 (+0.57%) | 20.114.2 Gwet

All Filters v Search by Address

#### promoting transparency in the system.

As projects are listed on the marketplace, a transaction is triggered which is permanently recorded on the blockchain, the transaction shows the amount of RENW tokens minted, reflecting the quantity of verified MWh added to the marketplace.

Overview ERC-20			Profile Summary		
RICE	FULLY DI \$0.00	LUTED MARKET CAP (2)	Contract:	0xf6	644(
otal Supply:	640,475 RENW ①		Decimals:	18	
Holders:	1 addresses		Social Profiles;	Not	Ava
Transfers:	102				
Transfers Holders	Info Contract 🗢 Ana	alytics Comments			
A total of 102 transaction	is found				
A total of 102 transaction	ns found				
A total of 102 transaction	Method ③	Age	From		Ţ
A total of 102 transaction Txn Hash 0x83d4e5c51c2cfcdf97	Method ③ 3 Fund Project	Age 52 days 2 hrs ago	From 0xf69a9bee3afd2b615d6		T
A total of 102 transaction Txn Hash 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26	Method ③ 3 Fund Project T1 Fund Project	Age 52 days 2 hrs ago 52 days 19 hrs ago	From 0xf59a9bee3afd2b615d6 0xf69a9bee3afd2b615d6		N
A total of 102 transaction Txn Hash 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16	Is found Method ③ 3 Fund Project Fund Project Fund Project	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago	From           0x159a9bee3afd2b615d6           0x169a9bee3afd2b615d6           0x169a9bee3afd2b615d6		N
A total of 102 transaction <b>Txn Hash</b> 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88fcec7	Is found Method ③ 3 Fund Project Fund Project Fund Project Fund Project	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago	From           0x159a9bee3afd2b615d6           0x169a9bee3afd2b615d6           0x169a9bee3afd2b615d6           0x169a9bee3afd2b615d6		N
A total of 102 transaction <b>Txn Hash</b> 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88tcec7 0xa7cade4937d01ecb5	Ins found Method () 3 Fund Project 11 Fund Project Re Fund Project Re Fund Project Re Exec Transaction	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 20 hrs ago	From         0xf59a9bee3afd2b615d6         0xf69a9bee3afd2b615d6         0xf69a9bee3afd2b615d6         0xf69a9bee3afd2b615d6         0xf69a9bee3afd2b615d6         0xf69a9bee3afd2b615d6		N
A total of 102 transaction Txn Hash 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88fcec7 0xa7cade4937d01ecb5 0xe31fdd686ac5c49c85	Is found Method () 3 Fund Project f1 Fund Project ie Fund Project ie Fund Project f1 Exec Transaction	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 20 hrs ago	From         0xf59a9bee3afd2b615d6         0xf69a9bee3afd2b615d6		N N N
A total of 102 transaction <b>Txn Hash</b> 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88tcec7 0xa7cade4937d01ecb5 0xe31fdd686ac5c49c85 0x2e1d0ce652ead5dd0	Ins found Method ③ 3 3 4 6 6 6 6 6	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 20 hrs ago 52 days 20 hrs ago	From           0xt59a9bee3afd2b615d6           0xt69a9bee3afd2b615d6		N N N O
A total of 102 transaction <b>Txn Hash</b> 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88fcec7 0xa7cade4937d01ecb5 0xe31fdd586ac5c49c85 0x2e1d0ce652ead5dd0 0x541859b7adc8044aa	Ins found Method () 3 Fund Project Fund Project	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 20 hrs ago 52 days 20 hrs ago 52 days 20 hrs ago	From           0xf59a9bee3afd2b615d6           0xf69a9bee3afd2b615d6           0xf69a9bee3afd2b615d6		
A total of 102 transaction <b>Txn Hash</b> 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88fcec7 0xa7cade4937d01ecb5 0xe31fdd686ac5c49c85 0x2e1d0ce652ead5dd0 0x541859b7adc8044aa 0x49e62de1927e1c147	Is found Method () 3 3 4 6 6 6 6 6	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 20 hrs ago 52 days 20 hrs ago 52 days 20 hrs ago 52 days 20 hrs ago	From         0xt69a9bee3afd2b615d6		
A total of 102 transaction <b>Txn Hash</b> 0x83d4e5c51c2cfcdf97 0x8d8ca5259d49c9c26 0xa2a55a2d11bf39fa16 0x850786c1fed88fcec7 0xa7cade4937d01ecb5 0xe31fdd686ac5c49c85 0x2e1d0ce652ead5dd0 0x541859b7adc8044aa 0x49e62de1927e1c147 0x2097a34175ce8abac	Is found Method ③ 3 Fund Project 11 Fund Project 14 Fund Project 6 Fund Project 6 Fund Project 7 Exec Transaction 6 Exec Transaction 70 Fund Project 70 Fund Project	Age 52 days 2 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 19 hrs ago 52 days 20 hrs ago	From           0xf59a9bee3afd2b615d6           0xf69a9bee3afd2b615d6		





# Platform Overview

### SCADA Integration

SCADA stands for Supervisory Control and Data Acquisition<sup>6</sup>. In the context of RECs, SCADA systems are used to monitor and control the generation and distribution of renewable energy from sources such as solar and wind farms. These systems collect and analyze data from various sensors and devices, allowing energy producers to monitor the performance of their equipment and adjust it as necessary.

SCADA systems also play an important role in verifying that energy is being generated from

SCADA systems also play an important role in verifying that energy is being generated from renewable sources, which is a requirement for the creation of RECs. By using the data collected by SCADA systems, energy producers can demonstrate that they are producing a certain amount of renewable energy and are eligible to receive RECs, which can then be sold to individuals, businesses, and governments that want to offset their energy usage with renewable energy.

The Reneum platform offers producers the options to

renewable sources, which is a requirement for the creation of RECs. By using the data collected by SCADA systems, energy producers can demonstrate that they are producing a certain amount of renewable energy and are eligible to receive RECs, which can then be sold to individuals, businesses, and governments that want to offset their energy usage with renewable energy.



connect to their SCADA system and automatically extract the quantity of clean MWh produced for listing within the marketplace. At the end of each month an extract, transform, load (ETL) process is run to add any additional MWh produced over the last month to the pre-listed projects. Renewable energy producers who aren't connected to the SCADA system can manually add the MWh produced in the project onboarding process, however, they will need to upload supporting documents to verify the MWh produced, these documents will be stored on IPFS for added transparency.

<sup>6</sup> Refer to the Wikipedia page on SCADA for more information



# Platform Overview

### **Chainlink Integration**

Chainlink oracles are decentralized systems that provide the secure and reliable transfer of data between smart contracts and real-world data sources. They allow blockchain-based applications to access data and information from external data sources, such as financial data, weather data, or shipping data. Oracles act as intermediaries between smart contracts and external data sources and ensure that the data is accurate and tamper-proof. The use of oracles helps to reduce the risk of fraud and data manipulation, as the data is verified by a decentralized network of nodes, rather than a single central

Reneum utilizes Chainlink oracles to calculate the current price of Polygon (MATIC) in USD. Given the current flat cost of \$5 USD per RENW, if a buyer chooses to purchase RECs with MATIC, the Oracle is required to calculate the current number of MATIC tokens (up to 16 decimals) to pay for the RECs.

As Reneum continues to develop, it is likely that additional Chainlink functionality will be incorporated to further utilize the Oracle network. The Chainlink Keepers service allows for functions to be called within the smart contract based on certain criteria

#### authority.

In the context of blockchain, oracles play a crucial role in bringing real-world data into the decentralized ecosystem and enabling the execution of complex financial transactions and other data-intensive use

cases.



being met, this functionality can significantly increase the level of decentralization by automating processes without using centralized services as the Chainlink Keepers service runs entirely on-chain.







# Platform Overview

### **Artificial Intelligence & Machine Learning**

 Al can be used to predict renewable energy generation, which is crucial for the tracking and trading of RECs. With accurate forecasting, the

The Reneum platform is designed with the vision of effective exploitation of emerging technology to improve the efficiency and effectiveness of the REC market. As previously mentioned, the transparency and immutable aspects of the blockchain are ideal to act as a permanent record of the ownership and funding of RECs. However, there is also extensive opportunity to use Artificial Intelligence & Machine Learning to further optimize the process for validating projects and improving efficiency. With extensive prior experience in Data Science & AI, the Reneum Institute will be exploring several potential uses of AI over the REC market can operate more efficiently and
reduce the risk of over- or under-production of
renewable energy, this can be further utilized to
potentially look at optimizing the pricing of RECs
to ensure the greatest level of adoption.

 Al can be used to detect fraudulent activity in the REC market. For example, Al algorithms can be trained to identify patterns of behavior that are indicative of fraud and alert regulators or other stakeholders to potential problems, this will help ensure that producers listed within Reneum are held to a high standard.

#### next few phases of release:

- Al can be used to analyze and score the various projects onboarded to the Reneum platform to provide a ML optimized score for each project. The score would align with the overall quality and transparency that the Al has determined, along with a summary of the key variables which drove the prediction. This would allow less informed buyers to easily understand which projects align with their environmental goals whilst also providing a KPI for producers to optimize against, further increasing the overall transparency of the projects listed within the marketplace.
- Al can be used to analyze energy consumption & on-chain blockchain activity data, which can provide valuable insights into the energy needs of companies and households. With this information, companies and individuals can make more informed decisions about how to reduce their energy consumption and meet their sustainability goals. Targeted campaigns and messaging can be driven through the results generated by the Al through analyzing the behavior of ideal organizations to offset with.
- Automated REC trading: Al can be used to automate the trading of RECs, reducing the time

Al can be used to automate the verification and auditing process which producers must go through before listing on the marketplace, automating this process would further decentralize the Reneum platform and would minimize the number of "human-error" driven errors.

and cost associated with transactions. For example, AI algorithms can be trained to match buyers and sellers based on price, availability, and other factors, making the process of trading RECs more efficient and cost-effective. If Reneum was to offer "offsetting-as-a-service" an AI intermediary layer can be used to automatically choose the ideal REC for the buyer without them having to visit the marketplace and manually choose a specific project.







# Platform Overview

### **Artificial Intelligence** & Machine Learning

#### As well as the potential benefits of integrating AI, the

Reneum platform places great importance on the quality of data and how the data is stored, both from an IPFS perspective, but also in terms of the internal storage solutions used. All on-chain activity and IPFS data is stored on a cloud hosted PostgreSQL & MongoDB, acting as a fail-safe layer to ensure there are appropriate redundancy measures.











### Technical Paper

21

# Process Flows

### **Project Onboarding**

The diagram shows the process for a producer to join the Reneum platform and request a project to be added to the marketplace. It then shows the audit and

#### listing process which follows.



Brianna / Harib approve listing the project	Request to list project on blockchain viaOpenZeppelin Defender
$\bigcirc Approved \longrightarrow$	RENW tokens minted and held by the treasury to reflect the MWh 1:1
Rejected	Project set to active and added to the
	marketplace







# Process Flows

### Funding dRECs

The diagram shows the process for a buyer to register on the Reneum platform and fund a project with cryptocurrency, it then shows how the buyer can view information relating to the retired REC



# **3.0 Process Flows**

### **Reserving Multi-Year** dRECS

The diagram shows the process for an enterprise buyer to reserve RECs for multiple years. It then subsequently shows the process for a producer to add additional MWh in the future and how the RECs are automatically issued to the buyer



Technical

Paper

White





**Project Verification** 

reneum Technical White Paper



The Reneum platform is open to any renewable energy producer which meets the standards and successfully passes the auditing process. Listing on the Reneum marketplace unlocks liquidity for projects and provides global access to enterprise & individual buyers. Renewable energy producers can access the self-service project onboarding dashboard within the Reneum platform to request an audit once the relevant supporting documents have been submitted.

As part of the auditing process, the details of the audit as well as the supported documents are uploaded to IPFS. Note: in some cases, producers will request certain documents to remain private due to security or regulatory restrictions, in these situations, Reneum will internally hold a copy of the documents. Whilst these won't be publicly accessible, the various other aspects of the audit will still be added to IPFS, projects which choose to keep these documents private will be clearly marked within the marketplace and this will likely affect the Al's transparency score for the project.

Projects which successfully pass the audit are instantly added to the marketplace in a singular transaction without any additional actions required from the producer.





**Reserving Multi-Year** 

reneum Technical White Paper

### dRECS

once.

Buyers wishing to purchase RECs through the Reneum platform will generally do so through selecting a project which aligns with their ESG goals, selecting a vintage, the amount of MWh to fund, and the payment method. Buyers would then either confirm the transaction and receive their dREC or have the option of adding this to a basket and continuing to explore various other projects, this allows for a single transaction to fund multiple projects and therefore receive multiple dREC certificates at The Reneum platform facilitates this functionality
through the multi-year dREC reserving option. This
solution is exclusively designed for enterprises rather
than individuals and involves signing a bi-lateral
contract with Reneum Institute. Once a multi-year
reservation has been agreed upon, the MWh which
the buyer has decided to purchase is stored as a
variable on the smart contract. As the new year
approaches, the buyer is requested to make payment
for the following years dRECs, if this payment is made
before the deadline, the dRECs will automatically be

Organizations may purchase dRECs for multiple years in advance, to signal their commitment to using renewable energy and to demonstrate their leadership in sustainability. By purchasing dRECs for multiple years, organizations can demonstrate their long-term commitment to reducing their carbon footprint and contributing to the growth of renewable energy sources. Additionally, purchasing dRECs for multiple years can provide stability and predictability in the pricing and supply of clean energy, which can help organizations better manage their energy costs. Furthermore, it can also help organizations meet issued to the buyer on a monthly basis as the project adds their MWh throughout the year. The issuing of the dRECs will occur without any further action required from the buyer.

sustainability goals and improve their ESG ratings, which can positively impact their reputation and relationships with stakeholders.





### dREC Reservation

reneum Technical White Paper

### for Third-Parties

Accessing certain domains & regions may require the use of third party REC resellers to facilitate the purchasing of dRECs on behalf of other organizations. This functionality is facilitated within the Reneum platform. Buyers can register 3rd party end users within their buyer profile by providing some high level information on the end customer, allowing the buyer to choose for the dREC to be issued on behalf of one of their registered end customers rather than being assigned to themselves.

Enterprise resellers can sign agreements with Reneum, allowing them to reserve dRECs within the Reneum platform. If the reserved dRECs aren't funded and retired within the pre-agreed upon time limit, the dRECs will become unlocked and re-released to the marketplace. Any dRECs reserved through this process don't need to be funded at the point of reservation, once the reseller has found an end customer, they can then pay to retire the dREC and receive an SBT as proof. As the SBT is minted, the appropriate number of RENW tokens are burned from

the treasury.







### Forward Contracts

reneum Technical White Paper

The first-of-its-kind, Reneum is endeavoring to issue a financial instrument called dREC Forwards to support the development of greenfield renewable energy development.

These dREC forwards will allow buyers to pre-fund different renewable energy projects that are either pre-construction or still in development. dREC forwards will be purchased at a lower cost to operating market rate and are very similar to futures in that the dRECs are delivered to buyers at a predetermined price at some point in the future. The

objective of this market is to drive meaningful bankability of brand-new renewable projects in markets where climate finance is constrained.







### Data Traceability &

### Immutability

The decentralized and transparent nature of blockchain allows for an easily auditable record of all transactions and interactions between parties, making it a secure and efficient way to manage data traceability and immutability. With each transaction recorded on a tamper-proof ledger, it is difficult to alter, duplicate or delete the data. The transparency provided by the blockchain also helps to reduce the risk of fraud, as all transactions are recorded in a way that is visible to everyone. This creates a chain of trust between the different participants in the REC market, from renewable energy producers to consumers, and regulators, as everyone can view and verify the transactions. This makes it possible to verify the authenticity of the dRECs and trace their origin, which is crucial for establishing trust in the market.









### Verification

It can be difficult to independently verify the validity of companies claiming they are using renewable energy because the information and data related to their energy consumption and generation is often centralized and controlled by the company. Additionally, there is often a lack of standardization in terms of what is considered to be renewable energy and how it is measured. This can result in conflicting or misleading information about a company's renewable energy usage.

All dRECs purchased by a buyer are visible within the buyer's public profile page, this allows for individuals to independently verify any organization's claim of using renewable energy. All key information is always stored on the blockchain and IPFS and can be directly validated there, however, most users will find the experience within the platform more user friendly. The Reneum platform provides an easy-to-understand interface which allows newcomers to quickly digest the validity and the impact of dRECs purchased, whether by themselves or by third parties.

The absence of a comprehensive and accessible database of energy usage and generation data makes it difficult for third parties to independently verify claims made by companies. To address this, Reneum provides a standardized and transparent system that accurately records and verifies the renewable energy usage and generation of companies.







### Increased Liquidity

The traditional REC market suffers from a lack of liquidity due primarily to structural inefficiencies: the fragmented nature of the market, the slow registration and verification of renewable producers, geographic matching requirements that reduce attractiveness of projects in non-industrial nations, the cost-prohibitive nature of acquiring RECs, and the difficulties associated with transferring ownership of RECs. These factors result in a limited number of transactions and slow market growth.

The Reneum platform both expands the market to encompass previously neglected regions, as well as enables the creation of digital representations of RECs (dRECs) that can be easily bought, sold, and traded among participants. This eliminates the need for intermediaries, reduces the time and costs associated with the buying and selling of RECs, and enhances the overall efficiency of the REC market. Additionally, the use of smart contracts and automated processes on the blockchain helps to ensure that all transactions are secure and transparent, further boosting the liquidity of RECs. With Reneum, individuals and

organizations can easily buy and sell RECs, thereby promoting the growth and adoption of renewable energy.







### **Autonomous Funding**

Both individuals and companies can register on the Reneum platform as buyers, without any human intervention or approvals needed from Reneum Institute. This self-service & automated capability offers significant advantages over using a traditional REC broker. By removing intermediaries, the Reneum platform reduces the administrative and operational costs associated with REC transactions. This leads to lower prices for consumers, making renewable energy more accessible.

Users have the ability to purchase and manage their own dRECs in real-time, rather than relying on a broker to handle the process. This makes it easier to purchase the right type and number of RECs, and to track the progress of transactions. Often REC brokers will have misaligned incentives with companies and may not necessarily have the ESG goals as their best interest. The Reneum platform will provide integration with emission calculation services to allow organizations and individuals to receive a true representation of the number of dRECs they need to fulfill their ESG goals.







### Security & Points of Failure

In the traditional REC market, the certificates are stored on centralized storage solutions which are controlled by singular entities or brokers which can alter the state of the data and control access to which individuals can verify the RECs.

Each transaction made on the Reneum platform is recorded on the blockchain and verified by multiple nodes in the network, making it difficult for any one entity to tamper with the records. The use of cryptographic techniques ensures that the data on the blockchain is secure and cannot be easily altered Additionally, as there is no central point of control, there is no single point of failure, making it less susceptible to hacking or system failures. This enhances the overall security of the system and reduces the risk of fraud or manipulation, making it a trusted and reliable platform for storing data.









### Challenges & Limitations

Utilizing the Blockchain and emerging technology such as Artificial Intelligence brings great benefit to the Reneum platform and the wider renewable energy industry, however, they also pose challenges and limitations:

- Implementing a blockchain solution for the tracking and purchasing of RECs can be complex, requiring specialized technical skills and resources, the demand for these skills often outweighs the supply. The technologies are also prone to constantly developing & evolving which
- The use of blockchain in the context of RECs may raise regulatory and legal issues, such as the ownership and transfer of intellectual property rights, privacy, and data protection. Governments of countries may require extensive approvals and administrative checks before dRECs can legally be sold, furthermore governments are unlikely to be familiar with adopting blockchain based solutions.
- Artificial Intelligence and Machine Learning models are generally hard to explain and can be

requires continuous retraining and development.

 Some blockchain platforms have struggled to scale to handle large volumes of transactions, such as those that can occur in a rapidly growing market for dRECs. This can lead to slow transaction times and increased costs. Thus far
 Polygon has shown itself to be a stable and environmentally friendly blockchain, however, this can rapidly change. Reneum Institute plans to mitigate this through cross-chain interoperability capabilities in the future. thought of as "black-box models" This may pose a challenge if audits are performed automatically and without providing explanations. The use of Responsible AI will be practiced throughout the Reneum platform, mitigating the risks of the AI behaving unexpectedly.

Whilst there are certainly several complexities
involved in adopting blockchain and AI within the
Reneum platform, the benefits far outweigh the risks.
As the technology improves, the risk should continue
to minimize over time and Reneum will constantly take
steps to ensure the technology is adopted according
to best practices.





# Token Economics

### **RENW Token Price & Funding**

In the initial release version, RENW tokens (dRECs) will be launched exclusively in the closed Reneum Marketplace at a fixed price of US\$5 per RENW and will be burned automatically. It will not be possible to withdraw, hold or sell RENW tokens at this stage. In later versions of the Platform, the price of RENW is envisaged to fluctuate within the closed Reneum Marketplace. Projects can be funded via several payment options. Payments can be made through cryptocurrencies, specifically USDC & MATIC. Payments can also be made using a fiat on-ramp which will be integrated within the Reneum platform for main launch and allows organizations to fund projects using fiat payments. Regardless of the payment methodology which the end user chooses, the transaction will always be recorded on the blockchain, as per usual.





34





# Token Economics



### Distribution

Reneum has opted to issue fixed tranches of RENW tokens to its key stakeholders including its employees and advisors. Reneum has also completed a pre-seed round selling portions of Reneum's inventory of RENW. All the RENW tokens in the team and investor allocation are deducted from Reneum's 10% Platform fee. This fee is applied by Reneum to cover operation and development costs and is dispersed at Reneum's discretion to stakeholders responsible for ongoing operations. This means that all RENW tokens issued to key stakeholders are already backed by the Positive Environmental Attributes of MWh of renewable energy, with 90% of the original token value being distributed to the underlying Projects.





# Token Economics



Reneum operates under a strict and robust Certification Methodology for all dREC monitoring and verification. The Methodology can be found on Reneum's website for specifics, but a summary of the process is defined below:

As outlined above, Reneum is responsible for the generation of dRECs, in the form of RENW tokens. These RENW tokens are created through a process derived from internationally recognized best practices on REC verification, as accepted by leading institutions such as the RE100, Science Based Targets

Upon certification of renewable projects, Reneum connects projects into its back-end database, which acts as the token-generating apparatus based on MWh monitored. Reneum aggregates several key data points including MWh generated in real-time, geolocation, time stamp and source, allowing the Issuer to monitor MWh generation actively for any potential anomalies. RENW tokens are issued on a monthly, retroactive basis, reflecting all the accrued MWh generated by each project. Prior to issuance, Reneum reconciles monitored MWh with publicly available data or with the projected output based on the total capacity and location, as computed during the project onboarding. This helps Reneum ensure data accuracy and pre-emptively addresses balance reconciliation risks.

#### and the Climate Pledge.

To ensure optimal robustness and rigor in the verification process, Reneum adopted these guidelines as a foundation for its standards methodology, but further expanded them to incorporate post-verification monitoring and on-chain transaction verification systems. Certification requires verification of renewable energy provenance via thirdparty documentation, meter readings, power purchasing agreements (PPA), past environmental instrument transactions, and satellites.



36



# Technology Roadmap



### Functionality

Reneum has successfully completed a closed Beta which ran from December-2022 to January-2023. During the closed beta, 10 selected projects were onboarded through the self-service process, audits were performed, and the projects were listed on the marketplace. Internal testing of the funding process was run as well as external testing by a handful of regenerative finance (ReFi) focussed individuals. The following features have been built and deployed as part of the closed Beta:

- Generated templates for the individual & aggregated SBT images
- Created, evaluated, and deployed NFT smart contracts on Polygon
- Deployed the IPFS node & designed the metadata for projects
- Integrated Web3 technology to the front-end
- Developed & redesigned the marketplace
- Created the buyer registration process
- Created the project onboarding process
- Developed the admin dashboard for auditing and listing projects
- Created, evaluated, and deployed RENW Smart
   Contracts on Polygon

- Deployed PostgreSQL & MongoDB test & production servers
- Added support for USDC & MATIC payments
- Successfully funded the first projected and minted the first SBT







# Technology Roadmap

Main Launch

### Functionality

The main launch for the Reneum platform is scheduled for April-2023, this will open the Reneum platform to the public and allow any producer to request to onboard, as well as any buyer to purchase dRECs and offset. Prior to launching, a large number of producers will be onboarded to ensure there is sufficient liquidity to meet demand. To guarantee that the Reneum platform can facilitate as many transactions as possible, the following functionality will be delivered prior to main launch:

- Integration with the Co2.storage solution developed by Filecoin<sup>7</sup>
- Publicly publish an external audit of the smart contracts
- Integrate with SCADA for automated updating of MWh available
- Redesign of the public pages within the website

Reserving dRECs for multiple years

- Build an automated notification system for end

users

- Pay with fiat option for non Web3 buyers
- Add to basket and checkout as a single transaction

<sup>7</sup> The following article describes the Filecoin CO2.Storage grant awarded to Reneum









# Technology Roadmap

### Phase 280nwards

The main launch signifies a major milestone for Reneum, however, it is just the beginning of a journey in which Reneum will continue to develop and improve on the existing solutions in the renewable energy market and the wider climate change industry.

Updates will be shared after the main launch to outline the functionality to be delivered in phase 2 later this year. During the rest of the year, the focus will be on expanding the use of AI & ML throughout the Reneum platform and ensuring the Reneum platform is adoptable as a turnkey, enterprise ready

As Reneum continues to onboard projects and facilitate the funding of projects, the data accumulated, both on-chain and off-chain, will become exceptionally insightful and will allow for further analysis to be conducted on the behaviour of producers and consumers. This will eventually allow for a deeper understanding of the overall renewable energy market and how adoption can be driven.

Further detail will be released in Q3-Q4 2023

solution. Functionality will be enabled to facilitate the tradability of Reneum dRECs as and when appropriate based on customer demand and market conditions.





Technical White Paper

In conclusion, Reneum is an innovative platform that leverages the power of blockchain and emerging technology to transform and disrupt the legacy REC market. It aims to address the major challenges faced by traditional REC systems, such as lack of transparency, inefficiency, and inaccessibility to a wider audience.

Reneum provides a decentralized and secure platform where digital versions of RECs (dRECs) can be traded, verified and tracked, creating a transparent and accessible market. The platform also leverages the

By providing a secure and transparent platform for the trading of renewable energy credits, Reneum is poised to become the go-to platform for both renewable energy producers and consumers. The future is bright for Reneum, and we are confident that Reneum will make a significant contribution to the sustainable development of the renewable energy sector.

Join us at Reneum.com

power of AI and NFTs to ensure that all dRECs are of high quality and the ownership can be easily proven.

Reneum has the potential to revolutionize the way renewable energy is traded and consumed, leading to a future where renewable energy is accessible to everyone, and a cleaner and greener environment for all. The future for Reneum and the RECs market is exciting and full of opportunities, and we believe that Reneum will play a major role in shaping the future of renewable energy.





# **Smart Contracts**





The Reneum platform utilizes the UUPS upgradeable proxy (ERC-1822)<sup>8</sup> standard set out by OpenZeppelin, this allows for the smart contracts to be periodically upgraded as new functionality is built, similar to the iterative development process typically seen within software engineering. Upgradeable smart contracts reduce the level of decentralization as the contract can be changed by Reneum at any time, however, this design structure is appropriate for the solution being developed as there will always be some form of central entity to govern and review the onboarding processes. The following contract addresses refer to the proxy contracts which will remain static, the implementation contract being referred to by the proxy contract is subject to continuous change.

<b>RENW (ERC-20)</b>	0xF6440E5f56Fc35F9F2699fC72A061cb65464502F
<b>ESBT (ERC-721)</b>	0×9E7c1b5Fb73c873bA4b621ac3Cf18e369690aC4c
<b>SBT (ERC-721)</b>	0xec31D81F1f9E64AF7689409650F5Eb0D6c056e23
<b>Marketplace</b>	0×85F8809AfdC7fD4376C1738739aCdC547e2CFA7F

<sup>8</sup> Refer to the EIP for more information





# Smart Contracts

Roles & Privileges

Technical White Paper

Various roles & privileges have been assigned to addresses, to operate the smart contracts and access functions. In instances where the role is assigned to a multi-sig wallet, the transaction must be confirmed by multiple assigned parties before it can be approved, this is used to increase the security and decentralization of the Reneum platform.

#### MINTER\_ROLE

Assigned privileges to mint single & aggregated SBTs, used when a buyer funds a project. This role is assigned

#### LIST\_PROJECT\_ROLE

Assigned privileges to list approved projects on the marketplace. This role is assigned to a multi-sig with approval required from CEO, CTO & Head of Sales

#### UPGRADER\_ROLE

Assigned privileges to upgrade the smart contracts to a new implementation. This role is assigned to a multi-sig with approval required from the CEO & CTO





# Smart Contracts



As part of the process for preparing for main launch, a detailed audit will be completed and made publicly available, reviewing the various Reneum smart contracts. The audit will be performed by a reputable external smart contract auditing firm. In the interim, the following internal audit documents can be referred to, if a deeper understanding of the Reneum smart contracts is desirable.

Functional Graphs: Demonstrate the dependencies and interactions between the various functions.

#### Marketplace.sol

### Functional Graph Inheritance Graph

#### Files Description Table

 File Name
 SHA-1 Hash

 contracts/marketplace.sol
 45f9c43e875aa14dbf9907dc2f1bd8cf732c7e48

#### **Contracts Description Table**

Contract	Туре	Bases		
L	Function Name	Visibility	Mutability	Modifiers
Marketplace	Implementation	Initializable, AccessControlUpgradeable, UUPSUpgradeable		
L		Public ]	۲	NO
L	initialize	Public	۲	initializer
L	_authorizeUpgrade	Internal 🦲	۲	onlyRole
L	enableFunction	Public	۲	onlyRole
L	disableFunction	Public	۲	onlyRole
L	listProject	Public	۲	onlyRole
L	getProjectsOwnedByProvider	Public		NO
L	pauseProject	Public	۲	isProjectValid onlyRol
L	unpauseProject	Public ]	۲	isProjectValid onlyRol
L	addMWhToProject	Public	۲	isProjectValid onlyRol
L	removeMWhFromProject	Public 🖠	۲	isProjectValid onlyRol
L	addWhitelistBuyerForBeta	Public 🚪	۲	onlyRole
L	addWhitelistBuyerForBetaArray	Public 🛿	۲	onlyRole
L	removeWhitelistBuyerForBeta	Public	۲	onlyRole
L	setEisbaerSBTAddress	Public	۲	onlyRole
L	set Aggregated Eisbaer SBT Address	Public 🚪	۲	onlyRole
L	countryChecker	Internal 🦲	۲	
L	getCountriesByAddress	Public		NO
L	_computeAndBurnAmount	Internal 🦲	۲	
L	_mintSBTs	Internal 🦲	۲	
L	fundProject	Public 🛿	<b>11</b>	isProjectValid
L	getLatestPrice	Public		NO
L	howManyMatic	Public		NO
L	updateTreasuryWallet	Public	۲	onlyRole

Inheritance Graphs: Demonstrate the inherited smart contracts and libraries within the various deployed contracts.

Markdown Reports: Provide a high-level overview of the various functions included within each smart contract.

#### Legend

 Symbol
 Meaning

 Image: Symbol
 Function can modify state

 Image: Symbol
 Function is payable





# **Smart Contracts**





### **Functional Graph** Inheritance Graph

#### Files Description Table

File Name	SHA-1 Hash
contracts/RENWToken.sol	a0264825382632b56d32ac829f6481f942db7d6f

#### **Contracts Description Table**

Contract	Туре	Bases		
L	Function Name	Visibility	Mutability	Modifiers
RENWToken	Implementation	Initializable, AccessControlUpgradeable, ERC20Upgradeable, UUPSUpgradeable		
L	initialize	Public 🖁	۲	initializer
L	_authorizeUpgrade	Internal 🦲	۲	onlyRole
L		Public	۲	NO
L	mint	Public 🚪	۲	onlyRole
L	burn	Public 🖁	۲	onlyRole
L	transfer	Public 🛿	۲	NO
L	transferFrom	Public 🚦	۲	NO

#### Legend

Symbol	Symbol	Meaning
--------	--------	---------



#### **Functional Graph** Inheritance Graph

#### **Files Description Table**

File Name SHA-1 Hash contracts/ASBT.sol dc7e34f33623f7359fee043172d5faac543628a9

#### Contracts Description Table

Contract	Type	Bases		
E	Function Name	Visibility	Mutability	Modifiers
Aggregated Eisbaer SBT	Implementation	Initializable, ERC721Upgradeable, ERC721URIStorageUpgradeable, AccessControlUpgradeable, UUPSUpgradeable		
L		Public	۲	NO
L	initialize	Public	۲	initializer
L	aggregatedSBT	Public	۲	onlyRole
L	enableTransfer	Public 🛿	۲	onlyRole
E.	disableTransfer	Public	۲	onlyRole
E.	_authorizeUpgrade	Internal 🗂	۲	onlyRole
L	_burn	Internal 💼	۲	
L.	tokenURI	Public		NO
L.	supportsinterface	Public		NO
L	transferFrom	Public 🖁	۲	NO
L	safeTransferFrom	Public	۲	NO
£2	safeTransferFrom	Public	۲	NO

#### Legend

Symbol	Meaning
	Function can modify state





#### **SBT.sol**

#### **Functional Graph** Inheritance Graph

#### **Files Description Table**

File Name	SHA-1 Hash
contracts/SBT.sol	bb2f7a39157ac008f9364ae29adef154f68ecade

#### **Contracts Description Table**

Contract	Туре	Bases		
L	Function Name	Visibility	Mutability	Modifiers
EisbaerSB	T Implementation	Initializable, ERC721Upgradeable, ERC721URIStorageUpgradeable, AccessControlUpgradeable, UUPSUpgradeable		
L		Public	۲	NO
L	initialize	Public	۲	initializer
L	mintSBT	Public 🛛	۲	onlyRole
a.	enableTransfer	Public ]	۲	onlyRole
L	disableTransfer	Public	۲	onlyRole
L	_authorizeUpgrade	Internal 🦲	۲	onlyRole
L	_burn	Internal 🦲	۲	
L	tokenURI	Public		NO
L	supportsInterface	Public		NO
L	transferFrom	Public	۲	NO
L	safeTransferFrom	Public	۲	NO
L	safeTransferFrom	Public	۲	NO
egend				
Symbol	Meaning			
۲	Function can modify stat	e		
1000	Function is payable			

