BTCS

Ethereum Blockchain

Analyst & Investor Primer

March 2025

Introduction

Ethereum's blockchain is the world's largest decentralized computing platform and the foundation driving a decentralized global digital economy. It is also the world's second-largest cryptocurrency and has been for the better part of a decade. Ethereum stands as a transformative force in the blockchain ecosystem, pioneering the concept of programmable money, decentralized applications, and the future of finance and beyond.

For analysts and investors seeking to understand the industry's landscape, Ethereum serves as the ideal starting point. This primer aims to provide a technical understanding of Ethereum's value proposition, its innovative Proof-of-Stake consensus mechanism, and the Maximal Extractable Value ("MEV") landscape. By combining technical detail with practical context, this document equips analysts and investors with the knowledge to navigate and evaluate opportunities in Ethereum's ecosystem.

Contents

1 What is Ethereum?

1.1 Ethereum Blockchain Overview

Ethereum is a decentralized, open-source blockchain network that extends the capabilities of Bitcoin by incorporating a programmable layer. Initially proposed by Vitalik Buterin in 2013 and launched in 2015, Ethereum introduced smart contracts—self-executing code that operates without intermediaries. This innovation enables a wide range of applications, from financial instruments to digital collectibles, and enterprise solutions.

Unlike Bitcoin, which primarily functions as a digital store of value, Ethereum is a flexible platform designed for decentralized computation. Ethereum operates globally through a distributed network of validator nodes, ensuring high levels of resilience and security making it a critical infrastructure layer for a global decentralized digital economy.

Similar to how the internet revolutionized the global proliferation of information, Ethereum—a leading blockchain—is driving an evolution in the digitization of assets for a growing digital global economy, enabling a decentralized system that operates free from intermediaries and government influence.

1.2 Native Token: ETH

The native cryptocurrency of the Ethereum network, Ether ("ETH"), is central to its operation and economic model. It serves as both the platform's utility token and a digital asset with investment appeal.

ETH is required for all activity on the Ethereum network, serving as the currency to pay transaction fees (known as gas fees) and enabling transactions to be processed and recorded on Ethereum's blockchain. Additionally, ETH is used as collateral for staking, a crucial part of Ethereum's Proof-of-Stake ("PoS") consensus mechanism. Whereby validators lock up ETH to secure the network, ensure efficient resource allocation, and discourage malicious activity through slashing penalties.

Beyond its functional role as a currency used for gas fees in a global digital economy, ETH has gained recognition as a store of value and a medium of exchange within the broader cryptocurrency market. Its liquidity and adoption have positioned it as the second-largest cryptocurrency by market capitalization, behind only Bitcoin. ETH's utility and scarcity, particularly in the wake of its transition to a deflationary economic model, further enhance its value proposition.

2 Ethereum's Value Proposition

Ethereum represents a fundamental shift in how blockchain technology is utilized, extending its applications beyond simple monetary transactions to encompass a broad spectrum of programmable financial and computational activities. Its robust ecosystem, innovative mechanics, and continuous development have solidified its position as a leader in the blockchain industry.

2.1 Ultra-Sound Money Fueling a Global Digital Economy

Money generally has six key traits that determine its effectiveness as a medium of exchange, store of value, and unit of account. Here's how fiat currency, Bitcoin, and Ethereum compare:

Figure 1. Comparing Fiat Currency, Bitcoin, and Ethereum

Trait	Fiat (USD, EUR, etc.)	Bitcoin (BTC)	Ethereum (ETH)
Durability (Can withstand wear and tear over time)	Physical cash can degrade, digital fiat is durable	Extremely durable (digital)	Extremely durable (digital)
Portability (Easy to transport and transfer)	Yes, but bank restrictions exist often at the behest of governments	Highly portable, cross-border transactions possible	Highly portable, cross-border transactions possible
Divisibility (Can be broken into smaller units)	Yes	Yes	Yes
Fungibility (Each unit is identical to another of the same denomination)	Yes	Yes	Yes
Scarcity (Limited or controlled supply)	No (central banks print at will, causing inflation)	Yes (21 million cap)	No fixed cap, but burning mechanism (EIP-1559) reduces inflation
Acceptability (Widely accepted as a means of payment)	Yes (government-backed)	Growing adoption	Growing adoption

Based on the above traits Ethereum is superior to fiat currency. Ethereum, unlike government-issued money, isn't controlled by central banks that can print unlimited amounts, causing inflation. Instead, Ethereum uses something called a "burn mechanism," where a portion of transaction fees (paid in ETH) is permanently removed from circulation, reducing the total supply over time. This helps Ethereum maintain its scarcity better than fiat, similar to how Bitcoin has a fixed supply of only 21 million coins. Additionally, Ethereum matches Bitcoin in other key traits like durability, portability, divisibility, and uniformity. ETH is digital and doesn't degrade like physical cash; can be easily transferred globally, and can be broken into very small units. While Bitcoin is often called "digital gold" for storing value, Ethereum offers that plus the ability to support smart contracts and decentralized applications, making it versatile and forward-looking compared to both Bitcoin and traditional fiat money.

2.2 Ethereum's Utility

Ethereum's true value not only resides in its value as a currency like Bitcoin but also lies in its unparalleled versatility. It serves as the foundation for decentralized applications ("dApps"), enabling innovations across decentralized finance ("DeFi"), non-fungible tokens ("NFTs"), and enterprise-grade solutions. Smart contracts are self-executing agreements that allow developers to create trustless systems that replace traditional intermediaries. Quantitatively, Ethereum consistently leads the industry in key metrics such as transaction volume, active user base, and developer engagement. Total Value Locked ("TVL") in DeFi refers to the total amount of cryptocurrency assets deposited into DeFi protocols. It's a critical metric used to measure the size, growth, and overall health of a DeFi ecosystem. As of March 2025, the TVL across various blockchain networks showcases the distribution of assets within the DeFi ecosystem.

Below is a breakdown of the top blockchains by TVL:

Figure 2. *Top Blockchains by TVL*

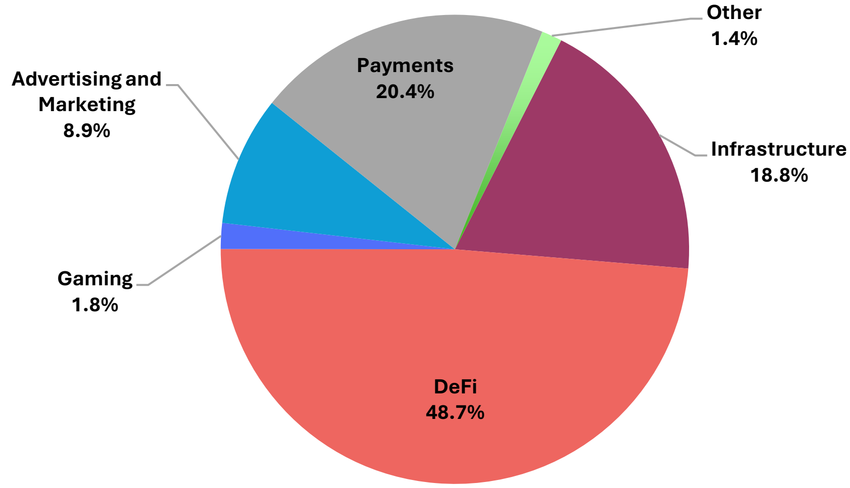
Blockchain	Market Share by TVL	TVL (in billions USD)
Ethereum	53.94%	$46.0
Solana	7.86%	$6.71
BNB Smart Chain	5.60%	$4.78
TRON	5.06%	$4.32

Source: CoinGecko as of March 11, 2025.

Qualitatively, Ethereum's programmable layer has spawned a global ecosystem of projects, each leveraging its platform for unique use cases, from DeFi, supply chain optimization, and gaming economies. Currently, most of Ethereum's revenue is generated from DeFi applications as illustrated in ***Figure 3*** below.

Figure 3.

Ethereum Revenue Distribution by Use Case



Source: VanEck: ETH 2030 Price Target and Optimal Portfolio Allocations

The 2008 Financial Crisis and the Birth of Crypto

The 2008 Financial Crisis exposed the fragility and inefficiencies of the traditional financial system. Banks over-leveraged their assets, provided loans with inadequate collateral, and created systemic risks that led to a global economic collapse. The crisis underscored the dangers of human greed, opaque financial instruments, excessive reliance on intermediaries, and lack of transparency. In response to these failures, a solution was needed to create a fair and transparent system. Bitcoin emerged in 2009 as a decentralized alternative—offering a transparent, peer-to-peer network, free from any centralized bank, government, or group. Ethereum was subsequently created in 2015 to expand blockchain financial capabilities beyond just decentralized digital currencies to smart contract-enabled DeFi and more.

How DeFi is Reshaping Finance

Stablecoins on Ethereum

Stablecoins are digital assets designed to maintain a stable value, typically pegged to a fiat currency like the US dollar. On the Ethereum blockchain, they serve as a foundational element for DeFi, enabling users to transact without the volatility commonly associated with cryptocurrencies. Today, the landscape is primarily focused on fiat-backed stablecoins, driven by increasing regulatory clarity, growing institutional adoption, and the expectation that stablecoin legislation will be passed by the U.S. Congress. The two largest stablecoins on Ethereum are:

- USDC (USD Coin) – Issued by Circle and fully backed by USD-denominated assets.
- USDT (Tether) – Issued by Tether Limited, also backed by a mix of fiat and cash-equivalent reserves.

Ethereum's smart contract functionality and large developer ecosystem make it the preferred platform for stablecoin issuance and adoption. The new U.S. administration has also signaled a strategic interest in stablecoins, viewing them as a potential tool to extend and reinforce the global dominance of the U.S. dollar by embedding it into digital financial infrastructure worldwide. The stablecoin market is currently valued at approximately $250 billion; however, due to their utility, it is anticipated to rapidly expand into the trillions.

The Tokenization of Real-World Assets ("RWA")

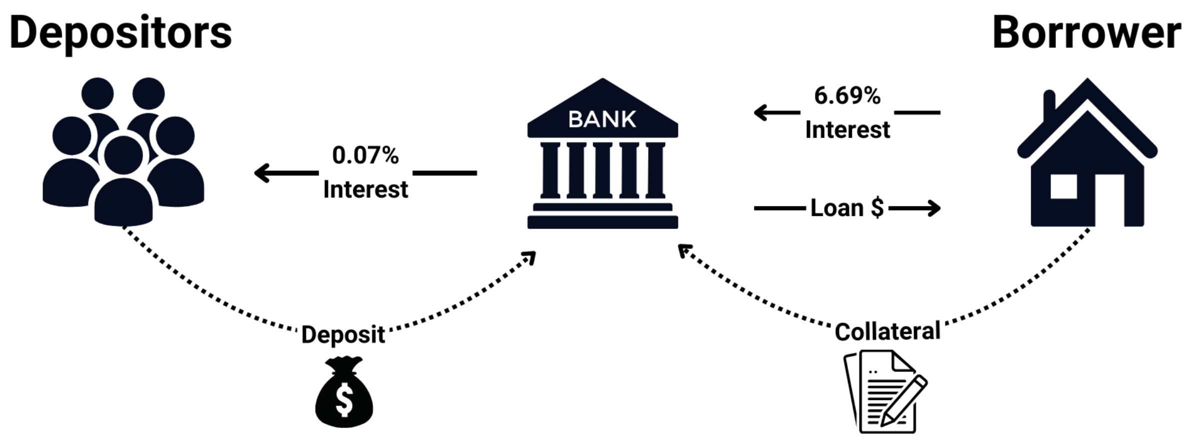
Tokenization is the process of representing ownership of real-world assets—such as real estate, commodities, bonds, or equity—on a blockchain. This allows these assets to be more easily transferred, fractionalized, and accessed globally. On Ethereum, tokenized RWAs typically use smart contracts to issue ERC-20 tokens that represent claims on physical or financial assets. These tokens can be traded, used as collateral, or integrated into DeFi platforms, unlocking liquidity that might not otherwise exist. Tokenized RWAs bridge traditional finance with blockchain infrastructure, offering benefits such as: greater transparency via on-chain data, reduced settlement times and transaction costs, and enhanced accessibility for global investors. Examples of tokenized RWAs include:

- Real estate: Property ownership or rental income streams tokenized for fractional investment.
- Treasury bills and bonds: Short-term U.S. government debt instruments.
- Private credit: Loans issued as blockchain tokens, offering DeFi yield opportunities.
- Securities: Stocks currently traded on traditional exchanges like BTCS Inc.

Lending and Borrowing

One example of how DeFi is reshaping finance is Aave, the leading decentralized lending and borrowing protocol that exemplifies Ethereum's capital efficiency and flexibility. Unlike traditional finance, where obtaining a loan often involves extensive paperwork, credit checks, title insurance, and centralized intermediaries, Aave enables trustless and permissionless borrowing and lending of digital assets. ***Figure 4*** illustrates how our traditional financial system works in connection with a home loan.

Figure 4. *Traditional Finance Example*

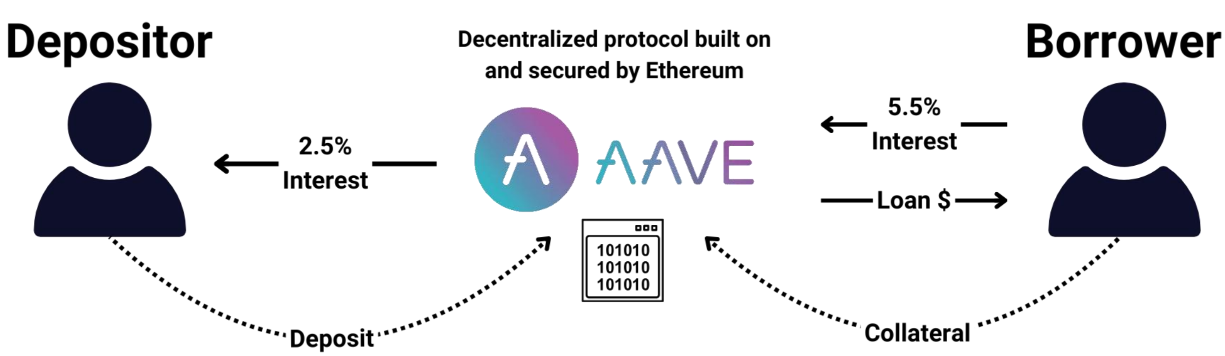


The example above illustrates how a large base of depositors pools funds with banks acting as intermediaries, which then lend these funds to borrowers using their homes as collateral. However, this process is often slow, expensive, and cumbersome, typically taking 30 to 60 days to complete. It requires extensive paperwork, credit checks, underwriting, title insurance, and regulatory oversight. The reliance on centralized institutions leads to inefficiencies, higher costs, and barriers to financial access, highlighting the need for more flexible and inclusive alternatives.

Additionally, traditional finance is poorly suited for microtransactions due to high fees, slow transaction speeds, and dependence on intermediaries. Minimum balance requirements, regulatory constraints, and processing delays further restrict accessibility, creating barriers for individuals looking to leverage their assets or participate in financial markets on a smaller scale. These inefficiencies highlight the need for decentralized alternatives that offer greater flexibility, lower costs, and improved accessibility.

In contrast, Aave enables users to instantly access liquidity and borrow assets without the need for a traditional bank or credit approval process. ***Figure 5*** illustrates how this process works by leveraging blockchain technology.

Figure 5. *Decentralized Finance Example*



Unlike conventional loans, Aave lets users borrow stablecoins (e.g. USDC) and other cryptos using their crypto holdings, like Ethereum and USDC, as collateral while still maintaining exposure to the posted collateral.

To ensure system solvency, Aave employs an over-collateralization model, requiring borrowers to deposit more collateral than the amount they wish to borrow—mitigating risk even in volatile market conditions. Additionally, deposited assets continue to earn interest, maximizing capital efficiency beyond what traditional finance can typically offer.

Aave's permissionless nature makes borrowing and lending of any size accessible to anyone, regardless of geographic location or financial status. Transactions are executed transparently on the blockchain, eliminating costly intermediaries and reducing settlement times from months to mere minutes. By leveraging smart contracts, Aave automates and enforces loan terms, removing the risk of human bias and institutional gatekeeping. Operating 24/7, 365 days a year Aave provides continuous access to financial services without reliance on banks or banking hours. ***Figure 6*** highlights the key benefits of Aave compared to traditional banking.

Figure 6. *AAVE vs Bank Comparison*

Category	AAVE	Bank
Spread	3.00%[1]	6.62%[2]
Risk	Overcollateralized	Undercollateralized
Operating Hours	24/7, 365 days a year	9AM – 5PM Monday – Friday, closed often
Governance	Computers, Smart Contract Logic, no human error risk	Humans: Subject to error and influences (political, monetary, etc.)

The advancements in DeFi, exemplified by protocols like Aave, are paving the way for the tokenization of real-world assets ("RWAs"). Tokenization involves representing physical or financial assets—such as real estate, vehicles, stocks, or commodities—as digital tokens on a blockchain. This innovation has the potential to unlock liquidity, enhance accessibility, and create new financial opportunities that were previously impossible within traditional finance.

From Pixels to Profit: How Ethereum is Transforming the Gaming Industry

The global gaming industry has evolved into one of the most dynamic sectors in technology. According to Statista, global gaming market revenue was approximately $221 billion in 2024 and is projected to reach almost $700 billion by 2029, driven by the rise of mobile gaming, cloud platforms, and increasingly sophisticated in-game economies. Despite this impressive growth, a fundamental limitation remains: players do not truly own the assets they invest time and money into. Notably, gaming currently accounts for only about 1.8% of Ethereum network revenue, but it represents a significant area of potential growth as the ecosystem continues to evolve and integrate more blockchain-enabled player-owned digital economies.

The Limitations of Traditional Game Economies

In conventional gaming environments, assets such as skins, weapons, or virtual currencies are confined to their respective games. These items hold no value outside of the platform they were created for and are typically controlled by the game developer. As a result, players are unable to transfer or monetize their assets independently. When a game becomes obsolete or is shut down, so too does the value of any in-game progress or investment.

[1] *AAVE spread is estimated using a USDT borrow rate of 5.5% and USDT interest deposit rate of 2.5% as of March 12, 2025.*

[2] *Bank spread is estimated using national average 30 yr fixed mortgage rate from bankrate.com of 6.69% and average checking account rate of 0.07% from nerdwallet.com as of March 12, 2025.*

Ethereum's Solution: True Digital Ownership

Ethereum, the leading smart contract blockchain, introduces a transformative concept to gaming: verifiable, decentralized ownership of digital assets. Through the use of non-fungible tokens (NFTs) and programmable smart contracts, Ethereum allows for the creation of in-game assets that are:

- Owned by the player, independent of the developer or game platform
- Tradable on open, decentralized marketplaces
- Interoperable across different games or virtual environments
- Convertible into real-world value through token exchanges

This shift transforms in-game items from disposable, isolated assets into components of a broader digital economy.

Immutable: A Case Study in Scalable, Player-Owned Gaming

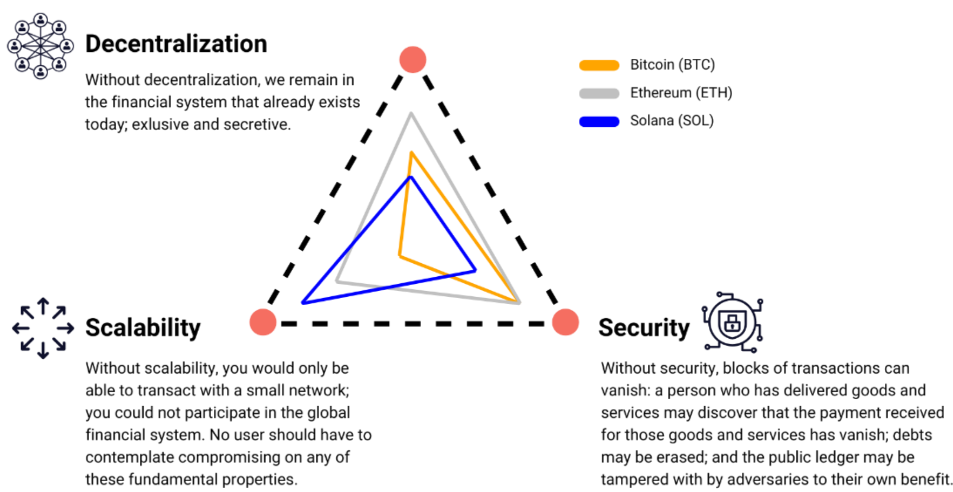
One example of Ethereum's capabilities in action is Immutable, a Layer 2 protocol built on Ethereum, designed specifically for NFTs and blockchain-based games. Games such as Gods Unchained and Illuvium utilize Immutable to empower players with genuine ownership of their assets. For example, every card in Gods Unchained is an NFT. Players can freely buy, sell, or trade cards on external marketplaces, and their value persists independently of the game's lifecycle.

2.3 Decentralization, Scalability, and Security

Ethereum carefully balances decentralization, scalability, and security—a tough trade-off often called the "scalability trilemma."

Figure 7.

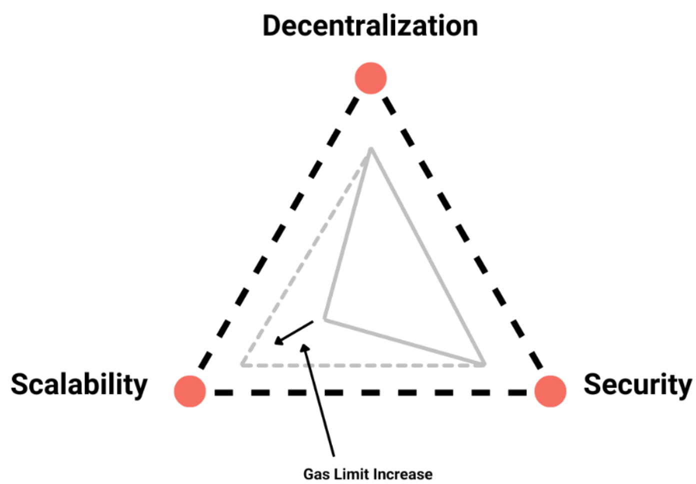
Blockchain Trilemma Bitcoin, Ethereum, and Solana



Ethereum currently faces pressure to slightly compromise decentralization to boost transaction speed and handle increasing demand. For example, enhancing throughput by increasing block sizes or gas limits may require validators to use more powerful hardware and stable high-speed internet connections. As illustrated in ***Figure 8*** *below*, this shift risks potentially sidelining smaller participants, such as an individual running a validator node on a simple Raspberry Pi ($100) computer with unreliable internet—potentially reducing the network's broad decentralization. However, with over 1 million validators currently securing Ethereum's network, there is room for scalability without significant sacrifices to security or decentralization.

Figure 8.

Blockchain Trilemma Ethereum Gas Limit Increase



In contrast, Solana aggressively sacrifices decentralization for rapid scalability. While this allows high-speed transactions, it leaves the network vulnerable to centralization and control by powerful entities, like governments or large corporations, which could manipulate or dominate the network. Solana's centralization, with less than 2,000 validators, has already shown tangible risks: the network experienced several high-profile outages, including incidents in 2021 and 2022 when validator coordination failures caused hours of downtime, severely impacting user trust. Ethereum aims to avoid such pitfalls by cautiously balancing its decentralization, even if slight compromises to speed are necessary.

2.4 Economic Model and Deflationary Mechanics

On September 15, 2022, Ethereum's economic model underwent a significant transformation with the network's transition to Proof-of-Stake through EIP-3675, referred to as the ("Merge") and the introduction of EIP-1559, which implemented a transaction fee burn mechanism. These upgrades reshaped Ethereum's monetary policy, reducing new ETH issuance which gradually removes ETH from circulation.

The Merge marked Ethereum's transition from energy-intensive Proof-of-Work ("PoW") mining to the more sustainable Proof-of-Stake consensus, replacing miners with validators who secure the network by staking ETH. This shift reduced Ethereum's energy consumption by over 99.9%. Additionally, the Merge significantly decreased ETH issuance, cutting daily rewards from 13,000 ETH under PoW to approximately 1,700 ETH under PoS, an 88% reduction in new supply. During periods of high network activity, ETH issuance can even turn negative, reinforcing its value proposition as "ultra-sound money."

Why EIP-1559 Matters

- **Deflationary Effect**: By burning the base fee, Ethereum can gradually reduce the amount of ETH in circulation. Similar to how a company buying back its shares can raise its stock price, reducing ETH supply drives scarcity, and should help increase its value over time.
- **Predictability**: EIP-1559 makes transaction fees more predictable, helping users avoid unexpected spikes in costs.
- **Improved User Experience**: With clearer fee structures, Ethereum becomes more user-friendly, encouraging greater adoption and use.

How EIP-1559 Works

Under EIP-1559, transaction fees are split into two distinct parts:

Base Fee

- **What's the Base Fee?**: It's a mandatory fee charged to anyone who makes a transaction utilizing Ethereum's blockchain.
- **How it works**: The base fee automatically adjusts based on network congestion. When many users are making transactions, the base fee goes up. When fewer users are active, it goes down. It can be thought of as a toll road, that raises prices during rush hour and lowers them when it's quiet.
- **What happens to it**: Importantly, this fee isn't paid to validators (previously miners). Instead, it is "burned" or "shredded" i.e., permanently removed from circulation. This means there will be less ETH over time, which can increase the value of existing ETH.

Priority Fee (effectively a Tip)

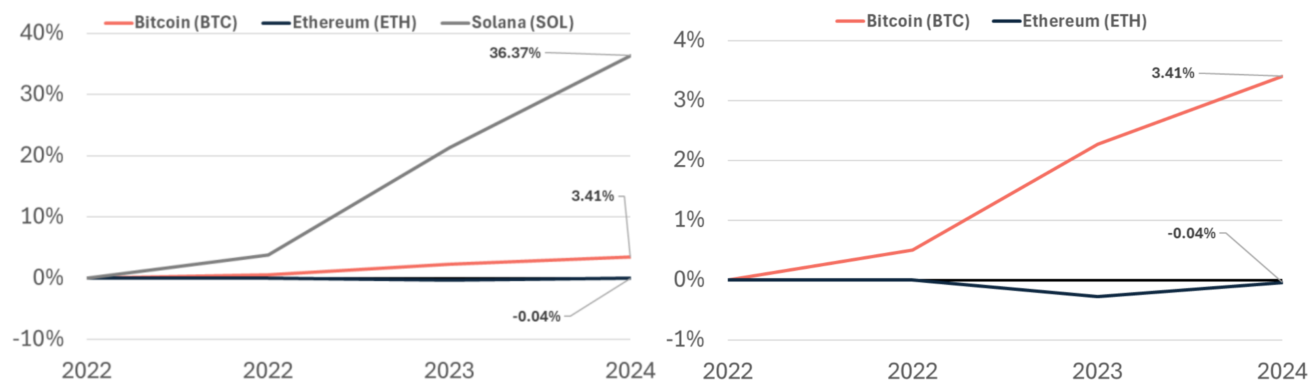
- **What's the Priority Fee?**: Its an optional extra fee users pay to have their transaction processed faster.
- **How it works**: Users who need their transactions confirmed urgently can pay a higher tip to incentivize validators (previously miners) or builders if validators have sold their block space to prioritize their transactions. The priority fee is like paying for a VIP check out or sending someone a package via FedEx instead of using the post office. If you're not in a hurry, you can pay a lower tip or even no tip at all.

Total Transaction Fee = Base Fee + Priority Fee

Results

Since the introduction of the Merge, the issuance rate of new ETH has been significantly reduced, enhancing ETH's appeal as a store of value. Ethereum's EIP-1559 introduced a deflationary mechanism by burning transaction fees, constraining ETH's supply over time. While Bitcoin maintains a strict supply cap, Ethereum combines scarcity with flexible monetary policy and broader usability, distinguishing itself significantly from both traditional fiat and Bitcoin.

Figure 9. Cumulative Dilution of Bitcoin, Ethereum, and Solana Since Merge



Sources: Glassnode and Etherscan from dates ranging from September 15, 2022 to December 31, 2024.

Unlike government-issued fiat currency, Ethereum does not aim to serve as a government-issued currency but rather serves as a decentralized global currency powering a digital economy and, therefore, avoids many pitfalls, such as centralized control and unchecked inflation due to continuous printing. Ethereum is designed to serve as “ultra-sound money” in a global digital economy, combining robust economic properties with the flexibility needed to support a vast array of decentralized applications.

Figure 10. *Annualized Return and Current Value of Ethereum, Bitcoin, and U.S Dollar Since 2015*

Asset	9 year Annualized Return	5 year Annualized Return	Value of $1 Invested in 2015
Ethereum	147.4%	92.17%	$3,469
Bitcoin	81.1%	67.73%	$209
U.S. Dollar	-3.00%	-4.61%	$0.76

Sources: Coinlore and In2013Dollars CPI Inflation Calculator for dates December 31, 2015, and December 31, 2019 to December 31, 2024.

Moreover, because the base fee is burned with each transaction, increased usage of Ethereum leads to greater amounts of ETH being permanently removed from circulation. This means that as Ethereum becomes more widely adopted and transaction volumes grow, the overall supply of ETH could decrease, creating an even scarcer resource over time. This deflationary dynamic could potentially increase ETH's value as adoption continues to expand, further solidifying its appeal as global decentralized ultra-sound money.

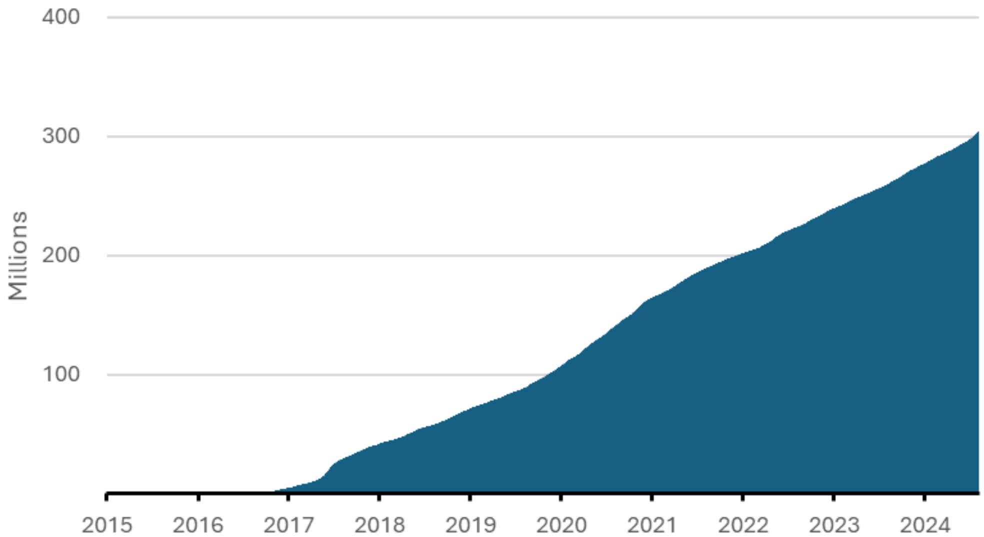
2.5 User Types and Growth

Active Users

Ethereum’s growth trajectory is evidenced by its expanding user base, measured through metrics like unique wallet addresses, ***Figure 11*** below, and daily active users. With over 300 million wallet addresses and growing participation across retail and institutional users, Ethereum has demonstrated its broad appeal.

On-chain activity reveals consistent transaction growth, driven by diverse applications such as DeFi protocols, NFT marketplaces, and gaming platforms. Adoption is further accelerated by integrations with traditional financial institutions and the burgeoning Layer 2 ecosystem, which lowers the barriers to entry by reducing transaction costs and increasing throughput.

***Figure 11**. Unique Addresses on Ethereum*



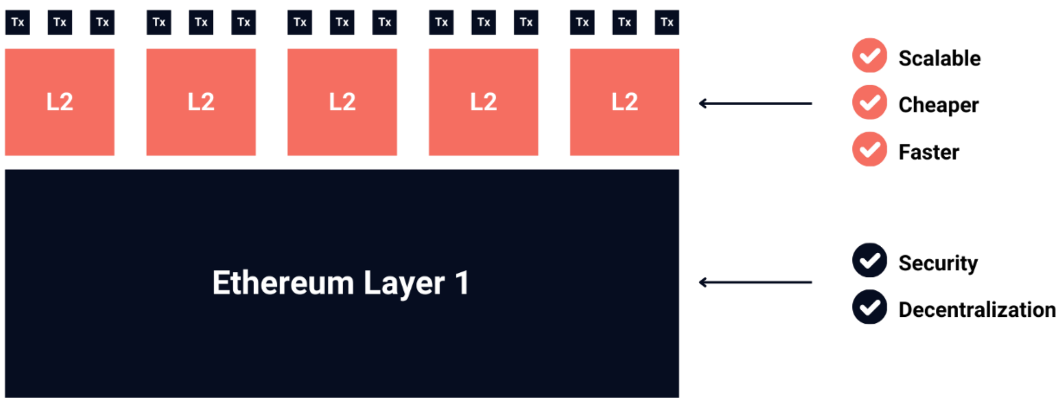
Source: Etherscan Ethereum Unique Addresses Chart for dates ranging from July 30, 2015 to March 6, 2025.

Layer 2 Blockchains

Ethereum's scalability has been significantly enhanced by the advent of Layer 2 ("L2") solutions, which leverage Ethereum's security layer while reducing costs and increasing transaction throughput. These solutions, such as Arbitrum, Optimism, Polygon, and Base, operate atop Ethereum as shown in ***Figure 12*** below. These innovative solutions enable faster and cheaper transactions without compromising decentralization or security. By using Ethereum for final settlement and security, L2s leverage Ethereum's robust security and decentralization in exchange for gas fees paid to the Ethereum network.

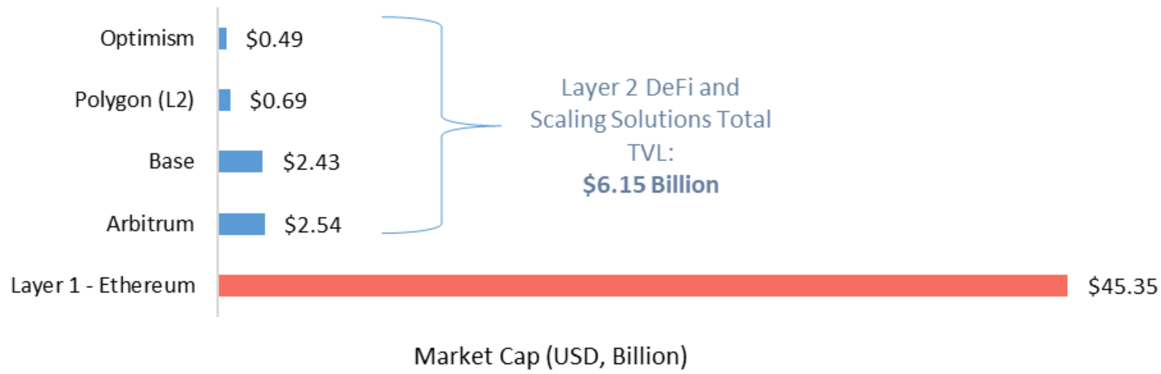
Figure 12.

Ethereum Layer 1 and Layer 2 Visualized



Layer 2 networks have become indispensable for applications requiring high throughput, such as DeFi protocols, gaming platforms, and NFT marketplaces. The combined Total Value Locked across L2 solutions represents over $6 billion dollars, underscoring their importance to Ethereum's ecosystem. Competition to build and launch Ethereum scaling solutions has become a rapidly growing area within Ethereum. For example, in 2023 Coinbase launched Base, a layer 2 solution for Ethereum that has rapidly grown to become one of the largest layer 2 networks by TVL.

Figure 13. *Ethereum and Layer 2 Total Value Locked*



Source: The Total Value Locked for Ethereum and Layer 2 solutions such as Base, Arbitrum, Polygon, and Optimism on March 10, 2025 according to DeFiLlama

In addition to driving scalability, Layer 2 solutions significantly contribute to Ethereum's fee generation. L2 activity feeds back into the Ethereum through gas fees, as transactions on L2s ultimately settle on Ethereum. This symbiotic relationship reinforces Ethereum's position as the foundation of a thriving decentralized economy, with the added benefit of a growing revenue stream from increasing L2 adoption.

2.6 Protocol Development and Governance

Ethereum's success is rooted in its robust, open-source development and decentralized governance framework. While the Ethereum Foundation plays a key role in funding research and coordinating upgrades, the network's evolution is driven by global collaboration. Developers worldwide contribute to protocol improvements through Ethereum Improvement Proposals ("EIPs"), ensuring upgrades reflect the diverse needs of the ecosystem.

The following table highlights the contrast in how Ethereum has undergone frequent, transformative upgrades (focusing on scalability, sustainability, and functionality) while Bitcoin has made far fewer improvements.

Figure 14. *Ethereum and Bitcoin Key Upgrades Timeline*

Year	Ethereum Key Upgrades	Bitcoin Key Upgrades
2009	-	**Bitcoin Launch** (Genesis Block)
2015	**Ethereum Launch** (Frontier)	-
2016	**Homestead** (Stability improvements) **The DAO Fork** (Ethereum Classic split)	-
2017	**Byzantium** (Part 1 of Metropolis; privacy, scalability)	**SegWit** (Segregated Witness)
2019	**Constantinople & Istanbul** (Gas cost reduction, security)	-
2020	**Ethereum 2.0 Phase 0** (Beacon Chain launch, start of PoS)	-
2021	**London Hard Fork** (EIP-1559: Fee burning)	**Taproot** (Privacy, smart contracts)
2022	**The Merge** (Switch to Proof-of-Stake)	-
2023	**Shanghai/Capella Upgrade** (Staked ETH withdrawals)	-
2024	**Dencun Upgrade** (Proto-Danksharding: scalability improvements)	-
2025	**Pectra Upgrade** [Expected Q2 2025] (Further scalability, improved account abstraction, advanced zk-rollups)	-

The anticipated Pectra upgrade should strengthen Ethereum's position against competing blockchains by enhancing efficiency and usability. Pectra focuses on scalability, staking improvements, and wallet functionality to offer a more secure and decentralized alternative.

Among the updates included in Pectra are the following EIPs:

- **EIP-7251:** Scaling Validator Staking

  This proposal increases the maximum ETH stake per validator from 32 ETH to 2,048 ETH, streamlining Ethereum's staking infrastructure. Currently, validators staking more than 32 ETH must distribute their holdings across multiple validator nodes, creating inefficiencies. By raising the cap, EIP-7251 simplifies validator operations, potentially improving network security and reducing overhead costs for large-scale stakers.

- **EIP-7702:** Advancing Wallet Functionality

  This proposal lets wallets temporarily act like smart contracts, enhancing user experience. This innovation enables:

  - **Flexible Fee Payments:** Users can pay transaction fees in stablecoins (e.g. USDC) rather than ETH, improving accessibility.
  - **Automated Transactions:** Subscription-based payments and recurring transfers become seamless.
  - **Simplified Wallet Recovery:** Users gain easier access to their funds without relying on complex seed phrases.

With Pectra, Ethereum continues to evolve into a more efficient, secure, and user-friendly blockchain ecosystem driving mainstream adoption. Further, it's anticipated that both Pectra and future upgrades may drastically improve the network and L2 capacity.

Ethereum's decentralized governance ensures transparency and inclusivity, with decisions shaped by input from developers, validators, and users. This approach maintains Ethereum's adaptability and alignment with its community's needs, reinforcing its position as a leader in decentralized applications and programmable finance.

Further, due to Ethereum's focus on more frequent upgrades, it is currently much better positioned to become quantum-resistant compared to Bitcoin, though both will require significant upgrades if quantum computing becomes a practical threat.

2.7 Institutional Investment

The institutional adoption of Ethereum has accelerated with the introduction of ETH exchange-traded funds ("ETFs") by major financial institutions such as BlackRock, Fidelity, and Goldman Sachs. These ETFs provide both retail and institutional investors with regulated, accessible avenues to gain exposure to Ethereum without the complexities of managing private keys or custodial risks. Early ETF launches have seen significant inflows, reflecting strong market demand. However, Ethereum ETFs do not currently stake their holdings or generate revenue, making direct ownership of Ethereum a more attractive option for those seeking staking rewards.

Figure 15.

Ethereum Exchange Traded Funds by AUM

Ticker	Fund Name	Total ETH	AUM (Billions)
ETHE	Grayscale Ethereum Trust ETF	1,417,788	$4.74
ETHA	iShares Ethereum Trust ETF	1,071,415	$3.57
FETH	Fidelity Ethereum Fund	471,750	$1.57
ETH	Grayscale Ethereum Mini Trust ETF	470,876	$1.57
ETHW	Bitwise Ethereum ETF	100,153	$0.26
ETHV	VanEck Ethereum ETF	24,531	$0.06
EZET	Franklin Ethereum ETF	12,540	$0.04
QETH	Invesco Galaxy Ethereum ETF	7,074	$0.02
CETH	21Shares Core Ethereum ETF	4,850	$0.01
	Total	**3,580,977**	**$11.86**

Source: Ethereum spot ETFs total ETH and assets under management from SEC filings as per the latest reporting

BTCS Inc. remains a notable pure-play, publicly traded Ethereum blockchain infrastructure company. BTCS combines direct Ethereum exposure via an ETH treasury strategy, akin to MicroStrategy, with the growth potential of a 2017-era Bitcoin miner—all without the burden of intensive capital expenditures.

Institutional adoption of Ethereum extends beyond ETFs. Large financial institutions, asset managers, and corporations are increasingly integrating Ethereum into their operations, whether through staking, decentralized finance DeFi participation, or tokenization of assets. This growing institutional presence fosters price stability, increases liquidity, and encourages further adoption across both traditional and decentralized markets.

In a significant development, President Donald Trump announced plans to establish a U.S. Crypto Strategic Reserve that includes Ethereum, alongside other cryptocurrencies such as Bitcoin, XRP, Solana, and Cardano. This initiative aims to elevate the digital asset sector and position the United States as a leader in the cryptocurrency industry. The announcement has been met with both enthusiasm and debate within the crypto community, reflecting the evolving relationship between digital assets and governmental policy.

3 How Proof-of-Stake Works

Ethereum's transition from Proof-of-Work to Proof-of-Stake in September 2022 marked a significant evolution in blockchain technology. This upgrade, known as the Merge, replaced energy-intensive mining with a staking-based mechanism, enhancing network efficiency, security, and sustainability.

Staking ETH is a fundamental aspect of Ethereum's Proof-of-Stake system, requiring participants to lock their assets as a commitment to the network's integrity. Validators who stake their ETH help maintain decentralization and are rewarded for following protocol rules. However, those who act maliciously or fail to meet performance requirements face penalties, such as the slashing of their staked ETH, ensuring alignment with the network's best interests. This mechanism not only reinforces Ethereum's resilience but also incentivizes responsible participation through predictable, protocol-driven rewards.

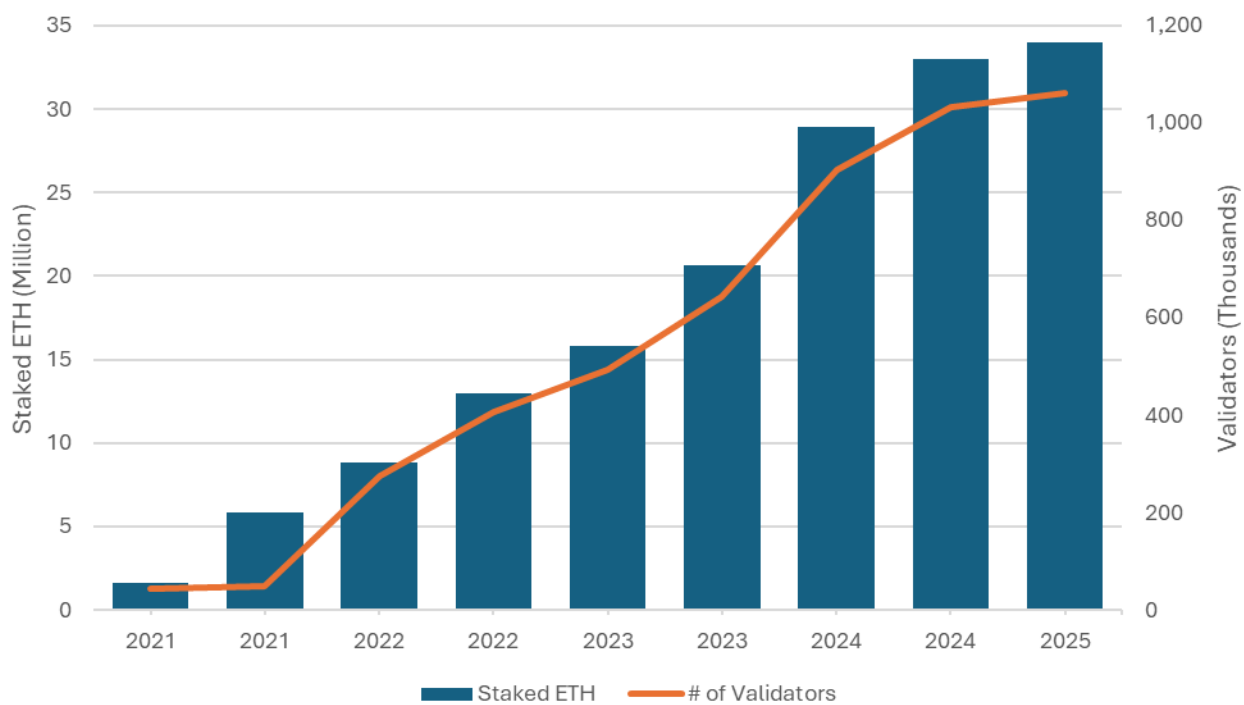
As staking adoption grows, Ethereum's network security becomes increasingly robust, further reinforcing the value of its PoS system.

3.1 Ethereum's PoS Architecture

Ethereum's PoS consensus mechanism is a dual-layered system comprising the **Consensus Layer** (formerly Ethereum 2.0 or Beacon Chain) and the **Execution Layer** (Ethereum's original mainnet). The Consensus Layer is responsible for validating transactions and securing the blockchain, while the Execution Layer handles transaction execution and smart contract computations. Together, they ensure Ethereum's operational integrity.

At the heart of PoS is the concept of validators—network participants who propose and attest to blocks by running validation software and staking ETH. This system replaces the computational competition of PoW blockchains like Bitcoin with economic incentives, aligning participants' interests with network health.

Figure 16. *Total Ethereum Validators and Staked ETH*



Source: Beaconcha.in for dates ranging from January 1, 2021 to January 1, 2025

The global geographical distribution of Ethereum's over 1 million validators, spread across 70+ countries, is crucial for ensuring the network's decentralization and security. This widespread distribution mitigates the risk of centralization, where control could be dominated by a few entities or regions and enhances network resilience against localized disruptions or regulatory actions. By operating validator nodes in diverse jurisdictions, Ethereum strengthens its position as a globally decentralized platform, ensuring continuous and secure operations irrespective of regional challenges.

Figure 17.

Ethereum Validator Distribution by Region

Country	Validator Distribution
United States	57.61%
Germany	9.66%
United Kingdom	3.17%
Canada	2.99%
France	2.89%
Netherlands	1.96%
Singapore	1.61%
Russia	1.21%
Belgium	1.14%

Source: Etherscan Node Tracker as of March 10, 2025.

Comparison to Proof-of-Work (e.g. bitcoin)

Ethereum's shift from PoW to PoS addressed several limitations inherent in mining-based consensus systems including, but not limited to:

1. **Energy Efficiency**: PoS consumes ~99.95% less energy than PoW, eliminating the need for power-intensive mining operations.

2. **Economic Accessibility**: PoS currently requires staking 32 ETH (or participating through staking pools) instead of expensive, depreciating hardware.

3. **Enhanced Security**: PoS deters attacks by requiring significant economic resources (ETH) to compromise the network, making attacks prohibitively costly.

This transition underscores Ethereum's commitment to sustainability and its adaptability in meeting the evolving demands of the blockchain ecosystem.

3.2 Validator Overview and Rewards

Validator Selection and Slot Mechanics

The selection of validator to propose a block of transactions for inclusion on Ethereum's blockchain is a randomized process, designed to maintain security and prevent collusion. A validator is randomly chosen approximately 6.4 minutes in advance to propose a block at each 12-second slot. This randomness is achieved through cryptographic techniques, ensuring no validator can predict or influence their selection. By distributing responsibilities and enforcing penalties for inactivity or malicious behavior, Ethereum's PoS design minimizes centralization risks and fosters a secure network environment.

Validator Roles and Rewards

Validators play a critical role in Ethereum's Proof-of-Stake consensus, ensuring the network's security, decentralization, and functionality. Validator duties are divided into two main activities:

1. **Block Proposals**: In each 12-second slot, a validator is randomly selected to propose a new block. The selected validator assembles the block to include pending transactions and broadcasts it to the network. In return, the validator earns **execution rewards** from the gas fees associated with the included transactions, providing a direct incentive to efficiently process high-value activity.

2. **Attestations**: Validators not chosen to propose a block during a slot are responsible for attesting to the validity of blocks proposed by other validators. Attestations are critical to achieving consensus and ensuring the integrity of the blockchain. Validators earn **consensus rewards** for providing accurate attestations, which contribute to finalizing blocks and maintaining the security of the network.

Economic Incentives in Proof-of-Stake

Validators earn staking rewards through two primary mechanisms, which together incentivize their active participation in securing the network:

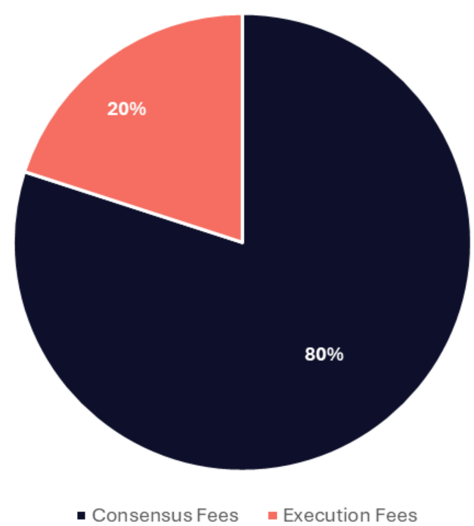
- **Execution Fees**: These are gas fees paid by users for transactions included in a proposed block. Execution fees are earned by the validator selected to propose the block and fluctuate based on network activity and transaction volume.

  Consensus Rewards: These rewards, distributed in ETH, are provided by the Ethereum network to validators proportionally to their staking contributions. Validators earn consensus rewards by attesting to proposed blocks, which is critical for finalizing blocks and maintaining the network's integrity.

Figure 18. below illustrates that validators earn approximately 80% of their rewards from Execution Fees (gas fees paid by users) and 20% from Consensus Rewards. This distribution highlights the importance of validator activities in both proposing and attesting to blocks to ensure consensus.

Figure 18.

Breakdown of Validator Rewards: Consensus vs. Execution Fees



Source: https://www.blockscholes.com/research/ethereum-staking-deep-dive---analysing-execution-layer-rewards-mev.

Additionally, staking rewards offer a consistent source of income for validators. Validators lock 32 ETH to become eligible and active on the network and in return, earn ETH rewards that are influenced by:

- **Network Participation Rate**: Increased validator and staking participation reduces individual validator yields due to fixed reward issuances. This is similar to Bitcoin mining; if a miner maintains the same hash rate but the overall network hash rate grows, their reward will decline.
- **Validator Performance**: Consistently proposing and attesting to blocks ensures maximum rewards, while downtime or malicious behavior leads to penalties, including slashing (a reduction of staked ETH).

This economic structure aligns incentives, encouraging validators to act honestly and maintain network security.

3.3 Liquid Staking Pools

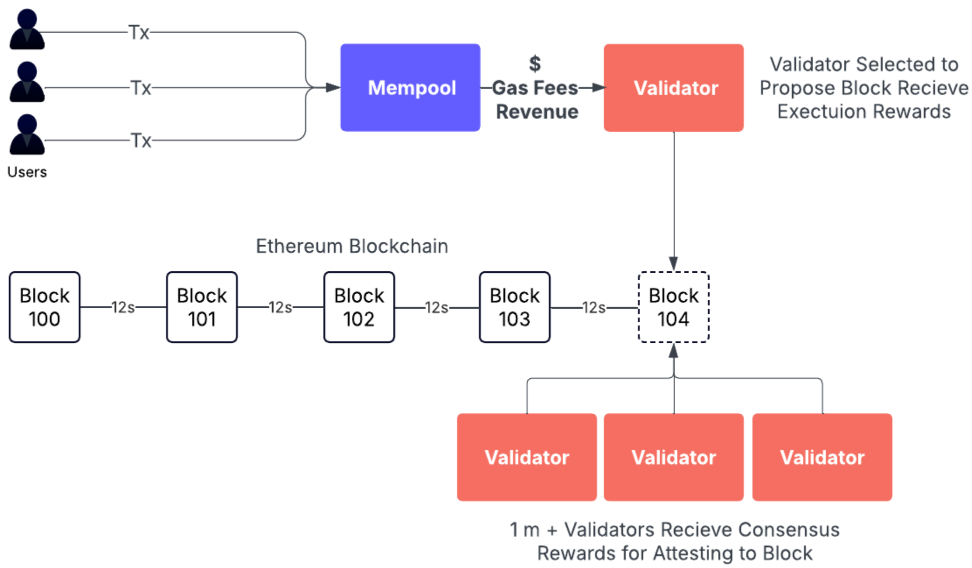
Liquid staking pools allow individuals to stake Ethereum and earn rewards while maintaining liquidity of their assets, all in exchange for a fee. Pools such as Rocket Pool, Lido, and Stader, act as intermediaries by gathering smaller amounts of ETH from multiple users and consolidating them to collectively fulfill a portion of the 32 ETH staking requirement per validator. This arrangement allows Ethereum validators, typically professionals, to participate in staking without individually meeting the 32 ETH requirement. However, validators participating in liquid staking pools are still required to contribute ETH; for example, Rocket Pool validators must currently stake 8 ETH, with the remaining 24 ETH supplied by Rocket Pool's collective deposits.

Professional validator operators utilizing staking Pools, manage the technical and operational complexities of running secure and efficient validators while participants receive a liquid staking token, such as rETH (Rocket Pool) or stETH (Lido), corresponding to their deposited ETH. The liquid staking token allows participants to earn staking rewards, net of fees, while retaining liquidity, as they can be freely traded or utilized within DeFi applications or on centralized exchanges like Coinbase, Kraken, and Binance. Rocket Pool, for example, allocates staking rewards to rETH holders after deducting an operational fee. The operational fee is shared between the validator operators and the Rocket Pool protocol. This economic model incentivizes validator operators by providing them with increased revenue from their take of the operation fee compared to independently running validator nodes.

4 Ethereum Transaction Lifecycle - Basic

The lifecycle of an Ethereum transaction involves multiple stages, from creation to final settlement on the blockchain. Understanding this process is crucial for analyzing network performance, gas fee dynamics, and user behavior. ***Figure 19*** below illustrates the various components of a transaction from initiation to landing on chain.

Figure 19. *Ethereum Transaction Lifecycle - Basic*



User Initiates Transaction

Every Ethereum transaction begins when a user initiates an action, such as transferring ETH, interacting with a smart contract, or submitting a bid in DeFi protocol. The transaction contains several key components:

- **Sender Address**: The wallet initiating the transaction.
- **Recipient Address**: The wallet or smart contract receiving the transaction.
- **Value**: The amount of ETH or tokens being transferred.
- **Gas Price**: The price a user is willing to pay for transaction execution.
- **Nonce**: A sequential counter ensuring the uniqueness of each transaction from a specific wallet.

Once created, the transaction is **signed** with the user's private key (akin to a password), secured against tampering, and broadcast to the network for inclusion in the mempool.

Mempool: The Transaction Waiting Room

The mempool is a public temporary holding queue for pending transactions. Validators access the mempool to select transactions for inclusion in the next block. Think of the mempool like a waiting room where anyone can see pending transactions awaiting confirmation.

Block Inclusion

Validators construct and propose blocks for inclusion.

Validation and Consensus

Once proposed, a block undergoes attestation by other validators in the network, including:

- The authenticity of transactions.
- Compliance with Ethereum's protocol rules.
- Proper execution of smart contract logic.

During this phase, validators provide attestations, which collectively determine whether the block is finalized and added to the blockchain. Finality is typically achieved after an epoch (32 slots, or ~6.4 minutes), ensuring that the block is permanently recorded and cannot be reversed.

Once a transaction is included in a block, it is considered confirmed. Users can monitor the status of their transactions through blockchain explorers like etherscan.io and beaconcha.in, which provide real-time updates on mempool status, gas usage, and block inclusion.

Gas Optimization and User Behavior

Gas fees are a critical component of Ethereum's transaction lifecycle. Users often optimize their transactions by:

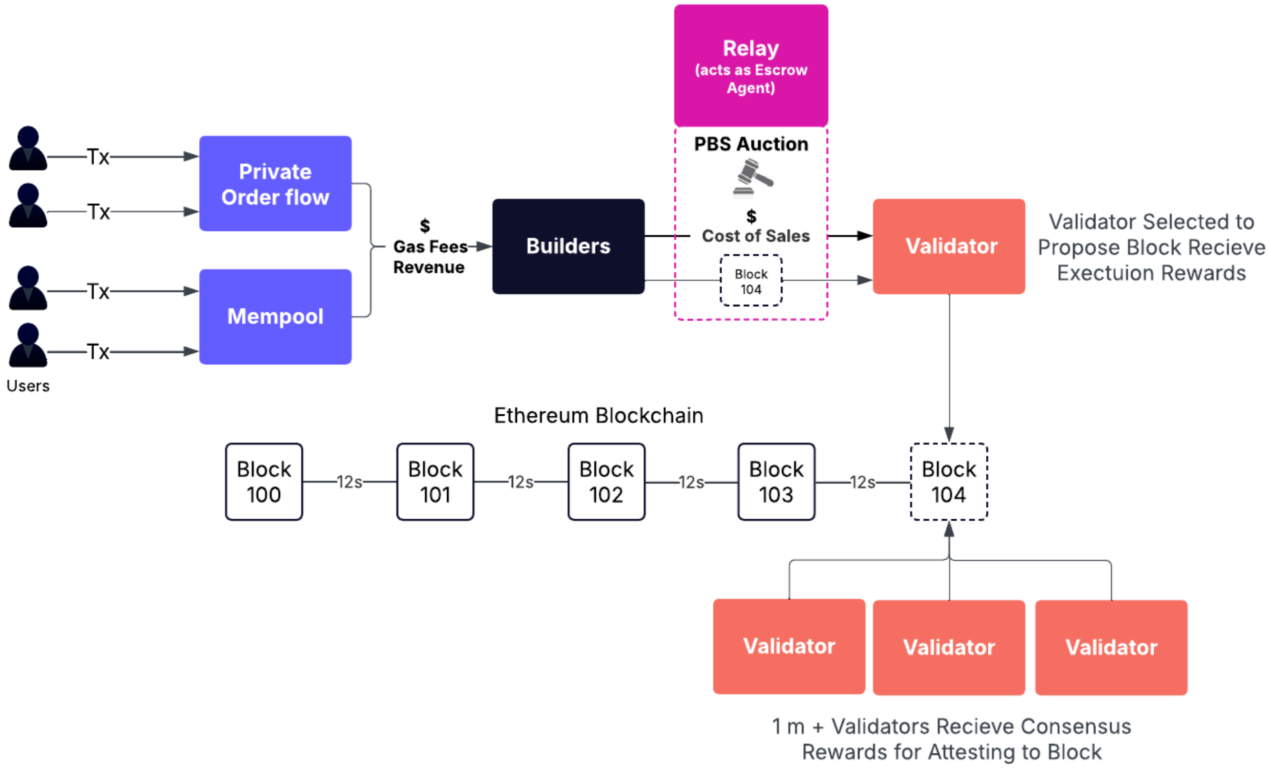
- **Timing**: Monitoring network congestion to execute transactions during periods of low activity.
- **Batching**: Grouping multiple operations into a single transaction to reduce fees.
- **Layer 2 Solutions**: Leveraging scaling platforms to minimize costs while benefiting from Ethereum's security.

5 Ethereum Transaction Lifecycle with MEV

5.1 What is MEV?

Maximal Extractable Value ("MEV") refers to the profit a block proposer or validator can extract by reordering, including, or excluding transactions within a block. Initially viewed as a byproduct of Ethereum's decentralized nature, MEV has evolved into a significant economic force, with far-reaching implications for network dynamics and user experience. ***Figure 20*** below illustrates the various components of a transaction from initiation to landing on chain with MEV.

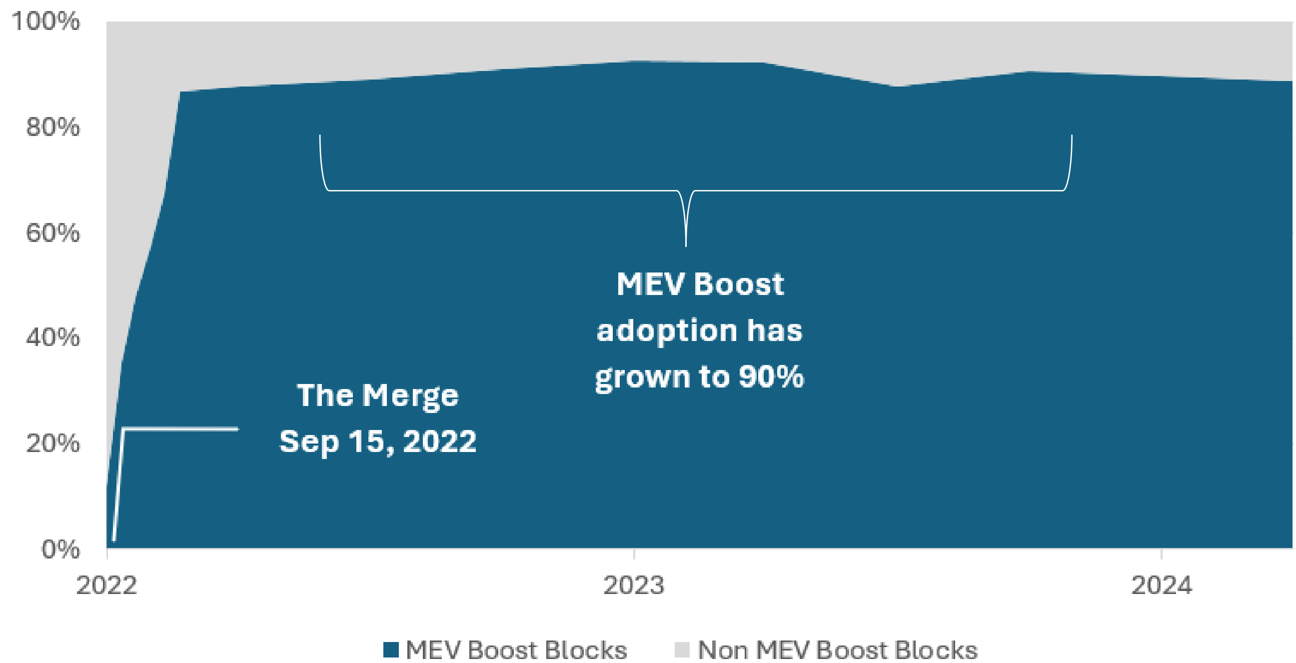
Figure 20. Ethereum Transaction Lifecycle with MEV



At its core, MEV arises from the flexibility inherent in Ethereum's transaction processing. Validators and block builders have the ability to extract value by controlling the sequence in which transactions are included in a block.

The transaction lifecycle intersects with MEV opportunities, particularly during the mempool and block inclusion phases. Sophisticated and specialized actors—such as searchers, block builders, and relays—have created an auction-based system that significantly benefits validators by maximizing block rewards. Since its introduction after the Merge, the Proposer Builder Separation ("PBS") system has seen rapid adoption and remains the dominant method for validators to outsource block-building to specialists.

Figure 21. *MEV Boost Adoption*



Source: MEV-Boost Slot Share mevboost.pics.

Market Size

The overall total market size, inclusive of validators and builders, is about **$2-4 billion**[3] and Ethereum block builders generating approximately **$400-$800 million**[4] in annual revenue.

The block-building sub-sector has become a significant revenue driver within Ethereum's ecosystem. Builders earn transaction fees by prioritizing, including, or excluding transactions within a block to maximize profitability, especially during periods of network congestion.

Total Market Size

$2-4 Billion

5.2 MEV Participants

Ethereum's ecosystem is driven by a diverse set of participants, each competing for block space to execute transactions, settle trades, and optimize on-chain activity. From market makers and exchanges to searchers and Layer 2 networks, these users play a crucial role in maintaining liquidity, securing transactions, and scaling the network while vying for efficient and timely inclusion in Ethereum blocks. These participants often privately send their order flow to builders instead of broadcasting them to the public mempool.

3 Estimate of all Ethereum revenue based on prices during 2024.
4 Estimate of the block-building market based on a 20% share of the total Ethereum Revenue market in 2024.

Private Order Flow: Non-Public Transactions

Users routing their transactions directly to block builders is akin to brokerage firms and trading desks using "darkpools" in the stock market. In dark pools, stocks are privately traded to avoid tipping off the market, preventing others from potentially moving prices against them. Similarly, in Ethereum, private order flow allows users, e.g., market makers, MEV Protection Services, L2s, and Exchanges, to prevent their transactions from being seen or manipulated prior to execution. Block builders receiving private order flow can offer superior execution by constructing blocks without the risk of public competition or front-running.

This practice benefits both the users and the block builders. Users get improved privacy and potentially better execution terms, while block builders secure exclusive high-paying transaction fees, giving them an edge in profitability and efficiency over builders relying solely on public mempool transactions.

Market Makers

Market makers provide liquidity to decentralized and centralized exchanges by continuously quoting buy and sell prices. Firms such as Wintermute and Jump Crypto play a crucial role in stabilizing markets, reducing slippage, and improving trade execution. Some market makers use MEV strategies to optimize their profitability while managing risks associated with liquidity positions.

MEV Protection Services

MEV protection services such as Blink, Merkle, and Flashbots Protect are designed to prevent users from falling victim to front-running, sandwich attacks, and other exploitative MEV tactics by keeping transactions out of the public mempool. They provide private transaction routing, batching mechanisms, and alternative ordering strategies to secure transactions.

L2s

Layer 2 solutions play a critical role in scaling Ethereum by processing transactions off-chain and settling them on Ethereum's mainnet. As L2s grow, they create additional demand for block space, as transactions must still be finalized on Layer 1. Protocols like Arbitrum and Optimism bundle multiple transactions into a single batch before submitting them to Ethereum, competing for inclusion in blocks to ensure timely finalization.

Exchanges

Centralized exchanges ("CEXs") generate significant demand for block space as they facilitate user deposits, withdrawals, liquidations, and fund transfers between wallets or across chains. Unlike decentralized exchanges, where every trade is settled on-chain, CEXs operate off-chain but must frequently interact with blockchains for settlement.

Binance, Coinbase, and Kraken regularly move large amounts of crypto on-chain to manage liquidity, facilitate institutional trades, and support customer withdrawals. These transactions compete for block space, especially during market volatility when users rush to move funds in or out of exchanges.

Searchers (i.e. Traders)

Searchers are independent participants who specialize in identifying and capturing MEV opportunities through active trading. Their role is critical in the MEV ecosystem, as they craft transaction bundles and execute trades to generate a profit. These trade bundles consist of carefully ordered, interdependent transactions designed to achieve a specific outcome, such as arbitrage or liquidation.

Unless vertically integrated, searchers do not participate in block-building auctions but instead submit their trade bundles directly to block builders. By doing so, they rely on builders to include their transactions in blocks. To mitigate risks such as front-running or leaking strategies, searchers often use private channels to deliver their trade bundles to builders, or many vertically integrate and operate their own builders. This approach ensures confidentiality and/or protects their trades.

Example MEV strategies include:

- **Arbitrage:** Exploiting price differences between exchanges.
- **Back-Running:** Placing a transaction immediately after a target transaction to benefit from its impact.
- **Front-Running:** Inserting a transaction ahead of another to capitalize on expected market movements.
- **Liquidations:** In DeFi, liquidations occur when a borrower's collateral falls below the required loan-to-value ratio, triggering the need for their position to be liquidated or partially liquidated to maintain protocol solvency. MEV actors play a crucial role in this process by competing to execute liquidations as quickly as possible. Since speed is essential, they often pay higher gas fees to secure priority inclusion in a block.

Arbitrage and back-running are highly beneficial for stabilizing markets and eliminating price discrepancies globally across both centralized and decentralized exchanges; while front-running has significant implications for users, as it can lead to increased costs, reduced liquidity, and altered transaction outcomes.

MEV exists across all blockchain networks but is particularly prevalent on Ethereum due to its robust DeFi ecosystem, where financial transactions present numerous arbitrage opportunities creating a competitive market for block space.

5.3 Block Builders

Block building is a foundational process in Ethereum, encompassing the selection, arrangement, and validation of transactions into a cohesive unit called a block. With Ethereum's Proof-of-Stake mechanism and Proposer Builder Separation PBS model, block-building has evolved to optimize rewards through a more specialized market.

Overview of Block Building

Block building begins when a validator is randomly chosen to propose the next block. The block builder, whether the validator themselves or an outsourced entity (like BTCS), performs the following tasks:

1. **Transaction Selection**: Transactions are chosen from the mempool or private sources, prioritizing high-gas transactions or bundles to maximize rewards.
2. **Transaction Ordering**: A builder arranges transactions within a block to maximize profitability.
3. **Block Assembly**: Selected transactions are packaged into a block that adheres to Ethereum's gas limit and protocol rules.
4. **Submission**: The block is passed via a relay to a validator and proposed to the network for inclusion.

Proposer-Builder Separation (PBS)

Ethereum's PBS framework decouples the roles of block proposers and block builders. Validators focus on securing the network and proposing blocks, while specialized block builders compete to assemble the most profitable blocks. As the market matures, participants play increasingly specialized roles.

How PBS Works:

- Builders participate in an auction to offer their pre-built blocks to validators.
- Validators select the block that maximizes their rewards (typically the block with the highest fee offering (i.e. bid)).
- The selected block is then proposed to the network for validation.

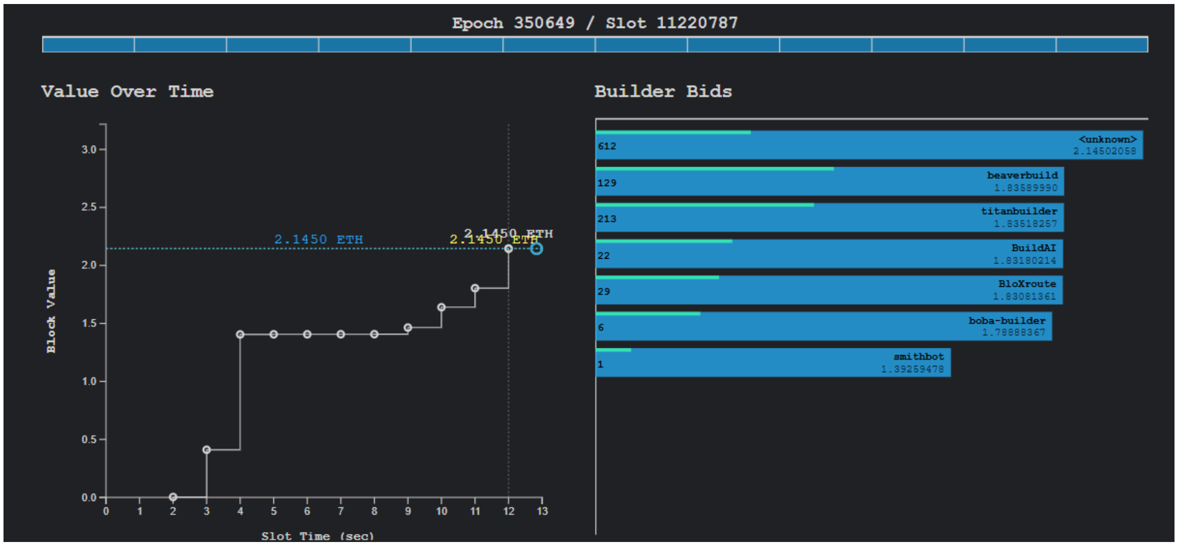
PBS has expanded the market by enabling specialized players to create more value and increase overall market growth. This framework encourages the rise of niche expertise, where block builders can focus on maximizing profitability through sophisticated MEV strategies, thus enhancing the network's efficiency and economic viability.

PBS Auctions

Block building under PBS operates through a 12-second auction cycle, where builders submit bids to validators in exchange for having their blocks proposed. This system enables validators to maximize rewards by outsourcing block construction to specialized builders, allowing even less sophisticated validators to remain competitive.

Tools like payload.de provide real-time and historical insights into PBS auctions. ***Figure 22*** below showcases a block built by BTCS, along with the competing bids leading up to the 12-second slot time deadline.

__Figure 22.__ PBS Auction Visualized on Payload.de



Example of block #22005181 built by BTCS show on https://payload.de/data/22005181/

Block Building and MEV

MEV is deeply embedded in the block-building process. Builders optimize block profitability by extracting MEV through the strategic organization and bundling of transactions from the mempool and private sources. Validators benefit from outsourcing block-building duties, receiving larger MEV revenue from builder payments.

Competitive Landscape / Concentration of Market Share

The competitive landscape of Ethereum block-building reflects the interplay of validators, builders, and MEV extractors. With the advent of Proposer Builder Separation and increasing MEV opportunities, the block-building ecosystem has grown into a dynamic marketplace with significant revenue potential and strategic implications.

The block-building market is characterized by a mix of independent participants and large, specialized entities. While Ethereum's decentralized design encourages broad participation, certain trends have led to the concentration of market share:

Currently, there are 16 active block builders, with 5 accounting for approximately 99% of block production. This concentration raises concerns of centralization as a few entities wield disproportionate influence over the network's operations. The table below in ***Figure 23*** illustrates the current market share.

Figure 23. *Builder Market Concentration*

Builder	Searcher[5]	Builder	Relay	Validator	Market Share
Titan		✓	✓		48.8%
Beaver	✓	✓			36.5%
Rsync	✓	✓			11.0%
BTCS		✓	✓	✓	**1.9%**
Builder Net		✓			1.0%

Source: Builder Market share obtained from Rated Explorer on March 15, 2025.

Competitive Dynamics

The consolidation of block-building presents the following challenges:

1. **Economic Inequalities**: Smaller validators and builders may struggle to compete with professional builders, exacerbating disparities in block-building rewards.
2. **Regulatory Concerns**: As the MEV market grows, regulatory pressure on block builders may lead to censorship and compliance restrictions.
3. **Reliance on the Existing System**: For validators aiming to maximize profitability, outsourcing block production to professional builders has become the only widely adopted method. Without alternative solutions, validators are effectively dependent on this system, reinforcing the dominance of block builders centralization in Ethereum's block production process.

Revenue Opportunities in Block Building

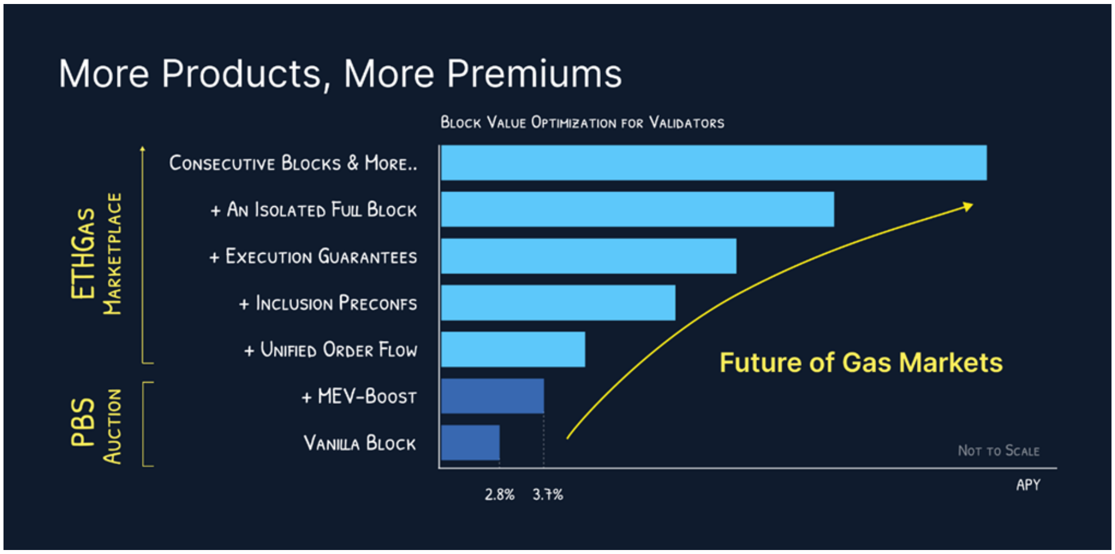
The growth of **block builder revenue** is driven by several key factors that influence MEV extraction and block auction dynamics.

1. **Price of Ethereum**: A higher ETH price increases the value of block rewards, making block-building more profitable.
2. **Transaction Activity**: Greater network usage, especially during volatile market conditions, can lead to more transaction fees and larger MEV opportunities.
3. **Expanding Products**: New technological advancements can create additional revenue streams for builders beyond traditional transaction inclusion.

As Ethereum continues to scale, the potential for revenue growth is projected to increase, reshaping how builders and validators approach block construction. This growth may be further accelerated by companies like ETHGas, which is working on building a new marketplace for gas on Ethereum. This development is intended to unlock ultra-low-latency scaling on Ethereum's blockchain, enabling transaction confirmations approximately 100 times faster than Solana and growing the overall market share with new products.

[5] *Including affiliations. Based on management research which may be inaccurate.*

Figure 24. ETHGas - The Future of Gas Markets[6]



Source: ETHGas: The Gas Stack Presentation.

5.4 Relays

Relays act as trusted intermediaries in the PBS auction, ensuring a fair and secure bidding and settlement process between block builders and validators. Similar to an escrow agent, a relay facilitates transactions by verifying and forwarding the highest bidder's block header while preventing validators from viewing the block's contents before accepting the bid.

Once the bid is accepted, the relay verifies the block's validity and forwards it to a validator for unmodified inclusion on the blockchain. This system protects builders while enabling validators to outsource block construction to earn higher rewards. By enforcing fairness and integrity in the PBS auction, relays play a critical role in Ethereum's MEV marketplace.

5.5 Validators

In Ethereum's Proof-of-Stake system, validators play a crucial role in securing the network by attesting to blocks proposed by other validators and proposing new blocks when randomly selected. While validators have the option to construct their own blocks, the vast majority—over 90%—choose to sell their block space to sophisticated block builders through the PBS auction. This allows validators to maximize their earnings while requiring minimal sophistication and infrastructure.

When a validator opts to sell its block space through the PBS auction, its revenue comes directly from the payment made by the highest-bidding builder. For builders, their payment to a validator represents their cost of sales, as they have purchased the right to the validator's block space for that slot. This auction-based system ensures validators earn competitive rewards, while builders strive to maximize block profitability by including high-value transactions.

[6] *Disclosure: BTCS Inc. is an investor in ETHGas and a priority builder in their marketplace.*

6 Future Outlook

As Ethereum continues to evolve, its future trajectory is shaped by technological innovation, market dynamics, and its ability to address current challenges. With its established leadership in decentralized applications, smart contracts, and financial innovation, Ethereum remains extremely well-positioned to play a pivotal role in a growing global digital economy.

6.1 Future Trends in MEV and Block Building

As the MEV market and block-building advance, new innovations are emerging that could reshape how block space is allocated and monetized. One of the most notable developments is ETHGas, a marketplace introducing real-time settlements and block space futures to Ethereum. By enabling validators to sell entire blocks or predefined portions of a block, ETHGas offers financial maturation to the current PBS auction system.

ETHGas introduces preconfirmation mechanisms, allowing users to bid for guaranteed inclusion or even execution outcomes in future blocks. This model contrasts with PBS, where builders compete in every slot's auction to construct and submit the most valuable block. Instead of relying solely on block builders to extract MEV and optimize transactions, ETHGas could decentralize control over block space allocation, giving users, traders, and protocols more direct access and control of transaction inclusion.

While still in beta, ETHGas' innovative market could enable hedging of transaction (gas) fees, expand the overall market of fee-based products, attract new participants, and enable transaction confirmations approximately 100 times faster than Solana. Though PBS remains the dominant model, ETHGas' emergence signals a potential transformation in how Ethereum's block space is traded, priced, and optimized in the future.

6.2 The Role of Layer 2 Solutions

L2 scaling solutions are expected to play an increasingly critical role in Ethereum's future. Platforms like Optimism, Arbitrum, and zkSync have already proven their ability to alleviate congestion and reduce transaction fees, making Ethereum more accessible to a wider audience. As these solutions mature, they will likely become integral to Ethereum's ecosystem, supporting use cases that demand high throughput and low latency.

The interplay between Ethereum's and its L2 networks will also foster innovation in areas like gaming, micropayments, and decentralized identity. By leveraging Ethereum's security while providing scalability, L2 solutions ensure that the network remains the platform of choice for developers and enterprises alike.

6.3 Global Adoption

As Ethereum's financialization accelerates, institutional participation is expected to grow, driven by developments like Ethereum-based ETFs, blockchain-based lending, and asset tokenization. The network's deflationary mechanics and staking rewards further position ETH as a compelling asset for institutional portfolios, deepening its integration with traditional financial markets.

6.4 Real World Use Cases

Beyond finance, Ethereum's innovations are set to transform industries such as supply chain management, gaming, fraud & identity protection, and healthcare, enabling programmable, trustless interactions that go beyond traditional capabilities. However, mainstream adoption will depend on improving usability, such as simplified wallet interfaces, and better educational resources. As Ethereum evolves, its continued growth will likely be driven by its ability to make blockchain technology more user-friendly, widely accessible, and seamlessly integrated into everyday applications.

6.5 Risks and Challenges

While Ethereum's ecosystem continues to evolve and grow, it is not without risks. These challenges encompass technical, economic, and regulatory domains, each with implications for the network's scalability, decentralization, and user experience.

Scalability Challenges

Scalability remains one of Ethereum's biggest challenges, particularly during periods of high demand. Network congestion can lead to elevated gas fees, which may price out smaller users and create delays in transaction processing. Layer 2 solutions have alleviated some of these pressures, and other solutions are being built such as ETHGas. The Ethereum Foundation has also gone through leadership changes with the goal of proactively addressing issues like this.

Centralization Risks

The concentration of power among large staking pools and professional block builders poses a risk to Ethereum's decentralization. Validators and builders with outsized influence could seek to undermine the network's resilience. Proposer Builder Separation and decentralized staking protocols are key initiatives aimed at mitigating these risks, ensuring that power is distributed more evenly across the ecosystem.

Regulatory Uncertainty

While regulatory clarity is forthcoming, shifting government administrations could lead to future volatility in Ethereum's regulatory landscape. Key concerns include whether ETH is classified as a security, as well as evolving compliance requirements for DeFi platforms and staking services. Changes in leadership and policy direction may create inconsistencies in enforcement, impacting adoption, innovation, and institutional participation.

Security Threats

The open and programmable nature of Ethereum makes it susceptible to security vulnerabilities. Smart contract exploits, and phishing attacks pose potential threats to the credibility of the ecosystem. Enhanced security measures, including rigorous audits and slashing penalties for validators, are essential to maintaining network integrity.

User Experience (UX) Issues

Ethereum's technical complexity is currently a barrier for non-technical users, with challenges such as gas fees, complex wallet interfaces, and a steep learning curve slowing mainstream adoption. However, user interfaces are continually improving, and this is anticipated to be less of an issue for younger generations, who have grown up in a technology-native era and may be more comfortable exploring blockchain ecosystems.

Competing Blockchains

Ethereum's blockchain faces competition from other blockchains, such as Solana, with emerging technologies and alternative consensus mechanisms that could challenge Ethereum's dominance.

7 Appendices

Appendix A: References and Resources

This primer draws on various foundational materials and tools that can deepen understanding:

- **Ethereum Whitepaper**: ethereum.org/whitepaper
- **Ethereum Foundation Blog**: Insights into protocol upgrades and ecosystem developments. blog.ethereum.org
- **Etherealize**: Dashboard with key performance indicators on Ethereum. http://www.etherealize.io
- **Flashbots Documentation**: Comprehensive guides on MEV and related tools. flashbots.net
- **Etherscan**: A block explorer providing real-time data on Ethereum transactions. etherscan.io

Appendix B: Suggested Reading and Media

Technical Papers and Articles:

- "Ethereum: A Secure Decentralized Generalized Transaction Ledger" by Buterin et al.
- "MEV 101: A Glimpse Into MEV" by LBank Labs.