coinbase

cbETH white paper

June 2024

Outline

Executive Summary

Coinbase mission and Ethereum staking

Coinbase's mission is to increase economic freedom in the world. Everyone deserves access to financial services that can help empower them to create a better life for themselves and their families. If the world economy ran on an open, common set of standards that could not be manipulated by any company or country, the world would be a more fair and free place, and human progress would accelerate.

As the largest and most decentralized smart contract platform, the Ethereum network is emblamatic to Coinbase's mission of increasing economic freedom. In 2020, Ethereum began transitioning from a Proof of Work (PoW) to a Proof of Stake (PoS) security model, which will drastically improve security, lower energy consumption by ~99.95% (per ethereum.org), and enable staking on Ethereum.

Staking on Ethereum is the process by which anyone can lock their ETH to put it to work on the network, allowing them to participate in consensus, validate transactions, and create blocks, thereby securing the network. Doing this work well earns stakers ETH rewards, while doing it poorly can result in lost ETH due to penalties.

While staking is beneficial to the network and ecosystem, there are some drawbacks. While a user is staking, their ETH tokens are locked on the network, making them non-transferrable. And until the Shanghai upgrade, it won't be possible to unstake ETH. Furthermore, following the completion of that upgrade, when a user wishes to unstake and withdraw their tokens, they may face a delay of anywhere from 27 hours to as long as several weeks, depending on how many others are unstaking at the same time.

This unpredictability and lack of liquidity limits the willingness of ETH holders to stake, diminishing network security. Worse still, staked ETH cannot be used for anything else (like collateral in DeFi), making the ETH token itself less useful.

Change Log

Edits were made to the Conversion Rate section of this white paper on June 11, 2024, to update customers on the new cbETH conversion rate methodology. All other sections remain unchanged, reflecting the content published during the original cbETH launch in June 2022.

Liquid staking

Liquid staking was created to address some of the shortcomings of traditional staking. With liquid staking, locked staked assets are wrapped into transferable tokens that represent ownership of the underlying staked assets, and any rewards earned. The resulting tokens are fully transferable and can be unwrapped to claim the underlying staked assets.

Our view is that liquid staking is inevitable in a mature market and is a crucial step towards continued adoption. The Ethereum community is a bellwether for the broader crypto ecosystem and the success of Lido and other solutions is an encouraging sign.

The problem with the liquid staking market is the same as many other markets - liquidity begets liquidity. All things being equal, a user would always choose a more widely adopted and liquid solution. However, this "winner take most" outcome is untenable when it comes to consensus-bearing systems like Ethereum, as there are consensus thresholds that should act as soft limits on any one solution.

Therefore, it is necessary for the liquid staking market to have strong, competing solutions with differentiated qualities.

Today the liquid staking market on Ethereum is dominated by a single solution that is on the verge of breaching 33% network penetration (the first consensus threshold). Following the success of USDC, we believe that cbETH has the potential to achieve significant adoption and diversify the crypto ecosystem. Our view is that key Coinbase strengths such as our trusted brand, security, stringent risk policies, compliance, and others, are key differentiators for users.

Keeping Ethereum secure and decentralized is critical to Coinbase's mission and our hope is that cbETH contributes to that cause.

cbETH

Coinbase is supporting liquid staking for its ETH stakers with Coinbase Wrapped Staked ETH (cbETH), where the staked asset is Ether (ETH), and the staking provider and token issuer is Coinbase. Our hope is that cbETH will achieve robust adoption for trade, transfer, and use in DeFi applications. With cbETH, Coinbase aims to contribute to the broader crypto ecosystem through creating high-utility wrapped tokens and open sourcing smart contracts.

cbETH follows the cToken model and can be minted or burned according to a floating conversion rate. At a high level, this conversion rate tracks the underlying staked ETH to account for staking/unstaking activity, rewards, penalties, and fees. This allows users to easily move between ETH and cbETH (once unwrapping is available) under constantly changing network conditions. It also means that ETH and cbETH are not pegged or expected to be interchangeable 1:1. In fact, as the underlying staked ETH continues to accrue rewards, each cbETH token is expected to represent more staked ETH, which may result in a divergence in prices for these assets over time.

Use cases

1. Exiting staked ETH: Bob staked ETH with Coinbase in 2021 and wants to sell his position in 2022, but staked ETH on the Beacon Chain is still locked for the time being. He thus wraps his ETH to cbETH at the prevailing conversion rate, and sells for cash at the cbETH market exchange rate.
2. Collateral in DeFi: Alice wants to earn staking rewards on her ETH while also borrowing USDC on a DeFi protocol. She can do this by wrapping her staked ETH to cbETH, then depositing the cbETH into the protocol as collateral and subsequently borrowing USDC against it. In doing so, Alice maintains her ETH position and accrues the associated staking rewards as a holder of cbETH.
3. Transferring staked ETH: Brian has staked ETH with Coinbase and wants to gift it to a friend. He sends the cbETH from his Coinbase account to his friend's non-custodial wallet, who now has exposure to ETH and staking rewards.

cbETH in DeFi

As soon as cbETH is live, any DeFi protocol will be able to add support for it without help or permission from Coinbase. Coinbase is a public company, cbETH contracts are open source, and our smart contract audit is published publicly, enabling other entities like DeFi protocols to make informed choices when evaluating cbETH for support.

Having said that, Coinbase hopes to drive adoption for cbETH among our ecosystem of protocol, dapp, and business partners. We may put forward governance proposals or support third parties who do so, and we may publish research or data about cbETH as educational content for market participants.

cbETH and lsETH (Alluvial)

In May 2022, Coinbase announced Alluvial, an enterprise-grade liquid staking standard, with support from Coinbase Cloud and Figment. cbETH and Alluvial's lsETH are both liquid staking solutions, but there are some important distinctions to keep in mind.

At a high level, having both cbETH and lsETH aligns with the Coinbase philosophy of offering a first-party ecosystem for customers who want the ease and simplicity of remaining inside the Coinbase ecosystem (cbETH), as well as offering third-party solutions in parallel for customers who prefer decentralized solutions (lsETH).

Other distinctions include target markets, fees, infrastructure providers, and so on. The full analysis is beyond the scope of this whitepaper, but readers are welcome to refer to the Alluvial website for more information.

Technology

Token model

As DeFi has matured, several models have emerged as ways to represent tokenized ownership of an underlying asset.

aTokens

Pioneered by Aave, these tokens operate by constantly updating supply to map 1:1 with the underlying asset. Because of the dynamic nature of the supply, aTokens are also referred to as "rebase tokens" or "elastic supply tokens"

> ↘ ***Example:*** *Alice supplies 10 ETH to lending protocol and receives 10 aETH. After some time passes, she earns 2 ETH of rewards. Her aETH position incrementally rebases to 12 aETH over that time. Rebasing does not require transactions; it is more akin to "updates." She then removes her liquidity from the protocol, converting her 12 aETH back to 12 ETH.*

cTokens

Another model, and the one adopted by cbETH, is the cToken model.

Pioneered by Compound, cTokens represent ownership of underlying principal plus any rewards accrued on that principal, minus any penalties (e.g., slashing). The conversion rate between the cToken and the underlying assets (principal + rewards - penalties) thus changes as a function of the rewards and penalties affecting the principal.

> ↘ ***Example:*** *Bob supplies 10 ETH to a lending protocol and receives 10 cETH. After some time passes, he earns 2 ETH of rewards. His cETH position remains at 10 cETH (no change in supply held), but it's now backed by 12 ETH (which changes the conversion rate of cETH relative to ETH). He then removes his liquidity from the protocol, converting his 10 cETH for 12 ETH.*

Structured as a cToken, cbETH will have rights to underlying staked ETH and accrued rewards and penalties. Changes in these underlying amounts would have effects on the conversion rate between cbETH and ETH.

In preparation for the Merge, Coinbase will move to an effective APY rewards structure. Post-Merge, transaction fee rewards (i.e., tips) and any other sources of validator revenue will be re-staked to compound ETH staking rewards.

Rationale for choosing the cToken model

cTokens are most widely compatible with dApps in DeFi today, due to the fact that they are ERC-20 compliant. aTokens, on the other hand, are not.

It is worth noting that aTokens allow for a more elegant UX by maintaining a 1:1 mapping between wrapped token and underlying asset. While compelling, this feature was ultimately outweighed by a design choice for the user that maximized utility, composability and efficiency of cbETH.

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Conversion rate

Definitions

Wrap request - a request made to convert staked ETH into cbETH

Unwrap request - a request made to convert cbETH back into staked ETH

Settled Wrap Request - wrap request which has gone through settlement

Settled Unwrap Request - unwrap request which has gone through settlement

Settlement - the point at which a request is considered settled. For wrap requests, this is when we set the amount of tokens we will issue given the amount of staked ETH in the wrap request. For unwrap requests, this is when we set the amount of staked ETH we will credit given the amount of tokens in the unwrap request

Epoch - a period of 32 slots in Ethereum PoS; consensus time taken for blocks to be completed onchain

Net rewards per unit of staked ETH = $\frac{\textit{Inflationary protocol rewards earned + transaction fees - penalties incurred - Coinbase fee}}{\textit{total ETH staked in validators by Coinbase}}$

The conversion rate is the rate at which cbETH will be issued or redeemed relative to the amount of staked ETH being wrapped or unwrapped, and can be pulled from both the smart contract and the Exchange API (which is informed by the smart contract).

At first mint, there was a 1:1 ratio between staked ETH on Coinbase and cbETH. This mint occurred on 2022-06-12 at 18:04:35 in preparation for the cbETH public launch. This ratio will continue to deviate over time for the reasons explained above. This is very similar to the relationship between cTokens and their underlying assets on Compound (docs).

Original Rate Calculation

Upon cbETH's launch in June 2022, the cbETH conversion rate was a function of the amount of net rewards earned by 1 ETH staked on 2022-06-12 during the initial mint. At a high level, the conversion rate at the total pool level was calculated as follows:

$$\text{Conversion Rate} = \frac{\textbf{Total Wrapped Staked ETH}}{\textbf{Total cbETH Supply}}, \text{ where}$$

Total Wrapped Staked ETH = *Staked ETH in settled wraps* - *Staked ETH in settled unwraps* + *Net Rewards*

Total cbETH Supply = *cbETH issued* - *cbETH redeemed*

Net Rewards = ***(*** *Inflationary protocol rewards* + *Transaction fees (tips) & any other validator rewards* - *Penalties* ***)*** × *0.75*

Updated Rate Calculation

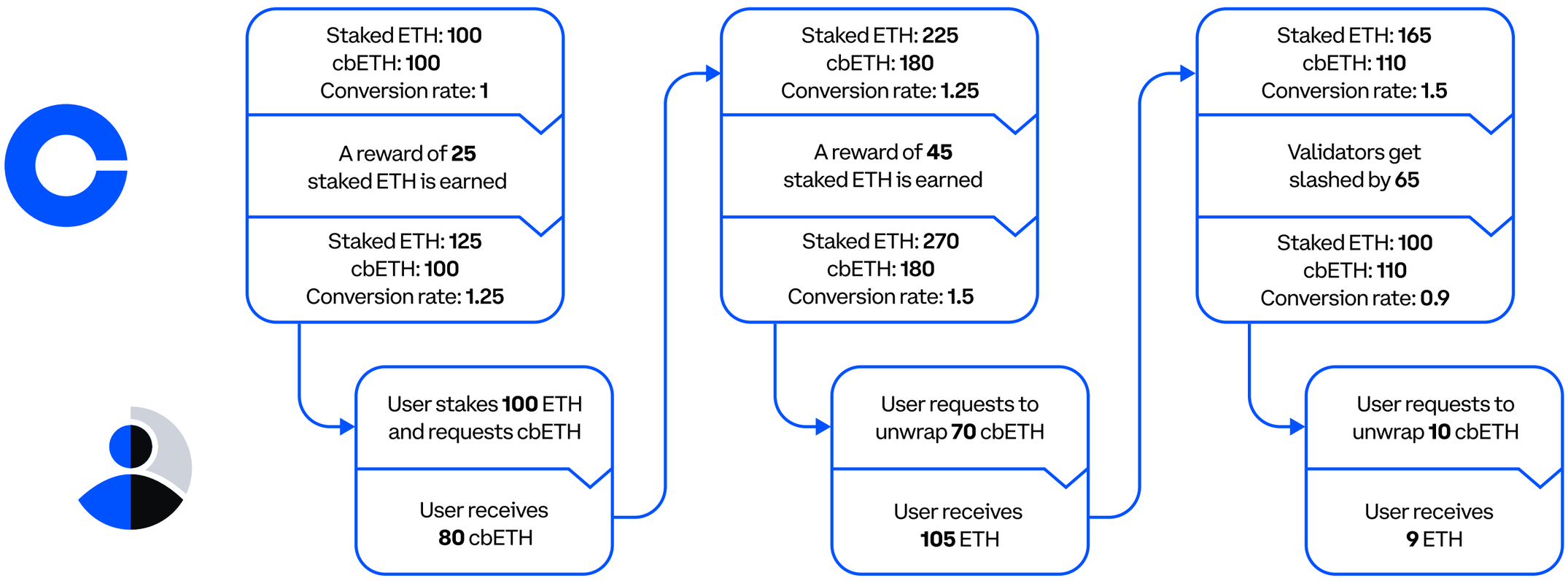
Starting June 11, 2024, the cbETH conversion rate will move away from being indexed on total wrapped staked ETH, and will instead be indexed on the staked ETH backing 1 cbETH. For example, if the conversion rate on June 11, 2024 (date of methodology change) is 1.073, then the cbETH conversion rate will be computed based on the rewards earned by that 1.073 staked ETH, instead of at the total pool level. The original and the updated rate calculation formulas are designed to result in the same conversion rate.

$$\text{cbETH conversion rate}_{\text{epoch n}} =$$

$$\text{cbETH conversion rate}_{\text{epoch n-1}} + (\text{conversion rate}_{\text{epoch n-1}} * \frac{\text{net rewards earned}_{\text{epoch n-1}}}{\text{total ETH staked}_{\text{epoch n-1}}})$$

User example

Please note: The below visual is an illustrative example of how the cbETH conversion rate changes over time.



Market exchange rate

The price of cbETH will be determined by the market and is not pegged or in any other way maintained by Coinbase. Market participants can buy, sell, wrap, and (eventually) unwrap cbETH based on factors such as the defined conversion rate in our smart contract or different forms of risk to affect the price of cbETH relative to ETH.

Coinbase's token wrapping operations

cbETH is the first token built on the Coinbase wrapping token contract.
(Smart contract code open source repository: Github)

On an ongoing basis, Coinbase assesses how much eligible ETH is staked on platform, and will mint a corresponding amount of cbETH, in accordance with the current conversion rate. The cbETH is minted on-chain to the designated receiver wallet. cbETH supplies are updated based on the underlying staked ETH on a 4-hour cadence.

The cbETH contract is inherited from USDC with two feature additions: an exchangeRate and an oracle role. The exchangeRate allows anyone to query the latest conversion rate. The oracle role updates the exchangeRate. Coinbase controls the oracle's address and will update the exchangeRate every 24 hours at 4pm UTC. This update cadence may be changed in the future.

Key roles of the wrapping contract managed by Coinbase

- Admin: can upgrade the wrapped token implementation contract
- Owner: can assign all roles except the Admin's
- Blacklister: can blacklist an address from transferring, minting, and burning
- MasterMinter: can assign minters and their limits
- Minter: can mint and burn tokens
- Pauser: can pause all transfers, mints, and burns for the contract

Other parameters available in the smart contract

- Number of underlying staked ETH Units
- Max total supply of cbETH
- ETH principal staked
- Accrued rewards

Security audits

Coinbase engaged OpenZeppelin in an audit of the cbETH smart contract, which can be seen here (link).

Risks

Slashing risk

Ethereum's consensus mechanism has several rules intended to protect the integrity of the network. If any of these rules are broken (voluntarily or not), a portion of the staked ETH is removed. Some examples include validator downtime and double-signing. We take a number of measures to mitigate these risks, including but not limited to: client diversification, node operator diversification, and geographical / hosting diversification (more detail under Coinbase Advantages below). These mitigants aren't a panacea though. In the event of a validator or protocol failure, this network "slashing" could reduce the amount of staked ETH held by Coinbase on behalf of cbETH holders. In this event, the cbETH<>staked-ETH conversion rate would decrease–just as it increases when the network distributes rewards for successfully proposing and validating blocks.

Smart contract security risk

cbETH is at its core a smart contract, and with that comes risk that the code may be exploited in unforeseen ways. This risk is partially mitigated by the fact that the foundation of cbETH is based on heavily audited and battle tested smart contracts (like USDC). Additionally Coinbase obtained a smart contract audit from OpenZeppelin specifically for cbETH (link).

Blockchain technical risk

As mentioned above, Ethereum is undergoing its largest upgrade ever right now. Potential flaws with the Beacon Chain or the upcoming Merge could lead to adverse consequences for cbETH, like all staked ETH.

Custodial risk

There is always a non-zero custodial risk in crypto. In this case, Coinbase custodies keys associated with the staked ETH underlying cbETH. To the extent these keys are ever compromised, this would likely lead to the underlying ETH they control being lost.

cbETH price risk

The price of cbETH will be determined by the market and is not pegged or in any other way maintained by Coinbase. As with any asset trading in free markets, there is always some degree of price risk inherent in the trading of cbETH. As an example, because withdrawals from the Beacon Chain are initially unavailable (until the Shanghai upgrade allows for staking withdrawals), market participants are limited in their ability to arbitrage the price of cbETH to fair value. This may lead to cbETH trading at a price inconsistent with the amount of staked ETH and rewards that a user could redeem by unwrapping cbETH.

Coinbase Advantages

Coinbase has been operating a best-in-class staking operation since 2019 and began staking ETH on behalf of users in 2021. A number of measures are taken to ensure both the security of the ETH staking operation as well as the robustness of the Ethereum network broadly.

Client diversification

Coinbase's provisioned validators run multiple Ethereum clients, reducing the risk of a network-crippling bug that could result in a heavily correlated slashing event.

Node operator diversification

When running validators, Coinbase enlists a number of different node operators. This helps to reduce risk specific to any one operator.

Geographical & hosting diversification

Our node operators collectively run validators in multiple hosting environments (e.g., bare metal, AWS, GCP, etc.) and in multiple regions to maximize the resilience of their infrastructure. Again, this reduces the risk of correlated slashing.

Custody

Coinbase will custody the keys controlling the wallet addresses holding the staked ETH wrapped for cbETH. Coinbase's best-in-class rigor has been keeping user funds safe for 10+ years.

Protocol Specialists

Coinbase has a team of Protocol Specialists contributing to the Ethereum ecosystem and staying on top of the latest developments.

Fees

There are no fees associated with wrapping or unwrapping cbETH. Coinbase staking fees still apply to the underlying staked ETH.

Glossary

ETH

The native asset and gas token of the Ethereum network

cbETH

The liquid wrapped token following the ERC-20 standard on Ethereum representing staked ETH on Coinbase.

The Merge

The Merge represents the joining of the existing execution layer of Ethereum (the Mainnet used today) with its new proof-of-stake consensus layer, the Beacon Chain. It eliminates the need for energy-intensive mining and instead secures the network using staked ETH. The upgrade to the Ethereum network is slated for September 2022, but is subject to change.

Shanghai Upgrade

The network upgrade following the Merge which will enable transfers on the Beacon Chain.

Conversion Rate

The formulaic rate at which cbETH can be issued / redeemed for staked ETH. Note that for now this is referred to as the “exchangeRate” in the cbETH smart contract.

Market Exchange Rate

The free market rate at which cbETH will trade.

Principal

The Ethereum network specifies a deposit of 32 ETH to activate validator software (increments of 32 ETH per validator). From a network perspective, this 32 ETH is the principal put up per validator. From the user perspective, principal is the initial sum of ETH staked. Coinbase’s staking operation enables this sum to be in increments other than 32 ETH.

Rewards

The sum of non-principal ETH, earned as rewards for participating in staking (e.g., transaction fees, inflationary block rewards, and any other sources of validator revenue).

Legal Disclaimer

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