

Staking, explained: running a validator alone or through a pool

A plain guide to how Ethereum staking works under its consensus rules, what a validator earns and risks, and how Lido and Rocket Pool let people stake without running 32 ETH alone.

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AT A GLANCE

- 1 An Ethereum validator needs 32 ETH to become active, under the consensus specs' MIN_ACTIVATION_BALANCE ^[4].
- 2 Since Electra, a compounding validator can count up to 2,048 ETH toward its effective balance, the figure the protocol uses to size rewards and penalties ^{[4][5]}.
- 3 Rewards are weighted out of 64: source 14, target 26, head 14, sync committee 2, proposer 8 ^[2].
- 4 Solo stakers run their own validator; Lido and Rocket Pool pool deposits and issue tokens for them ^{[6][8]}.
- 5 Slashing rules have changed by fork; Electra divides by a minimum penalty quotient of 4,096, against 128 at launch, so the initial penalty is smaller ^{[1][4]}.

1. What it is

Locking ETH to secure Ethereum

Ethereum chooses who proposes and checks blocks from validators that have put up ETH. That deposit is the stake. Validators earn rewards for doing their duties and lose part of the stake if they break the rules.

Analogy, not the mechanism itself: it is a security deposit. You get paid for keeping the building safe, and you forfeit part of the deposit if you are caught doing harm.

The validator

A validator is the unit that does the work: a set of keys plus software that follows the consensus rules. In the specs, a validator needs a balance of at least 32 ETH to activate; the Electra spec describes `MIN_ACTIVATION_BALANCE` as the "minimum balance for a validator to become active" ^[4].

Solo staking

A solo staker deposits the full 32 ETH, holds the validator keys and runs the software. Rocket Pool's docs put it plainly: "solo stakers... are required to put 32 ETH up for deposit to create a new validator" ^[8]. The consensus rules apply to the solo staker directly.

Pooled and liquid staking

Pooled staking lets people stake without running a validator or without holding 32 ETH. Lido and Rocket Pool are two such services. Both issue a token that represents a staked deposit: stETH and wstETH for Lido ^[6], rETH for Rocket Pool ^{[8][9]}.

Why the choice matters

Solo staking keeps keys and duties with the owner. Pooled staking hands them to node operators and smart contracts, in exchange for a lower entry point, such as Rocket Pool's 4 ETH node bond ^[8], and a token that represents the deposit. Each route carries different risks, covered in section 4.

2. How it works

Slots and epochs

Time on Ethereum's consensus layer is split into slots, and slots are grouped into epochs. The phase0 spec sets `SLOTS_PER_EPOCH` at 32 ^[1].

How rewards are split

The Altair spec divides each reward into weighted parts out of 64: 14 for a timely source vote, 26 for a timely target vote, 14 for a timely head vote, 2 for sync committee work, a rotating group of validators that helps light software follow the chain, and 8 for proposing ^[2]. A validator's base reward scales with its effective balance; in the spec, `get_base_reward` multiplies the validator's balance increments by a per-increment reward ^[2].

Analogy, not the mechanism itself: the 64 points are a pay slip with line items. Most of the pay comes from voting on time, and a smaller share from proposing blocks.

Penalties and slashing

Missing duties costs a validator rewards. Slashing is harsher, for provable misbehavior such as signing conflicting messages. The initial slashing penalty is the balance divided by a quotient. That quotient was 128 in phase0 ^[1] and is 4,096 in Electra ^[4]. A second, proportional penalty uses a multiplier, 1 in phase0 ^[1] and 3 since Bellatrix ^[3].

The inactivity leak

If the chain stops finalizing, meaning blocks can no longer be locked in as permanent, inactive validators lose balance faster until it recovers. Bellatrix sets `INACTIVITY_PENALTY_QUOTIENT_BELLATRIX` at 2^{24} ^[3].

Staking rules in one table

Rule	Value	Source
Balance to activate	32 ETH	Electra spec ^[4]
Largest effective balance, compounding validator	2,048 ETH	Electra spec ^[4]
Balance at which a validator is ejected	16 ETH	phase0 spec ^[1]
Slots per epoch	32	phase0 spec ^[1]
Base reward factor	64	phase0 spec ^[1]
Minimum slashing penalty quotient	4,096 (Electra); 128 (phase0)	Electra spec ^[4] ; phase0 spec ^[1]
Proportional slashing multiplier	3 (since Bellatrix); 1 (phase0)	Bellatrix spec ^[3] ; phase0 spec ^[1]

Every value comes from the parameter tables in the cited specs, at the commit given in Sources.

Rocket Pool's split deposit

Rocket Pool nodes "only need to deposit 4 ETH per validator (called 'bonded ETH')," which "will be coupled with 28 ETH from the staking pool" ^[8]. That borrowed ETH "comes from liquid staker deposits in exchange for rETH" ^[8]. To the beacon chain, the docs say, such a validator "looks exactly the same as a normal validator" ^[8]. "Each megapool validator earns 5% commission on rewards generated from the 28 protocol ETH" ^[8].

3. What changed

Altair's reward weights

The Altair fork introduced the participation weights in section 2: source 14, target 26, head 14, sync 2 and proposer 8, out of a denominator of 64 ^[2].

Bellatrix raises slashing

Bellatrix set the proportional slashing multiplier to 3 and the minimum slashing penalty quotient to 32 ^[3]. Earlier forks had used lower multipliers: 1 in phase0 ^[1] and 2 in Altair ^[2].

Why it mattered: misbehavior that many validators commit together is punished more heavily.

Electra and 2,048 ETH

Electra added compounding validators, whose rewards can stay in the validator's balance, with a maximum effective balance of 2,048 ETH (MAX_EFFECTIVE_BALANCE_ELECTRA) ^[4]. It also set the minimum slashing penalty quotient to 4,096, which makes the initial slashing penalty smaller than under Bellatrix ^{[3][4]}. EIP-7600 lists the Prague/Electra ("Pectra") upgrade's mainnet activation at epoch 364,032, Unix timestamp 1746612311, which is May 7, 2025, at 6:05 a.m. ET ^[5].

Why it mattered: a large staker can run fewer validators, each with a higher balance, instead of many 32 ETH validators.

Lido's two tokens

Lido's docs describe stETH as "a rebasable ERC-20 token that represents ether staked with Lido" ^[6]. "stETH implements rebasing mechanics which means the stETH balance updates regularly. On the contrary, the wstETH balance does not change on its own but rather increases in value against stETH" ^[6]. wstETH is stETH's "non-rebasable, value-accruing counterpart," and "any amount of stETH can be converted to wstETH via a trustless wrapper and vice versa" ^[6].

Lido withdrawals

Lido's withdrawal contract manages "a queue of withdrawal requests" and commits finalization "as a part of the AccountingOracle report" ^[7]. A request is represented by an unstETH NFT that "is minted upon request and burned on the claim" ^[7].

Rocket Pool's rETH and RPL

"The rETH token will not rebase. The number of tokens on your wallet will remain constant but they appreciate in value over time," Rocket Pool's FAQ says ^[9]. Node operators "may optionally stake RPL to their node to qualify for additional rewards and to gain voting power within the protocol DAO" ^[8].

4. What is open

Slashing and operator risk

A solo staker who runs two copies of a validator by mistake can be slashed. In a pool, that risk sits with node operators; in Le Coin's view, stakers then rely on the pool's rules to share any loss. The spec penalties apply either way ^{[1][3][4]}.

Correlated failures

The proportional penalty grows when more validators are slashed around the same time ^{[1][3]}. In Le Coin's view, many validators run by one operator, or on the same software, can fail together.

Smart-contract risk

Pooled staking adds contracts on top of the consensus rules: Lido's token and withdrawal contracts ^{[6][7]} and Rocket Pool's deposit pool ^[8]. A flaw in that code is a risk that solo stakers do not carry.

Rounding in stETH

Lido's docs note that stETH balances use integer division, so a transfer can leave "the last 1-2 wei on the sender's account" ^[6]. It is a tiny amount, but integrations need to allow for it.

Waiting to withdraw

Lido withdrawals are finalized through its oracle report ^[7], so they are not instant. This page does not state a typical wait, because Le Coin has not verified one.

What this page leaves out

By Learning Hub policy, this dive carries no yields, prices or validator counts. It does not cover Rocket Pool's older minipool design or launch dates, Lido's risk disclosure, or restaking.

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