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Ethereum: The Merge

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Research and Insights

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Contents

Executive Summary

This report is an overview of the Ethereum's The Merge.

- The Merge was finally completed on 15 September 2022. It is Ethereum's transition to a Proof-of-Stake consensus mechanism and proponents expect it to set the stage for significant improvements in scalability.

- Ethereum's **energy consumption is expected to drop by ~99.95%** after The Merge, as the conditions for a computational power arms race are removed.

- Some common misconceptions about The Merge are that it will reduce gas fees and significantly increase transaction speeds. But it is the first step toward potential future upgrades and scaling activities that will address these issues.

- The Merge is expected to have a great impact on Ethereum's tokenomics, and potentially cause ETH to become deflationary. It will greatly reduce ETH issuance.

    - Before The Merge, approximately 13,000 ETH is issued daily for miner rewards, while 1,600 ETH is issued for staking rewards.

    - After The Merge, only the 1,600 ETH for staking rewards (rewards for validators who attest to and propose blocks) will remain. This implies that the **total new ETH issuance will decrease by around 90%** after The Merge.

- The Merge combined with the EIP-1559 burn mechanism is expected to cause a 'triple halving' effect, approximately equivalent to the effect of three Bitcoin halvings. **The ETH inflation rate is expected to reduce from 4.3% to 0.43%** after The Merge. This has also led to many people calling ETH 'ultra-sound money'.

- Layer-2 solutions are expected to remain useful and relevant after The Merge, and even after The Surge (sharding), which is the next step after The Merge. According to the Ethereum Foundation, sharding will enable layer 2 solutions to offer even lower transaction fees while leveraging the security of Ethereum. The Merge and sharding are expected to work synergistically with layer-2 rollups to supercharge the scalability of Ethereum.

1. What is The Merge?

Ethereum's The Merge was finally completed on 15 September 2022. It is the most significant upgrade in Ethereum's history and one of the most anticipated events in the cryptosphere. The Merge has been dominating the headlines, but what exactly is it and its impact?

1.1 Transition to Proof-of-Stake

The Merge is the Ethereum blockchain's **transition to a Proof-of-Stake (PoS) consensus mechanism from Proof-of-Work (PoW).** Blockchains use consensus mechanisms to produce new blocks of transactions and verify that they are correct before posting them to the blockchain.

- PoW requires miners to compete with each other using computational power to produce blocks that contain transactions. This requires solving a complex mathematical puzzle using special and expensive computer hardware (also known as mining rigs). The first miner to solve the puzzle gets to produce a new block; the block is then posted to the blockchain once it has been verified as correct by other node operators, and the miner is rewarded with native coins of the blockchain (in Ethereum's case, ETH).

- In PoS, instead of miners, **validators** produce and verify new blocks of transactions. To participate in this process, validators must **stake** an amount of native coin as collateral.

- **Instead of competing to produce new blocks, an algorithm chooses which validator gets to propose a new block of transactions.** Once a certain number of other validators have verified that the transactions are correct, the blocks of transactions are posted to the blockchain. Validators are then rewarded with native coins. Those who fail to validate (e.g., by going offline) or validate malicious transactions may have the collateral that they staked taken away.

Ethereum's transition to PoS is called The Merge because, in practice, it will happen when Ethereum developers **merge** Ethereum's mainnet (which is PoW) with the Beacon Chain (a separate PoS blockchain that the developers have set up to facilitate the transition).
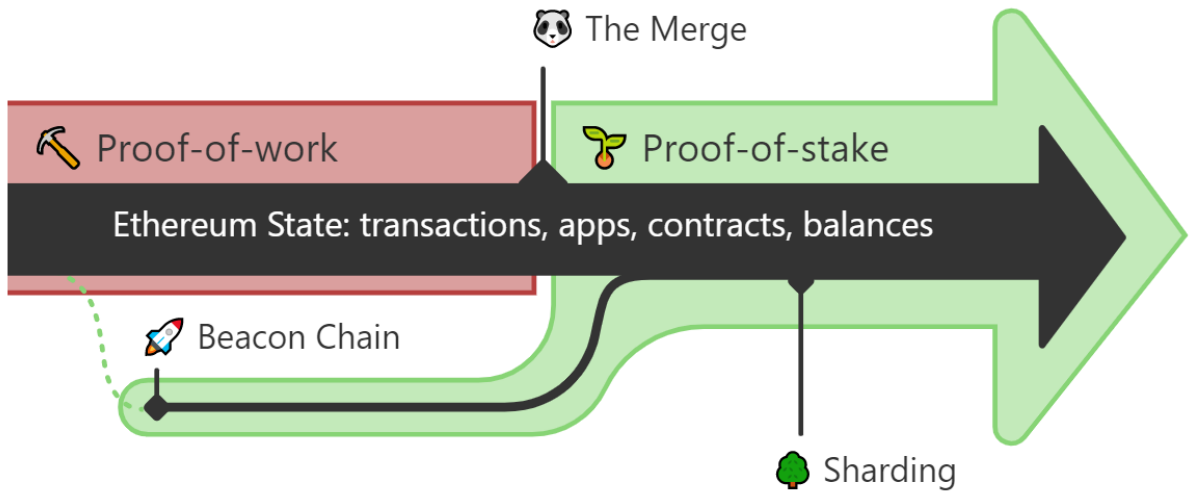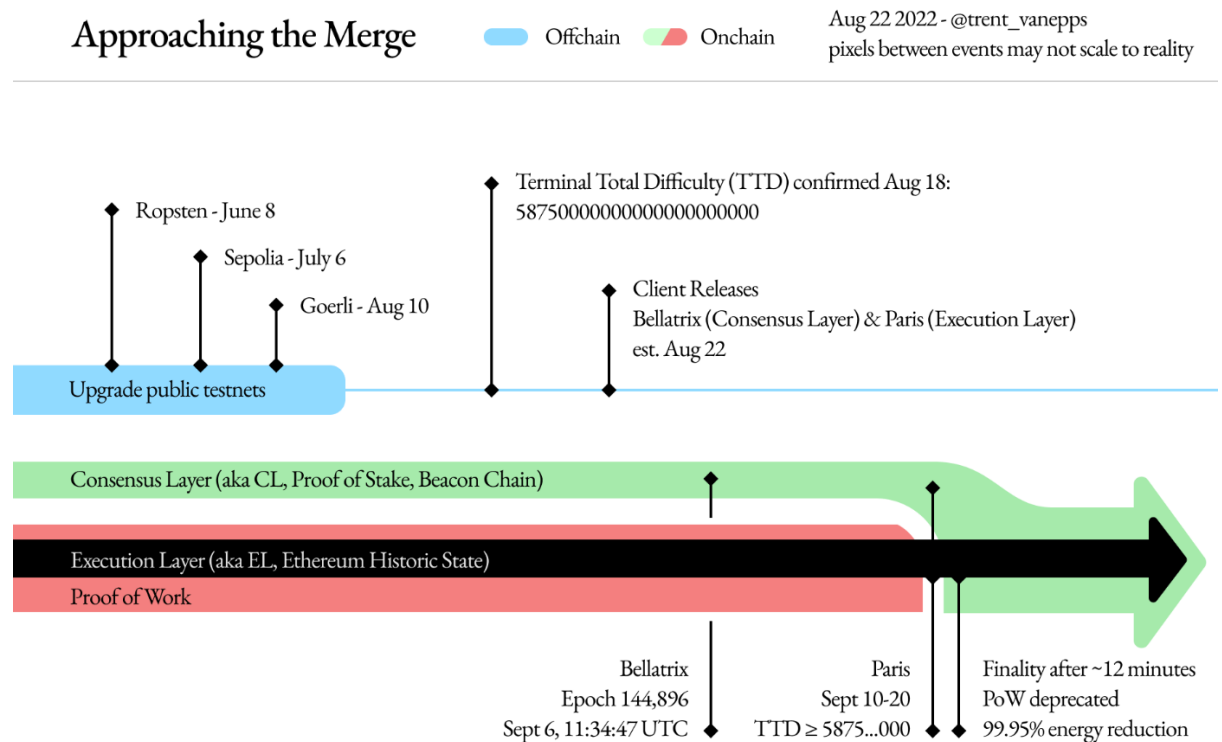
Source: ethereum.org

Notable upgrade and test milestones on the journey to The Merge include:

Upgrade/Test	Date	Description
Beacon Chain launch	Dec 2020	Launch of the first PoS blockchain
London hard fork	Aug 2021	Includes changes to how transaction fees are determined
Altair upgrade	Oct 2021	Includes fixing validator incentive issues and increasing penalties
Arrow Glacier upgrade	Dec 2021	Delays difficulty bomb (network setting that makes PoW mining more difficult)
Kiln testnet merge	Mar 2022	Uses testnet Kiln to test the transition from PoW to PoS
Multiple shadow forks	Apr-Sep 2022	Stress-tests to ensure network safety during permanent upgrades
Ropsten testnet merge	Jun 2022	Uses testnet Ropsten to test transition from PoW to PoS
Gray Glacier upgrade	Jun 2022	Delays the difficulty bomb again
Sepolia testnet merge	Jul 2022	Uses testnet Sepolia to test the transition from PoW to PoS
Goerli testnet merge	Aug 2022	Uses testnet Goerli to test the transition from PoA (Proof-of-Authority) to PoS

The Merge itself happens in a two-step process. The first step, called the Bellatrix upgrade, is a network upgrade on the Beacon Chain (also known as the consensus layer) triggered by an epoch height. This was launched on 6 September 2022.

The second step, called Paris, is when the PoW mainnet (also known as the execution layer) transitions to PoS. It is triggered upon the terminal total difficulty (TTD) hitting the specific threshold of 58750000000000000000000. TTD is a cumulative measure of the total mining power that has gone into building the chain. When this trigger occurs, the next block will be created using PoS, marking the beginning of Ethereum as a PoS blockchain. Paris was completed on 15 September 2022.

Source: ethereum.org

1.2 Setting the Stage for Scalability

One of the blockchain holy grails is solving the **Blockchain Trilemma**, a theory that says a blockchain can only achieve two of the following three: **security, decentralisation, and scalability**.

Read more about the Blockchain Trilemma

Currently, Ethereum is plagued by scalability issues. **High demand is congesting the network**, resulting in slow transaction speeds and high transaction fees (i.e.,

gas fees). These issues make Ethereum impractical to use for the vast majority of people. Ethereum's vision is to become more scalable—arguably the most important factor for reaching more users—and secure, but remain decentralised.

Ethereum needs to be able to process more transactions per second, but without increasing the size of the nodes in the network, according to the Ethereum Foundation. Therefore, it needs more nodes, which could also mean better security and decentralisation.

- Proponents of PoS say that because of the lower barriers to entry for validators (i.e., no need to invest in expensive computer hardware as miners do in PoW), there is less chance of a few validators dominating the validation process, making the network more decentralised and also more secure from, for example, a 51% attack.

- Detractors point out, however, that validators with more ETH staked as collateral could have higher odds of being chosen, meaning that those with access to larger reserves of ETH could still have an outsized influence.
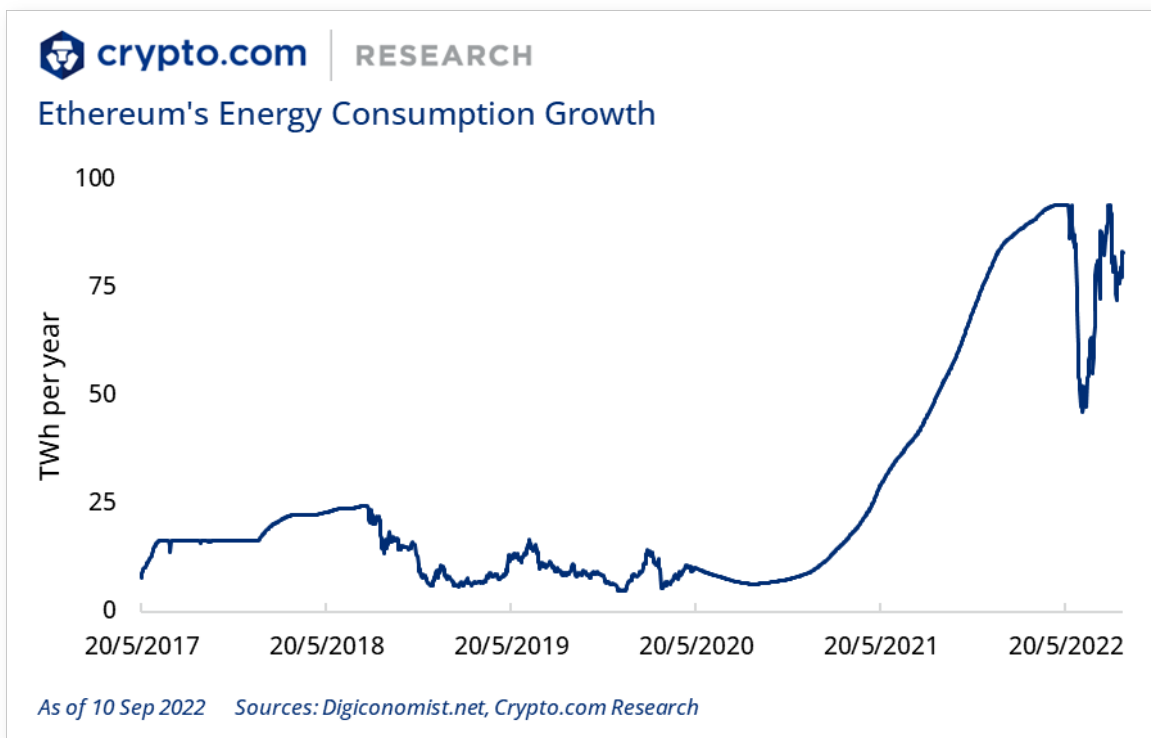
It is important to understand that the transition to PoS does not immediately solve the scalability issues. Instead, **PoS is the necessary prerequisite for future upgrades that are not possible under PoW,** namely potentially relieving network congestion and therefore significantly increasing transaction speed and reducing gas fees. One of these future potential upgrades is **sharding**, which aims to spread the data storage across multiple chains.
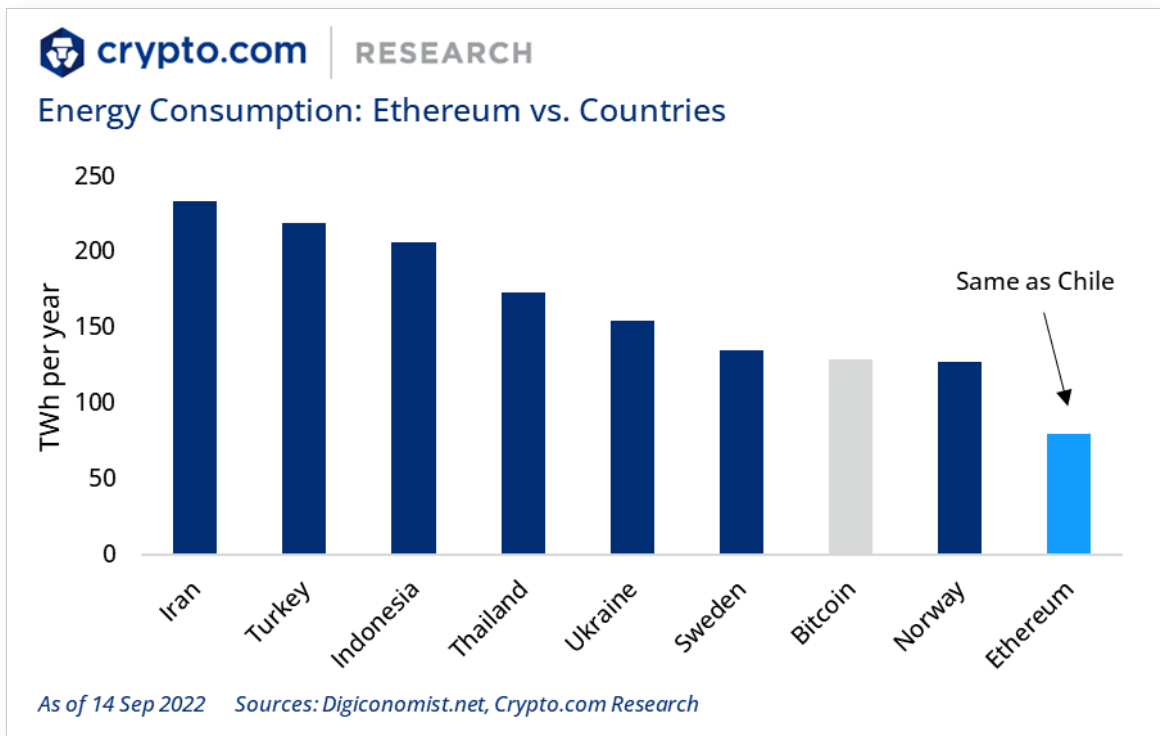
Read more about sharding

1.3 Reducing Energy Consumption

Growing crypto adoption and the enormous increase of applications that utilise the Ethereum blockchain, such as those related to DeFi, NFTs, the Metaverse, and GameFi, have resulted in surging transactions.

Increasing the amount of computational power by acquiring more powerful computer hardware is critical for miners to win the competition in PoW to create the next block. However, this comes at a cost to the environment, in the form of **increased energy consumption and computer hardware waste.** Ethereum's annual energy consumption has grown to 80.06 terawatt hours (TWh), a more than tenfold increase compared to 7.75 TWh in May 2017.

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Ethereum's Energy Consumption Growth

As of 10 Sep 2022   Sources: Digiconomist.net, Crypto.com Research

Currently, Ethereum's PoW blockchain has an **appetite for energy similar to that of a whole country.** At the time of writing, according to estimates by Digiconomist, Ethereum has an annual electrical energy consumption equal to that of Chile and an annual carbon footprint that is in parallel with Hong Kong at 44.65 Mt CO2. A single Ethereum transaction has the same carbon footprint as 253,860 Visa card transactions or 19,090 hours of watching YouTube.

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Energy Consumption: Ethereum vs. Countries

As of 14 Sep 2022   Sources: Digiconomist.net, Crypto.com Research

After the transition to PoS, Ethereum's energy consumption is estimated to reduce by ~**99.95%**. This is because the PoS mechanism does not require miners to compete with each other to produce the next block of transactions. There is no incentive for miners to invest in more powerful computer hardware. Instead, validators can use normal laptops and desktops.

The ~**99.95% reduction would bring Ethereum's energy consumption to less than 0.05 TWh per year.** This is significantly lower than gold mining at 240 TWh per year, Bitcoin (which uses PoW) at 129 TWh per year, and Paypal at 0.26 TWh per year, according to estimates from Digiconimist and the [Ethereum Foundation](#).

1.4 What The Merge Is Not

The Merge is one of the most exciting events in the crypto sphere and is expected by its proponents to set the stage for significantly improving the fundamentals of the Ethereum blockchain. However, according to the [Ethereum Foundation](#), there are some **common misconceptions about The Merge**.

- **It will reduce gas fees.** Gas fees are a function of network demand relative to network capacity. The Merge is a change in the consensus mechanism, not an expansion of network capacity. However, transitioning to PoS is necessary for other upgrades, such as [sharding](#) and scaling activities (e.g., [Layer-2 rollups](#)) that may help to reduce gas fees.

- **It will noticeably increase transaction speeds**. Under PoS, new blocks will be produced only around 10% more frequently compared to PoW. This is insignificant and not likely to be noticed by users. However, PoS is a prerequisite for potential future upgrades that may help to increase transaction speeds significantly.

- **Running a node requires staking 32 ETH**. There are two types of Ethereum nodes: those that propose blocks and those that don't. Nodes that propose blocks currently do have to stake 32 ETH. The other nodes, who help to verify the validity of new blocks, do not have to stake anything.

- **It will result in downtime of the chain.** The Merge has been designed to have zero downtime. It will be triggered by the TTD reaching a specific threshold. When this trigger occurs, the next block will be created using PoS.

- **Staked ETH can be withdrawn once The Merge occurs.** Staking withdrawals will not be possible with The Merge. Withdrawals are planned to be enabled with the Shanghai upgrade, which is the next major upgrade following The Merge.
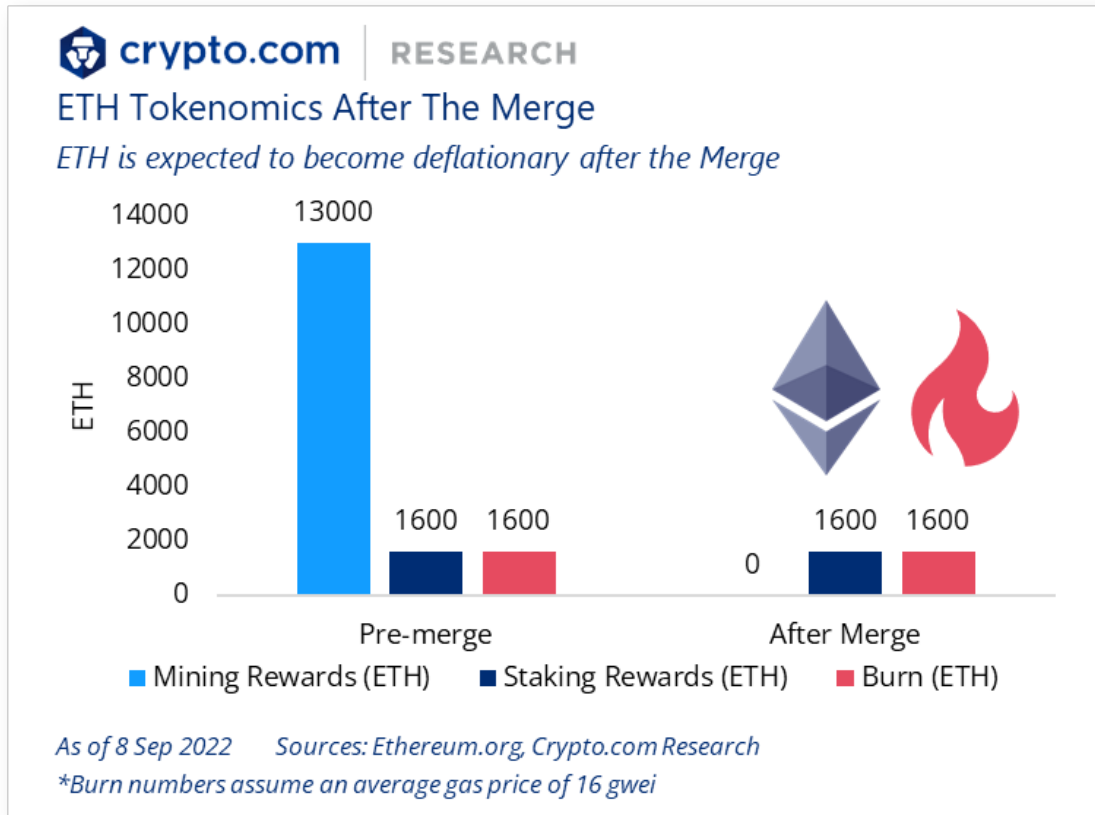
2. Effects of The Merge

2.1 Tokenomics After The Merge

The Merge is expected to have a great impact on Ethereum's tokenomics, and potentially cause ETH to become deflationary. Overall, the ETH supply is mainly controlled by two primary forces: issuance and burn.

The Merge will greatly reduce ETH issuance. Before The Merge, approximately 13,000 ETH is issued daily for miner rewards, while 1,600 ETH is issued for staking rewards. In other words, the total daily issuance is 14,600 ETH.
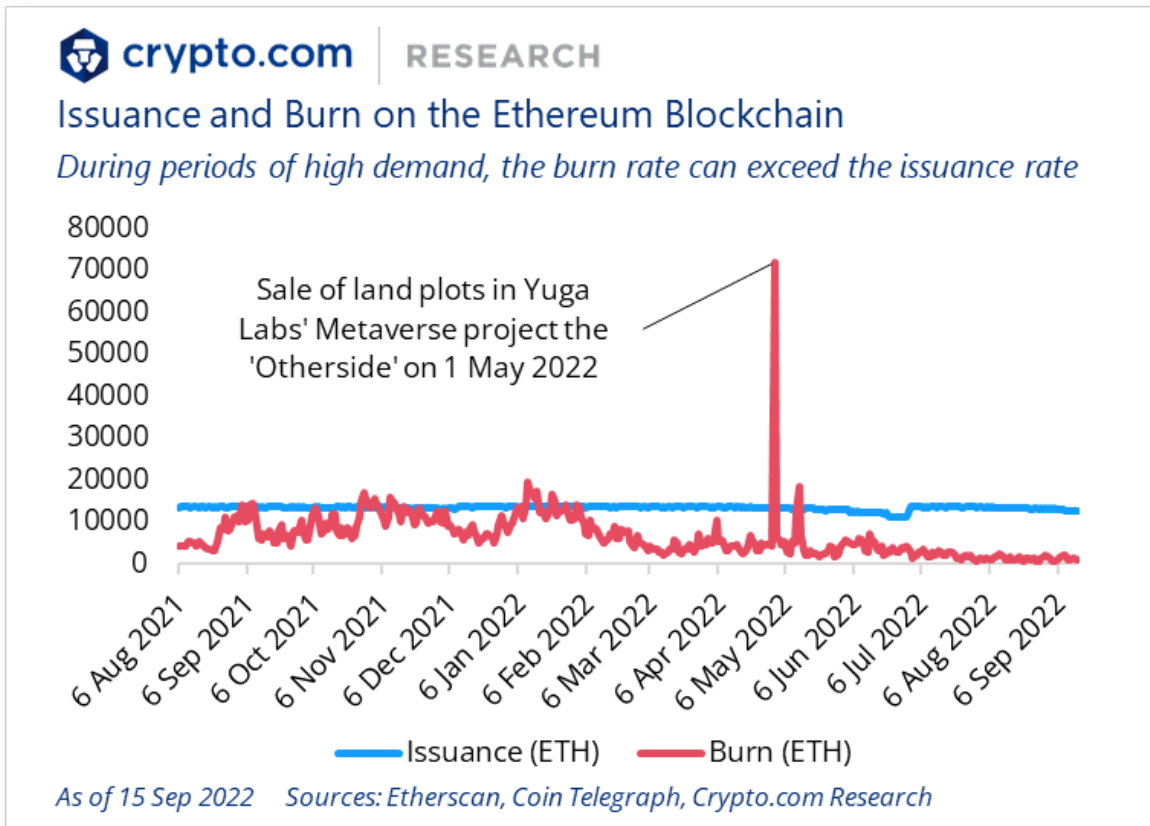
After The Merge, only the 1,600 ETH issuance for staking rewards (rewards for validators who attest to and propose blocks) will remain. Thus, the **total new ETH issuance will decrease by around 90%** after The Merge. The burn mechanism introduced by EIP-1559 would burn at least 1,600 ETH daily, assuming an average gas price of at least 16 gwei. This would effectively result in **zero net ETH inflation or less (i.e., deflationary ETH)** after The Merge.
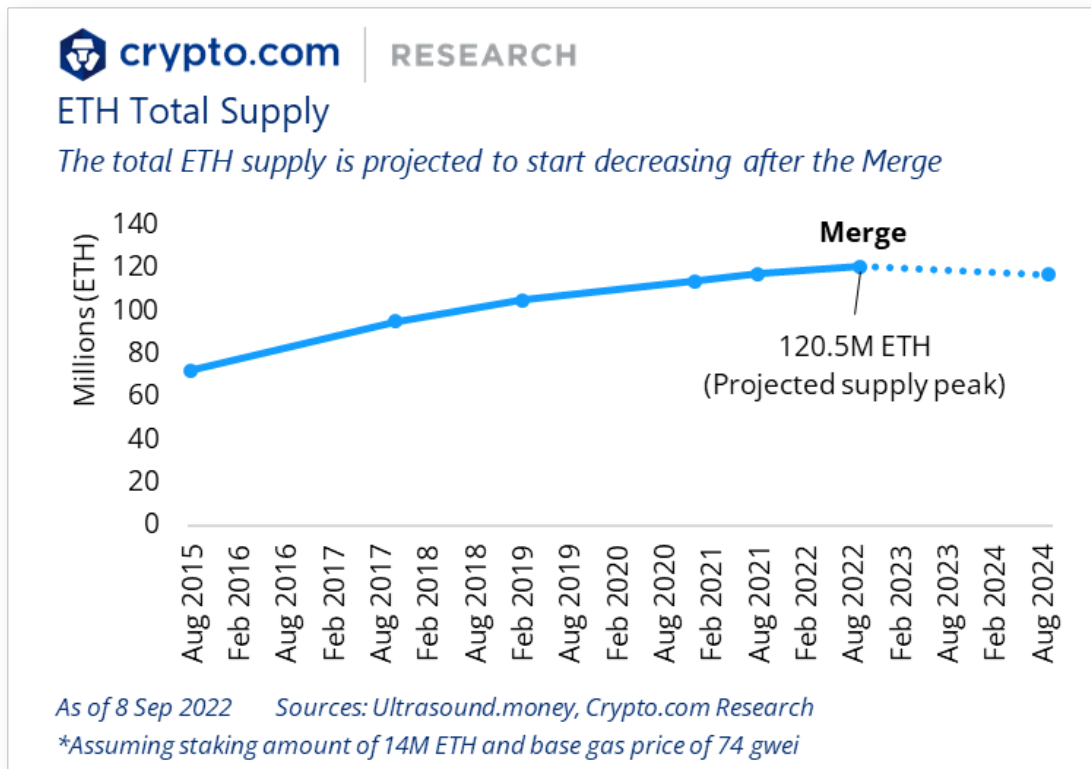
ETH Tokenomics After The Merge
ETH is expected to become deflationary after the Merge

2.2 Influence on ETH Economics

The Merge combined with the EIP-1559 burn mechanism is expected to cause a 'triple halving' effect, approximately equivalent to the effect of three Bitcoin halvings. **The ETH inflation rate is expected to reduce from ~4.3% to ~0.43%** after The Merge.

During periods of high demand, for example the sale of tokenised land plots in Yuga Labs's Metaverse project 'Otherside' on 1 May 2022, the burn rate can exceed the issuance rate. This would cause Ethereum to become deflationary during that period. After the Merge, the lowered issuance rate would make it more likely for the burn rate to exceed the issuance rate.

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Issuance and Burn on the Ethereum Blockchain

During periods of high demand, the burn rate can exceed the issuance rate

Sale of land plots in Yuga Labs' Metaverse project the 'Otherside' on 1 May 2022

Issuance (ETH)   Burn (ETH)

As of 15 Sep 2022   Sources: Etherscan, Coin Telegraph, Crypto.com Research

This potential trend has led to many people calling ETH 'ultra-sound money'. Bitcoin (BTC) is regarded by some as 'sound money' because of its fixed supply of 21M BTC. After The Merge, ETH could potentially become deflationary, meaning that the total supply of ETH could gradually decrease.

ETH Total Supply

The total ETH supply is projected to start decreasing after the Merge

Merge

120.5M ETH
(Projected supply peak)

As of 8 Sep 2022   Sources: Ultrasound.money, Crypto.com Research
*Assuming staking amount of 14M ETH and base gas price of 74 gwei

According to the law of supply and demand, there is an **inverse relationship between the supply and price when demand is unchanged.** In other words, according to economic theory, the price of Ethereum is expected (but not guaranteed) to rise when the supply declines. There are factors that would affect this outcome, such as the small risk of The Merge failing, or the possibility that The Merge is already priced in by the market.

2.3 Impact on Layer-1 and Layer-2s

Many layer-1 solutions gained popularity by offering lower gas fees compared to Ethereum. During the peak of Ethereum's popularity, gas fees spiked up to hundreds or even thousands of dollars per transaction. Since many users cannot afford such exorbitant fees, they turned to other layer-1s offering lower fees. If Ethereum manages to lower its gas fees, it is possible that these users may move back to Ethereum.

It has been clarified by the Ethereum Foundation that **The Merge would not reduce gas fees.** This is because gas fees are primarily affected by network demand relative to the network's capacity. The Merge only changes the consensus mechanism from PoW to PoS; it does not change any other parameters directly related to network capacity or throughput. Hence, even after The Merge, Ethereum would not compete directly with other layer-1s offering lower gas fees.

Transaction speed of Ethereum also would not be significantly faster after The Merge.

Nevertheless, a big advantage of The Merge is that Ethereum is expected to **reduce the network's energy consumption by an estimated 99.95%.** This could further boost the popularity of Ethereum among people who are looking for an eco-friendly blockchain. As there is increasing concern about the environmental impact of cryptocurrency, the transition to PoS will definitely help Ethereum be viewed in a more positive light.

There have been some concerns on whether layer-2 solutions are still relevant after The Merge. Since it has been clarified that The Merge would not lower Ethereum's gas fees, **layer-2s can still continue to play an important role because of their lower gas fees.**

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Transaction Fees for Layer 2 Scaling Solutions

Layer 2 solutions can still play a major role due to their lower gas fees

As of 12 Sep 2022   Sources: L2fees.info, Crypto.com Research
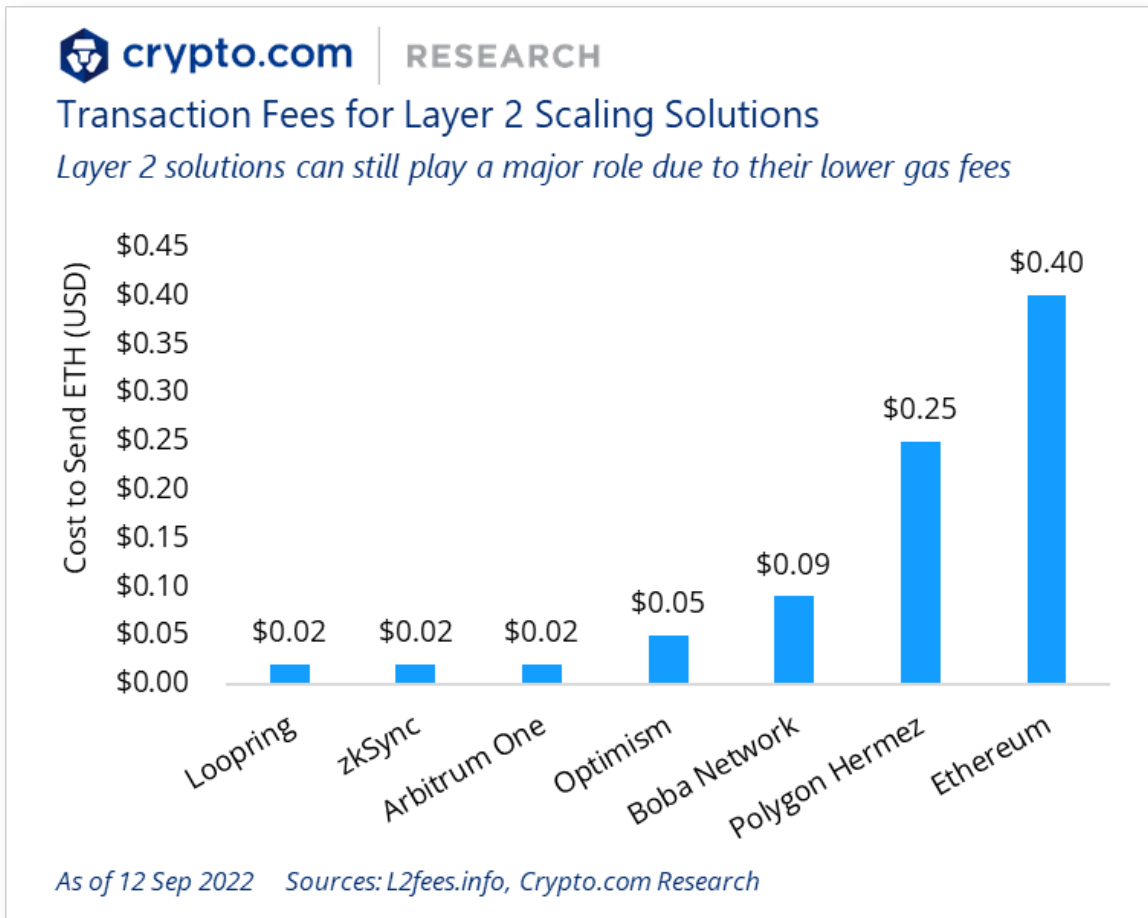
Even after the Surge (sharding), which is the next step after The Merge, **layer-2 solutions are still expected to be highly relevant.** According to the Ethereum Foundation, sharding will enable layer-2 solutions to offer even lower transaction fees while leveraging the security of Ethereum. **The Merge and sharding are expected to work synergistically with layer-2 rollups to supercharge the scalability of Ethereum.**

Lastly, the **risk of a ETH PoW chain hard fork, which could result in potential loss in users, liquidity, and developers, is low.** One of the potential hard forks is ETHPOW, which is supported by some Ethereum miners who intend to validate the current PoW Ethereum chain post-Merge. Historically, previous Ethereum forks like Ethereum Classic (ETC) have not been successful in displacing the main Ethereum chain; hence, it appears that this risk is quite small.

2.4 Next Steps After The Merge

According to Vitalik Buterin, Ethereum is only '40% complete'. Even after The Merge, Ethereum will only be approximately 55% complete. **After The Merge, Ethereum will still undergo upgrades such as the Surge, Verge, Purge, and Splurge.** These upgrades are expected to happen in parallel, according to Vitalik.

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Future Roadmap of Ethereum
Even after the Merge, Ethereum would only be 55% complete

The Surge	Scalability increases for layer 2s through sharding
The Verge	Statelessness through Verkle trees
The Purge	Eliminating certain historical data
The Splurge	Miscellaneous upgrades to simplify the use of Ethereum

As of 12 Sep 2022   Sources: Ground Zero, Crypto.com Research

The Surge refers to sharding, which splits a database horizontally to spread the load. Sharding will help Ethereum to scale while still maintaining decentralisation. With sharding, validators no longer need to store the entire database, which helps to reduce costs of storage, as well as lower hardware requirements.

The Verge is a technical upgrade that proposes to transition from Merkle trees to Verkle trees. Its purpose is to solve the problem of the Ethereum blockchain getting larger in size as time goes by. Switching to Verkle trees will only require block proposers to store state, and allow all other nodes to verify blocks statelessly. This would help to maintain the scalability and sustainability of Ethereum.

After **The Purge** upgrade, not all nodes have to permanently store all of the historical blocks. Clients can stop storing history that is older than one year. This

would help to reduce the hardware requirements for nodes, as well as the bandwidth of the network.

Finally, **The Splurge** consists of various miscellaneous upgrades that help to simplify the use of Ethereum for average users. It will also help to check network performance after implementing the above upgrades.

3. Conclusion

The Merge finally completed on 15 September 2022. It is Ethereum's transition to a PoS consensus mechanism and is one of the biggest events in the cryptosphere. The Merge is a significant step toward Ethereum's vision of a scalable, secure, decentralised, and sustainable blockchain.

Some common misconceptions about The Merge are that it will reduce gas fees and significantly increase transaction speeds. It will not, but instead is a prerequisite for potential future upgrades and scaling activities that will address these issues.

The Merge will greatly transform Ethereum's tokenomics for the better. After The Merge, ETH is expected to become deflationary, with the amount of ETH burned being higher or equal to the amount of ETH issued. These unique properties of ETH have led to people calling ETH a 'triple point asset' — a commodity, yield-bearing capital asset, and store of value.

Finally, The Merge is just one of the many upcoming upgrades for Ethereum. After The Merge, Ethereum will only be approximately 55% complete. Ethereum will still undergo critical upgrades, such as the Surge, Verge, Purge, and Splurge. It will be exciting to see what the future holds for Ethereum.

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