# Zero Gas Tokeneconomics

**Abstract**

ZeroGas represents a pioneering leap in blockchain technology, initiated by the ZeroGas Foundation with a vision to revolutionize the industry. Historically, emerging technologies often begin with prohibitive costs, only to become widely accessible and affordable over time. This trend is evident in the evolution of the Internet, which transitioned from an expensive novelty to a universally available service with minimal interaction costs beyond a subscription.

Web3 technology is poised for a similar transformation. Currently, every action on a blockchain ledger incurs a transaction fee, which poses a significant barrier to widespread adoption. ZeroGas aims to overcome this hurdle by introducing a groundbreaking approach: Proof of Holding. This paradigm shift is set to make Web3 interactions more accessible by removing transaction fees for most interactions once an initial holding is established.

Central to this innovation is the Central Pay Master (CPM), which implements delegated payment at a chain-wide level. This mechanism is designed to eliminate the transaction fee barrier, facilitating the application of blockchain technology to real-world use cases.

The ZeroGas Foundation is dedicated to refining and advancing the Proof of Holding model, striving to make Web3 as intuitive and cost-effective as traditional Internet interactions, thereby paving the way for mass adoption.

**Keywords:** Blockchain, Fees, Gas, Layer 1

## 1 ZeroGas Overview

The primary objective of ZeroGas is to drive mass adoption of blockchain technology by eliminating transaction fees, a significant barrier to widespread use. Traditional blockchains rely on transaction fees to secure the network and incentivize node operations, yet these same fees pose challenges for both newcomers and frequent users, limiting accessibility and scalability[1].

ZeroGas introduces an innovative economic model that resolves this dilemma by shifting from fee-based incentives to a system that rewards users for their participation in the ecosystem. This approach not only ensures network security and operational sustainability but also fosters a more inclusive environment for all users.

## 1.1 Introduction

The ZeroGas blockchain introduces a pioneering approach to blockchain technology by leveraging Proof of Holding (PoH) and the Central Pay Master. The native token, ZeGas, is central to the network's functionality and economy. This tokenomics model aims to create a balanced, sustainable, and incentivized ecosystem for all participants, ensuring both short-term engagement and long-term growth. The tokenomics of ZeGas and the associated Free Transactions Credits (FTC) are designed to facilitate a scalable and user-friendly environment, addressing key challenges in blockchain adoption, such as high transaction costs and complex user experiences[2].

## 1.2 Central Pay Master

In account abstraction, Pay Masters are specialized smart contracts that facilitate flexible gas fee policies. They enable decentralized applications (dApps) to cover gas costs on behalf of their users, allowing for operations to be sponsored without users needing to pay gas fees in the blockchain's native currency. Alternatively, paymasters can accept gas fee payments in ERC-20 tokens, such as USDC, instead of the blockchain's native currency[3].

Introduced through Ethereum Improvement Proposal (EIP) 4337, paymasters integrate with other Account Abstraction components like bundlers and the entry point smart contract. This integration compensates these components for fronting the gas required to execute user operations, thereby streamlining the user experience and expanding payment options within the ecosystem[4].

ZeroGas extends this same approach to become an intrinsic part of the blockchain itself by introducing the Central Pay Master (CPM). The function of the CPM is to pay the transaction fees on behalf of the user if the user has access to enough credit. By adopting the CPM ZeroGas not only provides the ability to have gasless transactions but also rewards the nodes in a compatible way with the current chain architecture.

## 1.3 Free Transaction Credits (FTC)

At the core of the ZeroGas chain is the Free Transaction Credits (FTC) system. The main innovation provided by the FTC is that instead of inflating the current circulating supply of the ZeroGas token, namely ZeGas, it introduces a credit token only usable to pay for the transaction fees. The FTC is converted to ZeGas at the transaction time by the CPM in order to pay for the transaction.

- The number of FTC generated per epoch is proportional to the total amount of ZeGas held or staked.
- Projects within the ecosystem can prepay for FTC or leverage node validators' unused capacity, providing flexibility for managing transaction costs.
- FTC do not expire, allowing users to accumulate them across multiple epochs.

## 1.4 Proof of Holding (PoH)

The philosophical foundation of Proof of Holding (PoH) is the intrinsic alignment between the strength of a blockchain and the engagement of its users. Typically, a blockchain's robustness is derived from its token holders, yet requiring these holders to pay for each transaction undermines their participation [5].

PoH addresses this by rewarding token holders with the ability to transact freely, enhancing their incentive to remain active in the network. This model ensures that holding the chain's tokens not only contributes to the network's strength but also provides practical benefits. The mechanics of PoH can be summarized as follows:

- Users must hold a minimum amount of ZeGas in their wallet to receive FTC.
- Eligibility for FTC is determined by snapshots taken during the last epoch, with the minimum amount held during that period qualifying for FTC.
- FTC are allocated at the end of each epoch based on the amount of ZeGas held during the epoch.
- FTC do not expire, ensuring that users can accumulate and utilize them over time.

## 1.5 Organizational Node

Most current blockchains primarily cater to individual wallet transactions and overlook the needs of enterprises and organizations. For businesses to effectively integrate blockchain solutions, they must be able to cover transaction fees on behalf of their users. Expecting end customers to bear both service costs and transaction fees is impractical—akin to a business accepting credit card payments but also requiring customers to cover the card's transaction fees[6].

To address this challenge, ZeroGas introduces the Organizational Node (ON). This innovative feature allows organizations to pay transaction fees on behalf of designated contracts or whitelisted users. The ON enables businesses to offer blockchain-based services without passing transaction costs onto their users, while also contributing to network security. The main functions of the ON are as follows:

- Users can stake ZeGas to create nodes, requiring approximately 74,600 ZeGas.
- Node creators can whitelist other wallet addresses to receive FTC.
- Stakers receive additional ZeGas rewards and a bonus in FTC for contributing to network security.

## 1.6 Reward and Incentive Mechanisms

- Initial Annual Percentage Yield (APY) starts at 100% for FTC, decreasing to a stable 10% over time based on the number of eligible users and overall network participation.
- This dynamic APY model ensures early adoption incentives while maintaining long-term sustainability.
- The reward distribution is designed to promote both holding and staking, balancing liquidity with network security.

# 2 Token Economics

## 2.1 Overview of ZeGas Tokenomics

ZeroGas (ZeGas) Token: The primary utility token of the ZeroGas blockchain, ZeGas, serves multiple purposes, including:

- Generating Free Transactions Credits (FTC): Holders of ZeGas receive FTC based on the amount held during each epoch.
- Gas Payment Alternative: ZeGas can be used as an alternative to FTC when users run out of free transactions credits.
- Project Development: Enables the creation and support of projects within the ZeroGas ecosystem.
- Staking Rewards: Users can stake ZeGas to become validators, earning rewards and contributing to network security and decentralization.
- Medium of Exchange: Facilitates transactions within the ZeroGas blockchain, including trading with other cryptocurrencies like BTC, ETH, USDT, and USDC.

Free Transactions Credits (FTC): FTC are gasless transaction credits generated by holding or staking ZeGas. They provide users with a cost-free way to interact with the blockchain, promoting accessibility and ease of use.

## 2.2 Token Supply and Distribution

- The initial total supply of ZeGas is set at 450,000,000, with a controlled release model designed to support long-term growth.
- The supply model incorporates a gradual increase to approximately 835,820,000 ZeGas over 20 years, considering the burning mechanisms and staking requirements.

$$RR = 156,321,300,000,000 + \left[ \frac{450,000,000 - 156,321,300,000,000}{1 + \left( \frac{t}{520{,}247{,}300} \right)^{0.7562364}} \right]$$

RR: ZeroGas Release in Coins t: Time period in years

## 2.3 Interaction Between ZeGas Token and Free Transaction Credits (FTC)

The ZeroGas tokenomics model intricately balances the value and utility of the ZeGas token with the provision of Free Transaction Credits (FTC) credits, ensuring that FTC credits do not undermine the economic integrity of ZeGas. This section details the relationship between ZeGas and FTC, highlighting their equivalence, allocation, and the integration of the EIP-1559 upgrade to enhance the ecosystem.

### 2.3.1 Value Equivalence and Usage

- **Equivalence**: FTC credits and ZeGas tokens are valued equally for the purpose of paying gas fees. One FTC is equivalent to one ZeGas in covering transaction costs, ensuring a straightforward and predictable system for users.
- **Usage Restriction**: FTC credits are used exclusively for gas payments within the ZeroGas blockchain. They cannot be transferred, traded, or used for any other purpose, preserving their role as a utility for reducing transaction costs without affecting the ZeGas market dynamics.

### 2.3.2 FTC Allocation and Accumulation

- **Distribution Mechanism**: FTC credits are awarded to users based on the amount of ZeGas held in their wallets during an epoch. This mechanism rewards active participants who maintain a balance of ZeGas.
- **No Expiry**: FTC credits do not expire, allowing users to accumulate them over time. This feature encourages long-term holding of ZeGas and provides a buffer for transaction costs, enhancing user experience without impacting ZeGas liquidity.

### 2.3.3 ZeGas as a Payment Alternative

- **Fallback Mechanism**: When users deplete their FTC credits, they must use ZeGas to pay for gas fees. This fallback mechanism ensures continuous demand for ZeGas, as users must hold a reserve to cover transactions when FTC credits are exhausted.
- **Continuous Circulation**: The necessity of using ZeGas for gas fees when FTC credits are unavailable ensures ongoing circulation and utility of ZeGas within the ecosystem. This demand supports the token's market value and utility.

### 2.3.4 Staking and Network Security

- **Dual Incentives**: Stakers, who create nodes by locking ZeGas, receive both ZeGas rewards and FTC credits. This dual incentive system strengthens network security and decentralization, motivating validators to participate actively.
- **Reduced Circulating Supply**: ZeGas staked for node creation are locked for a specified period, reducing the circulating supply. This scarcity can potentially increase the token's market value.

## 2.4 Integration of EIP-1559 with ZeGas and FTC

EIP-1559 introduces a base fee that adjusts dynamically based on network congestion[7]. Here's how EIP-1559 will work with ZeGas and FTC:

### 2.4.1 Dynamic Fee Structure

- **Base Fee Adjustment**: EIP-1559 introduces a base fee that adjusts dynamically based on network congestion, ensuring a predictable and stable gas fee environment.
- **FTC and ZeGas Payment**: Users pay the base fee using FTC if available. If FTC are exhausted, users pay the base fee using ZeGas.

### 2.4.2 Fee Burn Mechanism

- **Burning ZeGas**: A portion of the base fee paid in ZeGas is burned, reducing the total supply of ZeGas. This mechanism helps deflate the supply over time, potentially increasing the token's value.
- **Deflationary Pressure**: The burning of ZeGas creates deflationary pressure, aligning with the controlled supply model and ensuring long-term value retention for ZeGas holders.

### 2.4.3 Incentive for Holding and Staking

- **Continuous Demand**: By incorporating EIP-1559, the ZeroGas network ensures continuous demand for both FTC and ZeGas as the base fee is always required.
- **Value Proposition**: Stakers and holders benefit from the reduced supply of ZeGas due to the burning mechanism, enhancing the value proposition of holding and staking ZeGas.

### 2.4.4 Ensuring Value Stability

To ensure that FTC credits do not negatively impact the value of ZeGas, the following strategies are employed:

- **Non-Transferability of FTC**: By restricting FTC credits to gas payments only and preventing their transfer or trade, the impact of FTC on the ZeGas market is minimized. FTC function purely as a utility for reducing transaction costs without influencing ZeGas liquidity or trading dynamics.
- **Direct Demand for ZeGas**: The requirement for users to fall back on ZeGas for gas fees when FTC credits are exhausted ensures continuous demand for the native token, supporting its value and market presence.
- **ncentive Alignment**: Rewarding both holding and staking with FTC and ZeGas aligns incentives across different types of network participants. This alignment ensures that both users and validators have a vested interest in maintaining the value and utility of ZeGas.

## 2.5 Dynamic Gas Fee Model

Optimizing for network efficiency and user experience, we employ a dynamic gas fee model, drawing inspiration from Ethereum's EIP-1559 [8], formulated thus:

$$G(t) = \int_0^t \left( \text{BaseFee}(t) + \text{Tip} + \epsilon \left( \frac{P_{\text{target}} - P(t)}{P(t)} \right) \right) \cdot (\Delta C(\tau) + \Delta N(\tau))\, d\tau \quad (1)$$

- **BaseFee(t):** Dynamically adjusts based on block space utilization, ensuring adaptability to network demand.
- **Tip:** An optional incentivization for validators to prioritize transactions, enhancing throughput during peak times.

- **$\Delta C(\tau)$ and $\Delta N(\tau)$:** Represent the rate of change in transaction complexity and network congestion, respectively.
- **$\epsilon$:** A sensitivity parameter for the token price stabilization mechanism.
- **$P_{\textbf{target}}$ and $P(t)$:** Target and current token prices, guiding fee adjustments to market conditions.

## 2.6 Storage Fee Formulation

Reflecting considerations of data size, redundancy, and depreciating storage costs over time:

$$S(D, t, R) = \text{StorageBaseFee} \cdot D \cdot R \cdot e^{-\lambda t} \tag{2}$$

- **StorageBaseFee:** Cost per unit of data storage.
- **$D$:** Size of the data stored.
- **$R$:** Redundancy factor for data reliability.
- **$\lambda$:** Reflects decreasing storage technology costs over time.

## 2.7 Fee Distribution Mechanism

Encouraging a collaborative network through a model that rewards validators based on performance:

$$F_{\text{Layer1}} = F \cdot (\alpha + \beta P) \tag{3}$$

$$F_{\text{Layer0}} = F \cdot (1 - (\alpha + \beta P)) \tag{4}$$

- **$F$:** Total transaction fees collected.
- **$\alpha$:** Base coefficient for fee distribution between layers.
- **$\beta$:** Adjusts distribution based on validator performance.
- **$P$:** Performance metric for validators.

## 2.8 Wallets Rewards Dynamics

To ensure a fair and dynamic distribution of Free Transactions Credits (FTC) to users holding ZeGas above a certain threshold, we have formulated an advanced equation that accounts for the number of eligible users and the varying Annual Percentage Yield (APY). This equation considers multiple snapshots of the user's balance within an epoch (6 hours) and uses the minimum balance from these snapshots to calculate the rewards.

### 2.8.1 Variables and Definitions

- $T$: Total supply of FTC to be distributed per epoch.
- $N$: Number of eligible users.
- $B_i$: Minimum balance of ZeGas held by user $i$ during the epoch.
- $B_{\textbf{min}}$: Minimum threshold balance of ZeGas to be eligible for rewards.
- $R_i$: Reward in FTC for user $i$ for the epoch.

- $APY_{\textbf{start}}$: Initial APY (100%).
- $APY_{\textbf{end}}$: Stable APY (10%).
- $E$: Total number of epochs in a year ($E = 4 \times 365 = 1460$).

### 2.8.2 Dynamic Reward Calculation

***Determine the Adjusted APY***

The APY decreases from 100% to 10% depending on the number of eligible users. The adjusted APY ($APY_{\text{adjusted}}$) is calculated as follows:

$$APY_{\text{adjusted}} = APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left( \frac{N_{\text{max}} - N}{N_{\text{max}} - N_{\text{min}}} \right)$$

Where $N_{\text{max}}$ and $N_{\text{min}}$ are the maximum and minimum thresholds for the number of eligible users, respectively. This ensures a smooth transition of APY from 100% to 10%.

***Calculate Total FTC to be Distributed in the Epoch***

$$T = \frac{APY_{\text{adjusted}} \times \sum_{i=1}^{N} B_i}{E}$$

***Calculate Individual Rewards***

The reward ($R_i$) for each user $i$ is proportional to their minimum balance of ZeGas held during the epoch:

$$R_i = \frac{B_i}{\sum_{j=1}^{N} B_j} \times T$$

### 2.8.3 Summary

Combining the above steps, we get the dynamic equation for calculating FTC rewards for each user $i$:

$$R_i = \left( \frac{B_i}{\sum_{j=1}^{N} B_j} \right) \times \left( \frac{APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left( \frac{N_{\text{max}} - N}{N_{\text{max}} - N_{\text{min}}} \right)}{E} \times \sum_{k=1}^{N} B_k \right)$$

This equation ensures that the FTC rewards are dynamically and fairly distributed based on the minimum balance held by each user during the epoch, while the APY adjusts according to the number of eligible users, maintaining a balance between rewarding early participants and ensuring long-term sustainability.

### 2.8.4 Calculation Steps

To calculate this dynamic reward distribution in the ZeroGas blockchain, the following steps are taken for each epoch:

1. **Snapshot Collection:** Collect multiple snapshots of user balances throughout the epoch.
2. **Minimum Balance Calculation:** Determine the minimum balance for each user from the snapshots.
3. **Eligibility Check:** Identify eligible users who meet the minimum balance threshold.
4. **Adjusted APY Calculation:** Calculate the adjusted APY based on the number of eligible users.
5. **Total FTC Calculation:** Compute the total FTC to be distributed in the epoch.
6. **Reward Distribution:** Distribute FTC to eligible users based on their proportional share of the total minimum balance.

By following these steps, the ZeroGas network ensures a fair and dynamic distribution of FTC rewards, promoting active participation and long-term engagement.

## 2.9 Staking Rewards Dynamics

To ensure a fair and dynamic distribution of Free Transactions Credits (FTC) and ZeGas to nodes holding more than a certain threshold of ZeGas, we have formulated an advanced equation that accounts for the number of eligible nodes and the varying Annual Percentage Yield (APY). This equation considers the total ZeGas staked by each node and dynamically adjusts rewards based on the number of eligible nodes. Rewards are distributed every epoch, with the APY starting at 100% and gradually decreasing based on the number of nodes.

### 2.9.1 Variables and Definitions

- $T_{FTC}$: Total supply of FTC to be distributed per epoch.
- $T_{ZeGas}$: Total supply of ZeGas to be distributed per epoch.
- $N$: Number of eligible nodes.
- $S_i$: ZeGas staked by node $i$ during the epoch.
- $S_{\mathbf{min}}$: Minimum threshold of ZeGas to be staked to be eligible for rewards.
- $R_{FTC,i}$: Reward in FTC for node $i$ for the epoch.
- $R_{ZeGas,i}$: Reward in ZeGas for node $i$ for the epoch.
- $APY_{\mathbf{start}}$: Initial APY (100%).
- $APY_{\mathbf{end}}$: Stable APY (10%).
- $E$: Total number of epochs in a year ($E = 4 \times 365 = 1460$).

### 2.9.2 Dynamic Reward Calculation

***Determine the Adjusted APY***

The APY decreases from 100% to 10% depending on the number of eligible nodes. The adjusted APY ($APY_{\text{adjusted}}$) is calculated as follows:

$$APY_{\text{adjusted}} = APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left( \frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)$$

Where $N_{\max}$ and $N_{\min}$ are the maximum and minimum thresholds for the number of eligible nodes, respectively. This ensures a smooth transition of APY from 100% to 10%.

***Calculate Total FTC and ZeGas to be Distributed in the Epoch***

$$T_{FTC} = \frac{APY_{\text{adjusted}} \times \sum_{i=1}^{N} S_i}{E}$$

$$T_{ZeGas} = \frac{APY_{\text{adjusted}} \times \sum_{i=1}^{N} S_i}{E}$$

***Calculate Individual Rewards***

The reward ($R_{FTC,i}$) for each node $i$ in FTC and the reward ($R_{ZeGas,i}$) for each node $i$ in ZeGas are proportional to their staked ZeGas during the epoch:

$$R_{FTC,i} = \frac{S_i}{\sum_{j=1}^{N} S_j} \times T_{FTC}$$

$$R_{ZeGas,i} = \frac{S_i}{\sum_{j=1}^{N} S_j} \times T_{ZeGas}$$

### 2.9.3 Summary

Combining the above steps, we get the dynamic equations for calculating FTC and ZeGas rewards for each node $i$:

$$R_{FTC,i} = \left( \frac{S_i}{\sum_{j=1}^{N} S_j} \right) \times \left( \frac{APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left( \frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)}{E} \times \sum_{k=1}^{N} S_k \right)$$

$$R_{ZeGas,i} = \left( \frac{S_i}{\sum_{j=1}^{N} S_j} \right) \times \left( \frac{APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left( \frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)}{E} \times \sum_{k=1}^{N} S_k \right)$$

These equations ensure that the FTC and ZeGas rewards are dynamically and fairly distributed based on the staked ZeGas of each node during the epoch, while the APY adjusts according to the number of eligible nodes, maintaining a balance between rewarding early participants and ensuring long-term sustainability.

### 2.9.4 Calculation Steps

To calculate this dynamic reward distribution in the ZeroGas blockchain, the following steps are taken for each epoch:

1. **Snapshot Collection:** Collect multiple snapshots of node balances throughout the epoch.

2. **Staked Balance Calculation:** Determine the staked balance for each node from the snapshots.
3. **Eligibility Check:** Identify eligible nodes that meet the minimum staking threshold.
4. **Adjusted APY Calculation:** Calculate the adjusted APY based on the number of eligible nodes.
5. **Total FTC and ZeGas Calculation:** Compute the total FTC and ZeGas to be distributed in the epoch.
6. **Reward Distribution:** Distribute FTC and ZeGas to eligible nodes based on their proportional share of the total staked balance.

By following these steps, the ZeroGas network ensures a fair and dynamic distribution of FTC and ZeGas rewards, promoting active participation and long-term engagement.

# 3 Chain Simulations

Blockchain simulation involves creating a controlled environment to replicate the operations of a blockchain network. This approach allows developers, researchers, and organizations to test and analyze blockchain behavior, performance, and scalability under various conditions without the risks or costs associated with using a live network.

## 3.1 Throughput Simulation over a 4-Year Cycle

This section presents a detailed simulation of blockchain throughput over a 4-year period. The simulation models network performance under two distinct scenarios: an optimistic growth scenario and a realistic market cycle scenario. The combined output using Latent Dirichlet Allocation (LDA) provides a comprehensive and realistic projection of the blockchain's throughput [9].

### 3.1.1 Simulation Parameters

- **Total Duration:** 4 years
- **Epochs per Year:** 1460
- **Total Epochs:** 5840
- **Scenarios:**
  - Optimistic Growth
  - Realistic Market Cycle

### 3.1.2 Methodology

***Optimistic Scenario:***

The optimistic scenario simulates a steady increase in users over 4 years, with transactions per second (TPS) rising linearly from 0 to a maximum of 35,000 TPS.

***Realistic Scenario:***

The realistic scenario simulates a market cycle similar to Ethereum's transaction volume, with TPS following a sinusoidal pattern to mimic market fluctuations from a bear market to a bull market, starting from zero.

***Combining Scenarios using LDA:***

The two scenarios are combined using Latent Dirichlet Allocation (LDA) to produce a more realistic throughput projection. Gaussian smoothing is applied to reduce noise and enhance the clarity of the simulation results.

### 3.1.3 Simulation Results

The simulation results provide a comprehensive view of the blockchain's potential throughput over a 4-year period under different scenarios. Combining the optimistic and realistic scenarios using LDA offers a balanced and realistic projection, helping to anticipate performance and scalability needs. The application of Gaussian smoothing ensures clarity of results, making the data more interpretable and actionable for stakeholders.

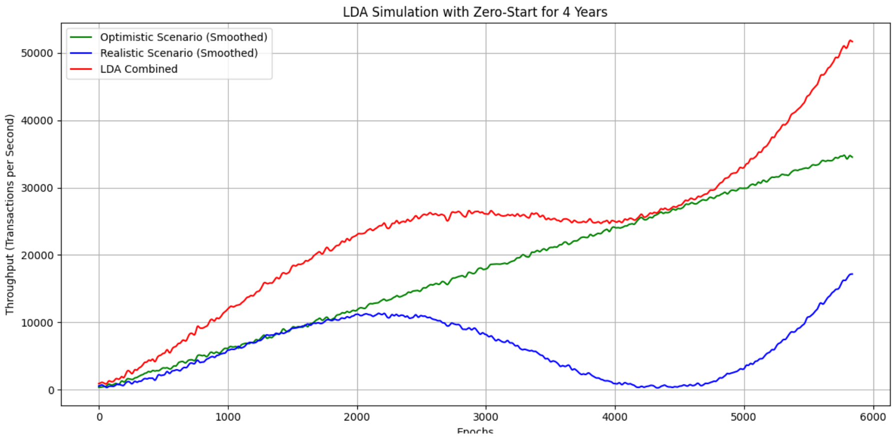


**Fig. 1** LDA Throughput Simulation.

## 3.2 APR Simulation for Node Staking

This section presents a detailed simulation of the Annual Percentage Rate (APR) for node staking over a 20-year period. The simulation models the APR for both ZeGas and Free Transactions Credits (FTC), providing a comprehensive view of how staking rewards evolve over time.

### 3.2.1 Simulation Parameters

- **Total Duration:** 20 years
- **Epochs per Year:** 1460

- **Total Epochs:** 29200
- **Initial APR:**
  - ZeGas: 50%
  - FTC: 100%
- **Final APR:**
  - ZeGas: 5%
  - FTC: 10%

### 3.2.2 Methodology

The APR decreases over time using a logarithmic decay function, providing a realistic model of how rewards diminish as the network matures. Gaussian smoothing is applied to the APR data to reduce noise and enhance clarity.

### 3.2.3 APR Simulation for ZeGas

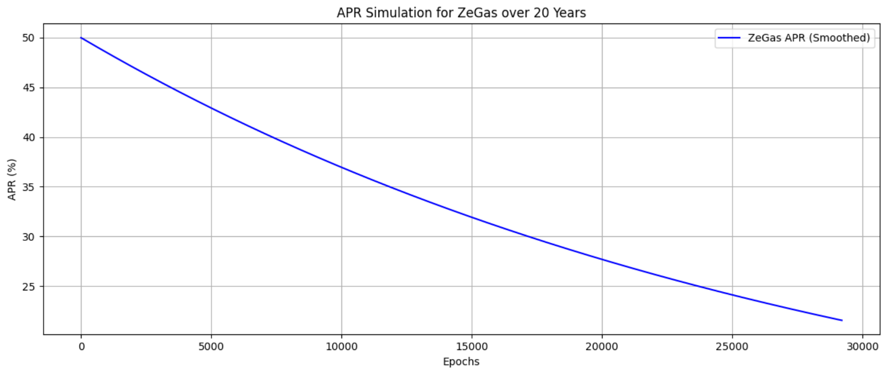


**Fig. 2** APR Simulation for ZeGas over 20 Years.

***Explanation:***

- The APR for ZeGas starts at 50% and decreases to 5% over 20 years.
- A logarithmic decay function is used to simulate the decrease, providing a realistic model of diminishing rewards.
- Gaussian smoothing is applied to the data to reduce noise.

### 3.2.4 APR Simulation for Free Transactions Credits (FTC)


**Fig. 3** APR Simulation for ZeGas over 20 Years

***Explanation:***

- The APR for FTC starts at 100% and decreases to 10% over 20 years.
- A logarithmic decay function is used to simulate the decrease, providing a realistic model of diminishing rewards.
- Gaussian smoothing is applied to the data to reduce noise.

## 3.3 Token Price Prediction

This section presents a detailed simulation and prediction of the token price impact over a 20-year period [10]. The simulation models the token price for ZeGas, considering various factors that influence token price dynamics. The goal is to provide a comprehensive view of how token prices may evolve over time.

### 3.3.1 Simulation Parameters

- **Total Duration:** 20 years
- **Epochs per Year:** 1460
- **Total Epochs:** 29200
- **Initial Prices:**
  - ZeGas: $1
- **Target Prices:**
  - ZeGas: $100

### 3.3.2 Methodology

The token price simulation considers the following factors:

- Market demand and supply dynamics.
- Network adoption rate.

- Staking rewards and their impact on token scarcity.
- Overall market conditions and external economic factors.

The simulation uses a combination of exponential growth, periodic dips to simulate bear markets, and random fluctuations to model realistic price dynamics.

### 3.3.3 Token Price Simulation for ZeGas

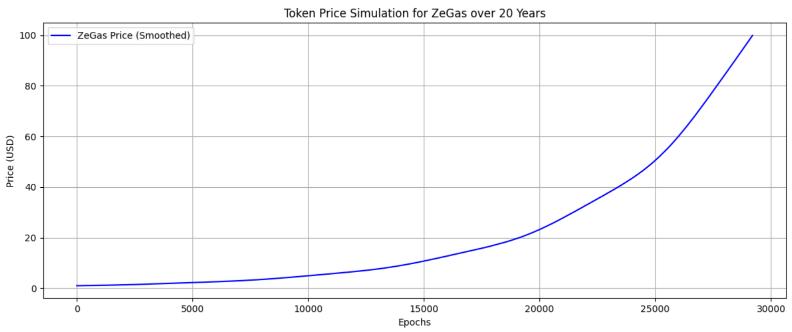


**Fig. 4** Token Price Simulation for ZeGas over 20 Years

***Explanation***

- The price of ZeGas starts at $1 and is predicted to reach $100 over 20 years.
- The simulation considers exponential growth, periodic bear market dips, and market fluctuations.
- Gaussian smoothing is applied to reduce noise and enhance clarity.

### 3.3.4 Conclusion And Chain Token Price Impact

The simulation results provide a comprehensive view of the APR evolution for node staking over a 20-year period. The logarithmic decay model and Gaussian smoothing ensure that the results are realistic and interpretable, offering valuable insights for stakeholders in the network. Assuming a starting price of $1 per token, we can see a path for the limited cap token to approach $100 over the next 2 decade.

# Appendix A Simulation Code Example

## A.1 LDA Throughput Simulation Code

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import gaussian_filter1d

# Set up simulation parameters
years = 4
epochs_per_year = 365 * 4
total_epochs = years * epochs_per_year

```

```
# Create time array
time = np.arange(0, total_epochs)

# Simulate optimistic scenario: gradually increasing transactions
optimistic_tps = np.linspace(0, 35_000, total_epochs) + 1_000 * np.random.randn(
    total_epochs)

# Simulate realistic scenario: bear to bull market cycle, starting from zero
realistic_market_conditions = np.sin(2 * np.pi * time / total_epochs) * 0.5 + 0.5
realistic_tps = np.linspace(0, 35_000, total_epochs) * realistic_market_conditions
    + 1_000 * np.random.randn(total_epochs)

# Apply Gaussian smoothing to both scenarios
smoothed_optimistic_tps = gaussian_filter1d(np.maximum(0, optimistic_tps), sigma
    =10)
smoothed_realistic_tps = gaussian_filter1d(np.maximum(0, realistic_tps), sigma=10)

# Combine the two scenarios using LDA (sum of both scenarios)
lda_combined = smoothed_optimistic_tps + smoothed_realistic_tps

# Plotting the combined LDA simulation
fig, ax = plt.subplots(figsize=(12, 6))

# Plotting smoothed throughput for optimistic scenario
ax.plot(time, smoothed_optimistic_tps, label='Optimistic Scenario (Smoothed)',
    color='g')
# Plotting smoothed throughput for realistic scenario
ax.plot(time, smoothed_realistic_tps, label='Realistic Scenario (Smoothed)', color=
    'b')
# Plotting LDA combined (sum of both scenarios)
ax.plot(time, lda_combined, label='LDA Combined', color='r')

ax.set_title('LDA Simulation with Zero-Start for 4 Years')
ax.set_xlabel('Epochs')
ax.set_ylabel('Throughput (Transactions per Second)')
ax.legend()
ax.grid(True)

plt.tight_layout()
plt.show()
```

**Listing 1** LDA Throughput Simulation Code

## A.2 ZeGas and FTC APR Simulation Code

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import gaussian_filter1d

# Set up simulation parameters
years = 20
epochs_per_year = 365 * 4
total_epochs = years * epochs_per_year

# Create time array
time = np.arange(0, total_epochs)

# Simulate APR for node stacking
# Initial APR starts at 50% for ZeGas and 100% for FTC
initial_apr_zeGas = 50
initial_apr_ft = 100
final_apr_zeGas = 5
final_apr_ft = 10

# Use a logarithmic decay to simulate more realistic APR decrease
```

```
apr_zeGas = initial_apr_zeGas * np.exp(-time / total_epochs) * (initial_apr_zeGas -
     final_apr_zeGas) / initial_apr_zeGas + final_apr_zeGas
apr_ft = initial_apr_ft * np.exp(-time / total_epochs) * (initial_apr_ft -
    final_apr_ft) / initial_apr_ft + final_apr_ft

# Apply Gaussian smoothing to APR data
smoothed_apr_zeGas = gaussian_filter1d(apr_zeGas, sigma=10)
smoothed_apr_ft = gaussian_filter1d(apr_ft, sigma=10)

# Plotting the APR simulation for ZeGas and FTC
fig, ax = plt.subplots(2, 1, figsize=(12, 10))

# Plotting smoothed APR for ZeGas
ax[0].plot(time, smoothed_apr_zeGas, label='ZeGas APR (Smoothed)', color='b')
ax[0].set_title('APR Simulation for ZeGas over 20 Years')
ax[0].set_xlabel('Epochs')
ax[0].set_ylabel('APR (%)')
ax[0].legend()
ax[0].grid(True)

# Plotting smoothed APR for FTC
ax[1].plot(time, smoothed_apr_ft, label='FTC APR (Smoothed)', color='g')
ax[1].set_title('APR Simulation for FTC over 20 Years')
ax[1].set_xlabel('Epochs')
ax[1].set_ylabel('APR (%)')
ax[1].legend()
ax[1].grid(True)

plt.tight_layout()
plt.show()
```

**Listing 2** APR Simulation Code

## A.3 Token Price Simulation for ZeGas over 20 Years Code

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import gaussian_filter1d

# Set up simulation parameters
years = 20
epochs_per_year = 365 * 4
total_epochs = years * epochs_per_year

# Create time array
time = np.arange(0, total_epochs)

# Initial token prices
initial_price_zeGas = 1
initial_price_ft = 0.1

# Target token prices after 20 years
target_price_zeGas = 100
target_price_ft = 10

# Calculate the exponential growth rate needed to reach the target price
growth_rate_zeGas = np.log(target_price_zeGas / initial_price_zeGas) / total_epochs
growth_rate_ft = np.log(target_price_ft / initial_price_ft) / total_epochs

# Simulate token prices with exponential growth, bear market dips, and random
    fluctuations
decay_rate = 0.02
random_fluctuation = 0.05

market_cycle = 4 * epochs_per_year

```

```
price_zeGas = initial_price_zeGas * np.exp(growth_rate_zeGas * time) * (1 - decay_rate * np.sin(2 * np.pi * time / market_cycle)) + random_fluctuation * np.random.randn(total_epochs)

smoothed_price_zeGas = gaussian_filter1d(price_zeGas, sigma=10)
fig, ax = plt.subplots(2, 1, figsize=(12, 10))

ax[0].plot(time, smoothed_price_zeGas, label='ZeGas Price (Smoothed)', color='b')
ax[0].set_title('Token Price Simulation for ZeGas over 20 Years')
ax[0].set_xlabel('Epochs')
ax[0].set_ylabel('Price (USD)')
ax[0].legend()
ax[0].grid(True)
```

**Listing 3** Token Price Simulation for ZeGas over 20 Years Code

# References


[1] Donmez, A., Karaivanov, A.: Transaction fee economics in the ethereum blockchain. Economic Inquiry **60**(1), 265–292 (2022)

[2] ElMessiry, M., ElMessiry, A., ElMessiry, M.: Dual token blockchain economy framework. In: International Conference on Blockchain, pp. 157–170 (2019). Springer

[3] Singh, A.K., Hassan, I.U., Kaur, G., Kumar, S., *et al.*: Account abstraction via singleton entrypoint contract and verifying paymaster. In: 2023 2nd International Conference on Edge Computing and Applications (ICECAA), pp. 1598–1605 (2023). IEEE

[4] Wang, Q., Chen, S.: Account abstraction, analysed. In: 2023 IEEE International Conference on Blockchain (Blockchain), pp. 323–331 (2023). IEEE

[5] Shifferaw, Y., Lemma, S.: Limitations of proof of stake algorithm in blockchain: A review. Zede Journal **39**(1), 81–95 (2021)

[6] Lin, I.-C., Liao, T.-C.: A survey of blockchain security issues and challenges. Int. J. Netw. Secur. **19**(5), 653–659 (2017)

[7] Roughgarden, T.: Transaction fee mechanism design for the ethereum blockchain: An economic analysis of eip-1559. arXiv preprint arXiv:2012.00854 (2020)

[8] Liu, Y., Lu, Y., Nayak, K., Zhang, F., Zhang, L., Zhao, Y.: Empirical analysis of eip-1559: Transaction fees, waiting times, and consensus security. In: Proceedings of the 2022 ACM SIGSAC Conference on Computer and Communications Security, pp. 2099–2113 (2022)

[9] Jelodar, H., Wang, Y., Yuan, C., Feng, X., Jiang, X., Li, Y., Zhao, L.: Latent dirichlet allocation (lda) and topic modeling: models, applications, a survey. Multimedia tools and applications **78**, 15169–15211 (2019)

[10] Khedr, A.M., Arif, I., El-Bannany, M., Alhashmi, S.M., Sreedharan, M.: Cryptocurrency price prediction using traditional statistical and machine-learning techniques: A survey. Intelligent Systems in Accounting, Finance and Management **28**(1), 3–34 (2021)