A SUSTAINABLE FUTURE: EXAMINING ETHEREUM'S POST-MERGE

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ABSTRACT

The merge of Ethereum's Proof of Stake(POS) and Proof of Work(Pow) network is symbolized by the Ethereum merge, a significant development in the field of blockchain technology. This study explores the complex effects of this important shift on the Ethereum network and larger blockchain ecosystem.

Keywords: Ethereum, Beacon Chain, Danksharding, Shanghai Upgrade, Merge, Validators, Miners.

I.　INTRODUCTION

On 15 September 2022 Ethereum's transition from Proof of Work(Pow) to Proof of Stake(Pos) consensus mechanism, knowns as the Ethereum Merge(Ethereum 2.0)This pivotal shift has reverberated through the blockchain space , raising critical questions about the broader implications for network performance, sustainability, and industry standards. Ethereum originally operated using Proof of Work(PoW)consensus mechanism .To participate in Ethereum network, users send transactions from their wallets to execute functions or transfer Ether(ETH), the native cryptocurrency. Miners , who specialized nodes in the network, validate these transactions. Miner compete to validate and package these transactions into blocks. They use computational powers to solve complex cryptographic puzzles, which as called as Proof of Work(PoW).The process of mining is highly competitive as multiple miners are racing to find the solution to the puzzle . This competition is what ensure the security and integrity of the networks. Miners are rewarded with newly created ether(block reward) and transaction fees for their efforts. These rewards incentivize miners to continue validating transactions and securing the network.

II.　METHODOLOGY

We start by giving a through rundown of the Ethereum merging, outlining the goals and underlying principles of this significant project . As Ethereum moves from proof-of- Work (POW) to Proof-of-stake (pos) consensus mechanism , the study investigates the energy consumption , scalability , and security . we'll also discuss about merge's additional effects, including as miner's and validators incentive income and Beacon chain deposit and withdrawal.

III.　MODELING AND ANALYSIS

Merge means transition from original Proof of Work (Pow) consensus mechanism to the more environmentally friendly Proof OF stake (PoS).

1) Environmental Sustainability:

One of the primary motivation for Merge is to address the environmental concerns associated with POW . In POW system as miners compete to solve the complex problem which demands substantial computational power and consumes a significant amount of electricity. POW has also faced criticism for its carbon footprint and inefficiency ,by moving to POS ,Ethereum aims to dramatically reduce its energy consumption and environmental impact.
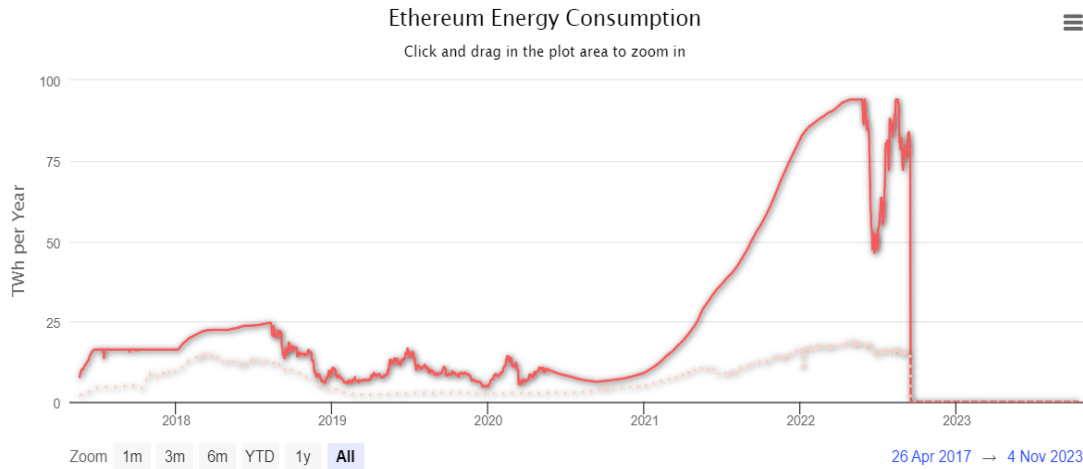
Figure 1: Electricity consumption of the Ethereum network (Digicomomist).

By transition to PoS (Proof of Stake) Ethereum has atleast 99.84% less of a need for electrical energy.

2) Scalability:

Ethereum has faced issues with network congestion, high gas fees , and low transaction times, especially during periods of high demand. To scale the Ethereum need more transactions per seconds , coupled with more nodes. The merge paves a way for network improvement and scalability through mechanisms like Danksharding which will allow Ethereum to process more transaction and smart contract in parallel, leading more efficient and responsive network. Layer 2 rollups scale Ethereum by moving transaction off-chain and only posting summary data to Ethereum. The rollups that started with Poto-Danksharding Is fully realized with Danksharding. Massive quantities of Ethereum space will be available for rollups to store their compressed transaction data thanks to Danksharding . This implies that Ethereum will be easily support hundreds of different rollups and enables millions of transaction per second.
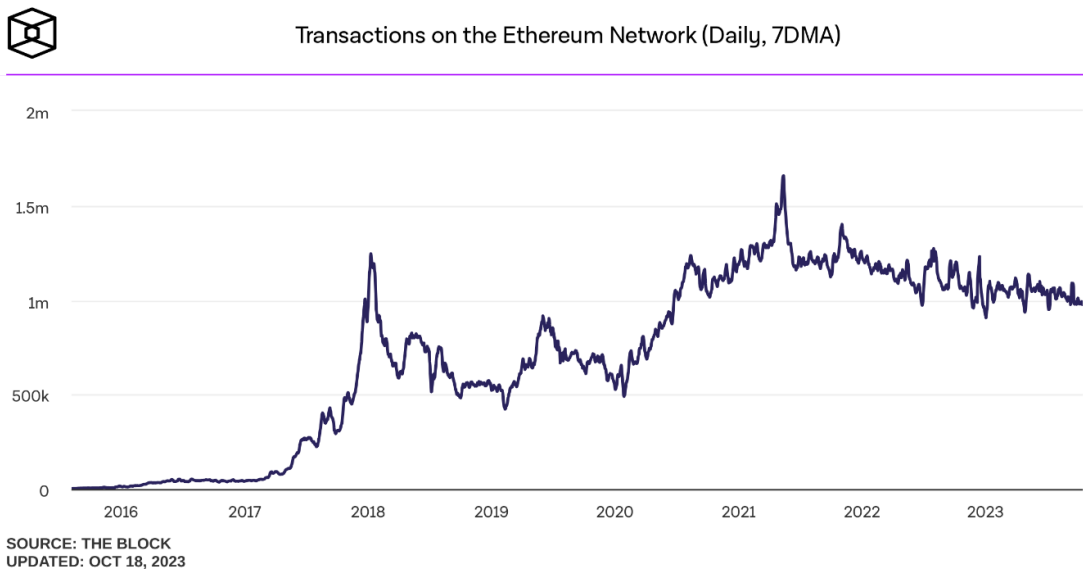
Figure 2: Transaction on the Ethereum network (Block)

Pow had limitations in terms of transaction processing speed and throughput . It could handle limited number of transaction per seconds, But with introduction of shard chain as a part of Ethereum 2.0, the network's transaction processing capacity is expected to increase significantly. The graph shows 7-day moving average.

3) Security and Decentralization:

Proof of Stake(POS) and Proof of work(POW) are two approaches to the same general problem, which is to assist the decentralized network in securely reaching consensus. Proof of Stake (POS) switches miners with validators, where validators have to stake their ETH as collateral , If they validate transaction correctly and

follow the network's protocol they earn reward in the form of additional ETH. However if they misbehave or make error they can be penalized by having some of their staked ETH slashed. Unlike Miners ,validators don't compete to create block instead they are chosen randomly by an algorithm.

4) Miner and Validator Reward :

Validators reward are significantly less than the mining reward that were previously issued under Proof of Work (2ETH every 13.5 seconds) as operating a validator node does not as economically intense and thus does not require or warrant as high reward.
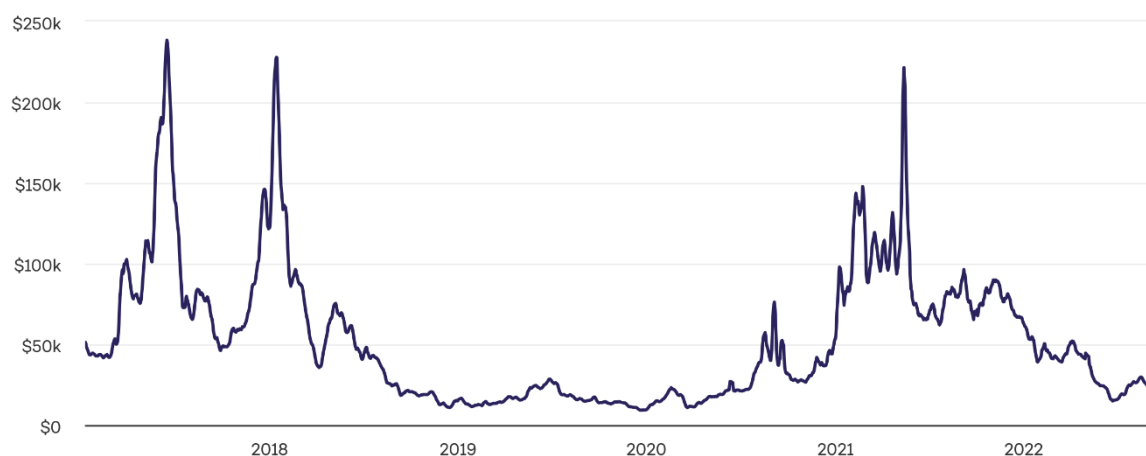

Figure 3: Miner reward (coinWarz).

Figure 4: Ethereum Miner reward (Block).

Daily miner revenue divided by TH/s for Ethereum network . This metric trends down over time but shifts from trendline indicate more/less profitable period for miners(Due to increase price, transaction fees or favorable difficulty) chart use 7-day moving average. On 15 September 2022, Ethereum changed consensus model and this metric became obsolete.
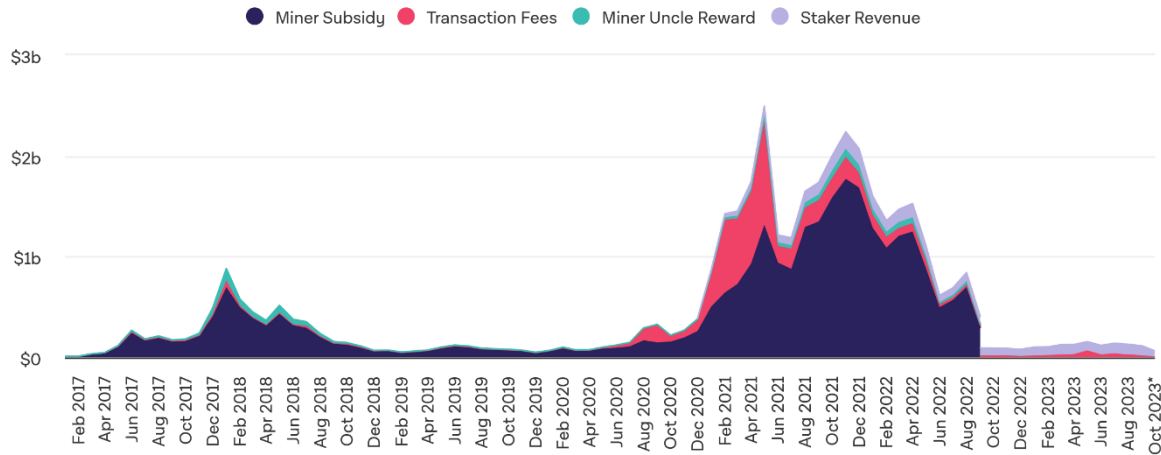
Figure 5: Ethereum Block validator Revenue (Block)

5) Pre and post merge issuance /inflation breakdown:

Using 14,000,000 total ETH staked , the rate of ETH issuance is approximately 1700 ETH/day.

Results in ~620,500 ETH issued in a year.

Results in inflation rate of approx. 0.52%

Figure 6: issuance pre merge

Since POW is no longer a valid means of block production under the upgrade rules of consensus . All execution layer activity is packaged into Beacon block which are published attested to by POS validator.

Total ETH supply :~120,520,000ETH (at the time of merge).

Execution layer issuance:0 .

Consensus layer issuance : same as above ~0.52%.

Figure 7: Issuance post-merge
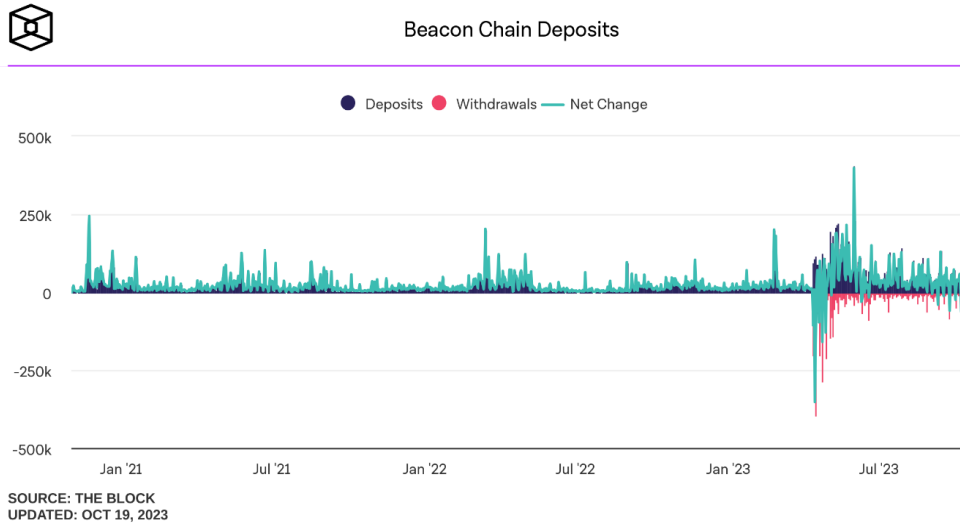
6) Beacon chain Deposit and withdrawals:

Beacon chain is fundamental component of Ethereum 2.0, Beacon chain Is separate POS blockchain running in parallel with existing Etherum POW chain. It is responsible for coordinating the actions of validators within the POS system. Beacon chain randomly select validators to propose and attest to block on shard chain and thus helps secure these chains.

Beacon chain manages the issuance of new ETH to validator as a reward for their participation in securing network. It also manages the penalty known as slashing .

Figure 8: Beacon Chain deposits and withdrawal (Block)

The daily number of ETH deposit into Beacon chain address versus the number of ETH withdrawn from beacon chain . Withdrawal were enabled on April 12th with the launch of the Shapella upgrade.

7) Myth of Merge:

i) The merge will reduce Gas fees:

Gas price are results of network demand in relation to network capacity. Although the Merge replace POS consensus with POW, it made no appreciable changes to any of the factor that directly affect capacity of network.

ii) The merge enables staking withdrawal:

Initially staker access to tips and MEV that were earned as result of block proposals. This rewards were credited to non -staking account of validators and are available immediately.

Since the Shanghai / Capella network upgrade , staker can now designate a withdrawal address to start receiving automatic payouts of any excess staking balance (ETH over 32 from protocol reward). This upgrade also enable validators to reclaim its entire balance upon existing from the network.

IV.   CONCLUSION

This research paper bridges the gap between technology and its practical implications by offering a multidimensional understanding of the significance of the Ethereum merge through the combination of quantitative analysis and qualitative insights. The Ethereum merge is catalyst for development of entire blockchain industry , not just a change to one network . With this study we hope to shed light on the significance ramification of this shift and add to the current conversation about the direction that decentralization system and digital innovation are taking.

V.   REFERENCES

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