PHICOIN (PHI): The Proof of Work High-Performance Infrastructure

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***Abstract*—PHICOIN (PHI) is a high-performance cryptocurrency based on the Proof-of-Work (PoW) mechanism. It aims to provide ordinary users with decentralized participation opportunities through an improved and innovative mining algorithm and fair design principles. PHI addresses the challenges of centralization in cryptocurrency mining by enhancing resistance to ASIC and FPGA devices and promoting fair participation. This paper outlines the technical specifications, mission, and roadmap for PHI, highlighting its potential to become a foundational infrastructure for PoW cryptocurrencies.**

***Index Terms*—PHICOIN, High Performance, Decentralization, Mining Algorithm, GPU Mining, Blockchain, Randomness, FP32 Computation, DAG Growth, Decentralized Protocol**

I. Introduction

In the early days of Bitcoin (BTC), the Proof-of-Work (PoW) mechanism provided ordinary people with a fair and decentralized opportunity to participate [1]. However, as the mining industry evolved, the widespread use of FPGA and ASIC devices turned mining into a centralized business, making it increasingly difficult for average individuals to profit from PoW mining.

BTC mining has become more specialized and centralized, raising the barrier to entry and hindering the essence of decentralization. Additionally, Bitcoin's low transactions per second (TPS) and lack of effective scalability make it insufficient for modern financial applications.

Since Ethereum (ETH) transitioned to the Proof-of-Stake (PoS) mechanism [2], many traditional GPU miners have lost stable mining income. Specialized ASIC devices have dominated the traditional Ethash mining market, and large-scale professional mining farms use outdated graphics cards (like RX470). These GPUs, large in scale and centralized like ASICs, create obstacles for ordinary people to participate, further impeding decentralization.

Moreover, large miners with access to cheap electricity resources have further monopolized the mining market, leading to centralization among miners and transactions, leaving ordinary users with virtually no chance to participate.

These issues have resulted in the market lacking a truly fair, decentralized, high-performance, and scalable PoW cryptocurrency. To address these long-standing pain points, we introduce PHICOIN—the PoW High-Performance Infrastructure cryptocurrency, aiming to become a foundational infrastructure for PoW cryptocurrencies.

We envision PHICOIN as a PoW cryptocurrency with high performance, capable of swiftly phasing out outdated equipment while maintaining continuous mining opportunities. It offers fair participation to everyone, allowing individuals to use their own equipment to contribute collectively and maintain the network. This project will belong to all participants, emphasizing complete decentralization and ensuring that the infrastructure is maintained by everyone.

II. Solution

PHI is a high-performance cryptocurrency based on the PoW mechanism. It aims to provide ordinary users with decentralized participation opportunities through an improved and innovative mining algorithm and fair design principles.

PHI's mining algorithm, **Phihash**, is based on the Ethash cache structure and incorporates the randomness of the KawPow/ProgPow algorithms [3]. It uses the Permuted Congruential Generator (PCG) technology to increase the unpredictability of branches. Additionally, we employ lookup table technology to ensure accurate branch hits, further enhancing the algorithm's randomness and resisting replication attacks from ASIC and FPGA devices.

Fig. 1. Bitmain Antminer S21 XP Hydro 473.00 Th/s @ 5676W [4]

An FPGA (Field-Programmable Gate Array) is an integrated circuit that can be programmed after manufacturing to perform specific tasks efficiently, offering flexibility but requiring

specialized knowledge to configure. An ASIC (Application-Specific Integrated Circuit), on the other hand, is a chip designed for a specific purpose, such as cryptocurrency mining, delivering superior performance at the expense of flexibility.

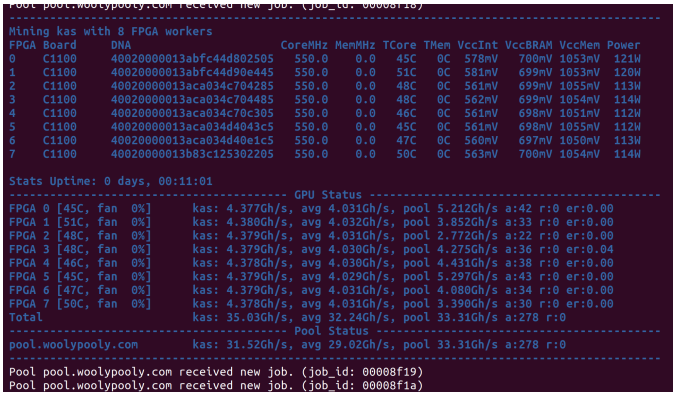

Fig. 2. Xilinx C1100 mining ETHash/ETChash at 4.37Gh/s [5]

The use of FPGA and ASIC devices contributes to the centralization of mining due to several factors. First, the technical barriers to entry are high, as developing and optimizing FPGA configurations or designing ASIC chips requires expertise in hardware programming, chip design, and algorithm tuning. [6] Second, development and operational costs are significant, with ASIC manufacturing involving high upfront capital investment, making it accessible primarily to large organizations. Finally, maintenance and infrastructure requirements—such as specialized cooling systems, power management, and data center facilities—further restrict participation to professional operators with access to industrial-grade setups.

This centralization poses a threat to the decentralized nature of blockchain networks, as large-scale mining farms can dominate the hashrate by leveraging optimized hardware and access to cheap electricity [4]. Such concentration of computational power increases the risk of network control, undermining both security and fairness. PHI aims to mitigate these risks by designing an algorithm that remains accessible to ordinary users with consumer-grade equipment, ensuring equal opportunities for participation and long-term network decentralization.

To achieve fairer participation, we have increased the memory requirement over 4 GB, ensuring that only users with modern GPUs can participate in mining. This approach not only prevents participation from outdated GPUs held by large miners—which are power-hungry, large-scale, and highly centralized, causing resource monopolization—but also effectively reduces their impact on the mining process. [7]

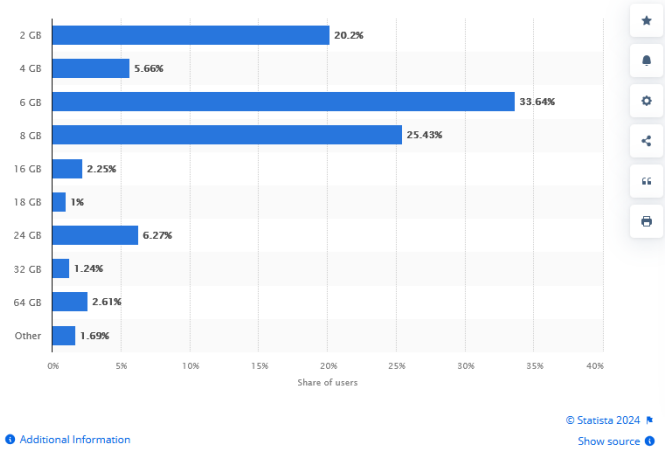

Fig. 3. Video random-access memory (VRAM) share among Steam users as of March 2024

We have also added FP32 logic computation branches in the mining algorithm, fully utilizing the high floating-point computing capabilities of GPUs. FP32 arithmetic has long been the backbone of GPU performance, playing a crucial role in applications from gaming to deep learning. GPUs excel at high-throughput FP32 computations by leveraging their parallel architectures, with thousands of cores capable of simultaneously performing floating-point operations. For example, Nvidia's Pascal architecture (2016) delivered 10.6 TFLOPS of FP32 performance, while more recent architectures like Ampere have pushed FP32 throughput to unprecedented levels. [8]

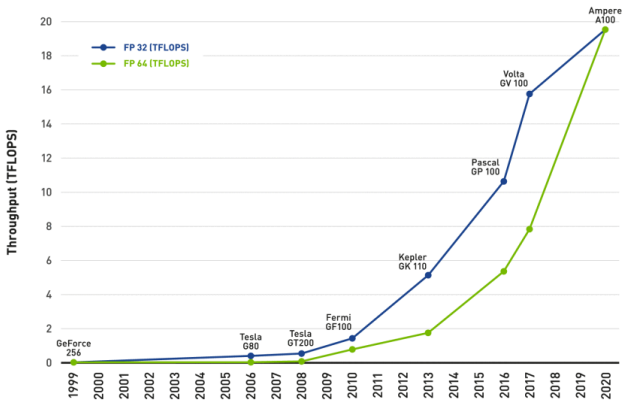

Fig. 4. Single GPU performance scaling [8]

As seen with Huang's Law, which states that GPU performance has been doubling annually since 2012.

Furthermore, GPUs are a consumer-friendly technology, driven by mass-market demand for applications such as VR, 8K, and 16K displays. As these technologies become mainstream, GPUs will become essential parts of personal computing setups, ensuring wide accessibility. This accessibility is crucial for promoting fairness and decentralization in

networks like cryptocurrency mining. When every individual can participate with widely available consumer hardware, it mitigates centralization risks posed by specialized hardware like ASICs.

By incorporating FP32 operations, our mining algorithm not only enhances computational efficiency but also provides gaming users with an opportunity to earn rewards without additional investment. This design taps into the vast installed base of consumer GPUs, encouraging decentralized participation and ensuring that the network remains fair and resilient.

III. Mission and Goals

PHI's mission is:

- **Decentralization and Fair Participation**: Ensure that every user, whether an ordinary gaming PC user or a small miner, can fairly earn rewards in the PHI network.
- **High Performance**: Provide superior transaction speed and performance to meet the needs of modern financial applications.
- **Becoming the Infrastructure for PoW Cryptocurrencies**: Offer high-performance infrastructure for PoW cryptocurrencies, supporting more applications in the future.

IV. Technical Highlights

A. General Information

- **Full Name**: PHICOIN
- **Description**: The PoW High-PerformanceInfrastructure
- **Genesis Block**: The Times 11/06/2024: Donald Trump wins US election 2024 to become 47th president.
- **Symbol**: Φ

B. Blockchain Specifications

- **Block Time**: 15 seconds.
- **Block Size**: 4 MB
- **TPS**: Approximately 1,243 TPS (assuming an average transaction size of 225 bytes)
- **DAG Size**: > 4 GB
- **DAG Increasing**: 25% / year
- **Total Supply**: unlimited
- **Halving**: Yearly
- **Halving Times**: 1

According to Huang's Law, the performance of GPUs has been increasing at a rate faster than Moore's Law. This trend is evident not only in computational power but also in memory capacity. Over the past two decades, the memory capacity of entry-level graphics cards has grown at an impressive average annual rate of 25.64%. In 2004, the NVIDIA GeForce 6200 offered only 64MB of memory, while by 2024, the NVIDIA RTX 3050 boasts 6GB, representing a nearly 100-fold increase.

This rapid evolution in GPU memory and performance is crucial for supporting the demands of modern applications, from real-time rendering and machine learning to blockchain operations and cryptographic computations. PHI Coin leverages these advancements to enhance network scalability, security, and efficiency. With GPUs becoming increasingly powerful, PHI Coin ensures its infrastructure remains future-proof by capitalizing on cutting-edge technologies for mining, encryption, and decentralized computing.

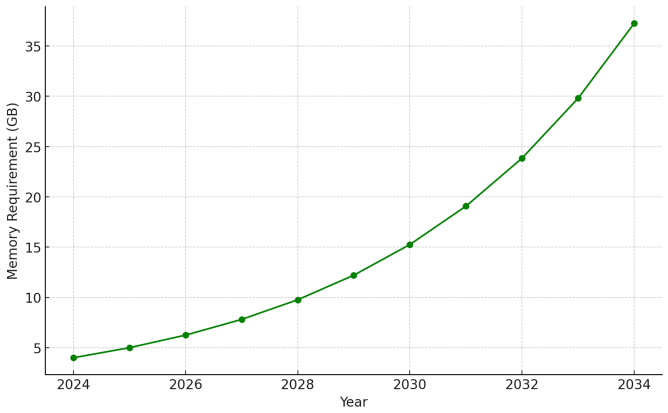

Fig. 5. Evolution of GPU Memory Requirement Over 10 Years

The chart above illustrates the planned evolution of GPU memory requirements for PHI coin mining over 10 years. Starting at 4 GB in the first year, the memory requirement increases by 25% every year, reaching 40 GB by the 10th year.

Unlike Bitcoin's halving model, PHI Coin adopts an alternative approach by increasing hardware requirements over time. Mining activities are always anchored to the memory capacity of entry-level devices, ensuring that as gamers and consumers naturally upgrade their equipment, they remain eligible to participate. This strategy guarantees fair participation across all timeframes, as everyone can access the network equally using readily available consumer-grade hardware.

We encourage continuous participation while phasing out outdated GPUs as the DAG file grows. By gradually raising the memory threshold, PHI coin ensures that miners remain competitive and profitable while maintaining a sustainable and up-to-date mining ecosystem. This thoughtful upgrade cycle not only extends the lifespan of the mining ecosystem but also supports the ecological balance of the network by discouraging outdated and inefficient hardware.

ALL VIDEO CARDS	MAY	JUN	JUL	AUG	SEP	
NVIDIA GeForce RTX 3060	6.19%	5.66%	5.88%	5.51%	5.86%	+0.35%
NVIDIA GeForce RTX 4060	2.82%	3.02%	3.47%	3.41%	4.58%	+1.17%
NVIDIA GeForce RTX 4060 Laptop GPU	2.84%	3.58%	3.21%	4.55%	4.37%	-0.18%
NVIDIA GeForce RTX 4060 Ti	2.31%	2.45%	2.84%	2.90%	3.66%	+0.76%
NVIDIA GeForce GTX 1650	4.52%	4.16%	4.00%	3.91%	3.64%	-0.27%
NVIDIA GeForce RTX 3060 Ti	3.84%	3.56%	3.58%	3.43%	3.57%	+0.14%
NVIDIA GeForce RTX 3070	3.70%	3.36%	3.52%	3.15%	3.31%	+0.16%
NVIDIA GeForce RTX 2060	3.75%	3.40%	3.43%	3.14%	3.30%	+0.16%
NVIDIA GeForce RTX 3060 Laptop GPU	3.37%	3.36%	3.00%	3.50%	3.00%	-0.50%
NVIDIA GeForce RTX 4070	2.46%	2.38%	2.76%	2.52%	2.91%	+0.39%

Fig. 6. Steam Hardware Survey: September 2024

Based on Steam's data, GPUs with 6GB, 8GB and 12GB of memory are increasingly becoming mainstream, reflecting gamers' growing demand for more powerful hardware capable of handling modern titles and higher resolutions. This shift highlights the importance of keeping mining requirements

aligned with these trends, ensuring that participants with popular mid-range and high-end GPUs can continue to mine PHI coin efficiently. [9]

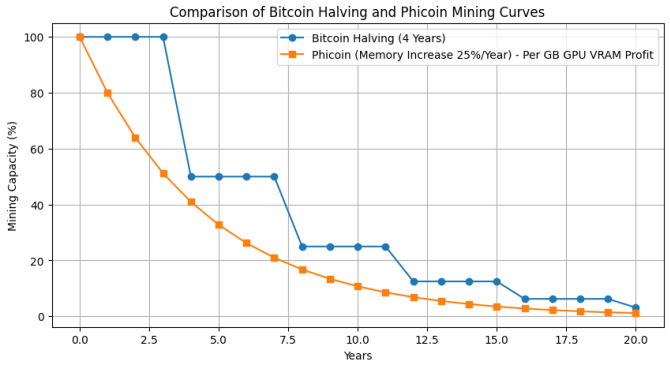

Fig. 7. Comparison of Bitcoin Halving per block and Phicoin Mining Curves per GB vram

This chart compares the mining reward models of Bitcoin and Phicoin over 20 years. The Bitcoin Halving Curve shows that the block rewards decrease by half every four years, resulting in a stepped decline in mining capacity. In contrast, the Phicoin Curve demonstrates that with an annual 25% increase in memory requirements, the mining capacity per GB of GPU VRAM gradually decreases over time.

The Phicoin memory-increase model functions similarly to Bitcoin's halving mechanism in terms of coin supply control. However, Phicoin's model has a unique advantage: the rising baseline hardware requirements align with the natural technology upgrade cycle. As people upgrade to more powerful GPUs for gaming, watching high-definition content, or other computational needs, they naturally acquire the required hardware without incurring additional burdens. This process eliminates outdated equipment and ensures fairness within the network by continuously leveling the playing field.

C. Mining Algorithm: Phihash

Phihash is an innovative Proof-of-Work (PoW) algorithm designed for the Phicoin blockchain. By integrating key features from Ethash and KawPow/ProgPow, it introduces enhancements to improve security, resist ASIC/FPGA mining hardware, and ensure decentralization. Phihash utilizes FP32 floating-point computations, the Permuted Congruential Generator (PCG) for randomness, and an advanced DAG growth mechanism to achieve fairness and efficiency in GPU mining.

1) Key Features of Phihash:

- **ASIC & FPGA Resistance:** Through randomized memory access and floating-point operations, Phihash minimizes the efficiency of specialized mining hardware.
- **Dynamic DAG Growth:** Phihash introduces a 25% exponential DAG growth factor per epoch, gradually phasing out outdated GPUs.
- **Optimized GPU Utilization:** FP32 operations maximize GPU parallel computation capabilities, ensuring fairness and high efficiency.
- **Enhanced Randomness and Entropy:** The use of PCG32 ensures high-quality randomness, crucial for mining fairness.

2) Improved DAG Growth Mechanism: Phihash implements a dynamic DAG growth strategy inspired by Ethash. Unlike the linear growth in Ethash, Phihash employs an exponential growth factor of 1.25 per epoch, ensuring a gradual transition to newer hardware.

Formula for DAG Growth:

$$\text{Items per Epoch} = \text{Initial Size} \times (1.25^{\text{Epoch Number}})$$

Example Calculations:

- **Initial DAG Size:** 4 GB
- **Epoch 1:** $4 \times 1.25 = 5\,\text{GB}$
- **Epoch 2:** $5 \times 1.25 = 6.25\,\text{GB}$

Code Example:

```
double growth_factor = 1.25;
int ethash_calculate_full_dataset_num_items(int
    epoch_number) noexcept {
    double _growth_factor = std::pow(growth_factor
        , epoch_number);
    int num_items_upper_bound = static_cast<int>(
        num_items_init * _growth_factor);
    return ethash_find_largest_prime(
        num_items_upper_bound);
}
```

Code 1. DAG Growth Calculation

3) Randomness with PCG32: Phihash uses the **PCG32** pseudo-random number generator to achieve high-quality randomness and enhance resistance to ASIC/FPGA optimizations. PCG32 ensures unpredictable operations in the mining process, making optimization for specialized hardware more difficult.

PCG32 Workflow:

1) **Initialization:** Seed values are derived from the block header hash, nonce, and epoch context.
2) **Random Number Generation:** High-entropy 32-bit integers are generated using bitwise shifts and XOR operations.

Code Example:

```
class pcg32 {
    uint64_t state;
    uint64_t inc;
public:
    pcg32(uint64_t initstate, uint64_t initseq) :
        state(initstate), inc(initseq) {}

    uint32_t operator()() {
        uint64_t oldstate = state;
        state = oldstate * 6364136223846793005ULL
            + (inc | 1);
        uint32_t xorshifted = static_cast<uint32_t
            >(((oldstate >> 18u) ^ oldstate) >> 27
            u);
        uint32_t rot = static_cast<uint32_t>(
            oldstate >> 59u);
        return (xorshifted >> rot) | (xorshifted
            << ((32 - rot) & 31));
    }
};
```

Code 2. PCG32 Implementation

Advantages of PCG32:

- High-quality randomness with minimal memory requirements.
- Efficient computation on modern GPU hardware.

4) FP32 Computations for GPU Optimization: Phihash integrates **FP32 (single-precision floating-point)** computations to exploit the high parallelism of modern GPUs. This ensures that:

- GPU miners achieve maximum efficiency.
- Mining remains accessible and fair for ordinary users with modern GPUs.

Example FP32 Operations:

- Trigonometric functions like $\tanh$, $\sin$, and $\cos$.
- Randomized addition, multiplication, and division.

These operations increase the computational complexity of the algorithm, reducing the advantage of ASICs and FPGAs.

5) PhiHash Algorithm: The **PhiHash** algorithm is designed to enhance security and decentralization in the Phicoin blockchain. It consists of several key steps, which are mathematically described as follows:

1) **Initialization of Keccak State:** Initialize the Keccak state using the block header hash and nonce:
$$\text{Keccak\_state} = \text{InitializeKeccak}(\text{header\_hash}, \text{nonce})$$
2) **Generation of Mix Seed:** Generate a seed for the mix array:
$$\text{Seed} = \text{GenerateSeed}(\text{Keccak\_state})$$
3) **Initialization of Mix Array:** Initialize the mix array using the generated seed:
$$\text{Mix} = \text{InitializeMix}(\text{Seed})$$
4) **Mixing Rounds:** Perform a series of mixing rounds to enhance randomness and security. For each round i from 1 to 64:
$$\text{Mix} = \text{MixRound}(\text{Mix}, \text{epoch\_context})$$
5) **Finalization of Hash:** Compute the final hash using the Keccak function:
$$\text{Final\_hash} = \text{Keccak}(\text{Mix})$$
6) **Output:** The final hash is returned as the result of the PhiHash algorithm.

6) Security and Decentralization: Phihash enhances the security and decentralization of the Phicoin blockchain by:

- **Reducing ASIC/FPGA Advantage:** Randomized memory access patterns and FP32 computations reduce the efficiency of specialized mining hardware.
- **Promoting Decentralized Participation:** By requiring GPUs with at least 4 GB of VRAM, Phihash ensures broad participation while phasing out outdated hardware.

Key Benefits:

- Enhanced network security through high entropy and randomness.
- Fair mining opportunities for ordinary GPU users.

7) Advanced Features of Phihash:

- **Memory Optimization:** Efficient use of DAG-based operations and randomized cache access patterns to utilize GPU L1 and L2 caches.
- **Exponential DAG Growth:** The 25% growth factor per epoch ensures long-term sustainability while gradually increasing hardware requirements.

V. Tokenomics

A. Coin Emission & Inflation Control

PHI's supply strategy ensures that 100% of the tokens are generated through mining, adhering to the principle of fair distribution. To maintain long-term sustainability and encourage continuous participation, PHI is designed as an unlimited-supply cryptocurrency. However, to control inflation after the second year, we introduce a carefully structured issuance plan.

In the first month, PHI will launch a Testing Mining phase, focused on testing internal blockchain parameters and stability. During this phase, the network will use the Kawpow algorithm to resist ASIC mining, ensuring a fair start for all participants. At the end of this phase, 210,240,000 PHI will be distributed to all participants based on their contributions during testing.

Once the mainnet goes live, the PHI earned during the Testing Mining phase will be fully allocated to participants. Following the mainnet launch, the issuance schedule is as follows: - First year: Each block generates 5 PHI. - Second year: Block rewards halve to 2.5 PHI. - Subsequent years: Block rewards stabilize at 2.5 PHI, without further reduction.

This issuance plan ensures a controlled inflation rate after the Testing Mining phase. The inflation rates for the first three years are: - 4.76% after the first year, - 2.32% after the second year, - 2.22% after the third year.

These inflation levels are carefully calibrated to foster sustainable growth, ensuring the longevity and viability of the PHI project. Block rewards start at 5 PHI per block, halving in the first year, and then remaining fixed 2.5 PHI per block. This design aims to incentivize early participants by increasing the initial supply and gradually reducing inflation to achieve supply stability, forming a more predictable supply structure.

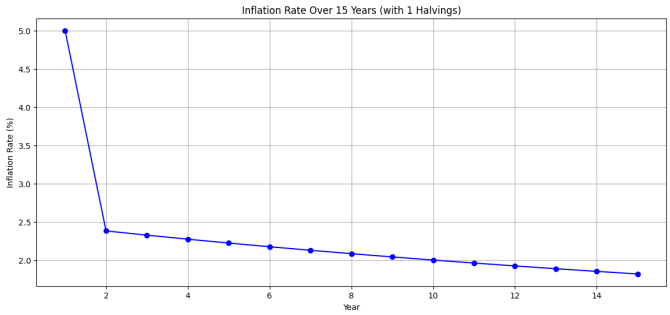

Fig. 8. Phicoin's Inflation Rate Over the Next 15 Years

By gradually reducing the minting amount and block rewards, PHI provides strong incentives for early adopters

while ensuring a low-inflation stable model in the long term, supporting the healthy ecological development of the currency.

B. Coin Distribution

All PHI tokens are generated exclusively through mining, ensuring that the network remains decentralized and fair. 95% of the mined tokens are allocated directly to miners, creating a robust incentive structure that rewards participants and ensures fairness.

To support the essential operations of the project, PHI collects a 5% mining fee, which is allocated as follows: - 3% is dedicated to maintaining core infrastructure, including the operation of fundamental nodes, blockchain explorers, and continuous airdrop activities to foster engagement and participation. - 2% is reserved for developer incentives, encouraging innovation and continuous improvements within the ecosystem.

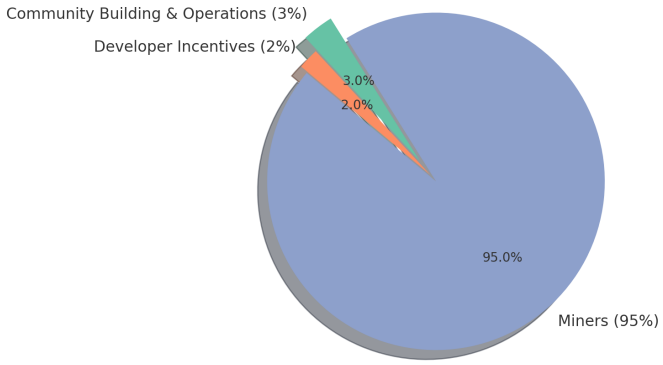

Fig. 9. Phicoin Distribution

Importantly, these coins are not distributed all at once. Instead, they are gradually released alongside mining activities, ensuring sustainable development and incentivization over the long term. We are committed to fostering an environment of fairness and sustainable growth, ensuring that PHI is a decentralized, participatory project.

We aim to ensure continuous mining opportunities for the community. Even after the second halving, Phicoin's issuance will not converge to zero. As the size of the DAG file increases, older, less efficient GPUs will naturally phase out, allowing miners with newer hardware to remain profitable. Our vision is to create a dynamic ecosystem where innovation and sustainability thrive, ensuring that both early supporters and long-term participants can benefit from mining PHI for years to come.

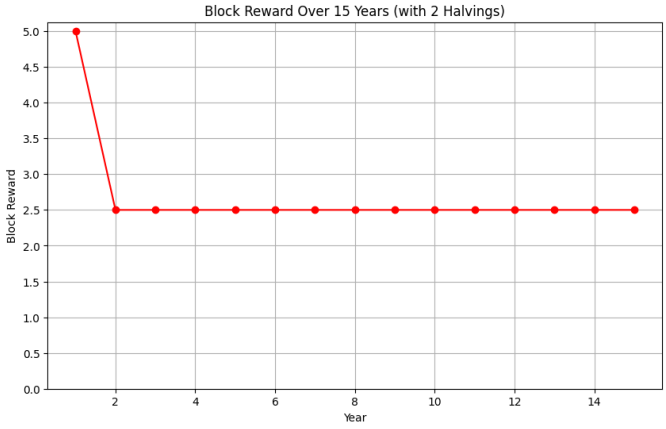

Fig. 10. Block rewards for each block over the next 15 years

VI. Roadmap

A. Phase 1: Testing Mining Phase

Launch the Testing Mining pool using the Kawpow algorithm for 14 days to create a fair starting point for all participants. This phase focuses on testing network parameters and stability, ensuring a robust and decentralized foundation for the PHI blockchain.

B. Phase 2: Launch Phase

Deploy the mainnet along with core infrastructure, including the blockchain explorer and wallets (desktop, web versions). To enhance user accessibility, a web wallet will also be developed, making it easier for users to manage and interact with Phicoin.

C. Phase 3: Phicoin Listings

Phicoin will seek to list on trading platforms to provide liquidity and value realization for miners' rewards. In this phase, we aim to list Phicoin on at least one small exchange and one mid-sized exchange. This will help miners convert their mining output into tangible value while expanding the accessibility of Phicoin.

D. Phase 4: Establishment of Phi Lab Foundation

Create a non-profit research institution, the Phi Lab Foundation, dedicated to researching decentralized protocols. This includes developing innovative solutions such as decentralized DNS (DDNS) [12] and decentralized AI systems to further expand the use cases and utility of Phicoin.

E. Phase 5: Development of Decentralized Applications (DApps)

Develop and deploy decentralized and innovative applications powered by Phicoin. This includes applications like the decentralized DNS protocol (DDNS) to showcase the blockchain's ability to support next-generation infrastructure for a decentralized internet.

F. Phase 6: Cross-Chain Bridges

Establish cross-chain bridges between Phicoin and major blockchain networks such as Solana and Ethereum. These bridges will enable Phicoin integration with decentralized exchanges (DEX), enhancing liquidity and use cases across multiple blockchain ecosystems.

G. Phase 7: Decentralized AI Applications and Protocols

Develop and deploy decentralized AI-powered applications and protocols on the Phicoin blockchain. These solutions will leverage Phicoin's infrastructure to create cutting-edge, decentralized AI services and protocols, further demonstrating the versatility and scalability of the Phicoin ecosystem.

H. Note on Centralized Exchange (CEX) Listings

Listing on centralized exchanges (CEX) can be costly, requiring both substantial funds and coins. While we will explore the option of accepting donations to facilitate CEX listings, our primary focus is on building a strong and efficient network. We believe that with a robust user base and well-developed infrastructure, PHI can thrive as a sustainable, evergreen PoW project. It will offer a fair participation option to all cryptocurrency enthusiasts and establish itself as a viable alternative in the blockchain ecosystem.

We hope that PHI can become an excellent PoW choice, encouraging CEXs and market makers to proactively integrate PHI into their platforms.

VII. Future Outlook

In the short term, we aim for PHI to develop into a GPU-based mining project that offers continuous and sustainable rewards. The name PHI originates from the Greek letter PHI, which symbolizes the golden ratio, a representation of perfection and harmony. PHI is designed to be fair, high-performance, and capable of sustainable generation, ensuring that participants—regardless of their size or resources—can benefit equitably from the network.

In the long term, we envision PHI becoming a foundational infrastructure in the world of Proof-of-Work (PoW) cryptocurrencies. We aspire to expand the meaning and scope of Phicoin beyond its current framework. Through our academic research institution, Phi Lab Foundation, we aim to explore and develop innovative applications such as decentralized domain name resolution protocols (DDNS) and decentralized AI protocols.

In this vision, the "**I**" in PHI comes to stand for **I**nfrastructure, **I**nnovation, and **I**ntelligence, reflecting our commitment to creating a versatile and forward-thinking ecosystem. PHI is not only a cryptocurrency but also a symbol of future possibilities in decentralized systems and cutting-edge technology.

Lastly, my favorite quote encapsulates our project: *We (the PoW miners) will never go out of style.*

VIII. Acknowledgments

Sincere thanks to Bitcoin (BTC), Ethereum (ETH), and Ravencoin (RVN) for pioneering the Proof-of-Work (PoW) mechanism, providing a solid foundation for GPU mining, and expanding the usability of classic blockchains. We would also like to express our heartfelt gratitude to the Phicoin community, including miners and users, for their continuous support. Your passion and trust have been instrumental in driving Phicoin's growth into a more secure and efficient decentralized domain name service platform.

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