

Validator Economics: Variable min validator deposit size

EF Academic Grant ID: FY23-1030

MILESTONE 1: IDENTIFICATION OF DATA SOURCES & INSIGHTS

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1 Overview

This document is the deliverable for Milestone 1 of EF Academic Grant ID: FY23-1030, and is joint work with Kerrie Mengersen and Patrick O'Callaghan. It details available information, data sources, and proposed visualisations that will provide relevant data insights to gain a deeper understanding of current validator economics and any intuitions or assumptions used in formulating proposed solutions to capping the number of validators.¹

The information gathering is targeted towards the proposal being evaluated, viz. a variable minimum validator balance, which is one of the proposals that Vitalik articulated in his blog post regarding single slot finality (SSF). As Vitalik summarises in his blogpost “Determining the validator economics” means “answering the question of who stays and who goes if demand for becoming a validator exceeds the system’s capacity to process validators” and he adds that this question “involves the hardest tradeoffs that are not-just-technical and merits engagement from the community.”

In other words, the floating minimum balance proposal is one of the ways put forward by Vitalik to manage a cap on the total number of validators. In this proposal, the validator with the lowest balance will be kicked out when the total number of validators is greater than the cap.

Vitalik highlighted a potential vulnerability that could be introduced with this proposal, viz. the emergence of a new type of griefing attack [?] where validators split their stake in order to push smaller validators out.

The consequence of such a successful griefing attack is that the wealthier validators increase their reward, R , because the total deposit amount, D , decreases. (Current formula to calculate the validator reward: $R = \frac{k}{\sqrt{D}}$).

Vitalik further suggests that this attack could possibly be mitigated by “adding a fee per validator slot, and target it so that under a Zipfian distribution this is never worth it. However, this would still leave open a potential vulnerability if the distribution becomes very non-Zipfian”.

As the project progresses and additional data requirements are identified, this document will be updated accordingly.

Many people have generously contributed time and data, and made helpful suggestions, which has been incredibly helpful in compiling the resources listed in this document. They include, but are not limited to Barnabé Monnot and the Rigorous Incentives Group (RIG) team, Justin Drake, Alexander Tesfamichael, Ben Edgington, Paul Harris and Josh Fernandez.

2 Data Sources

2.1 Key data points

- The beacon chain **deposit contract address** is: 0x00000000219ab540356cBB839Cbe05303d7705Fa
- The beacon chain **genesis block number** is 11182202

2.2 Key Parameters

Genesis settings

Name	Value
MIN_GENESIS_ACTIVE_VALIDATOR_COUNT	uint64(2**14) (= 16,384)
MIN_GENESIS_TIME	uint64(1606824000) (Dec 1, 2020, 12pm UTC)
GENESIS_FORK_VERSION	Version('0x00000000')
GENESIS_DELAY	uint64(604800) (7 days)

Time parameters

Name	Value	Unit	Duration
SECONDS_PER_SLOT	uint64(12)	seconds	12 seconds
SECONDS_PER_ETH1_BLOCK	uint64(14)	seconds	14 seconds
MIN_VALIDATOR_WITHDRAWABILITY_DELAY	uint64(2**8) (= 256)	epochs	~27 hours
SHARD_COMMITTEE_PERIOD	uint64(2**8) (= 256)	epochs	~27 hours
ETH1_FOLLOW_DISTANCE	uint64(2**11) (= 2,048)	Eth1 blocks	~8 hours

Validator cycle

Name	Value
EJECTION_BALANCE	Gwei(2**4 * 10**9) (= 16,000,000,000)
MIN_PER_EPOCH_CHURN_LIMIT	uint64(2**2) (= 4)
CHURN_LIMIT_QUOTIENT	uint64(2**16) (= 65,536)

Figure 1: Configuration settings

'Misc

Name	Value
GENESIS_SLOT	Slot(0)
GENESIS_EPOCH	Epoch(0)
FAR_FUTURE_EPOCH	Epoch($2^{64} - 1$)
BASE_REWARDS_PER_EPOCH	uint64(4)
DEPOSIT_CONTRACT_TREE_DEPTH	uint64(2^{5}) (= 32)
JUSTIFICATION_BITS_LENGTH	uint64(4)
ENDIANNESS	'little'

Figure 2: Miscellaneous key constant values

Misc

Name	Value
MAX_COMMITTEES_PER_SLOT	uint64(2^{6}) (= 64)
TARGET_COMMITTEE_SIZE	uint64(2^{7}) (= 128)
MAX_VALIDATORS_PER_COMMITTEE	uint64(2^{11}) (= 2,048)
SHUFFLE_ROUND_COUNT	uint64(90)
HYSTERESIS_QUOTIENT	uint64(4)
HYSTERESIS_DOWNWARD_MULTIPLIER	uint64(1)
HYSTERESIS_UPWARD_MULTIPLIER	uint64(5)

- For the safety of committees, `TARGET_COMMITTEE_SIZE` exceeds [the recommended minimum committee size of 111](#); with sufficient active validators (at least `SLOTS_PER_EPOCH * TARGET_COMMITTEE_SIZE`), the shuffling algorithm ensures committee sizes of at least `TARGET_COMMITTEE_SIZE`. (Unbiasable randomness with a Verifiable Delay Function (VDF) will improve committee robustness and lower the safe minimum committee size.)

Gwei values

Name	Value
MIN_DEPOSIT_AMOUNT	Gwei($2^{0} * 10^{9}$) (= 1,000,000,000)
MAX_EFFECTIVE_BALANCE	Gwei($2^{5} * 10^{9}$) (= 32,000,000,000)
EFFECTIVE_BALANCE_INCREMENT	Gwei($2^{0} * 10^{9}$) (= 1,000,000,000)

Time parameters

Name	Value	Unit	Duration
MIN_ATTESTATION_INCLUSION_DELAY	uint64(2^{0}) (= 1)	slots	12 seconds
SLOTS_PER_EPOCH	uint64(2^{5}) (= 32)	slots	6.4 minutes
MIN_SEED_LOOKAHEAD	uint64(2^{0}) (= 1)	epochs	6.4 minutes
MAX_SEED_LOOKAHEAD	uint64(2^{2}) (= 4)	epochs	25.6 minutes
MIN_EPOCHS_TO_INACTIVITY_PENALTY	uint64(2^{2}) (= 4)	epochs	25.6 minutes
EPOCHS_PER_ETH1_VOTING_PERIOD	uint64(2^{6}) (= 64)	epochs	~6.8 hours
SLOTS_PER_HISTORICAL_ROOT	uint64(2^{13}) (= 8,192)	slots	~27 hours

Figure 3: Parameters for committees and time

Rewards and penalties

Name	Value
BASE_REWARD_FACTOR	uint64(2**6) (= 64)
WHISTLEBLOWER_REWARD_QUOTIENT	uint64(2**9) (= 512)
PROPOSER_REWARD_QUOTIENT	uint64(2**3) (= 8)
INACTIVITY_PENALTY_QUOTIENT	uint64(2**26) (= 67,108,864)
MIN_SLASHING_PENALTY_QUOTIENT	uint64(2**7) (= 128)
PROPORTIONAL_SLASHING_MULTIPLIER	uint64(1)

- The INACTIVITY_PENALTY_QUOTIENT equals $\text{INVERSE_SQRT_E_DROP_TIME}^{**2}$ where $\text{INVERSE_SQRT_E_DROP_TIME} := 2^{**13}$ epochs (about 36 days) is the time it takes the inactivity penalty to reduce the balance of non-participating validators to about $1/\sqrt{e} \sim 60.6\%$. Indeed, the balance retained by offline validators after n epochs is about $(1 - 1/\text{INACTIVITY_PENALTY_QUOTIENT})^{*(n**2/2)}$; so after $\text{INVERSE_SQRT_E_DROP_TIME}$ epochs, it is roughly $(1 - 1/\text{INACTIVITY_PENALTY_QUOTIENT})^{*(\text{INACTIVITY_PENALTY_QUOTIENT}/2)} \sim 1/\sqrt{e}$. Note this value will be upgraded to 2^{**24} after Phase 0 mainnet stabilizes to provide a faster recovery in the event of an inactivity leak.
- The PROPORTIONAL_SLASHING_MULTIPLIER is set to 1 at initial mainnet launch, resulting in one-third of the minimum accountable safety margin in the event of a finality attack. After Phase 0 mainnet stabilizes, this value will be upgraded to 3 to provide the maximal minimum accountable safety margin.

Max operations per block

Name	Value
MAX_PROPOSER_SLASHINGS	2^{**4} (= 16)
MAX_ATTESTER_SLASHINGS	2^{**1} (= 2)
MAX_ATTESTATIONS	2^{**7} (= 128)
MAX_DEPOSITS	2^{**4} (= 16)
MAX_VOLUNTARY_EXITS	2^{**4} (= 16)

Figure 4: Parameters for rewards and penalties, and operations

2.3 Total ETH Supply

The total supply of ETH used to be fairly simple to work out, but it is now more complicated for two main reasons: implementation of EIP-1559 and the Merge. Currently we are “(a) burning ETH via the base fee and (b) the issuance is variable depending on the number of validators.” (Ben Edgington 2023).

- Ultrasound is considered a credible source for total ETH supply projections.
Ultra sound money visualises various aspects of Ether supply since the Merge, gas, supply projections, the burn, total value secured - TVS and monetary premium. See figures 11 - 19, on pages 13 - 16.
 - Ultrasound supplied two datasets for our analysis - the first had total supply at a more accurate and finer grained level, but shorter time period and the second dataset had data points roughly every 1,000 epochs covering from soon after Beacon chain genesis. The latter dataset is from Glassnode and would not be as accurate as the initial data provided by Alex Tesfamichael from Ultrasound.
- *Etherscan* is a good source of historic data for the growth in Ether supply since 2015. There are several pages of detailed information and the *Charts & Statistics* webpage has several visualisations, often with the ability to select different time ranges and a link to download the raw data as csv files, providing that Etherscan is acknowledged when these datasets are used.

Figures 34 to 44 on pages 29 to 33 show the visualisations that are currently available.

2.4 Validators, Stakers and Staking pools

There are several helpful documents explaining in detail the different options available for staking:

- Solo staking
- Staking as a Service (Saas)
- Pooled staking

According to the Staking Launchpad on June 2023:

- Total ETH staked: 19,357,605 ETH
- Total validators: 606,947
- Current annual percentage rate (APR): 4.74%

LIDO

LIDO is a popular liquid staking pool. At the time of writing, 7 June 2023, the total amount of ETH staked with LIDO is 7,127,430 ETH.

Several graphs have been generated in Dune Analytics. See Figures 45 to 47 on pages 34 to 35.

Rocket Pool

A Rocket Pool node only needs to stake 16 ETH, and this stake is then coupled with 16 ETH from the staking pool to create a validator, known as a “minipool”. Staking in the Rocket Pool can be a stake of a little as 0.01 ETH, which is then issued as an rETH token representing the amount deposited into the pool. A node operator would obtain staked ETH from the pool to form a validator.

Currently, 8 June 2023, Rocket Pool has staked 722,176 ETH and has 2,842 node operators.

If we can identify the number of distinct rETH token holders, we would be able to determine the number of stakers staking ETH in Rocket Pool. Examples of the graphs and information available from the Dune dashboard are shown in figures 48 - 60 on pages 36 - 42.

Data from an archive node

Accessing a teku-besu archive node, `teku-besu-ohio-mainnet-archive-01`, we were able to use several API endpoints to extract some rich data for validators.

We selected several API endpoints from those listed in GitHub: Eth Beacon Node API

Some visualisations of validator information from the archive node are in figures 114 - 118, pages 77 - 81.

Rated network explorer

Rated provides documentation for context and detail of the metrics and visualisations presented on its website. The home page displays Beacon Chain validator ratings for the Ethereum beacon chain, figure 20, page 17, but one can also select the Görli test network to display ratings for those validators. Figure 27, page 23 depicts four metrics to reflect network health and four reference rates of return for the entire active validator set.

2.5 Client and staking pool diversity

- *Diversify Now* dashboard by *Ether alpha* displays the current client distribution in the Consensus and Execution layers. (Figure 5, page 10).
- *Beacon Chain Network Public Dashboard* by *Miga Labs* has several visualisations:
 - Client diversity (Figure 6(a), page 11)
 - Client diversity evolution (Beacon chain client distribution over time) (Figure 6(b), page 11)
 - OS distribution of active nodes (Figure 7(a), page 11)
 - Geographical representation of client evolution over time (Figure 7(b), page 11)
 - Active nodes round trip time distribution (RTT) (Figure 8(a), page 12)
 - Graphical distribution (Beacon chain node distribution) (Figure 8(b), page 12)
 - RTT distribution (Figure 9(a), page 12)
 - Advertised attestation subnets subscription (Figure 9(b), page 12)
 - Number of beach nodes per IP (Figure 10), page 12)

However, it is important to note that it is challenging to measure peer types in the network, and therefore the figures are at best approximations based on the information at hand.

2.6 Multiple datasets

There are several resources that contain lists and visualisations of a variety of data from Ethereum Mainnet. Obtaining the raw data used on the websites and dashboards are not always easily accessible.

- *beaconcha.in*, an open source Ethereum explorer, is a rich and informative resource providing visualisations and summary statistics of various aspects of the chain. It is not clear if it is possible to gain access to the data used to generate the many graphs and summary statistics. The website currently contains the following:
 - On the home page, there is a **progress line** at the top of the page showing the *number of slots left in the current epoch*. (Figure 61, page 43)
 - Immediately below the progress line, there is a **summary line** showing the *current epoch number*, the *last finalised epoch*, the *current slot number*, the *number of active and pending validators*, the *total staked ETH* and the *average validator balance*. (Figure 61)
 - Below this summary there is a **graph** of the *number of active validators* and *staked ETH* for the last week (Figure 61)
 - Then there are two side by side tables. The **left table** has information about the most recent epochs: *epoch number*, *time*, *whether it is final*, *the eligible ETH*, the *number of percentage of votes*. The **right table** has information about the most recent blocks: *epoch number*, *slot number*, *block number*, *status of the block (proposed or missed)*, *time* and the *proposer id*. These two tables are shown in Figure 62, page 43).
 - Moreover, one can click on the epoch, slot and block numbers in the tables to obtain a detailed view of the epoch, slot or block number.
 - There is also a link to the validator ID in the right table that provides a detailed view of that validator.
 - Figures 63 - 67 on pages 44 - 46 displays detailed blockchain data.
 - Figures 68 - 78 on pages 47 - 51 displays detailed validator data.
 - Beaconcha.in provide additional visualisations and tools. For example, the ability to generate graphs to show the correlation between two variables (Figure 80 on page 52).
- *Mevboost.pics*
 - *MEV-Boost General Dashboard*
Examples of the contents displayed on the general dashboard can be seen in figures 97 - 100 on pages 59 - 62.
 - *MEV-Boost Builders Dashboard*
Examples of the contents displayed on the builders dashboard can be seen in figures 105 - 108 on pages 67 - 70.
 - *MEV-Boost Relays Dashboard*
Examples of the contents displayed on the relays dashboard can be seen in figures 101 - 104 on pages 63 - 66.
 - *MEV-Boost Validators Dashboard*
Examples of the contents displayed on the validators dashboard can be seen in figures 109 - 112 on pages 71 - 74.

- *Mevboost.pics* - *Open Data* will eventually provide links to download several datasets: (Figure 113, page 75)
 - * *eth_data* - Slots since Merge with additional MEV-Boost and validator info such as: date, slot, block number, relay, builder pubkey, proposer pubkey, mevboost value, builder, validator (*Available now*)
 - * *pubkey_mapping* - Validator public keys mapped to known entities such as Lido, Kraken ect. (*Available now*)
 - * *tc_txs* - Tornado Cash related transactions (*Not available*)
 - * *staking_txs* - Deposit transactions to the ETH2 Deposit contract (*Not available*)
 - * *relays_over_time* - Number of successfully relayed blocks per day (*Not available*)
 - * *builders_over_time* - Number of successfully built blocks per day (*Not available*)

2.7 Existing visualisations

Diversify Now



Figure 5: Consensus layer client diversity using Sigma Prime’s Blockprint data (a) and using Migalabs data (b). Execution layer client diversity using Ethernodes data (19 May 2023)

Migalabs

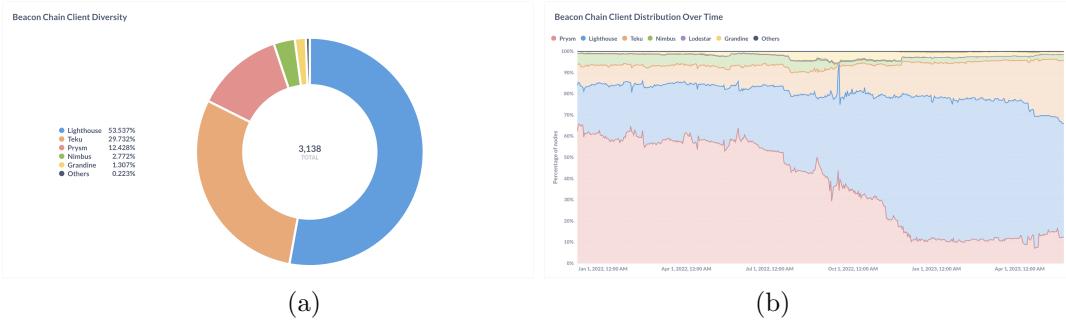


Figure 6: Beacon chain client diversity from Migalabs (a) and client distribution over time (b) (9 May 2023)

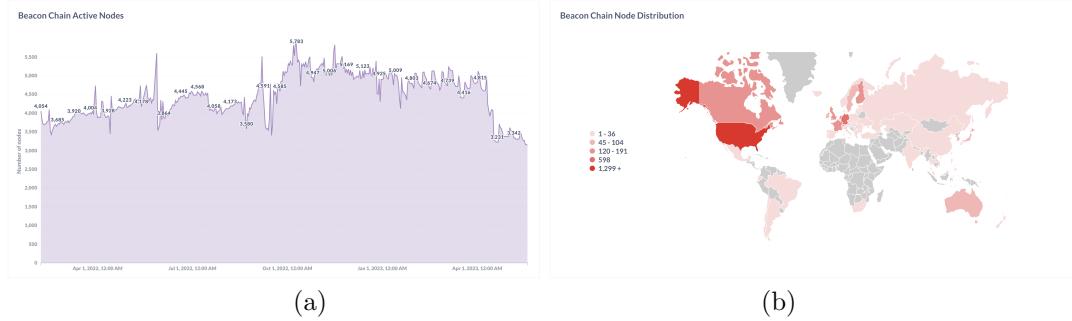


Figure 7: Operating system distribution of active beacon chain nodes from Migalabs (a) and client diversity evolution of beacon chain nodes (b) (9 May 2023)



Figure 8: Distribution of active beacon chain nodes round trip time (RTT) from Migalabs (a) and geographical distribution (b) (9 May 2023)

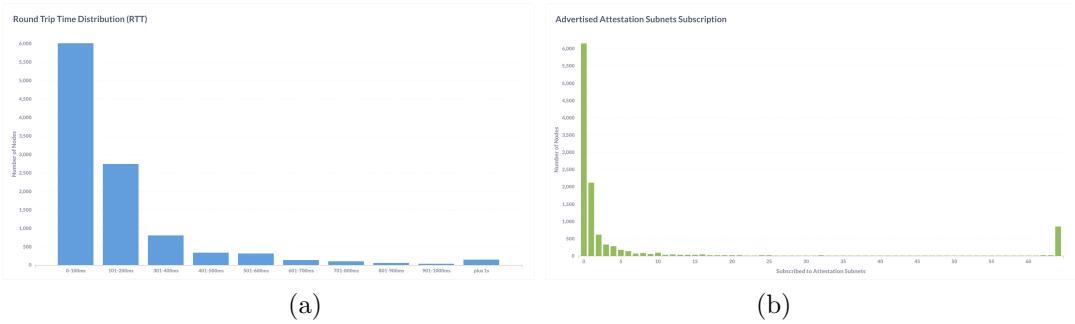


Figure 9: Distribution of active beacon chain nodes round trip time distribution (RTT) from Migalabs (a) and advertised attestation subnets subscription (b) (9 May 2023)

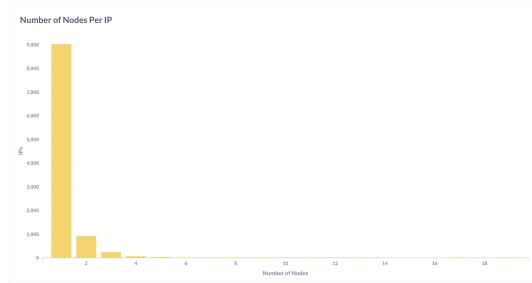


Figure 10: Number of beacon nodes per IP from Migalabs

Ultrasound money

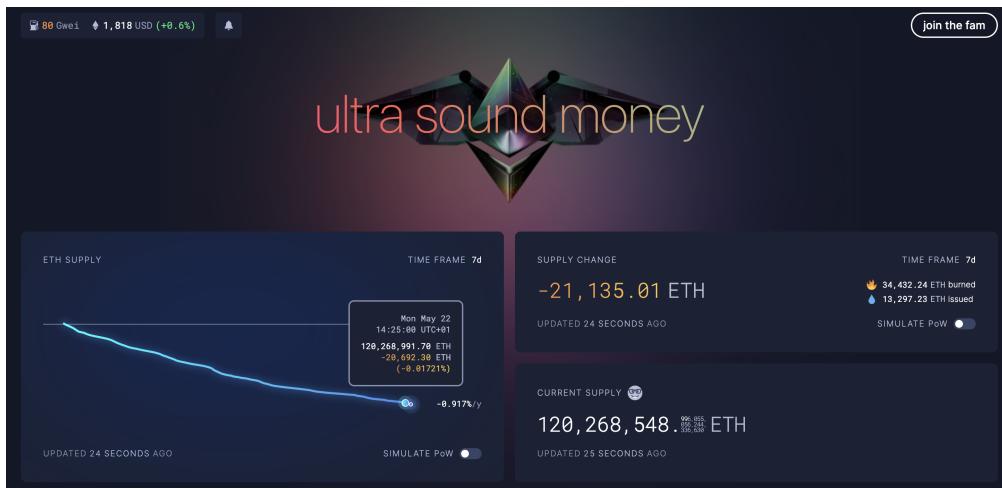


Figure 11: ETH supply over time, current supply and change, 22 May 2023

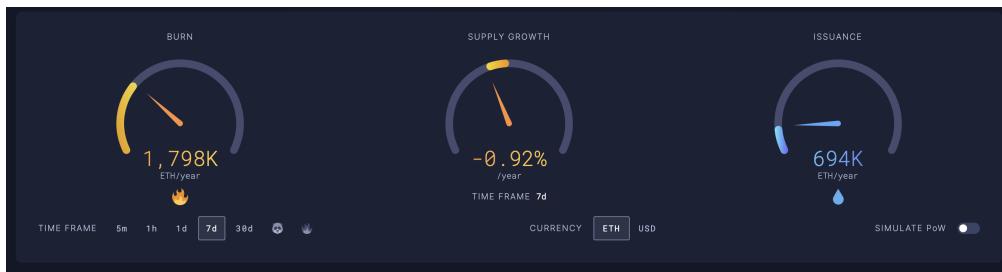


Figure 12: Burn, supply growth, and issuance, 22 May 2023

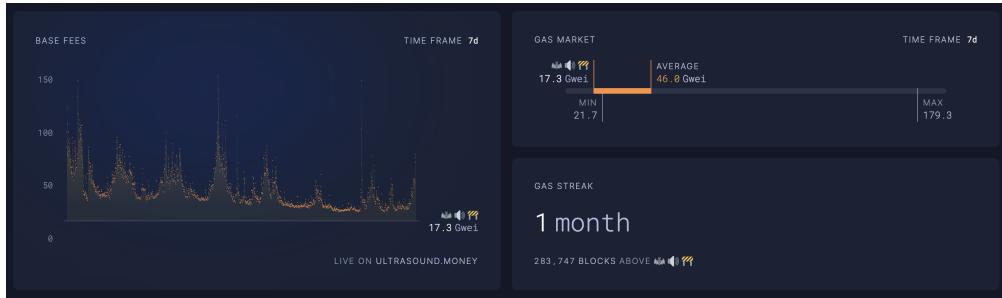


Figure 13: Gas market, 22 May 2023



Figure 14: Interactive ETH supply projections - sliders provided for issuance rewards and burn rate , 22 May 2023



Figure 15: 2YETH supply projection, 22 May 2023

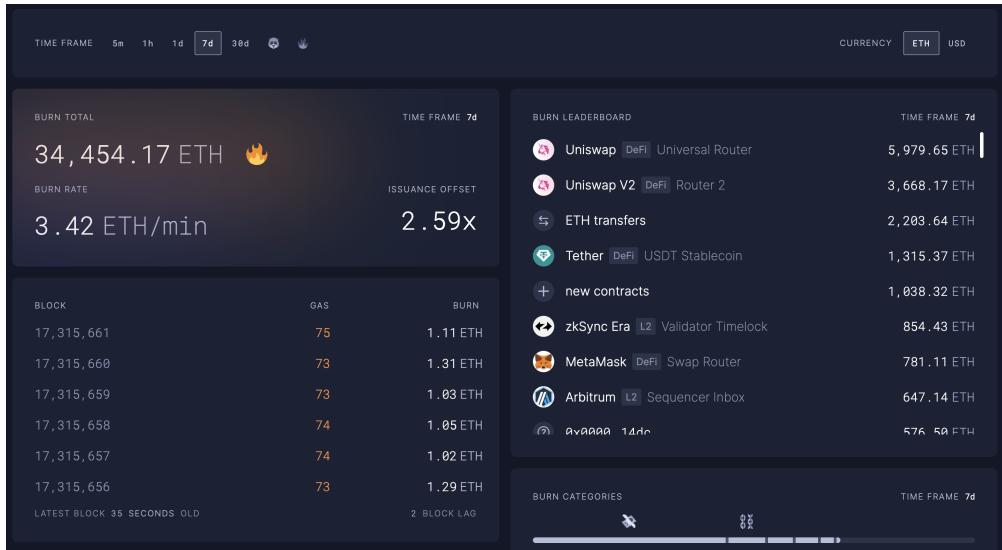


Figure 16: Total burn and rate for selected time interval; latest block gas and burn leaderboard, 22 May 2023

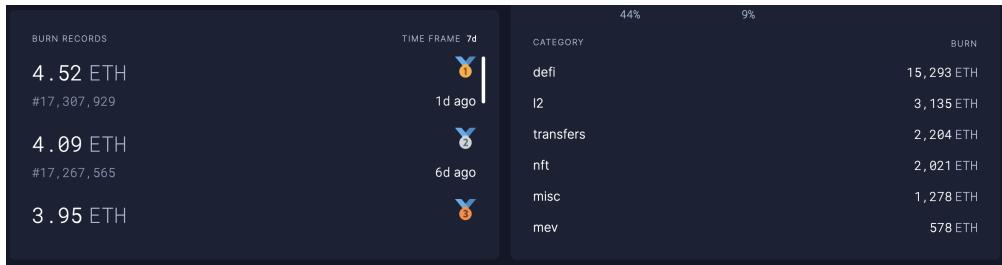


Figure 17: Burn records (top 3) and top 5 categories for most ETH burnt, 22 May 2023



Figure 18: Statistics for total value secured (TVS), including NFT and ERC20 leaderboards, 22 May 2023

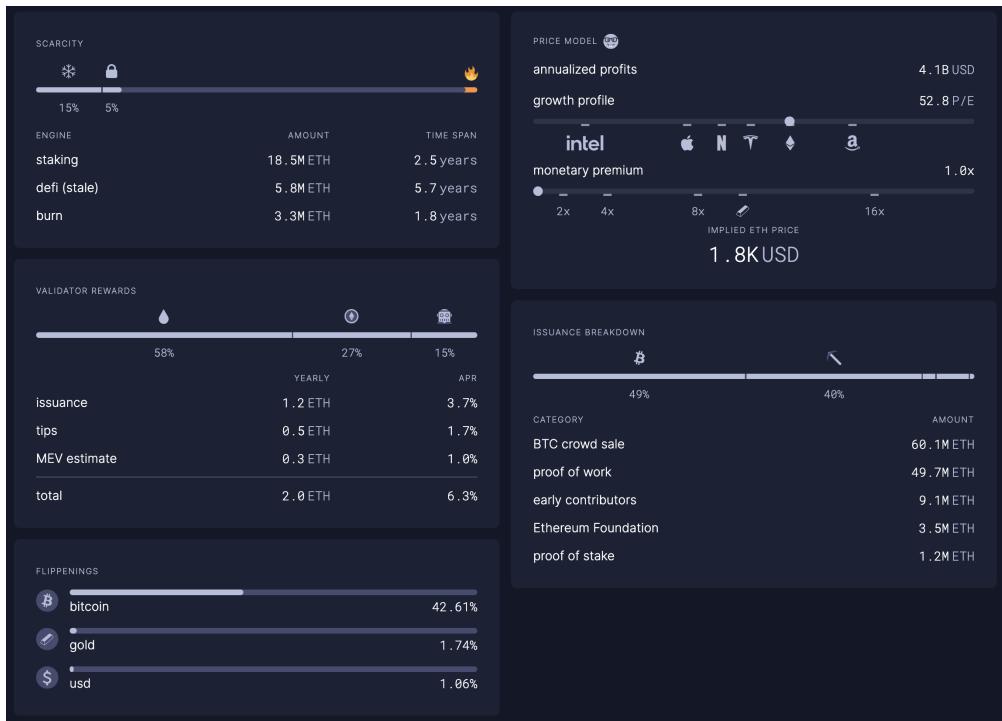


Figure 19: Monetary premium shows Scarcity (staking, defi, burn), Validator rewards (issuance, tips, mev, Flippennings (bitcoin, gold and usd), Issuance breakdown by category and an interactive price model based on selected growth profile and monetary premium, 22 May 2023

Rated network explorer

Entity Views

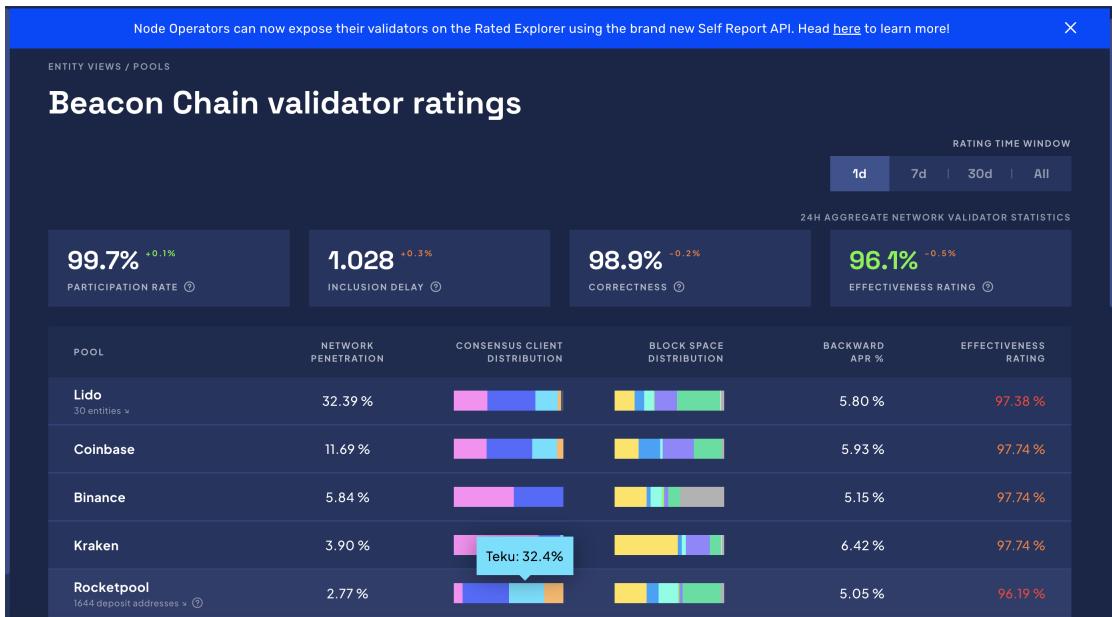


Figure 20: Rated network explorer: beacon chain validator ratings for staking pools. Select from timeframes: 1 day, 7 days, 30 days, or all (since merge) , 1 June 2023



Figure 21: Rated network explorer: beacon chain validator ratings for node operators. Select from timeframes: 1 day, 7 days, 30 days, or all (since merge) , 1 June 2023

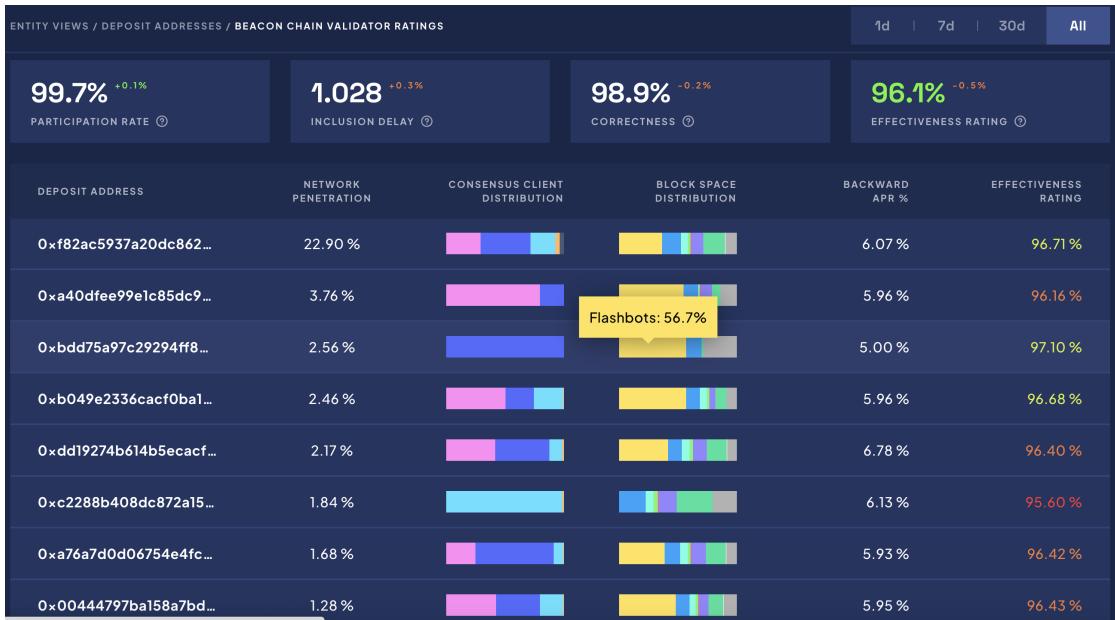


Figure 22: Rated network explorer: beacon chain validator ratings by deposit addresses. Select from timeframes: 1 day, 7 days, 30 days, or all (since merge) , 1 June 2023



Figure 23: Rated network explorer: view of a chosen validator (using id or public key). Select from timeframes: 1 day, 7 days, 30 days, or all (since merge) , 1 June 2023

Aggregate Views

RATING TIME WINDOW
1d | 7d | 30d All

By Effectiveness

TOP 5 OPERATORS BY EFFECTIVENESS (IDENTIFIED OPERATORS)			BOTTOM 5 OPERATORS BY EFFECTIVENESS (IDENTIFIED OPERATORS)		
#	METRIC	EFFECTIVENESS	#	METRIC	EFFECTIVENESS
1	Kukis Global 6609 validators	97.4% APR: 6%	1	Ergon Client Team 136 validators	88.6% APR: 3.7%
2	Prysmatic Labs 6100 validators	97.4% APR: 5.7%	2	T-Systems 137 validators	93.8% APR: 5.9%
3	XHash 1206 validators	97.3% APR: 6.2%	3	Gateway.fm 105 validators	95% APR: 4.8%
4	Attestant 6609 validators	97.3% APR: 6.2%	4	RockLogic GmbH 5789 validators	95% APR: 6.2%
5	CryptoManufaktur 6909 validators	97.2% APR: 6.1%	5	ChainSafe 6000 validators	95.2% APR: 6.3%

(a)

TOP 5 OPERATORS BY EFFECTIVENESS (DEPOSIT ADDRESSES)			BOTTOM 5 OPERATORS BY EFFECTIVENESS (DEPOSIT ADDRESSES)		
#	METRIC	EFFECTIVENESS	#	METRIC	EFFECTIVENESS
1	0xe3233c 680 validators	97.5% APR: 6.8%	1	0x2ed8eb 239 validators	79.6% APR: 3.2%
2	0xe6fa82 515 validators	97.5% APR: 6.2%	2	0xb8ed9e 300 validators	79.6% APR: 4.8%
3	0x0dicee 100 validators	97.5% APR: 5.2%	3	0x4069d8 1761 validators	81.1% APR: 6.1%
4	0xe2c29d 291 validators	97.4% APR: 5.7%	4	0x711cd2 500 validators	86.5% APR: 3.3%
5	0x6ed60d 256 validators	97.4% APR: 4.5%	5	0x101cb0 136 validators	88.6% APR: 3.7%

(b)

Figure 24: Rated network explorer: top 5 and bottom 5 identified operators (a) and the top and bottom 5 operators by deposit addresses (b). Timeframes: 1 day, 7 days, 30 days or all (since merge), 1 June 2023

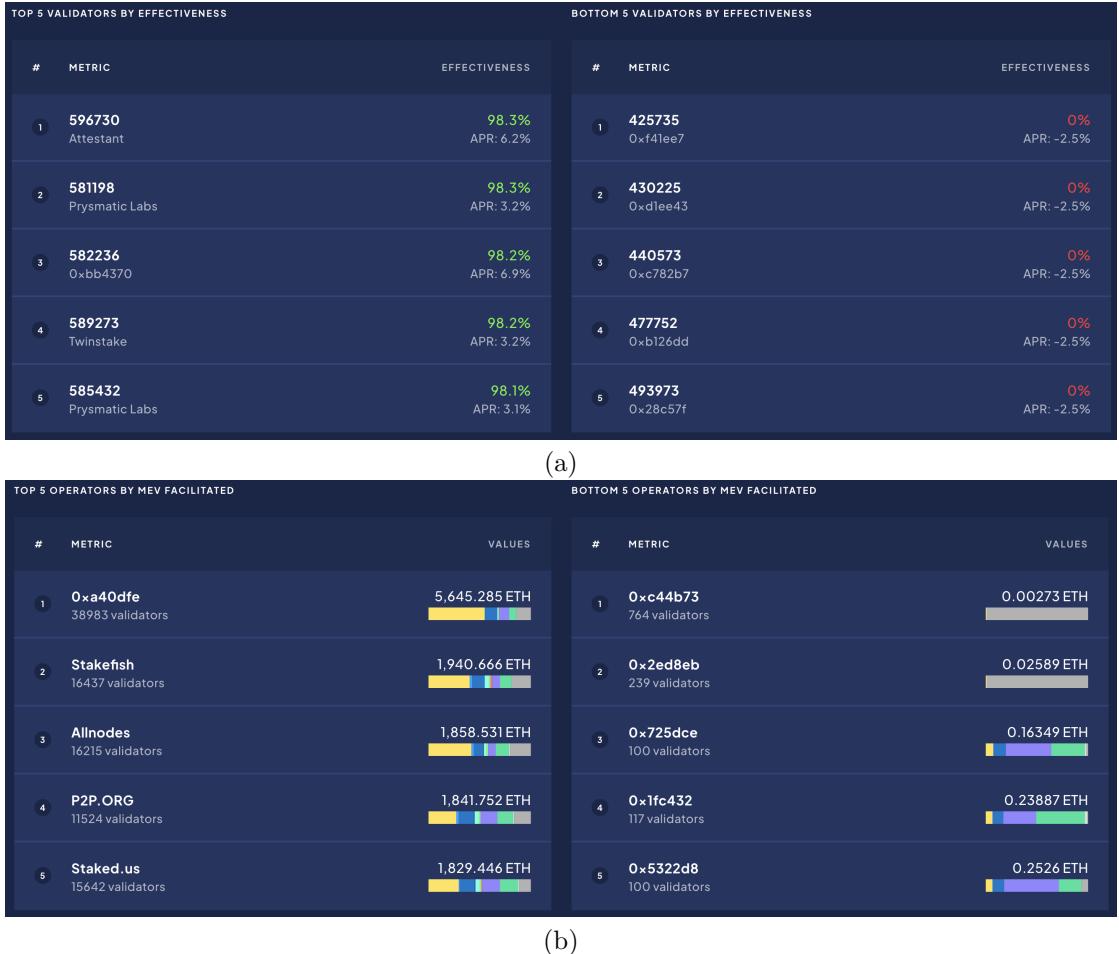


Figure 25: Rated network explorer: top 5 and bottom 5 validators (a). Top 5 and bottom 5 of operators that facilitated some MEV (total or average) (b), For both visualisations, select a timeframe: 1 day, 7 days, 30 days or all (since merge), 1 June 2023

TOP 5 ENTITIES BY TIMES SLASHED			TOP 5 OPERATORS BY SLASHES REPORTED		
#	METRIC	SLASHES	#	METRIC	SLASHES
1	Staked.us 15642 validators	92	1	0xa40dfe 38983 validators	21
2	0x46436f 922 validators	54	2	Stakefish 16437 validators	16
3	RockLogic GmbH 5789 validators	11	3	Staked.us 15642 validators	16
4	0x4069d8 1761 validators	10	4	0x711cd2 500 validators	10
5	0x3fb9d4 780 validators	8	5	0x61c808 3501 validators	9

Median slash time: January 2021
Median slash time: April 2023
Median slash time: December 2020
Median slash time: February 2021

Slasher pedigree: Prince Goro
Slasher pedigree: Scorpion
Slasher pedigree: Scorpion
Slasher pedigree: Reptile
Slasher pedigree: Reptile

Figure 26: Rated network explorer: top 5 entities by times slashed and top 5 operators by number of slashes reported. Select timeframes of 30 days, or all days (since merge), 1 June 2023

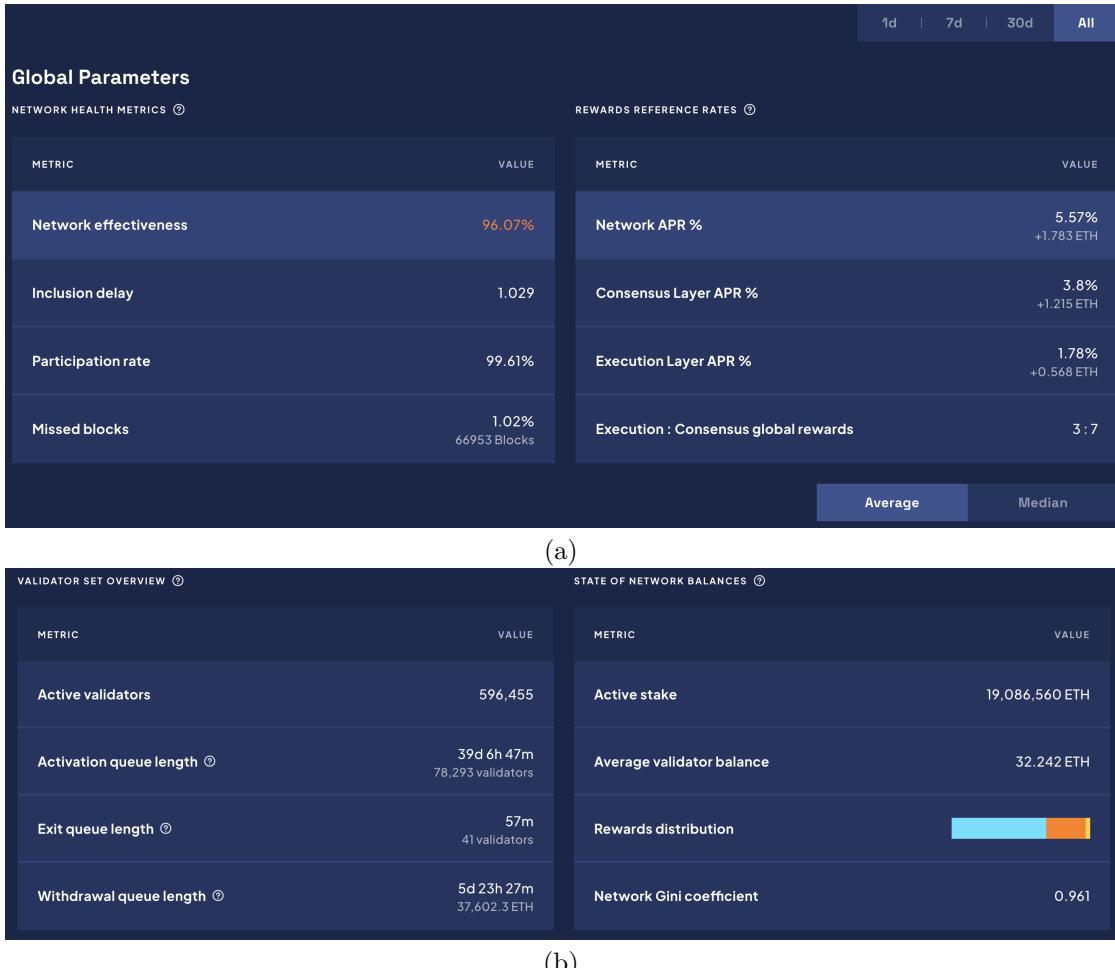


Figure 27: Rated network explorer: high level metrics to reflect the health of the network (a) and four reference rates of return for the entire active validator set. (b), For both visualisations, select a timeframe: 1 day, 7 days, 30 days or all (since merge), 1 June 2023

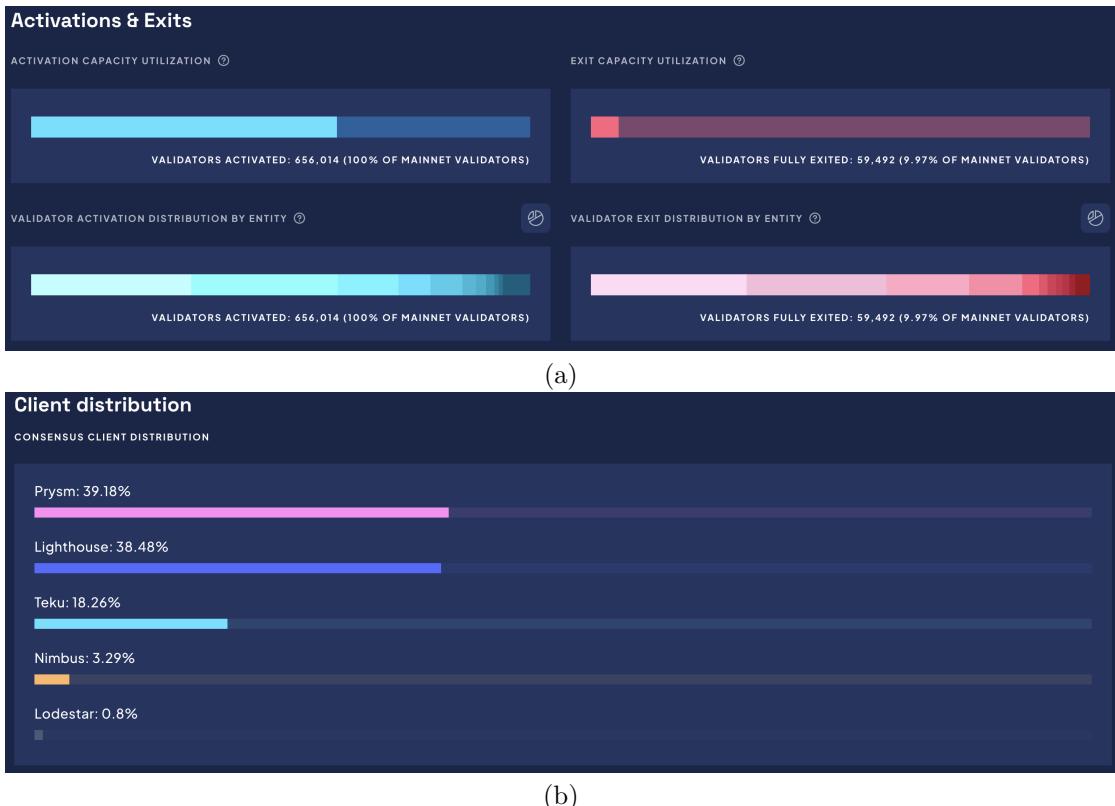


Figure 28: Rated network explorer: activation & exits information: the number of validators activated and the proportion of activation capacity for selected timeframe, and similarly for validators exiting. (a) and four reference rates of return for the entire active validator set. (b), For both visualisations, select a timeframe: 1 day, 7 days, 30 days or all (since merge), 1 June 2023

MEV Relay Landscape

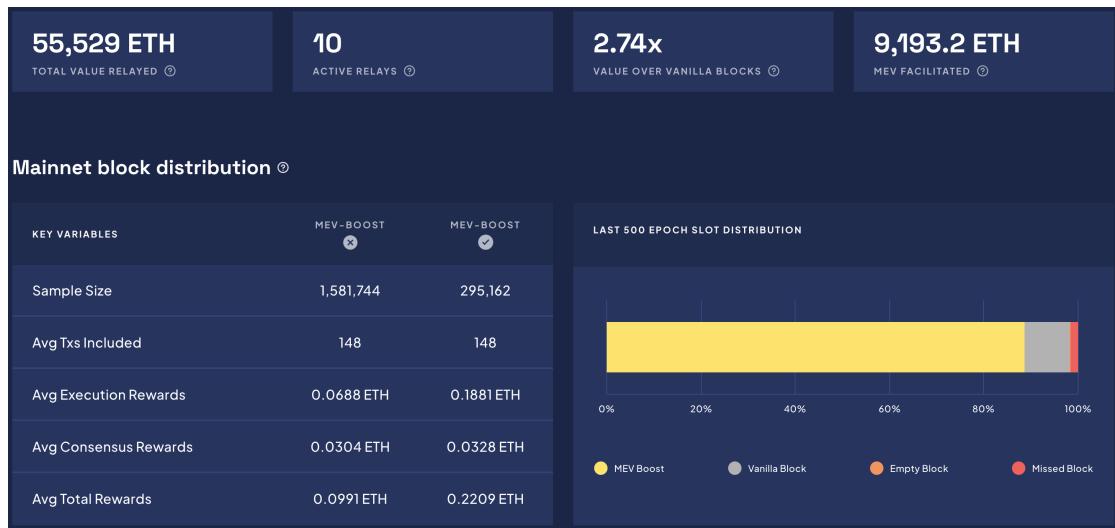


Figure 29: Rated network explorer: MEV relay summary statistics for 30 days, selected from timeframes: 1 day, 7 days, 30 days or all (since merge), 6 June 2023

MEV RELAYS	SAMPLE SIZE	AVG TXS INCLUDED	MEDIAN BASELINE MEV (IN ETH)	MEDIAN Prio FEES (IN ETH)	MEDIAN EXECUTION REWARDS (IN ETH)
Ultra Sound Money	122,633	141	0	0.0855	0.0977
Flashbots	92,852	138	0	0.0782	0.0899
Agnostic	79,460	141	0	0.0828	0.0945
Bloxroute (maxprofit)	29,764	143	0	0.0827	0.0943
Blocknative	17,808	149	0	0.0931	0.1041
Bloxroute (regulated)	4,336	149	0	0.0935	0.1038
Aestus	3,174	147	0	0.1189	0.1342
Eden Network	1,970	106	0	0.1078	0.1215
Manifold	637	129	0	0.0608	0.0669
Bloxroute (ethical)	380	129	0	0.0338	0.0371

Figure 30: Rated network explorer: Comparison between MEV relays for blocks procured from relays that were included in the canonical chain for all days, selected from timeframes: 1 day, 7 days, 30 days or all (since merge), 6 June 2023

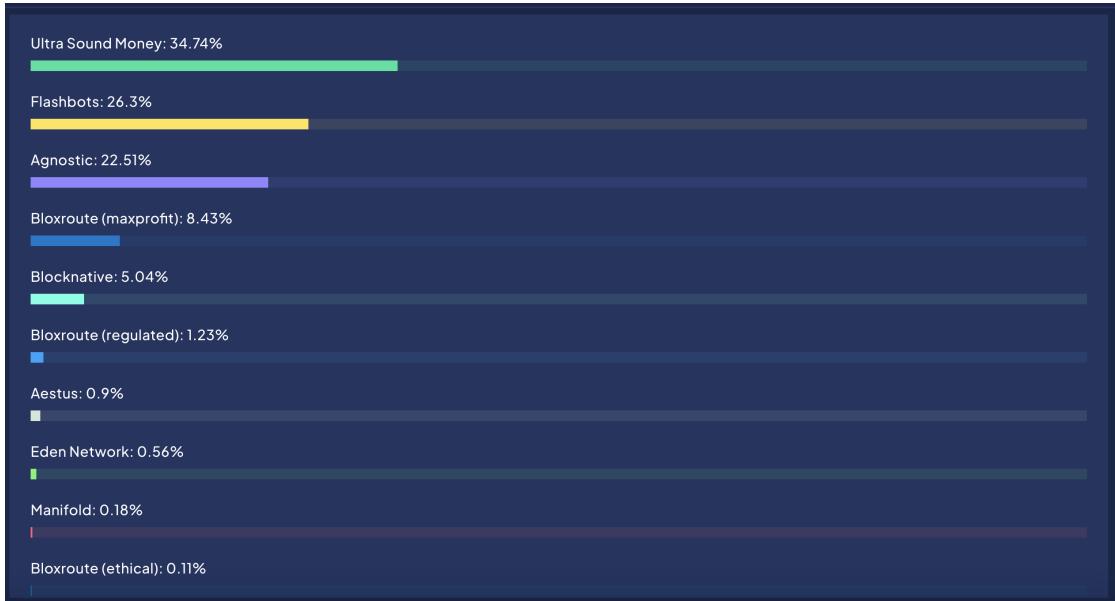


Figure 31: Rated network explorer: MEV-boost relay market share selecting all days from timeframes: 1 day, 7 days, 30 days or all (since merge), 6 June 2023

MEV Builder Landscape



Figure 32: Rated network explorer: MEV relay summary statistics for 30 days, selected from timeframes: 1 day, 7 days, 30 days or all (since merge), 6 June 2023

Diversified Staked ETH Index (dsETH) from Index Coop

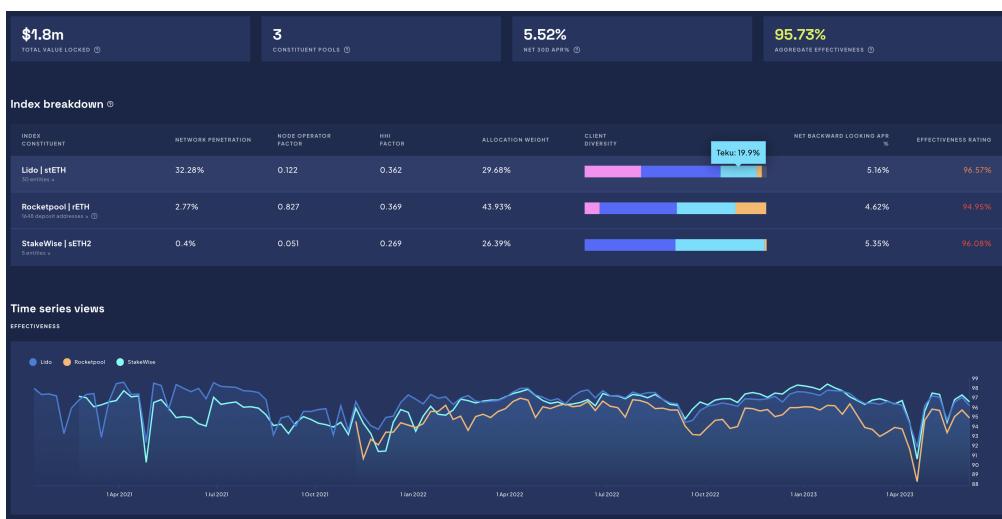


Figure 33: Rated network explorer: Key metrics of staked ETH index and time series for all available days, selected from timeframes: 1 day, 7 days, 30 days or all (since merge), 6 June 2023

Etherscan

There are several webpages with detailed information on transactions, blocks, accounts and tokens. In the screenshots below, figures 35- 40 on pages 29- 31), are a few extracts from the detailed information on Etherscan and the data visualisations provided by them. Many of the dashboards allow the user to interact with the data being displayed by entering specific validators, blocks etc, that are of interest, or selecting one of the different time periods available.

Moreover, there are several summary graphs and visualisations that have been created and are displayed in the *Charts & Statistics* section of the website. These visualisations are shown in figures 41- 44 on pages 32 - 33. There is some degree of interactivity in these charts and diagrams, which includes the ability to zoom in on a section of a graph in several instances.

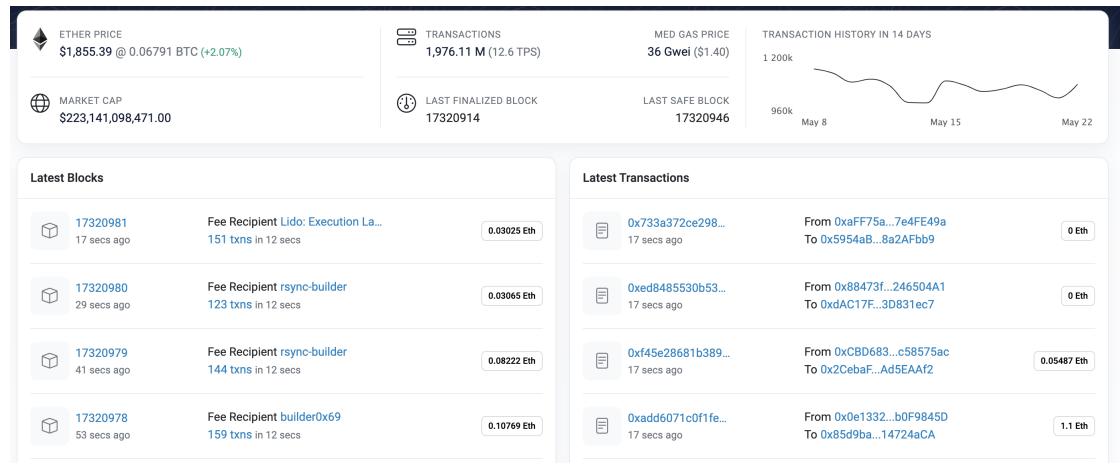


Figure 34: Etherscan home page, 23 May 2023

Detailed blockchain data

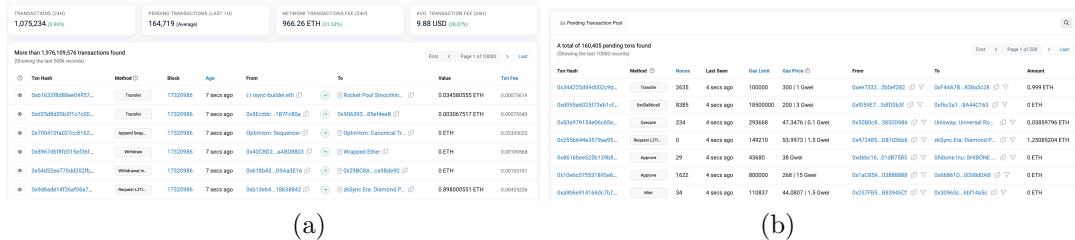


Figure 35: Transactions (a) and pending transactions (b) from Etherscan (23 May 2023)

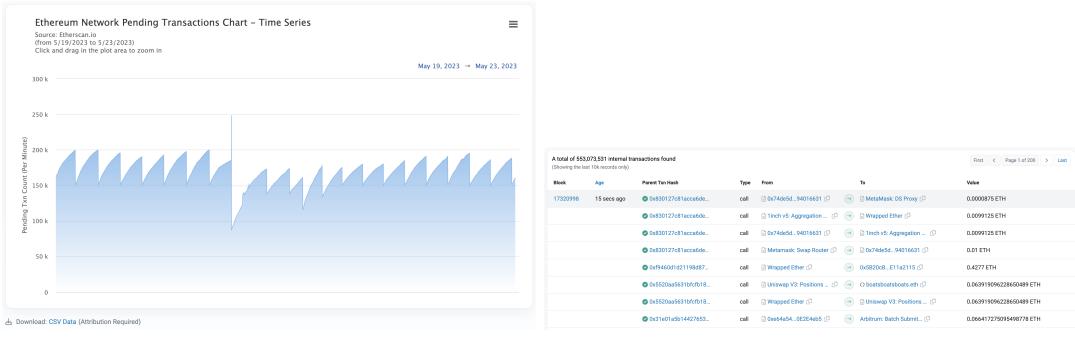


Figure 36: Chart of pending transactions (a) and contract internal transactions (b) from Etherscan (23 May 2023)

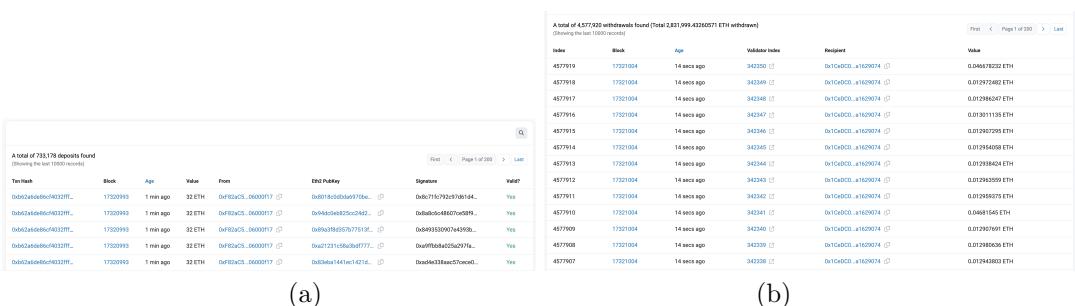


Figure 37: Beacon chain deposits (a) and withdrawals (b) from Etherscan (23 May 2023)

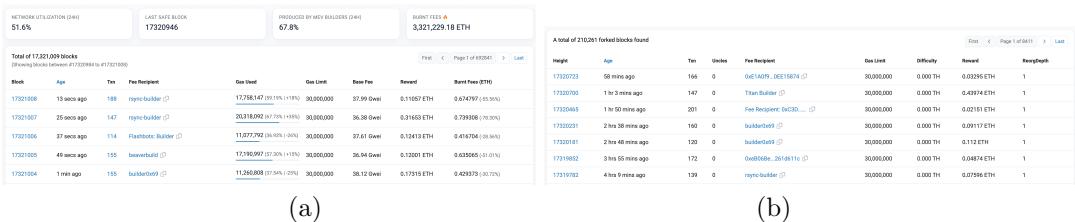


Figure 38: Details of beacon chain blocks (a) and forked blocks (b) from Etherscan (23 May 2023)

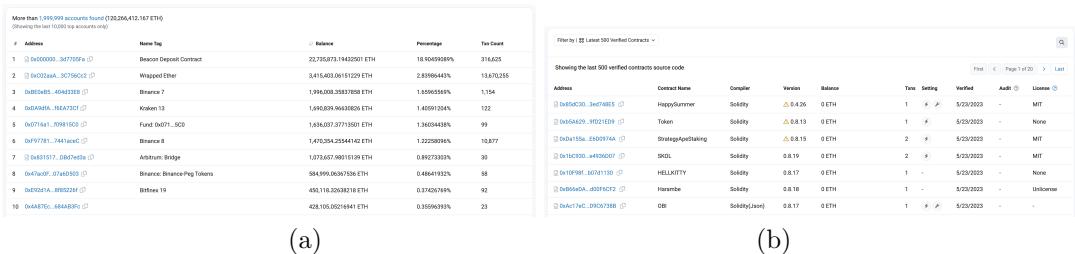
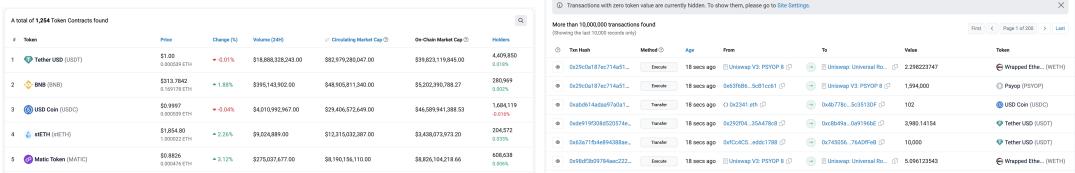


Figure 39: Top accounts by ETH balance (a) and verified contract source code (b) from Etherscan (23 May 2023)



(a)

(b)

Figure 40: Top ERC20 tokens (a) and ERC20 token transfers (b) from Etherscan (23 May 2023)

Charts and Statistics

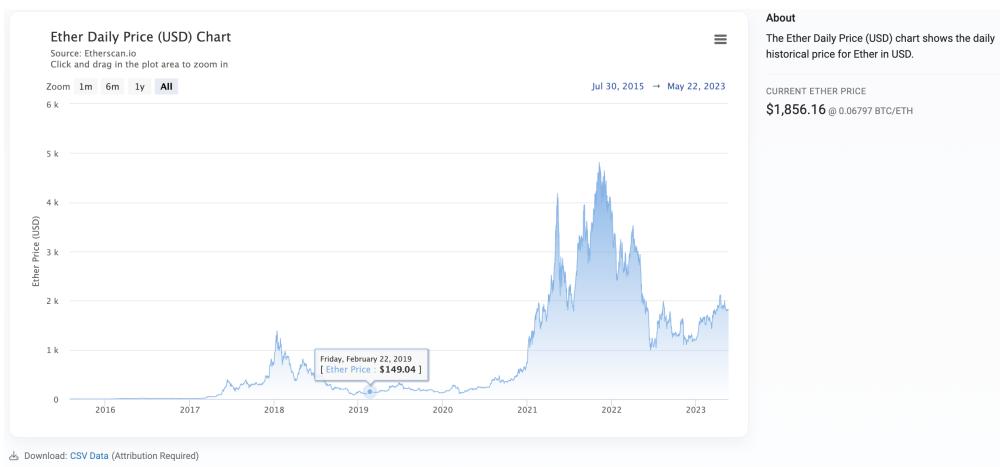


Figure 41: Ether daily price (USD) from Etherscan, 23 May 2023

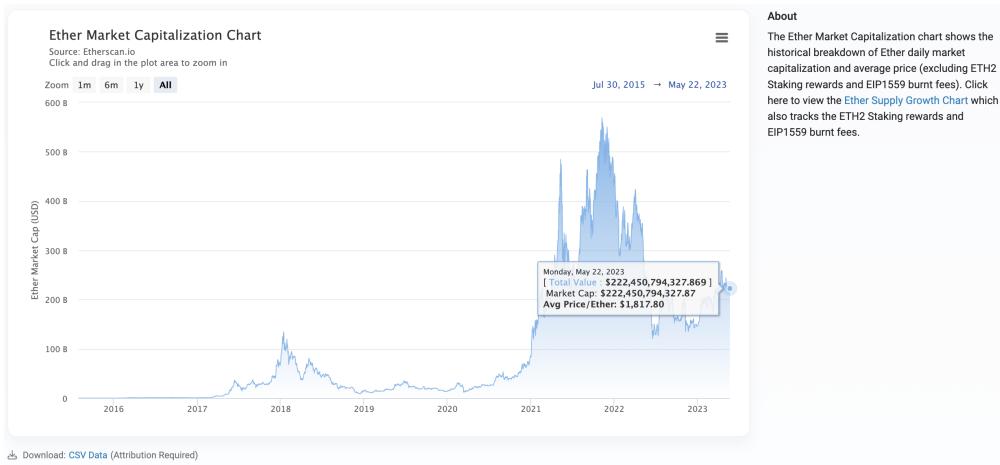


Figure 42: Ether market capitalisation from Etherscan - select time range or zoom in on selected part of graph, hover mouse for details (as shown), 23 May 2023

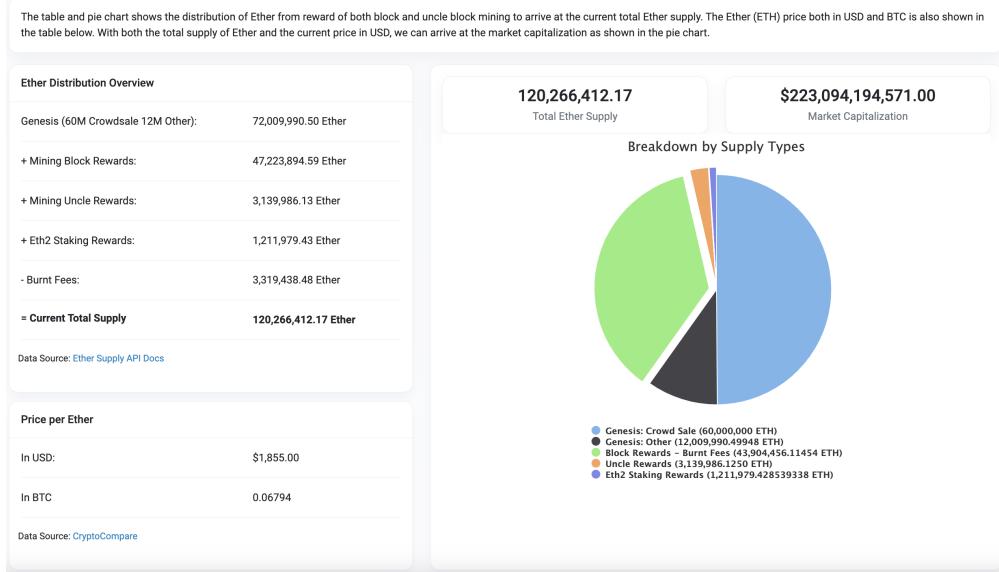


Figure 43: Ether total supply and market capitalisation from Etherscan, 23 May 2023

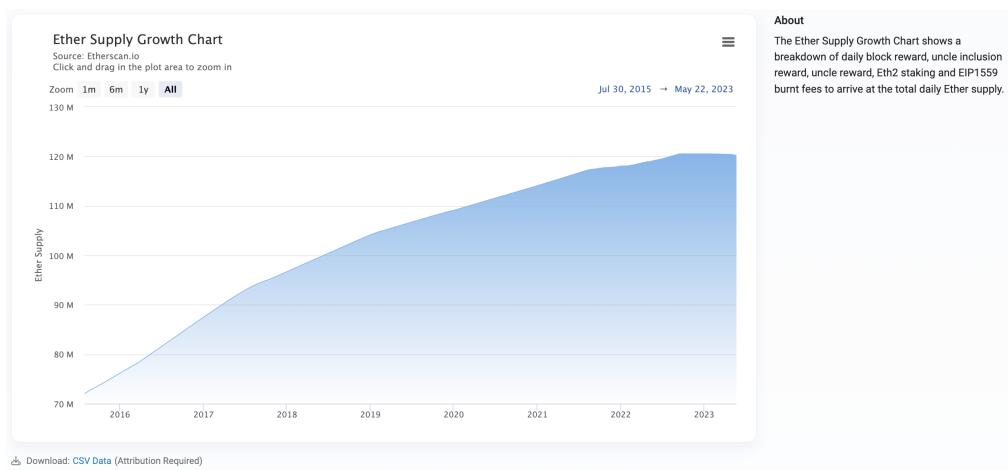


Figure 44: Ether supply growth chart from Etherscan - select time range or zoom in on selected part of graph, 23 May 2023

Dune Analytics

LIDO

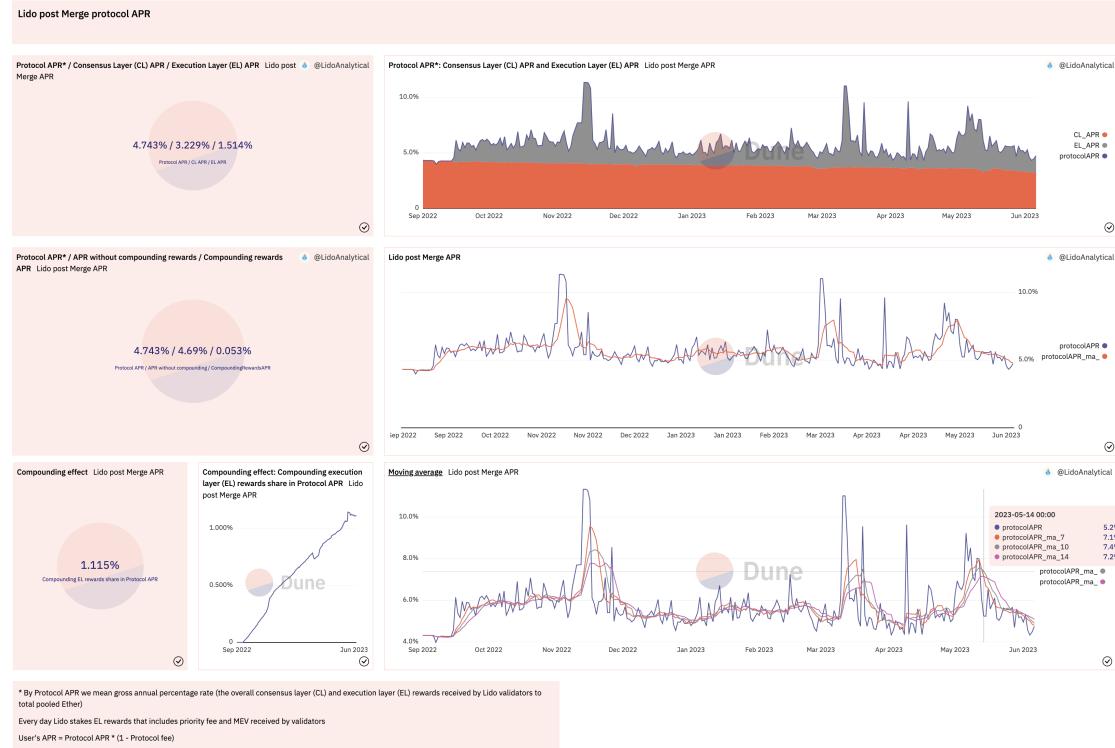


Figure 45: Dune Analytics Lido post Merge protocol APR dashboard by @LidoAnalytical (7 June 2023)

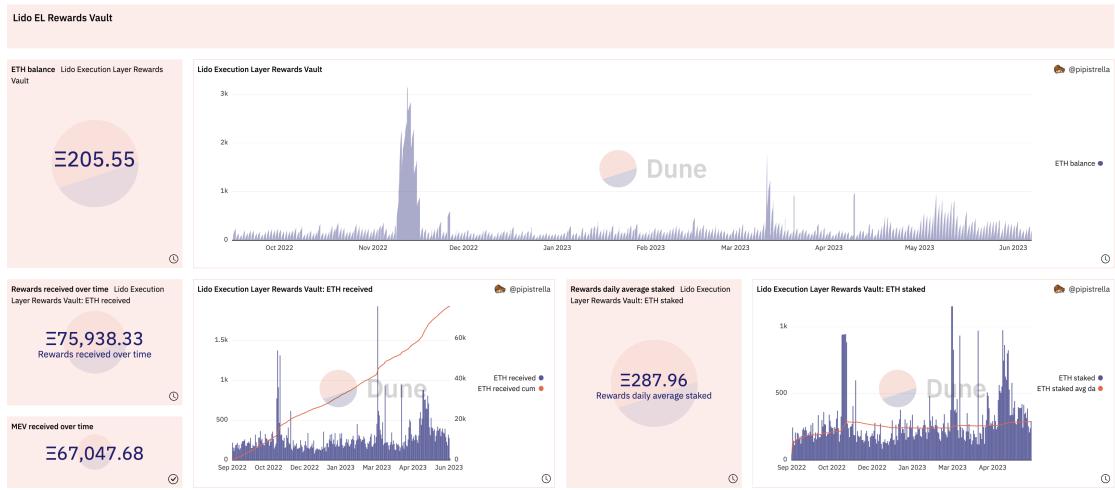


Figure 46: Dune Analytics Lido Execution Layer rewards by @LidoAnalytical (7 June 2023)



Figure 47: Dune Analytics Lido MEV builders statistics by @LidoAnalytical (7 June 2023)

Rocket Pool

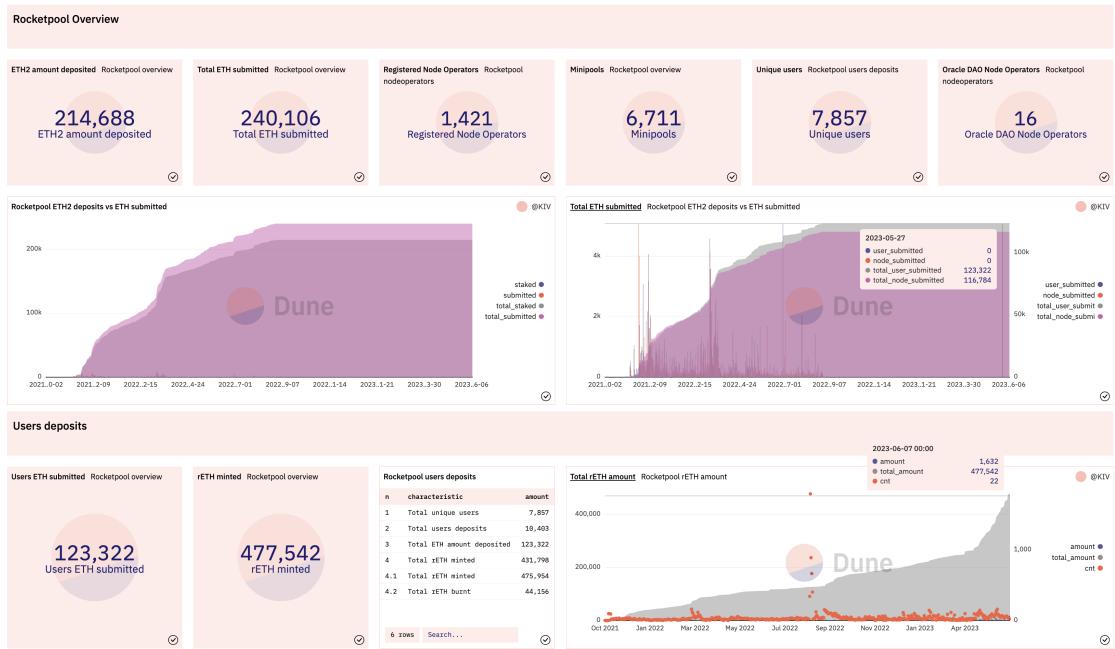


Figure 48: Dune Analytics Rocket Pool overview by @KIV (7 June 2023)

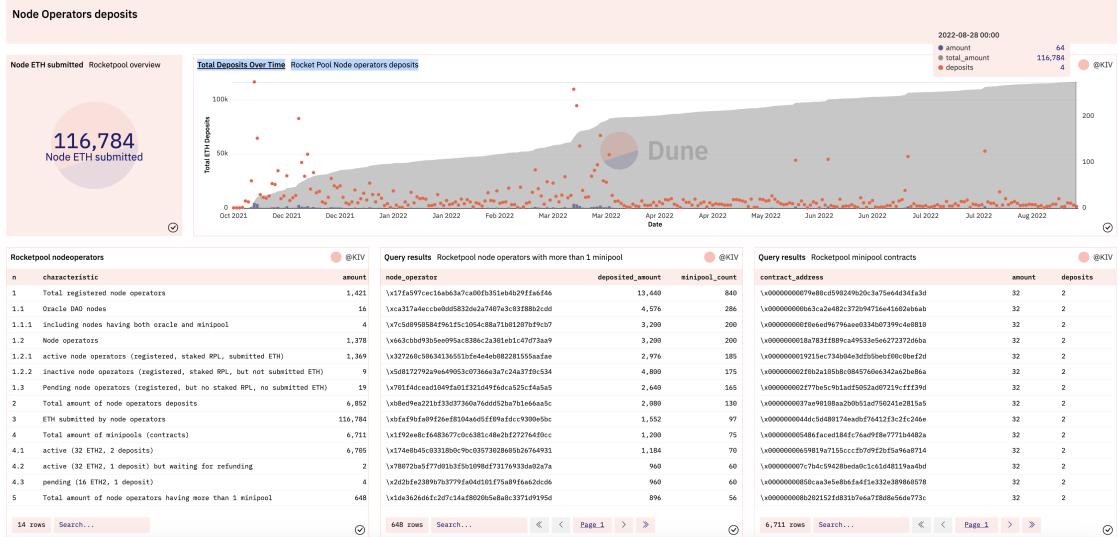


Figure 49: Dune Analytics Rocket Pool node operator deposits by @KIV (7 June 2023)



Figure 50: Dune Analytics Rocket Pool overview by @drworm (7 June 2023)

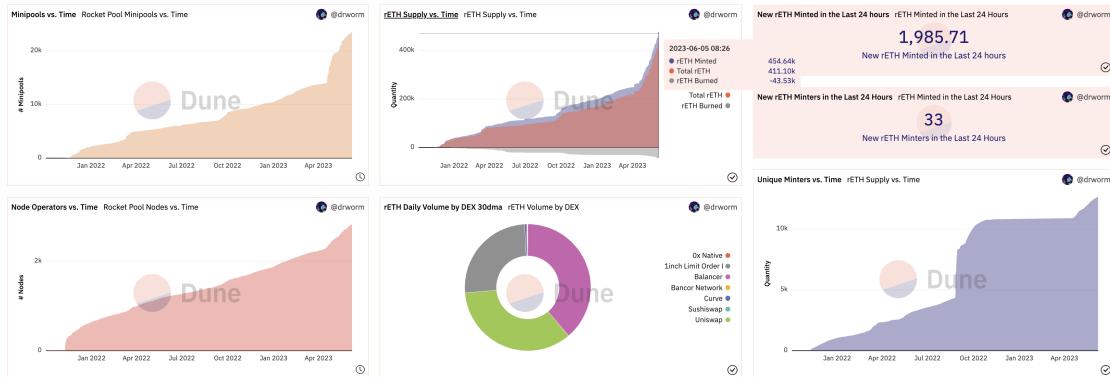


Figure 51: Dune Analytics Rocket Pool various statistics by @drworm (7 June 2023)

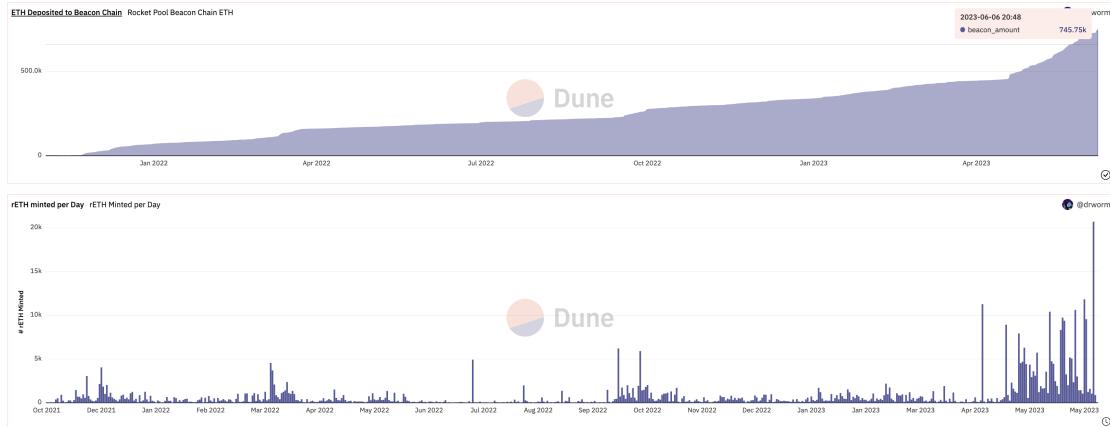


Figure 52: Dune Analytics Rocket Pool ETH deposited & rETH minted by @drworm (7 June 2023)



Figure 53: Dune Analytics Rocket Pool liquid staking derivatives peg price performance by @worm (7 June 2023)

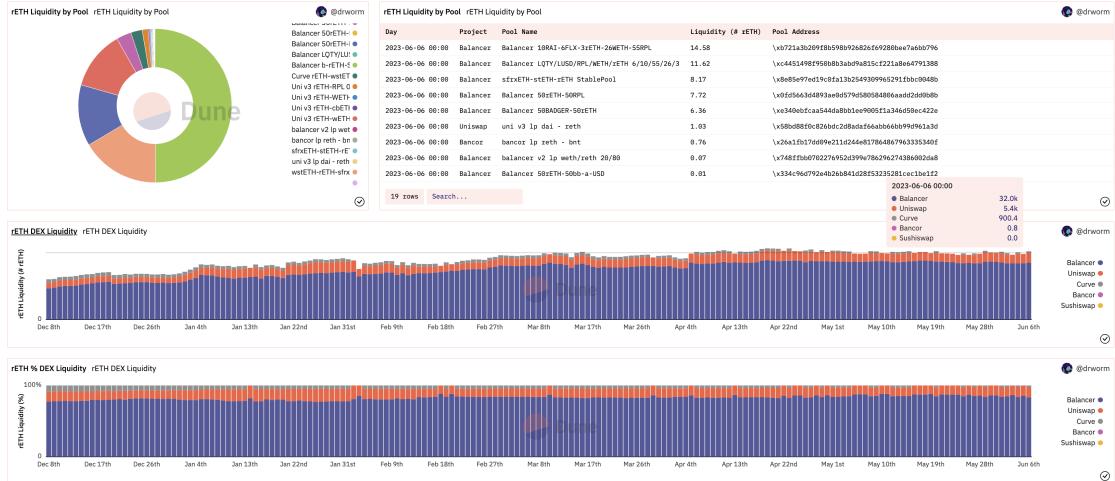


Figure 54: Dune Analytics Rocket Pool rETH liquidity by @drworm (7 June 2023)

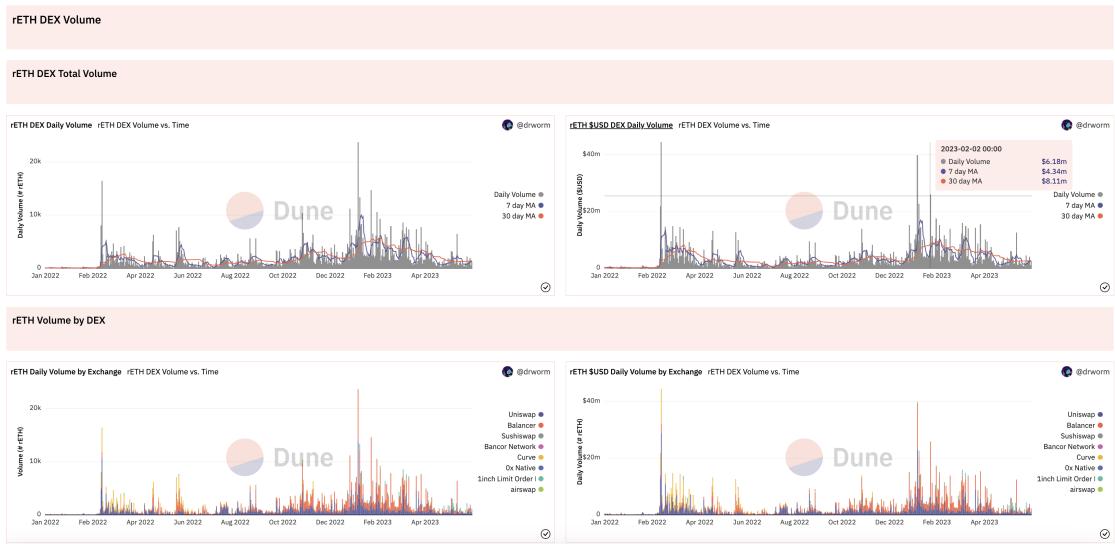


Figure 55: Dune Analytics Rocket Pool rETH DEX statistics by @drworm (7 June 2023)



Figure 56: Dune Analytics Rocket Pool rETH DEX graphs by @drworm (7 June 2023)

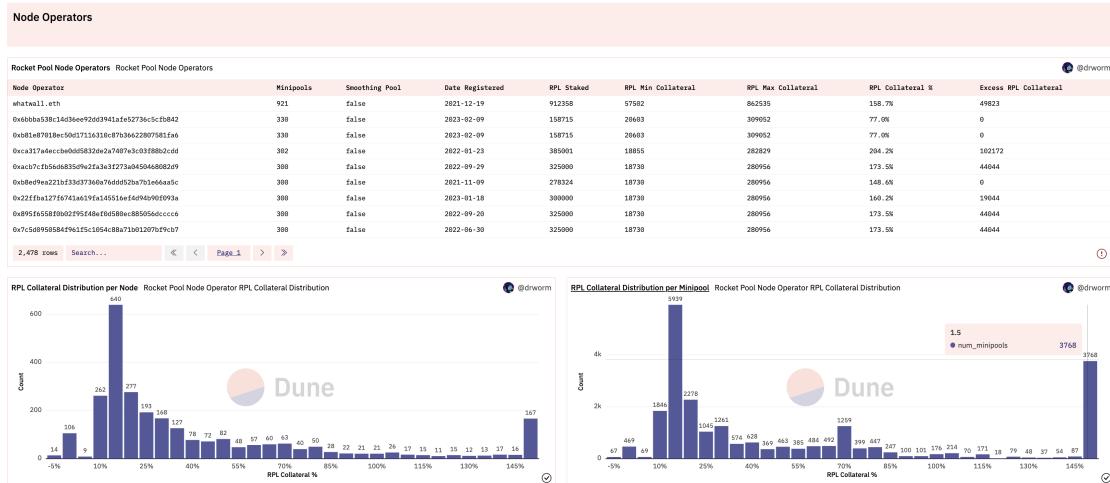


Figure 57: Dune Analytics Rocket Pool node operators by @drworm (7 June 2023)



Figure 58: Dune Analytics Rocket Pool oDAO-Reported RPL Price/RPL Staked by @drworm (7 June 2023)

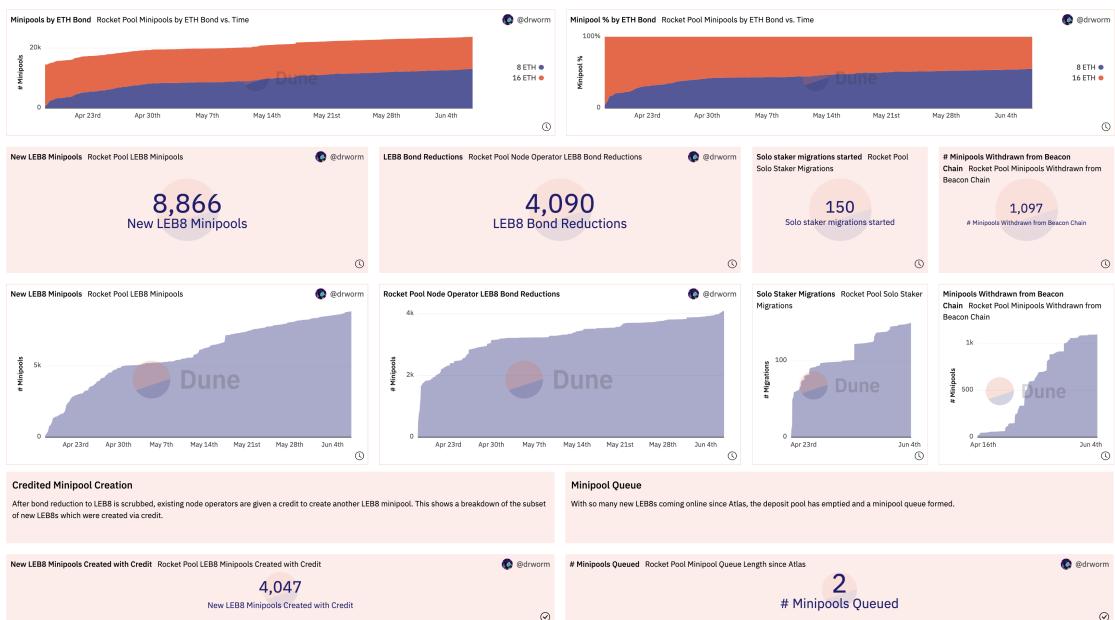


Figure 59: Dune Analytics Rocket Pool Minipools by @drworm (7 June 2023)

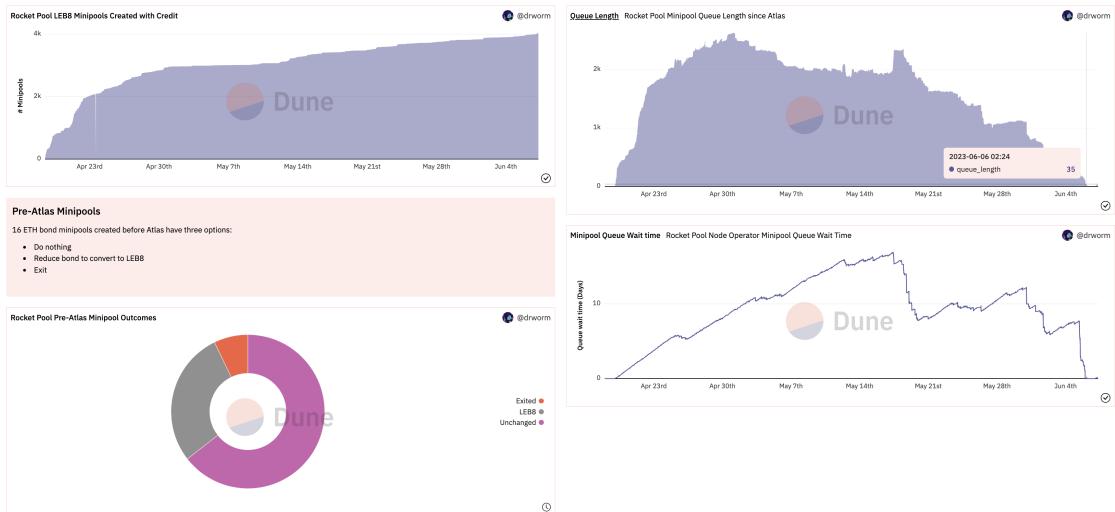


Figure 60: Dune Analytics Rocket Pool Rocket Pool Minipools by @drworm (7 June 2023)

Beaconcha.in

The website provides the ability to search using a variety of fields, including a public key, block number, block graffiti, proposer, slot, and epoch. Apart from the extensive information and visualisations shown here, there are several other

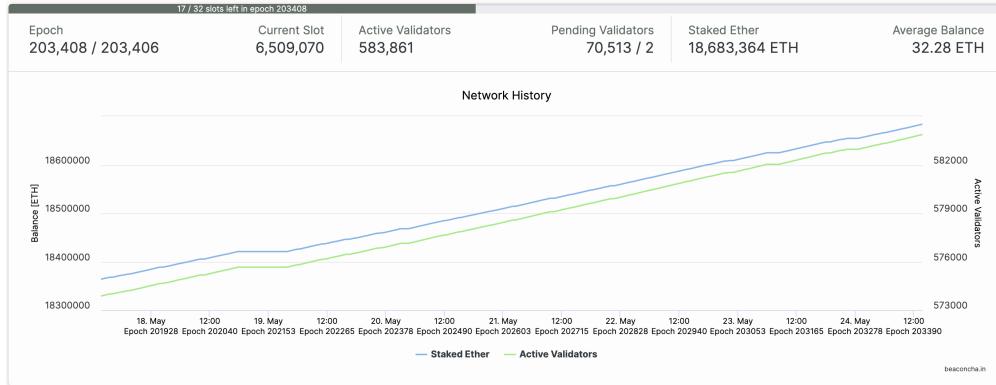


Figure 61: Homepage of beaconcha.in showing a progress line of the slots in the current epoch with a graph of total staked Ether and active validators over the last week, from Beaconcha.in (24 May 2023)

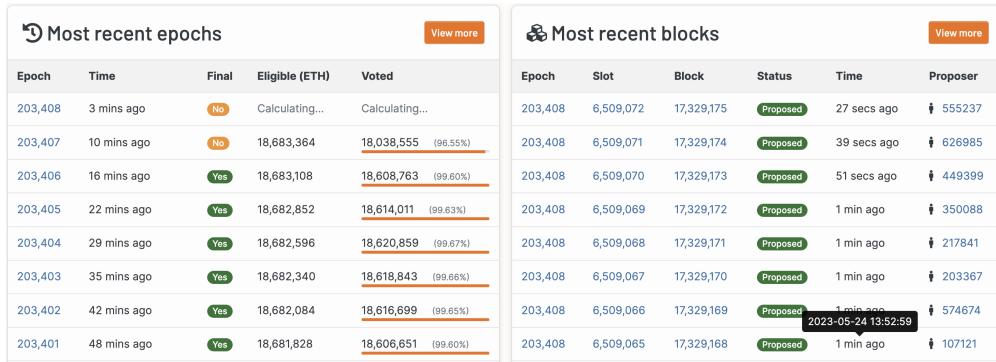


Figure 62: Homepage of beaconcha.in showing the most recent epochs and blocks, from Beaconcha.in (24 May 2023)

Blockchain data

Epoch	Time	Attestations	Deposits / Withdrawals	Slashings P / A	Finalized	Eligible	Voted
203,408	3 mins ago	513	0 / 80	0 / 0	No	0 ETH	Calculating...
203,407	10 mins ago	2950	0 / 512	0 / 0	No	18,683,364 ETH	18,038,555 (96.55%)
203,406	16 mins ago	3110	0 / 512	0 / 0	Yes	18,683,108 ETH	18,608,763 (99.60%)
203,405	23 mins ago	3376	0 / 496	0 / 0	Yes	18,682,852 ETH	18,614,011 (99.63%)
203,404	29 mins ago	3055	0 / 512	0 / 0	Yes	18,682,596 ETH	18,620,859 (99.67%)
203,403	35 mins ago	3219	0 / 512	0 / 0	Yes	18,682,340 ETH	18,618,843 (99.66%)
203,402	42 mins ago	3003	0 / 496	0 / 0	Yes	18,682,084 ETH	18,616,699 (99.65%)
203,401	48 mins ago	3362	0 / 512	0 / 0	Yes	18,681,828 ETH	18,606,651 (99.60%)
203,400	55 mins ago	3164	0 / 496	0 / 0	Yes	18,681,572 ETH	18,484,923 (98.95%)
203,399	1 hr 1 min ago	3265	0 / 512	0 / 0	Yes	18,681,316 ETH	18,615,195 (99.65%)
203,398	1 hr 7 mins ago	3071	0 / 496	0 / 0	Yes	18,681,060 ETH	18,582,875 (99.47%)

Figure 63: Detailed information for epochs with the ability to search for a specific epoch, from Beaconcha.in (24 May 2023)

Detailed information for slots											<input type="checkbox"/> Show only empty graffiti
Epoch	Slot	Status	Time	Proposer	Att	Deposits / Withdrawals	S- P/A	Exits	Votes	Sync Agg %	Graffiti
203,408	6,509,087	Scheduled	in 1 min	⌚ 525099	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,086	Scheduled	in 1 min	⌚ 530775	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,085	Scheduled	in 1 min	⌚ 158574	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,084	Scheduled	in 1 min	⌚ 220418	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,083	Scheduled	in 57 secs	⌚ 410529	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,082	Scheduled	in 45 secs	⌚ 496268	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,081	Scheduled	in 33 secs	⌚ 403275	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,080	Scheduled	in 21 secs	⌚ 333374	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,079	Scheduled	in 9 secs	⌚ 118701	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,078	Scheduled	3 secs ago	⌚ 356025	0	0 / 0	0 / 0	0	0	0.00	
203,408	6,509,077	Proposed	15 secs ago	⌚ 436846	91	0 / 16	0 / 0	0	0	99.61	teku/v23.5.0
203,408	6,509,076	Proposed	27 secs ago	⌚ 455281	107	0 / 16	0 / 0	0	18174	99.41	CryptoManufaktur-Lido

Figure 64: Detailed information for slots with the ability to search by block number, graffiti or proposer number, from Beaconcha.in (24 May 2023)

Detailed information of all blocks											
Epoch	Slot	Block	Status	Recipient	Proposer	Txn	Gas Used	Gas Limit	Base Fee	Reward	Burned Fees
203,409	6,509,088 42 secs ago	17,329,191	Proposed	0xdafef...8bc5	⌚ 458962	149 108	14,830,278 49.43% (-113%)	30,000,000	51.64781 GWei	0.08007	0.76595 Ether 958.57%
203,408	6,509,087 54 secs ago	17,329,190	Proposed	0x690b...c990	⌚ 525099	140 145	17,215,531 57.38% (+14.77%)	30,000,000	50.71154 GWei	0.06788	0.87302 Ether 1286.09%
203,408	6,509,086 1 min ago	17,329,189	Proposed	0x388c...9297	⌚ 530775	138 126	15,198,923 50.65% (+1.32%)	30,000,000	50.62761 GWei	0.07408	0.76948 Ether 1038.58%
203,408	6,509,085 1 min ago	17,329,188	Proposed	0x9522...afe5	⌚ 158574	138 54	13,661,240 45.53% (-8.92%)	30,000,000	51.19880 GWei	0.03164	0.69943 Ether 2210.23%
203,408	6,509,084 1 min ago	17,329,187	Proposed	0x1f90...c326	⌚ 220418	176 86	17,744,223 59.14% (+18.29%)	30,000,000	50.05414 GWei	0.06863	0.88817 Ether 1294.03%
203,408	6,509,083 1 min ago	17,329,186	Proposed	0x388c...9297	⌚ 410529	135 88	13,309,659 44.58% (-1.126%)	30,000,000	50.76929 GWei	0.11654	0.67572 Ether 579.79%
203,408	6,509,082 1 min ago	17,329,185	Proposed	0x1f90...c326	⌚ 496268	155 69	16,591,835 55.30% (+10.61%)	30,000,000	50.10463 GWei	0.05096	0.83132 Ether 1631.26%

Figure 65: Detailed information of all blocks, from Beaconcha.in (24 May 2023)

Tx Hash	Method	Block	Time	From	To	Value	Tx Fee
0xb14_df1e	0x7316b024	17,329,196	28 secs ago	0xd985_bF59	0x0000_2683	0.0000000 Ether	0.01692128 Ether
0xa7d_f667	execute	17,329,196	28 secs ago	0xbDb9_11D1	0xEf1c_BF6B	10 Ether	0.00686362 Ether
0xcfef_148e	0x8a56c398	17,329,196	28 secs ago	0xB722_11fb	0x0000_2683	0.0000000 Ether	0.20266461 Ether
0x36d6_7c5e	swapExactETHForTokensSupp...	17,329,196	28 secs ago	0x1e00_f2f8	Uniswap V2: Rou...	0.05 Ether	0.00898044 Ether
0xeb9c_1260	approve	17,329,196	28 secs ago	0x1e00_f2f8	0x916B_520e	0 Ether	0.00280960 Ether
0xb6f6_2fff	0x00000201	17,329,196	28 secs ago	0x27eb_C008	0xFd00_7AD7	0.0000000 Ether	0.01089586 Ether
0xfaa_26fc	exec	17,329,196	28 secs ago	0x62bd_a4A1	0x3CAC_83b6	0 Ether	0.03407473 Ether
0x6835_54de	deposit	17,329,196	28 secs ago	0x46ba_F459	Wrapped Ether	1.6 Ether	0.00136990 Ether
0xd8d1_e8f9	withdraw	17,329,196	28 secs ago	0x96FA_E007	Wrapped Ether	0 Ether	0.00148918 Ether
0xbb24_9844	transfer	17,329,196	28 secs ago	0x6859_2092	Tether: USDT St...	0 Ether	0.00454948 Ether

Figure 66: Detailed information of all transactions, from Beaconcha.in (24 May 2023)

Show 25 entries	Search:					
Hash	From	To	Value	Gas Limit	Gas Price	Nonce
0xfecae_bdcee	0xAdf_a0c6	0xAdf_a0c6	0 Ether	21,000	99.97304 gWei	2
0x7a2d5_b2d4f	0x6E8_813e	0x6E8_813e	0 Ether	56,311	99.90639 gWei	24
0x79e0c_8a0fe	0x5f4_d2ED	0x5f4_d2ED	0 Ether	21,000	99.77602 gWei	5
0xfa912_a6451	0xC67_799A	0xC67_799A	0 Ether	51,594	99.73214 gWei	33
0xa3b34_c6532	0x7e2_c71e	0xBef_71c6	0 Ether	121,341	99.72739 gWei	124
0x85986_2a62f	0x997_8134	0xD1_eBB0	0 Ether	48,416	99.58487 gWei	21
0x80085_bcef3	0x661_2863	0xC82_6Cc2	0 Ether	25,882	99.56017 gWei	71
0x3ee72_87789	0x266_4Ed7	0x266_4Ed7	0 Ether	21,000	99.55 gWei	24
0xa6a5_2863a	0xCaA_f14e	0xC82_6Cc2	0.015 Ether	45,038	99.23455 gWei	6

Figure 67: Mempool transaction details, from Beaconcha.in (24 May 2023)

Validator data

All 712863								
Public Key	Index	Balance	State	Activation	Exit		W/able	
0x80000001...	8499 (101ca7)	36.4121 ETH (32.0 ETH)	Active ⓘ	904 days 1 min ago (Epoch 0)	-	-	-	
0x800003d8...	197823	32.0064 ETH (32.0 ETH)	Active ⓘ	673 days 53 mins ago (Epoch 51,967)	-	-	-	
0x800006d4...	347967	32.0031 ETH (32.0 ETH)	Active ⓘ	401 days 9 hrs ago (Epoch 113,098)	-	-	-	
0x80000821...	413630	32.0015 ETH (32.0 ETH)	Active ⓘ	285 days 23 hrs ago (Epoch 139,059)	-	-	-	
0x80000cdd...	162791	34.9332 ETH (32.0 ETH)	Active ⓘ	712 days 4 mins ago (Epoch 43,209)	-	-	-	
0x8000118f...	611152	32.0101 ETH (32.0 ETH)	Active ⓘ	17 days 17 hrs ago (Epoch 199,419)	-	-	-	
0x80002598...	665475	32.0000 ETH (32.0 ETH)	Pending	-	-	-	-	
0x800026c3...	118493	0.0000 ETH (0.0 ETH)	Exited	771 days 13 hrs ago (Epoch 29,808)	24 days 20 hrs ago (Epoch 197,813)	23 days 17 hrs ago (Epoch 197,813)	-	
0x80002a23...	112948	32.0082 ETH (32.0 ETH)	Active ⓘ	784 days 1 hr ago (Epoch 26,999)	-	-	-	
0x80002b5a...	627027	32.0436 ETH (32.0 ETH)	Active ⓘ	9 days 2 hrs ago (Epoch 201,358)	-	-	-	

Figure 68: Overview of validators. Beaconcha.in (24 May 2023)

Show 10 entries					
Slashed Validators	Slashed by	Age	Reason	Slot	Epoch
7506	296952	8 hrs 37 mins ago	Attestation Violation	6,506,530	203,329
26165	22260	10 days 13 hrs ago	Attestation Violation	6,433,214	201,037
48608	553505	11 days 17 hrs ago	Attestation Violation	6,424,518	200,766
48607	144422	11 days 20 hrs ago	Attestation Violation	6,423,764	200,742
48609	169630	11 days 20 hrs ago	Attestation Violation	6,423,751	200,742
459890	188013	41 days 11 mins ago	Attestation Violation	6,213,857	194,183
459098	501282	41 days 11 mins ago	Attestation Violation	6,213,856	194,183
459140	501282	41 days 11 mins ago	Attestation Violation	6,213,856	194,183

Figure 69: Slashed validators. Beaconcha.in (24 May 2023)

Show 10 entries								
Rank	Index	Public Key	Balance	Income 1 day	Income 7 days	Income 31 days	Income 1 year	
1	187309	0xa2af8d...	32.1741 ETH	+0.04976 ETH	+0.31932 ETH	+0.38695 ETH	+1.60766 ETH	
2	482263	0xb66d21...	32.1408 ETH	+0.14362 ETH	+0.28783 ETH	+0.35538 ETH	+0.80752 ETH	
3	309298	0xa0591b...	32.0039 ETH	+0.00280 ETH	+0.28397 ETH	+0.35159 ETH	+1.79926 ETH	
4	513517	0xaed547...	32.2771 ETH	+0.04941 ETH	+0.28395 ETH	+0.35162 ETH	+0.60665 ETH	
5	540440	0xb2bed9...	32.1602 ETH	+0.00278 ETH	+0.28361 ETH	+0.35122 ETH	+0.49054 ETH	
6	338833	0xa5bdc0...	32.0032 ETH	+0.00277 ETH	+0.28297 ETH	+0.38394 ETH	+1.57859 ETH	
7	118247	0x8de57f...	32.1348 ETH	+0.00277 ETH	+0.27719 ETH	+0.37807 ETH	+1.60192 ETH	
8	559719	0xb178a5...	32.1412 ETH	+0.04829 ETH	+0.27689 ETH	+0.34082 ETH	+0.40748 ETH	
9	507023	0xa378ea...	32.2698 ETH	+0.00279 ETH	+0.27650 ETH	+0.37742 ETH	+0.63083 ETH	
10	210073	0xa64d69...	34.8922 ETH	+0.00277 ETH	+0.27600 ETH	+0.37651 ETH	+1.53077 ETH	

Showing 1 to 10 of 712,863 entries

First < 1 of 71287 > Last

Figure 70: Validator leaderboard - default listing order is by 7day income, but it is possible to display the order by income based on 1day, 31 days or 1 year. Beaconcha.in (24 May 2023)

This table displays the leaderboard for deposits made by Ethereum Addresses to the Deposit Contract												
Address												
Address	Total Deposited	Valid	Invalid	Pen	Att	Sla	Ex	Tot				
0xF82aC5...	4,850,560 ETH	151580	0	0	133098	11	0	150926				
0xa40dfE...	1,355,040 ETH	42345	0	0	23014	0	17612	42331				
0x8dD75A...	613,440 ETH	19170	0	0	14171	0	0	19170				
0xB049E2...	467,808 ETH	14619	0	0	14619	0	0	14619				
0xdd1927...	412,480 ETH	12890	0	0	12890	0	0	12890				
0xc2288B...	351,488 ETH	10984	0	0	10981	0	0	10981				
0xA76a7D...	319,232 ETH	9976	0	0	9976	0	0	9976				
0x004447...	244,448 ETH	7639	0	0	7639	0	0	7639				
0x5a0036...	221,889 ETH	6939	0	0	5498	0	334	6880				
0x1CeDC0...	207,360 ETH	6480	0	0	5200	0	0	6480				

Showing 1 to 10 of 105,551 entries

First < 1 of 10556 > Last

Figure 71: Leaderboard for deposits made by Ethereum addresses to the deposit contract - default order is by total amount deposited, but it is possible to display the order using any of the other columns shown in the table. Beaconcha.in (24 May 2023)



Initiated Deposits

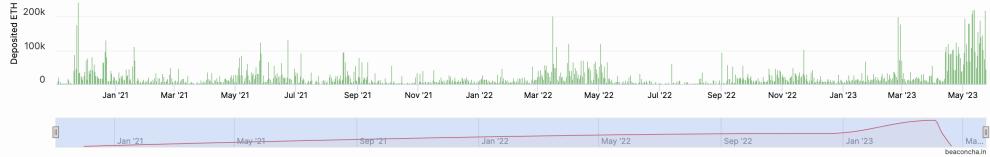


Figure 72: Visualisation of deposits since beaconchain genesis. Beaconcha.in (24 May 2023)

This table displays the deposits made on Ethereum for validators who wish to join the Beacon Chain.

Address	Validator Key	Withdrawal Credential	Amount	Tx Hash	Time	Block	Validator State	Valid Signature
0xa40dFE...	0x8182c8...	0x004f_...825c	32 ETH	0xfffff...	878 days 17 hrs ago	11531360	Exited	✓
0x74b142...	0xa8f64c...	0x009b_...f17	32 ETH	0xfffffae...	505 days 15 hrs ago	13935079	Active ⓘ	✓
0x89b48C...	0xa519e7...	0x00b9_...9cf9	32 ETH	0xfffffac...	663 days 14 hrs ago	12923243	Active ⓘ	✓
0x133058...	0xa6f5ac...	0x008d_...465a	32 ETH	0xfffff73...	456 days 22 hrs ago	14250193	Active ⓘ	✓
0x44894a...	0xaa4a72...	0x0100_...d65	32 ETH	0xfffff66...	11 days 21 hrs ago	17245128	Pending	✓
0xa40dFE...	0x9a0059...	0x004f_...825c	32 ETH	0xfffff51...	510 days 1 hr ago	13906660	Active ⓘ	✓
0x449dFE...	0xa62dcf...	0x004f_...825c	32 ETH	0xfffff51...	510 days 1 hr ago	13906660	Active ⓘ	✓
0xa40dFE...	0xa73de5...	0x004f_...825c	32 ETH	0xfffff51...	510 days 1 hr ago	13906660	Active ⓘ	✓
0xB15C29...	0xaea696...	0x00dd_...1ce6	32 ETH	0xfffff2c...	814 days 13 hrs ago	11949037	Active ⓘ	✓
0x91997f...	0xb542a...	0x001f_...751b	32 ETH	0xfffffe...	907 days 20 hrs ago	11341578	Active ⓘ	✓

Figure 73: Initiated deposits: table of the deposits made by validators wishing to join the beaconchain.. Beaconcha.in (24 May 2023)

This table displays the deposits made on Ethereum for validators who wish to join the Beacon Chain.

Address	Validator Key	Withdrawal Credential	Amount	Tx Hash	Time	Block	Validator State	Valid Signature
0x79f05c...	0x853ba9...	0x00f7...	1ETH	0x7885c...	931 days 19 hrs ago	11103311	Active ⓘ	✓
0x354a37...	0x1d1d...	0x00f2_...	1ETH	0xa0d2...	930 days 21 hrs ago	11101448	Active ⓘ	✓
0x354a37...	0x02ff47...	0x00f2_...	1ETH	0x14f1d...	930 days 21 hrs ago	11101485	Active ⓘ	✓
0x354a37...	0x9d6...	0x00f2_...	1ETH	0x14f1d...	930 days 21 hrs ago	11101501	Active ⓘ	✓
0x354a37...	0x803232...	0x00f2_...	1ETH	0x6e10...	930 days 21 hrs ago	11101501	Active ⓘ	✓
0x354a37...	0x803242...	0x00f2_...	1ETH	0x80c57...	930 days 20 hrs ago	11101512	Active ⓘ	✓
0xf1f181c...	0x8220ef...	0x00f4...	32 ETH	0x40406...	930 days 20 hrs ago	11101526	Active ⓘ	✓
0x2f7af4e...	0x1616...	0x00f2_...	32 ETH	0x9fb...	930 days 20 hrs ago	11101608	Active ⓘ	✓
0xf1f181c...	0x80707...	0x00f2_...	32 ETH	0x7080...	930 days 20 hrs ago	11101701	Active ⓘ	✓
0xf1f181c...	0x8058_...	0x00f2_...	32 ETH	0x95650...	930 days 20 hrs ago	11101703	Active ⓘ	✓
0xf1f181c...	0x80416...	0x00f2_...	32 ETH	0x1010...	930 days 20 hrs ago	11101703	Active ⓘ	✓

This table displays the deposits made on Ethereum for validators who wish to join the Beacon Chain.

Address	Validator Key	Withdrawal Credential	Amount	Tx Hash	Time	Block	Validator State	Valid Signature
0xf1f181c...	0x8537...	0x00f2_...	1ETH	0x6f08...	30 days 31 mins ago	17183201	Pending	✓
0xf0f0f...	0x8537...	0x00f2_...	1ETH	0x6f08...	12 days 7 hrs ago	17242120	Pending	✓
0xf42910...	0x80334...	0x00f2_...	1ETH	0x6375...	30 days 27 mins ago	17183338	Active ⓘ	✓
0x851548...	0x846a2c...	0x00f2_...	1ETH	0x6bf0...	30 days 25 mins ago	17183448	Active ⓘ	✓
0x81554c...	0x846a2c...	0x00f2_...	1ETH	0x6bf0...	10 days 9 hrs ago	17235580	Deposited	✓
0xf1f181c...	0x80339...	0x00f2_...	1ETH	0x6f08...	12 days 7 hrs ago	17242159	Pending	✓
0xf0f0f...	0x80339...	0x00f2_...	1ETH	0x6f08...	9 days 1 hrs ago	17201142	Deposited	✓
0x8480a2...	0x80227...	0x00f2_...	1ETH	0x6f08...	13 days 10 hrs ago	17234234	Pending	✓
0x42d10...	0x99eac...	0x00f2_...	1ETH	0x6b434...	30 days 22 mins ago	17183695	Active ⓘ	✓
0xf0f0f...	0x846e...	0x00f2_...	1ETH	0x6f08...	12 days 7 hrs ago	17242137	Pending	✓

(a)

(b)

Figure 74: Table of deposits ordered by time (a) and by amount deposited (b). Beaconcha.in (24 May 2023)

This table displays the deposits received by the Ethereum Beacon Chain.

Slot	Validator Key	Amount	Withdrawal Credentials	Signature
6,507,566	0xb7d1c7...	32 ETH	0x0100...adb5	0xaf5e...1048
6,507,566	0x83400c...	32 ETH	0x0100...a0d7	0xaac6...29d3
6,507,566	0x827851...	31 ETH	0x0100...2078	0xa553...327f
6,507,566	0x834c9c...	31 ETH	0x0100...7849	0xb5cc...c514
6,507,565	0xa64328...	32 ETH	0x0100...a81c	0x99fc...9673
6,507,565	0x882e17...	32 ETH	0x0100...a81c	0xb1a8...cd61
6,507,565	0xb79537...	32 ETH	0x0100...a81c	0xb63...d77a
6,507,565	0xb229c0...	32 ETH	0x0100...a81c	0x9073...776f
6,507,565	0xa3fea5...	32 ETH	0x0100...a81c	0x88e6...6ab6
6,507,565	0xb0473b...	32 ETH	0x0100...a81c	0x875c...13d3

Showing 1 to 10 of 734,155 entries

First < 1 of 73416 > Last

Figure 75: Included deposits: table of the deposits received by the beaconchain. Beaconcha.in (24 May 2023)



Figure 76: Histogram of processed withdrawals. Beaconcha.in (24 May 2023)

This table displays partial and full withdrawals.

Epoch	Slot	Index	Validator	Time	Address	Amount
203,416	6,509,332	4712767	492631	10 secs ago	0xD530d4_eD53FC	0.012949 Ether
203,416	6,509,332	4712766	492629	10 secs ago	0x91b9f0_20FE3D	0.012968 Ether
203,416	6,509,332	4712765	492628	10 secs ago	0xD530d4_eD53FC	0.012925 Ether
203,416	6,509,332	4712764	492627	10 secs ago	0xD530d4_eD53FC	0.012960 Ether
203,416	6,509,332	4712763	492626	10 secs ago	0xD530d4_eD53FC	0.012968 Ether
203,416	6,509,332	4712762	492625	10 secs ago	0xD530d4_eD53FC	0.012904 Ether
203,416	6,509,332	4712761	492624	10 secs ago	0xD530d4_eD53FC	0.012943 Ether
203,416	6,509,332	4712760	492623	10 secs ago	0xD530d4_eD53FC	0.012916 Ether
203,416	6,509,332	4712759	492622	10 secs ago	0xD530d4_eD53FC	0.012946 Ether
203,416	6,509,332	4712758	492621	10 secs ago	0xD530d4_eD53FC	0.012965 Ether

Showing 1 to 10 of 4,712,767 entries

First < 1 of 471277 > Last

Figure 77: Table of partial and full withdrawals. Beaconcha.in (24 May 2023)

This table displays the BLS address changes from 0x00 credentials to 0x01.

Epoch	Slot	Validator	Signature	BLS Public Key	New Withdrawal Address
203,410	6,509,142	21828	0x8dac_76da	0x8d25_c3cf	0x00B292_6bd404
203,406	6,509,008	34389	0x8951_63b9	0xa4b2_523d	0xC0FFEE_Fcc4CD
203,406	6,509,008	34375	0x8922_c529	0xa2b6_30e2	0xC0FFEE_Fcc4CD
203,406	6,509,008	3000	0xa2c9_edff	0xb369_12cf	0xC0FFEE_Fcc4CD
203,406	6,509,008	2999	0xac3a_e137	0xadaa_947e	0xC0FFEE_Fcc4CD
203,406	6,509,002	131273	0x8720_85e5	0xf65_cdb83	0xFACbEb_76e38E
203,403	6,508,919	91180	0x95d8_bbdd	0xb728_9230	0xFACbEb_76e38E
203,391	6,508,526	205643	0xa5d4_e51a	0x96ff_171c	0x6F1cb7_150604
203,387	6,508,388	123865	0xae8d_ece3	0x8188_ea89	0x9Ee7bc_B6fffc5
203,379	6,508,136	1581	0xa202_81d5	0x8449_c301	0x3C6621_D188f9

Showing 1 to 10 of 270,143 entries

First < 1 of 27015 > Last

Figure 78: Table displaying the BLS address changes from 0x00 credentials to 0x01. Beaconcha.in (24 May 2023)

The screenshot shows the Beaconcha.in Validator dashboard. At the top, there's a search bar and a summary table with metrics like Last Day, Last Week, and Last Month rewards. Below the summary is a table of validators with columns for Public Key, Index, Balance, State, Last Attestation, P, Income 7 days, and a search bar. To the right is a detailed history table for epoch 24, showing rewards and events for each epoch from 144,557 to 144,550.

Validators									History 70		
Public Key	Index	Balance	State	Last Attestation	P	Income 7 days	Epoch	Rewards	Events		
0xb9b20a39...	70	0.0000 ETH	Slashed		24 / 0	0 ETH	144,557	-11,020 GWei	Miss.		
0x85552a2f...	965	0.0000 ETH	Exited		35 / 0	0 ETH	144,556	-11,020 GWei	Miss.		
0x945732e5...	22221	28.6183 ETH	Active ⚡	No Attestation found	0 / 43	-0.01292 ETH	144,555	-11,020 GWei	Miss.		
0xb1ee1d19...	353910	16.0000 ETH	Deposited	No Attestation found	0 / 0	0 ETH	144,554	-11,020 GWei	Miss.		

Figure 79: Validator dashboard - add the validators of interest to the search bar. In this example we added three validators: one active, one voluntary exited and one slashed validator. Beaconcha.in (24 May 2023)

The screenshot shows the Beaconcha.in Correlations page. It features a dropdown menu for selecting X and Y variables, with options like AVG_BLOCK_UTIL, AVG_GASLIMIT, AVG_GASPRICE, AVG_GASUSED, and BLOCK_COUNT. There are also fields for Start Date and End Date, and a 'Generate Chart' button.

Figure 80: It is possible to generate correlation visualisations between several variables. Beaconcha.in (24 May 2023)

Consensus Layer Charts



Figure 81: History of daily blocks proposed (a) and daily active validators (b) from Beaconcha.in (24 May 2023)

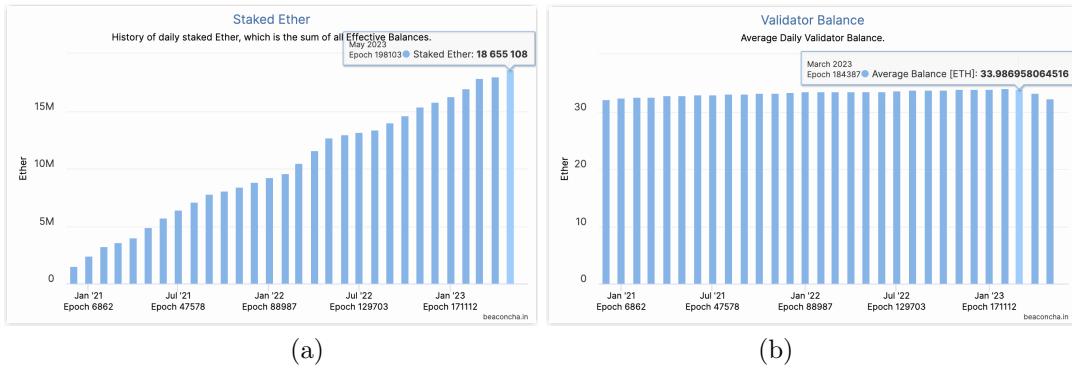


Figure 82: History of daily staked Ether (sum of all effective balances) (a) and average daily validator balance (b) from Beaconcha.in (24 May 2023)

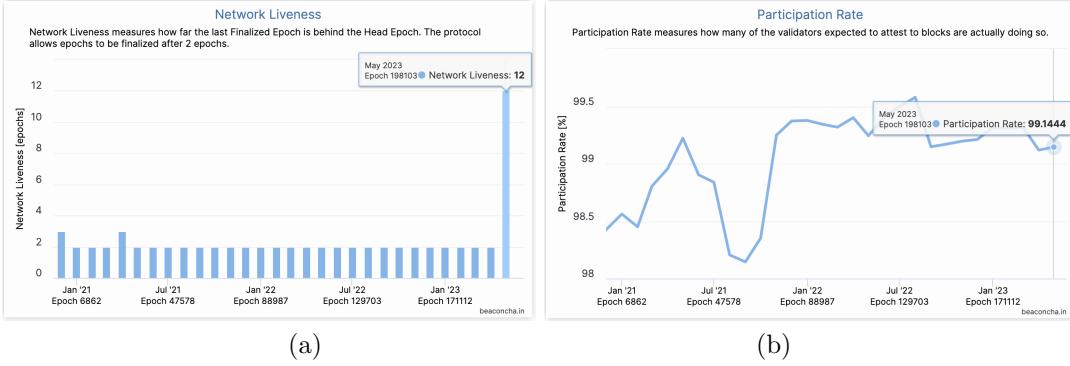


Figure 83: Network liveness (measures how far the last finalised epoch is behind the head epoch. The protocol allows epochs to be finalised after 2 epochs) (a) and participation rate (measures how many of the validators expected to attest to blocks are actually doing so) (b) from Beaconcha.in (24 May 2023)

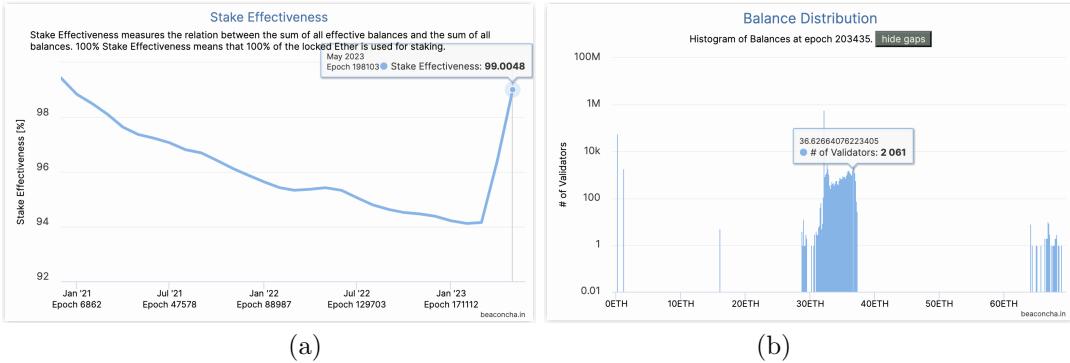


Figure 84: Stake effectiveness (measures the relation between the sum if all effective balances and the sum of all balances. 100% stake effectiveness means that 100% of the locked ETH is used for staking) (a) and balance distribution (b) from Beaconcha.in (24 May 2023)

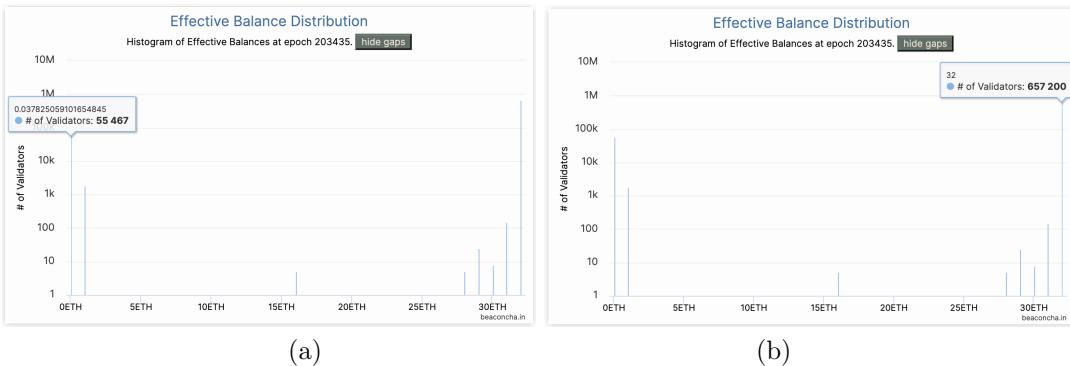


Figure 85: Effective balance distribution showing information on the lowest balance - 0.04ETH (a) and for 32 ETH (b) from Beaconcha.in (24 May 2023)

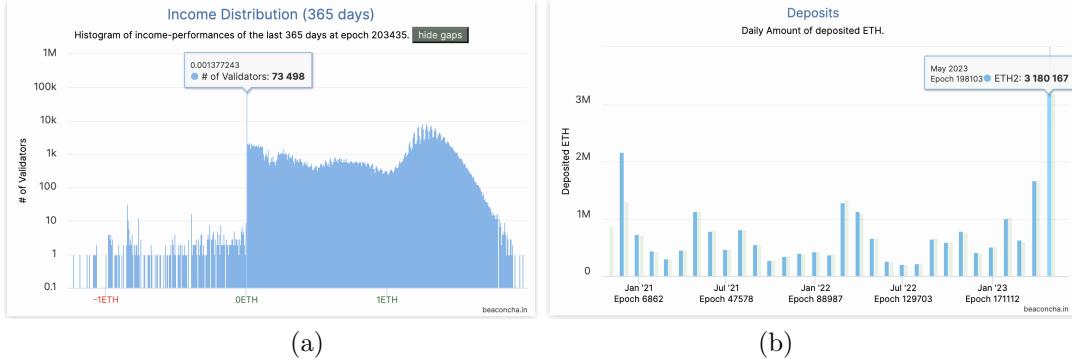


Figure 86: Income distribution for the last 365 days (a) and Daily amount of deposited ETH on the consensus layer (b) from Beaconcha.in (24 May 2023)



Figure 87: Daily amount of deposited ETH on the execution layer (a) and a graffiti word cloud of the 25 most occurring graffitiies (b) from Beaconcha.in (24 May 2023)

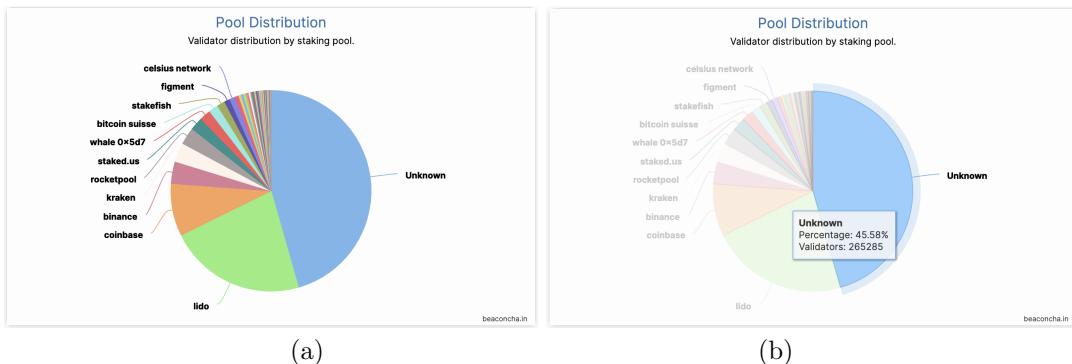


Figure 88: Validator distribution by staking pool (a) and honing in on the proportion of validators not allocated to a known staking pool (b) from Beaconcha.in (24 May 2023)



Figure 89: Validator distribution by staking pool showing the Lido pool (a) and Rocketpool (b) from Beaconcha.in (24 May 2023)

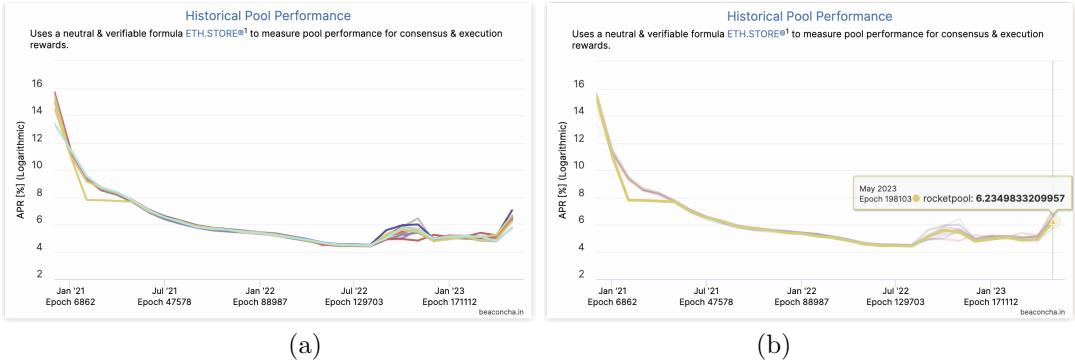


Figure 90: Historical pool performance (a) and honing in on Rocketpool preformance (b) from Beaconcha.in (24 May 2023)



Figure 91: Daily amounts of withdrawals (a) and slot visualisation (click on the diagram for more detail) (b) from Beaconcha.in (24 May 2023)

Execution layer charts

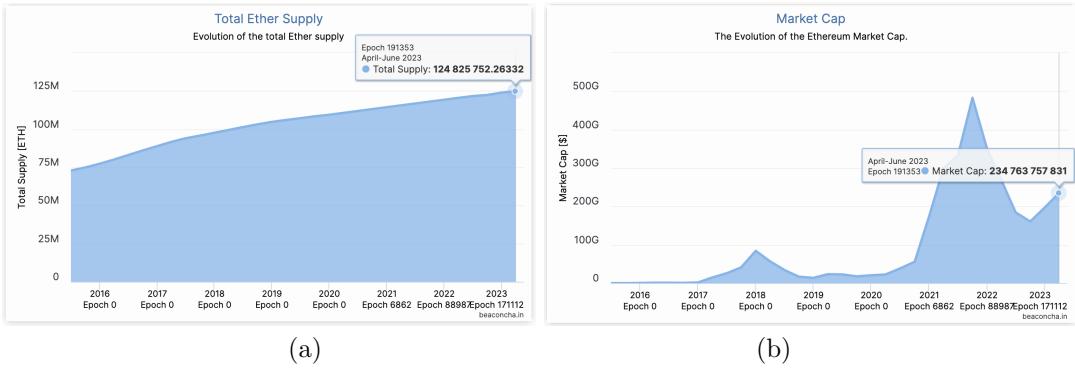


Figure 92: Evolution of total ether supply (a) and of the Ethereum market capitalisation (b) from Beaconcha.in (24 May 2023)

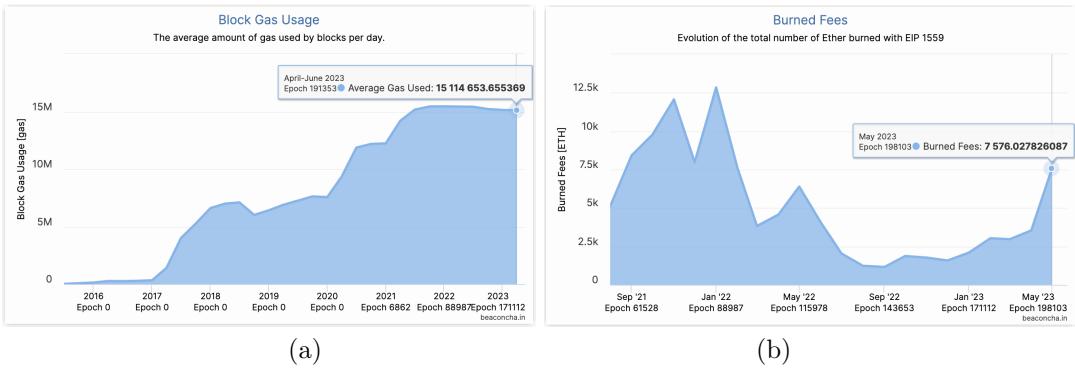


Figure 93: The average amount of gas used by blocks per day (a) and the evolution of the total amount of Ether burned with EIP1559 (b) from Beaconcha.in (24 May 2023)

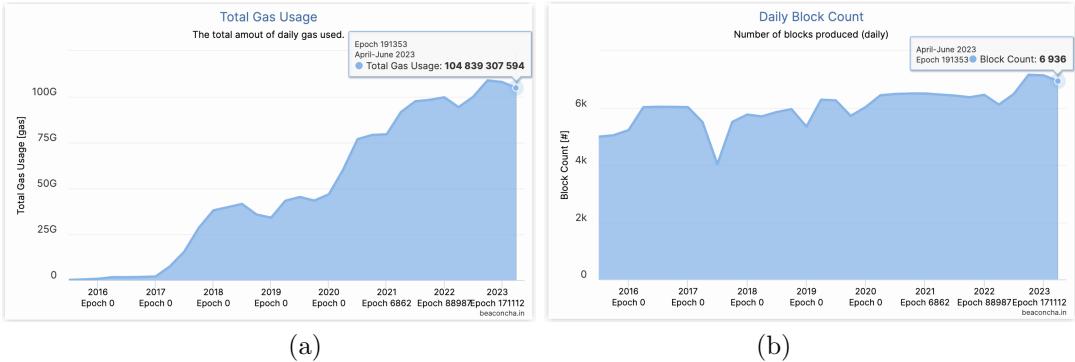


Figure 94: The daily total amount of gas used (a) and the number of blocks produced daily (b) from Beaconcha.in (24 May 2023)

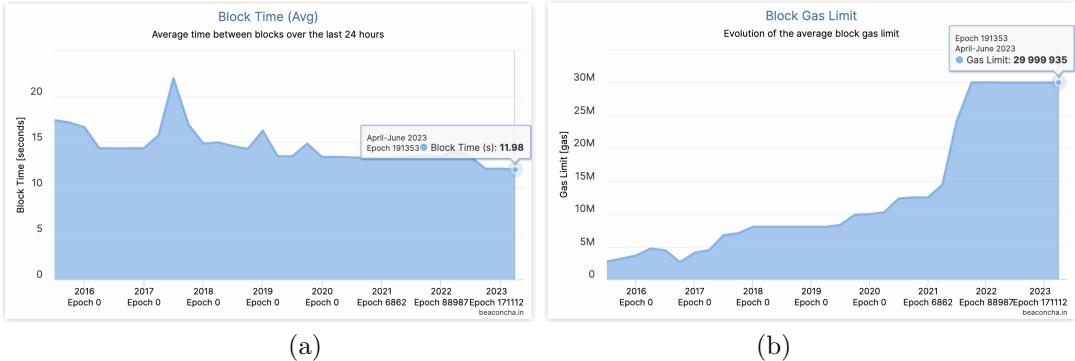


Figure 95: Average time between blocks over the last 24 hours (a) and the evolution of the average block gas limit (b) from Beaconcha.in (24 May 2023)

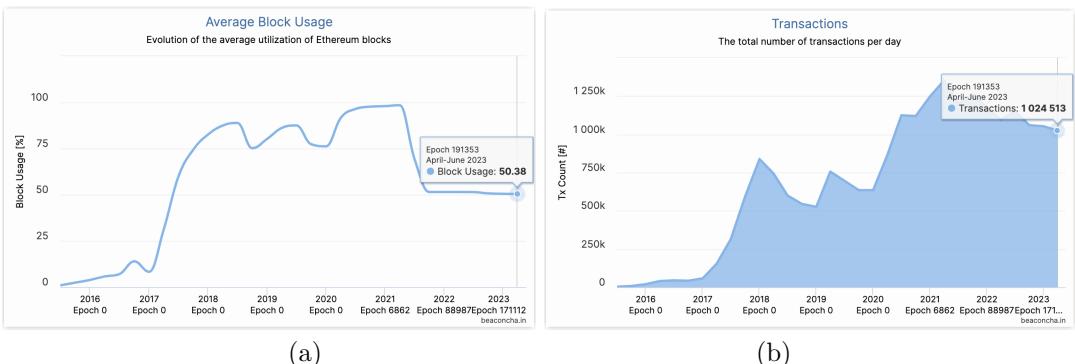


Figure 96: Evolution of the average utilisation of Ethereum blocks (a) and the total number of transactions per day (b) from Beaconcha.in (24 May 2023)

Mevboost.pics

General Dashboard

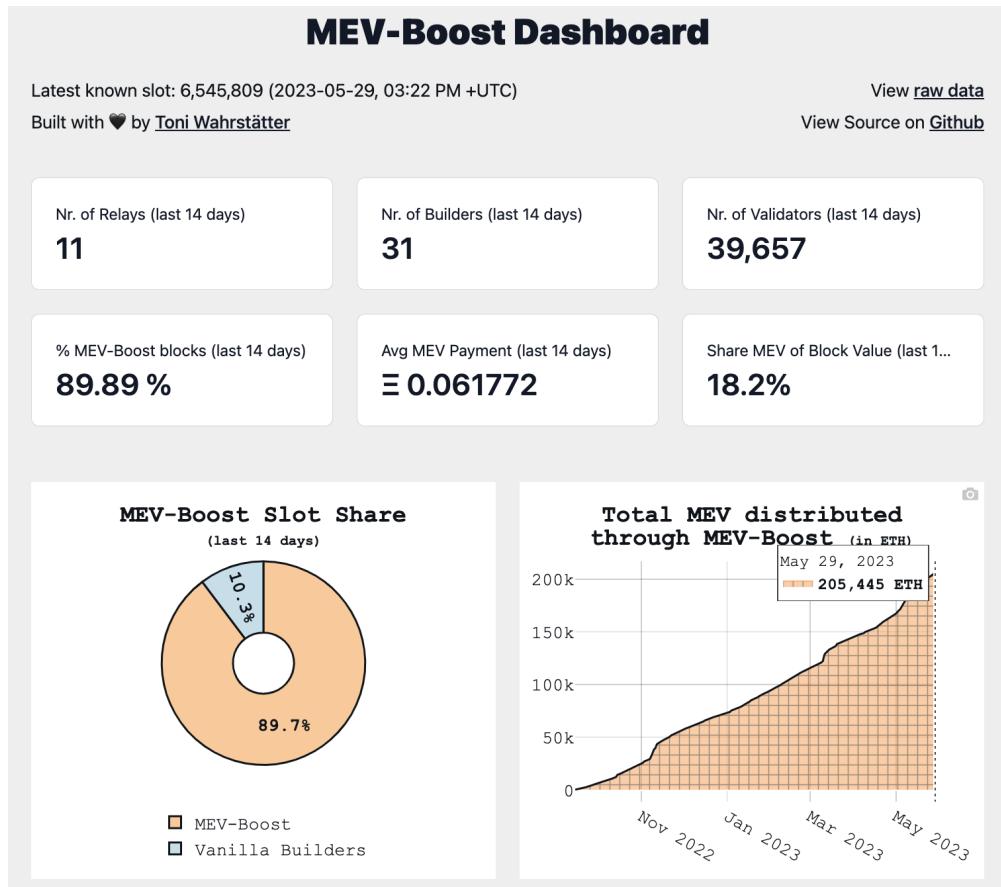


Figure 97: General Dashboard - summary statistics. Mevboost.pics.(29 May 2023)



Figure 98: General Dashboard - slot share, daily gas and MEV revenue with the option of choosing different time periods. Mevboost.pics.(29 May 2023)

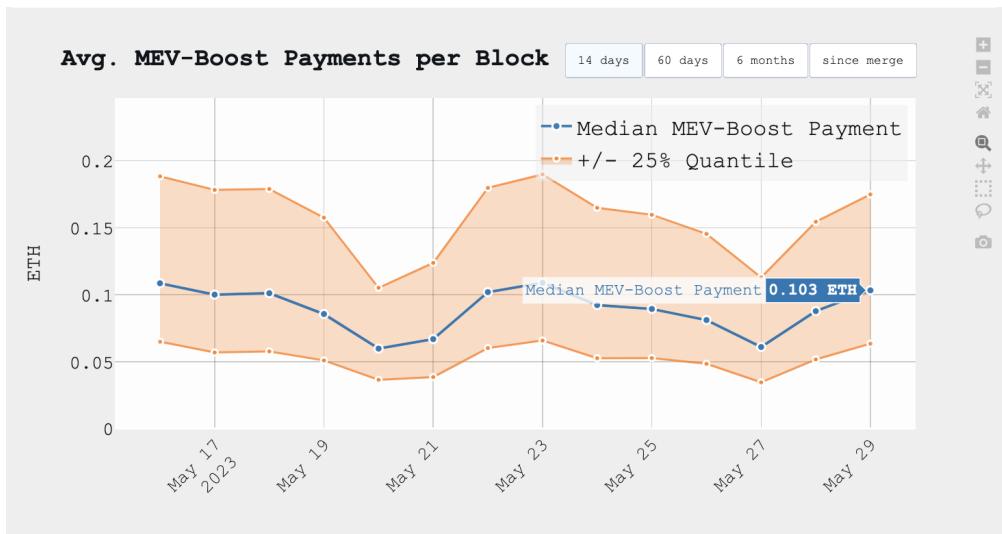


Figure 99: General Dashboard - Average MEV-Boost payments per block - choose between 14 days, 60 days, 6 months or since the merge. Mevboost.pics.(29 May 2023)

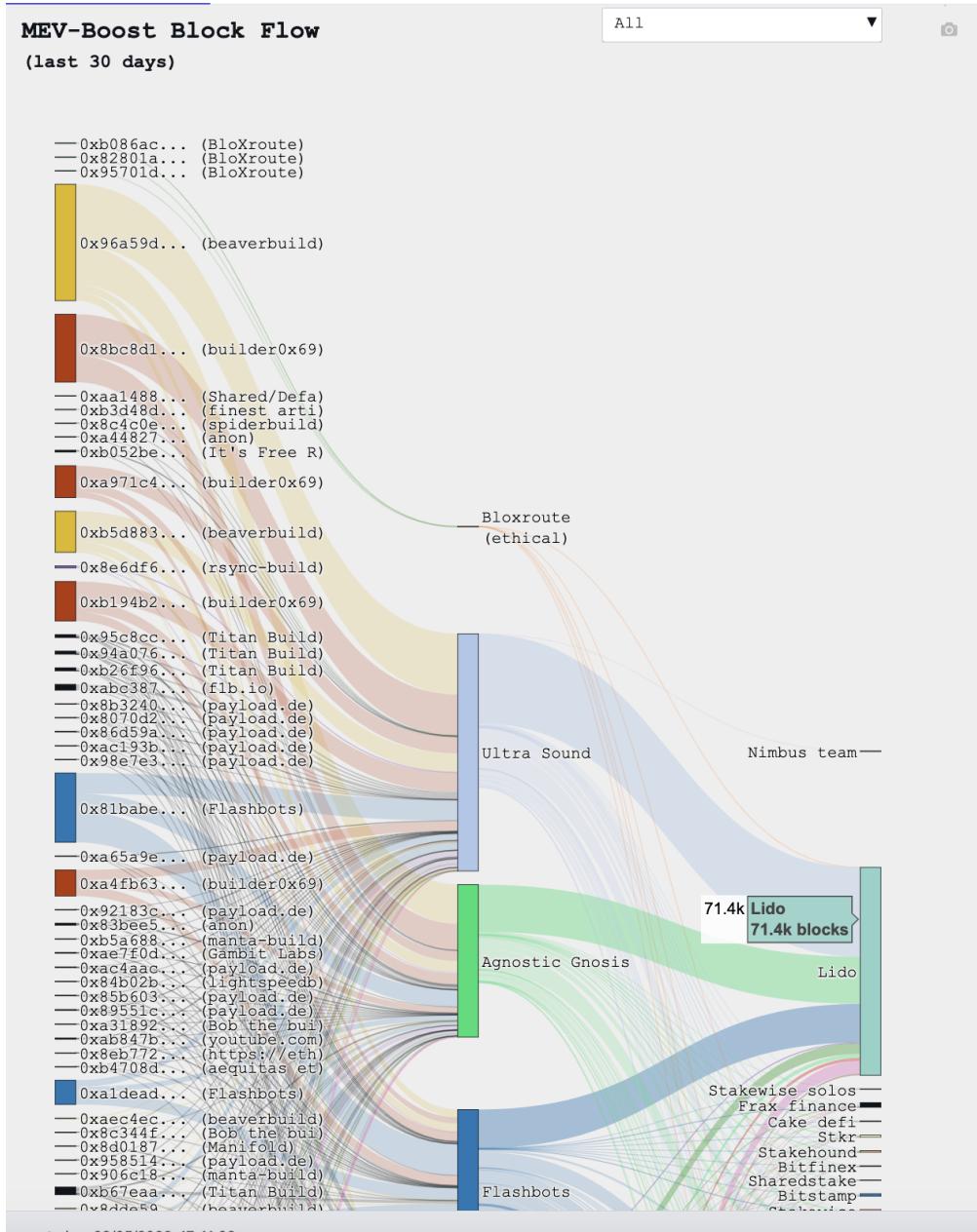


Figure 100: General Dashboard - MEV-Boost block flow. Select to display all builders, only builders active in the past 7 days, excluding small builders, or choose a builder from the available list. Mevboost.pics.(29 May 2023)

Relays Dashboard

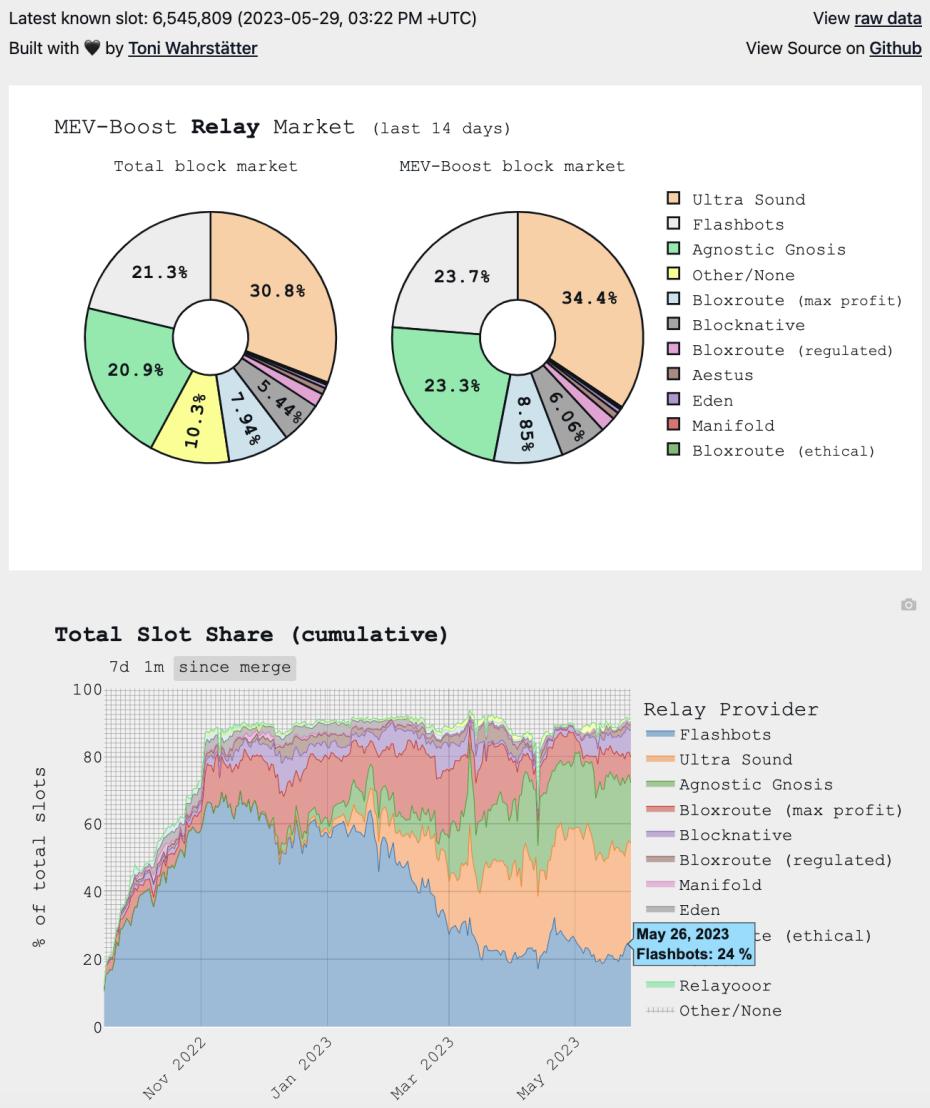


Figure 101: Relay Dashboard - MEV-Boost relay market (last 14 days) and total cumulative slot share (select from time ranges: 7 days, 1 month, since merge). Mevboost.pics.(29 May 2023)

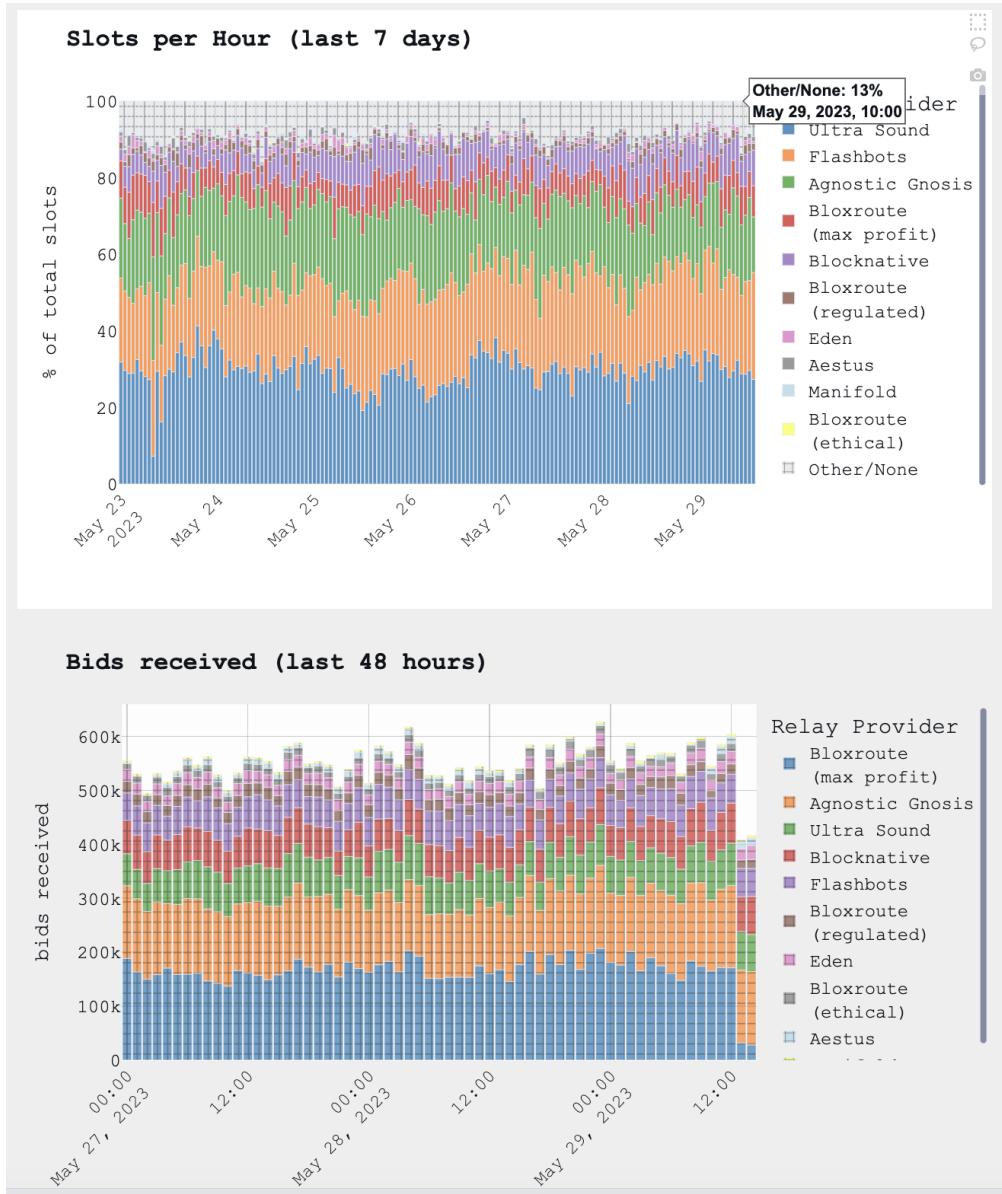


Figure 102: Relay Dashboard - Slots per hour (last 7 days) and bids received (last 48 hours). Mevboost.pics.(29 May 2023)

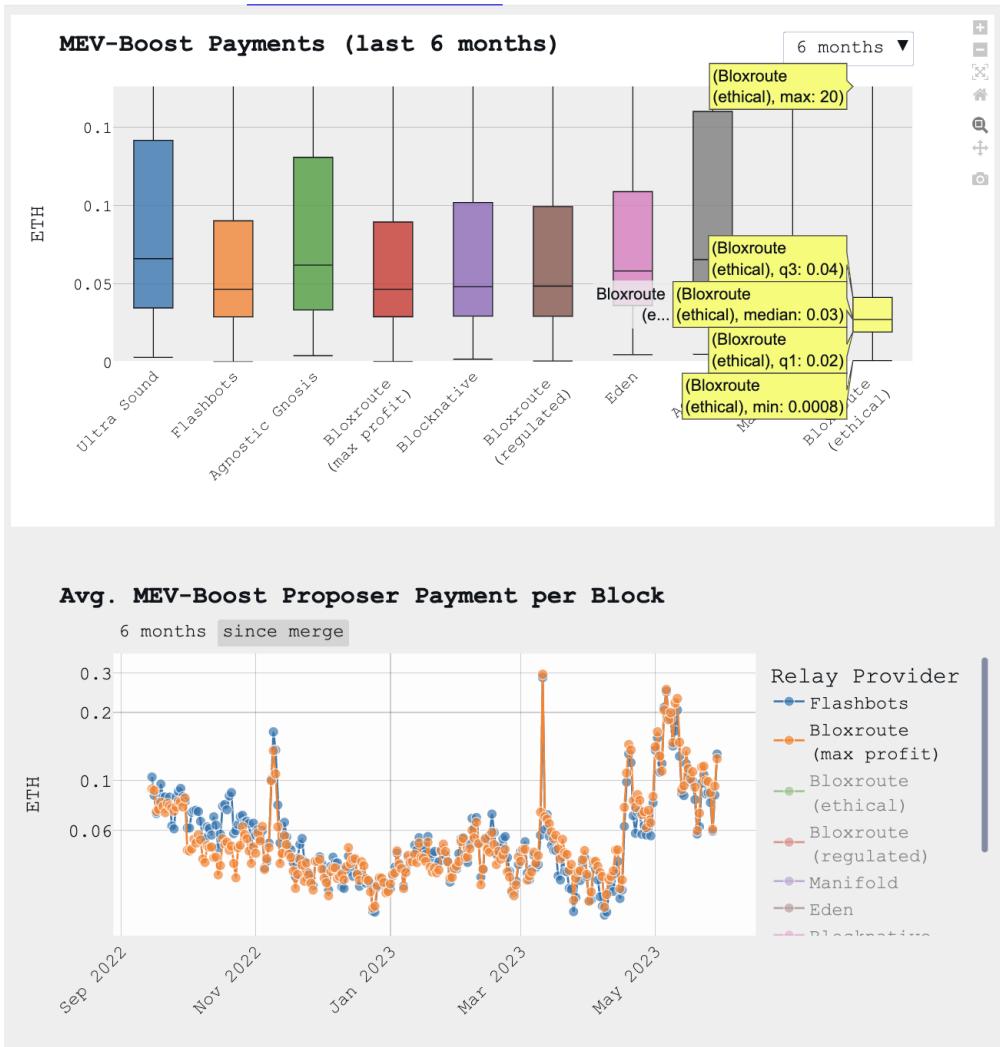


Figure 103: Relay Dashboard - MEV-Boost payments (select from last 48 hours, 7 days, 30 days or 6 months) and average MEV-Boost proposer payment per block (either for the last 6 months or since the merge). Mevboost.pics.(29 May 2023)

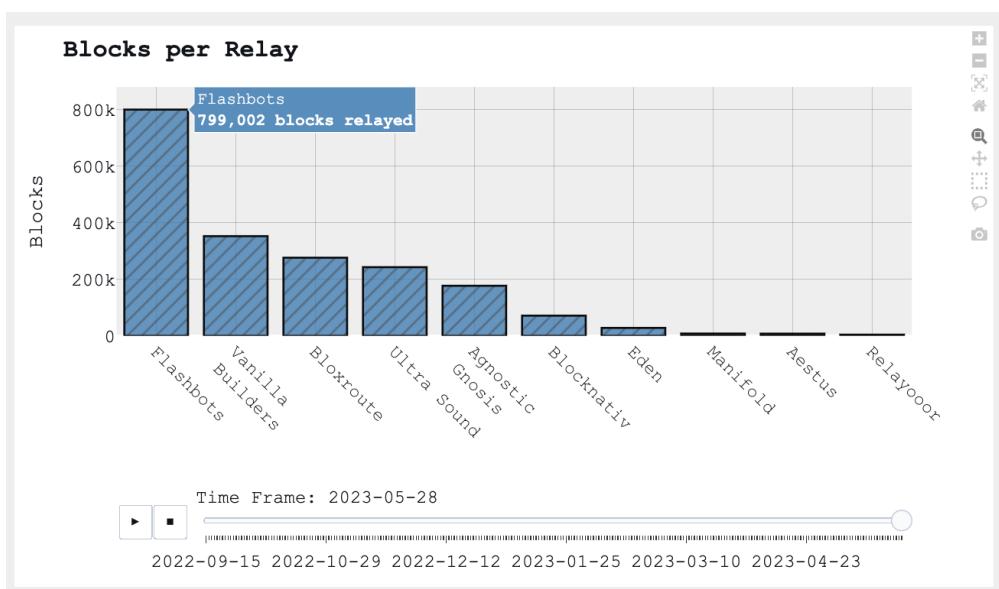


Figure 104: Blocks per relay. Press play to see the visualisation of the blocks per relay change over time.
Mevboost.pics.(29 May 2023)

Builders Dashboard

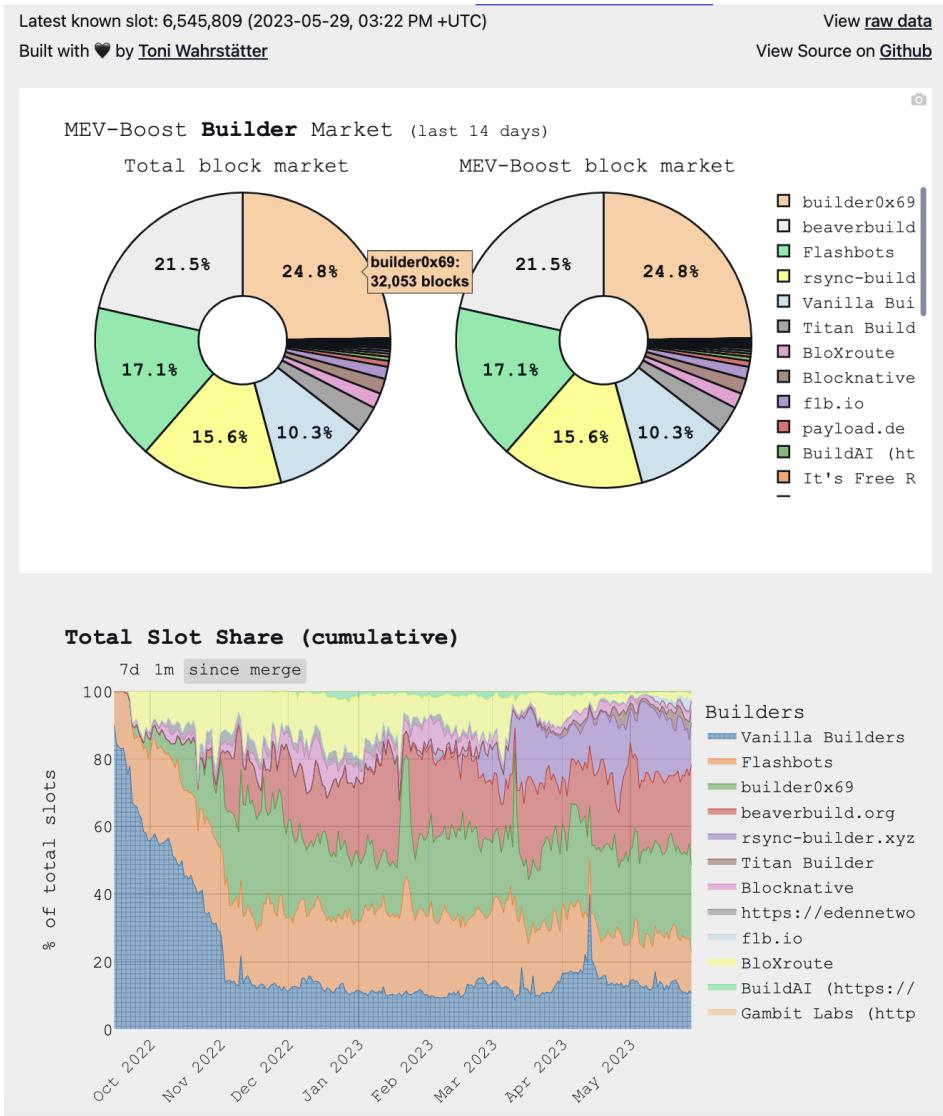


Figure 105: Builders Dashboard - MEV-Boost builder market for the last 14 days and total cumulative slot share (select from time ranges: 7 days, 1 month, since merge). Mevboost.pics.(29 May 2023)

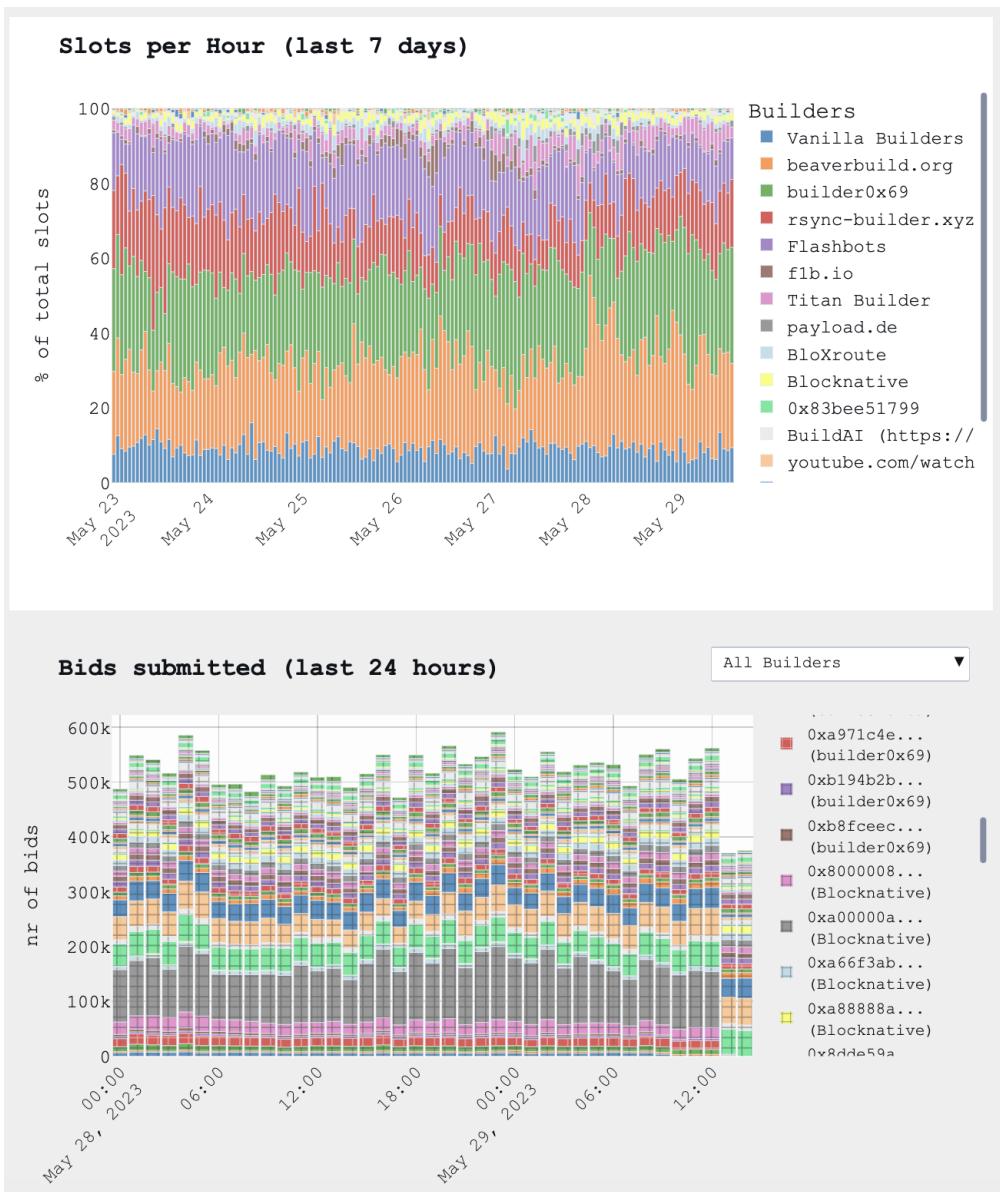


Figure 106: Builders Dashboard - Slots per hour (last 7 days) and bids submitted for the last 24 hours (select all builders, or one from the list provided). Mevboost.pics.(29 May 2023)

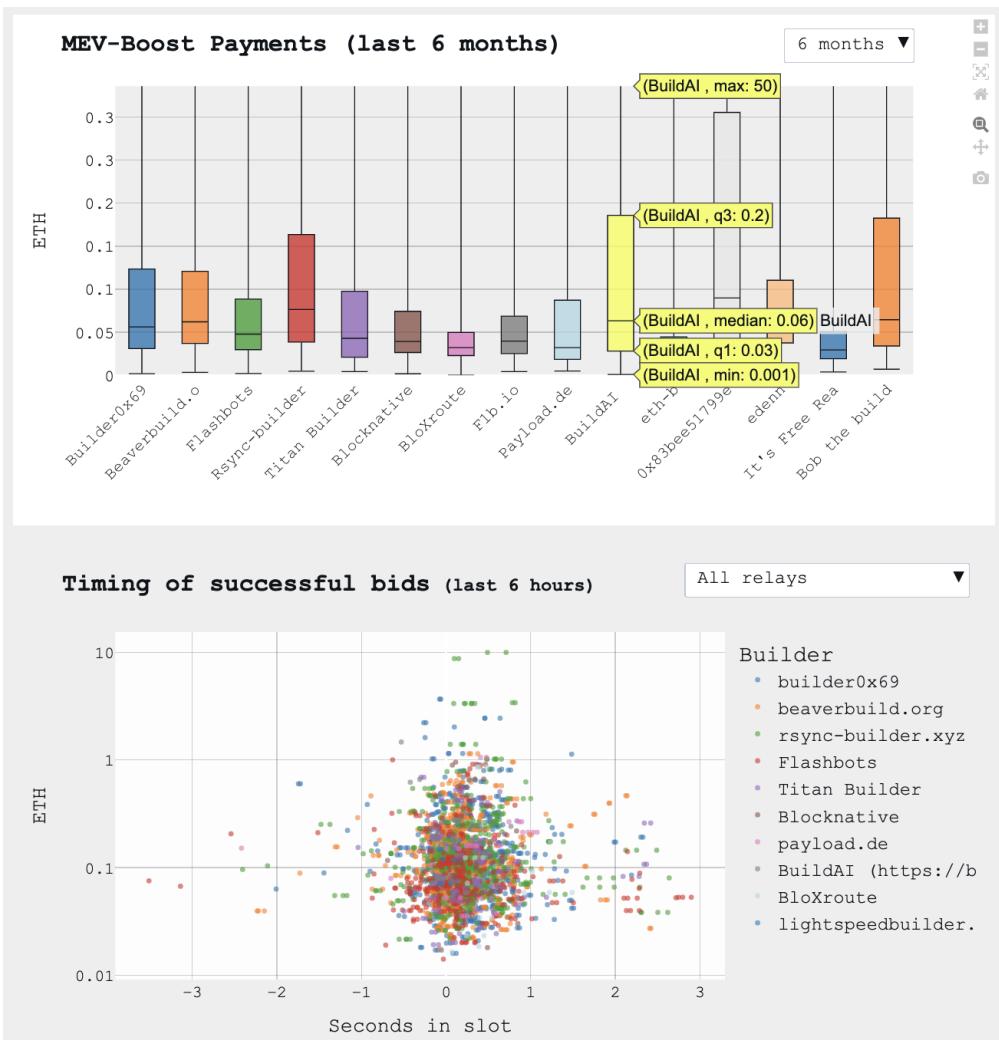


Figure 107: Builders Dashboard - MEV-Boost payments (select from 48 hours, 7 days, 30 days, or 6 months) and timing of the successful bids (select from all relays, or from the list provided). Mevboost.pics.(29 May 2023)

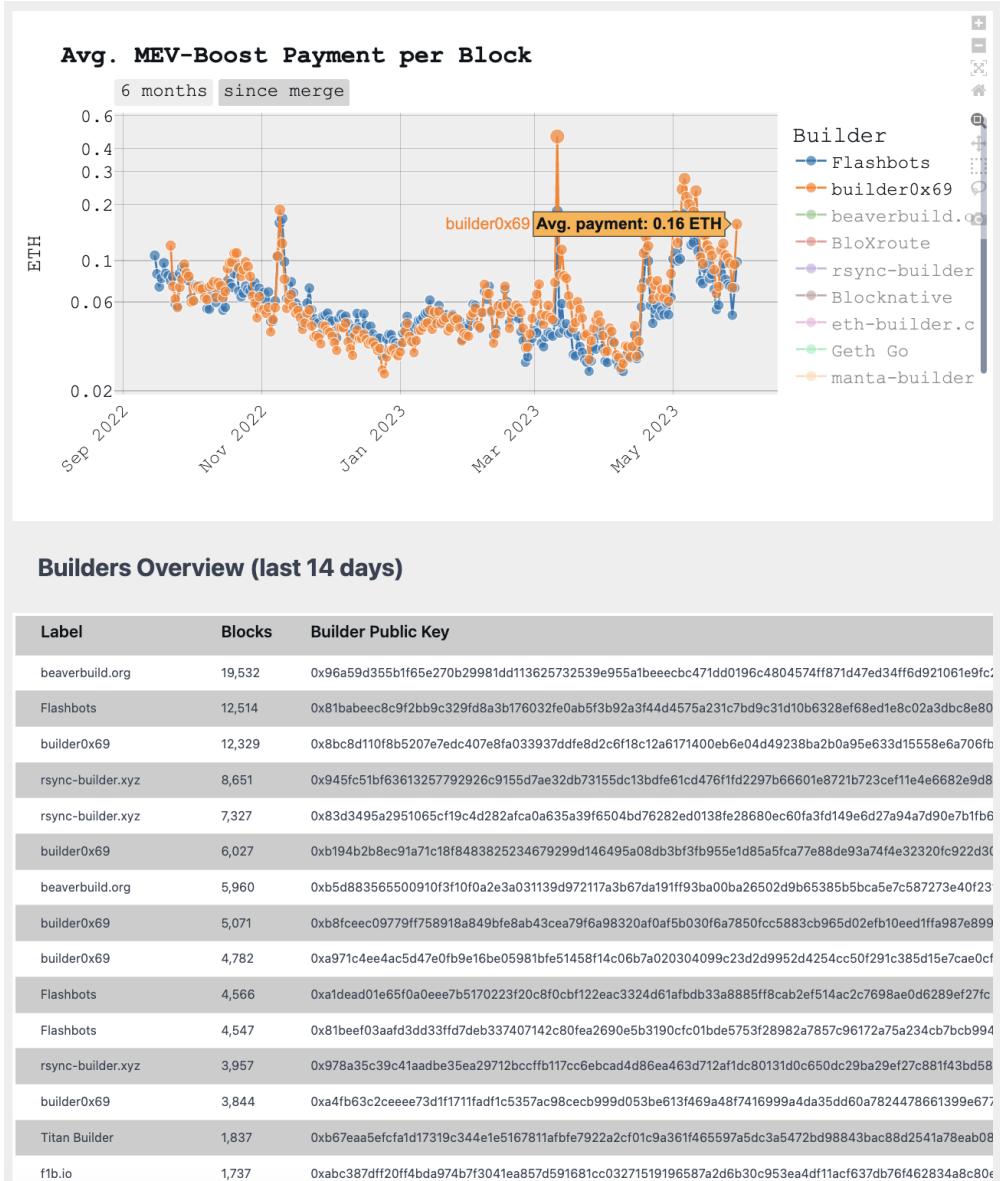


Figure 108: Builders Dashboard - Average MEV-Boost payments per block (select time range of last 6 months, or since merge) and builders overview of the last 14 days, ordered by the total number of blocks. Mevboost.pics.(29 May 2023)

Validators Dashboard

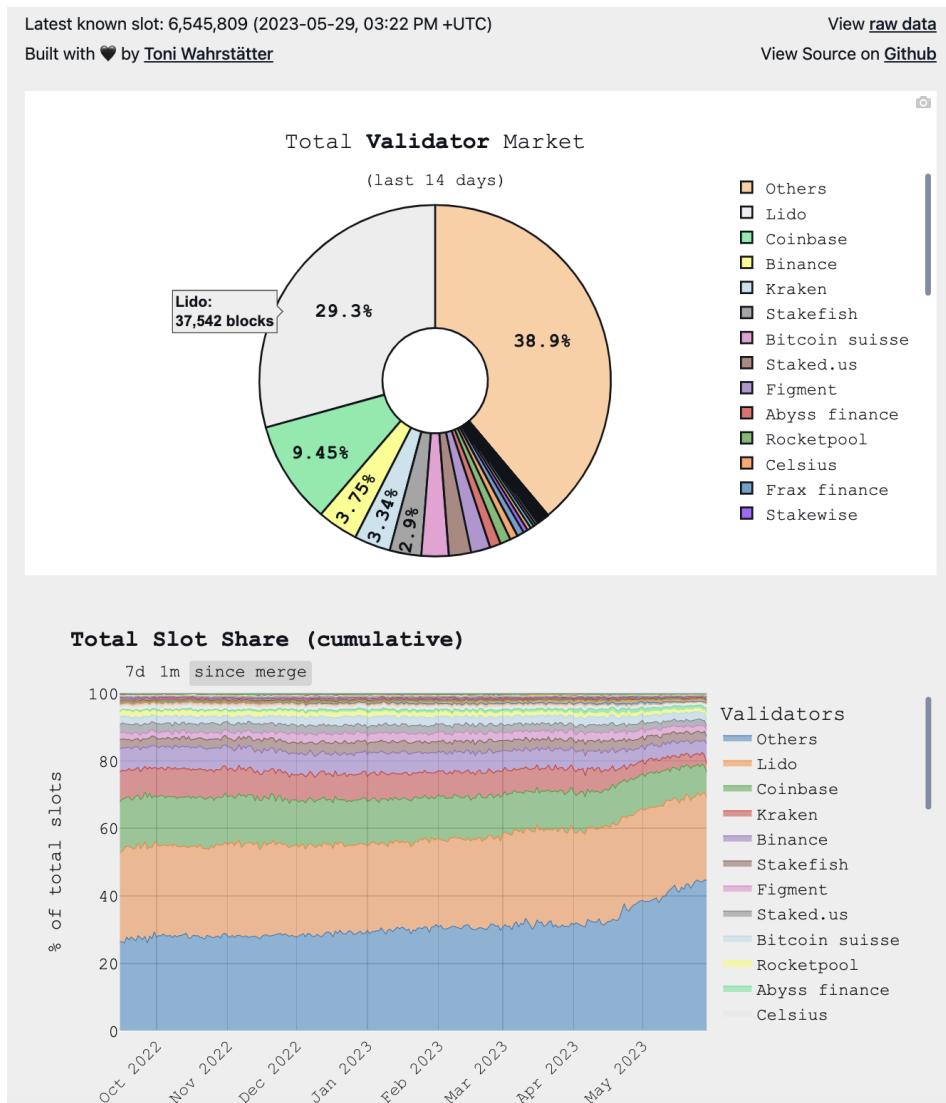


Figure 109: Validators Dashboard - MEV-Boost total validator market for the last 14 days and total cumulative slot share (select from time ranges: 7 days, 1 month, since merge). Mevboost.pics.(29 May 2023)

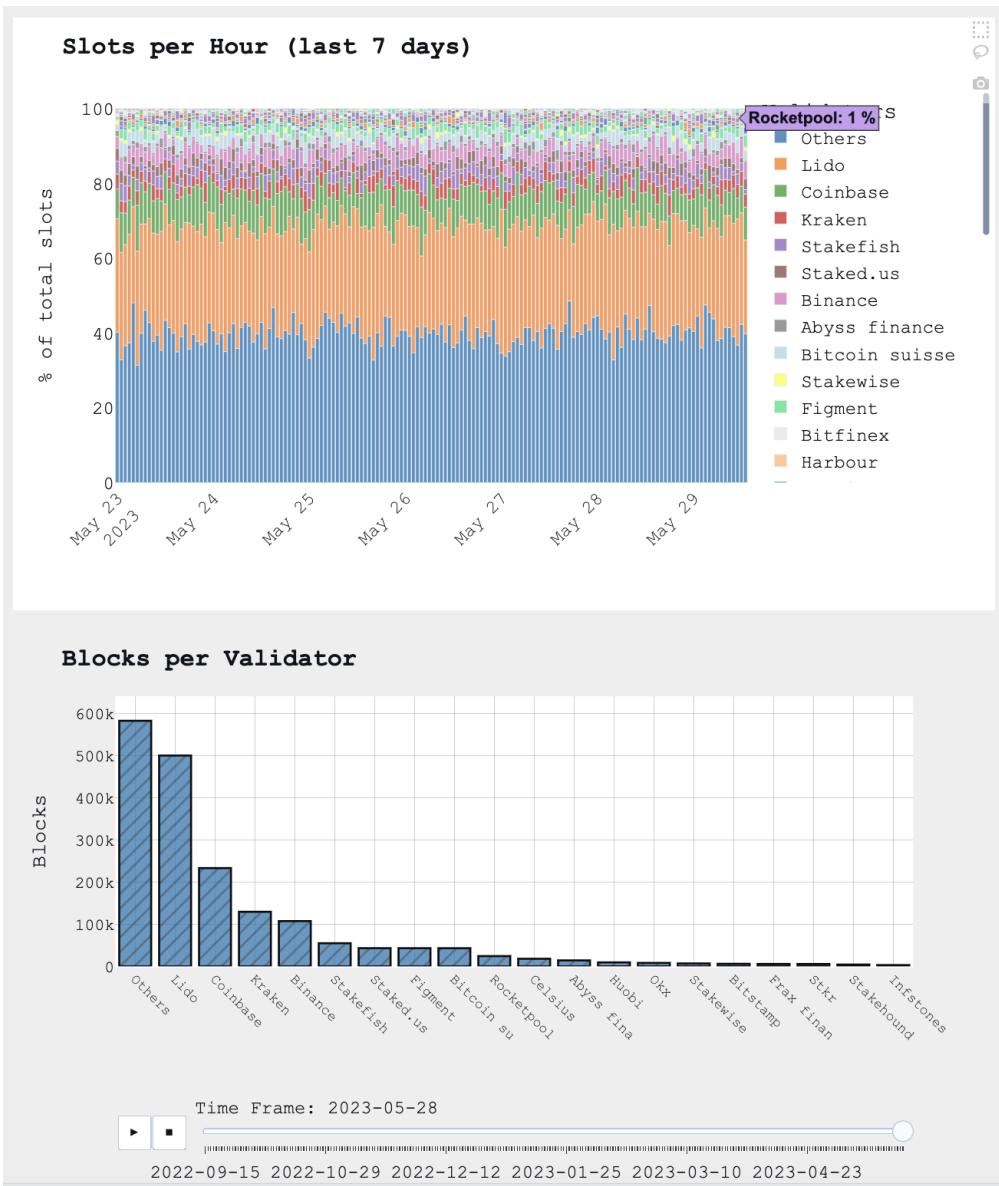


Figure 110: Validators Dashboard - Slots per hour (last 7 days) and blocks per validator: press play to see the visualisation of the blocks per validator change over time.. Mevboost.pics.(29 May 2023)

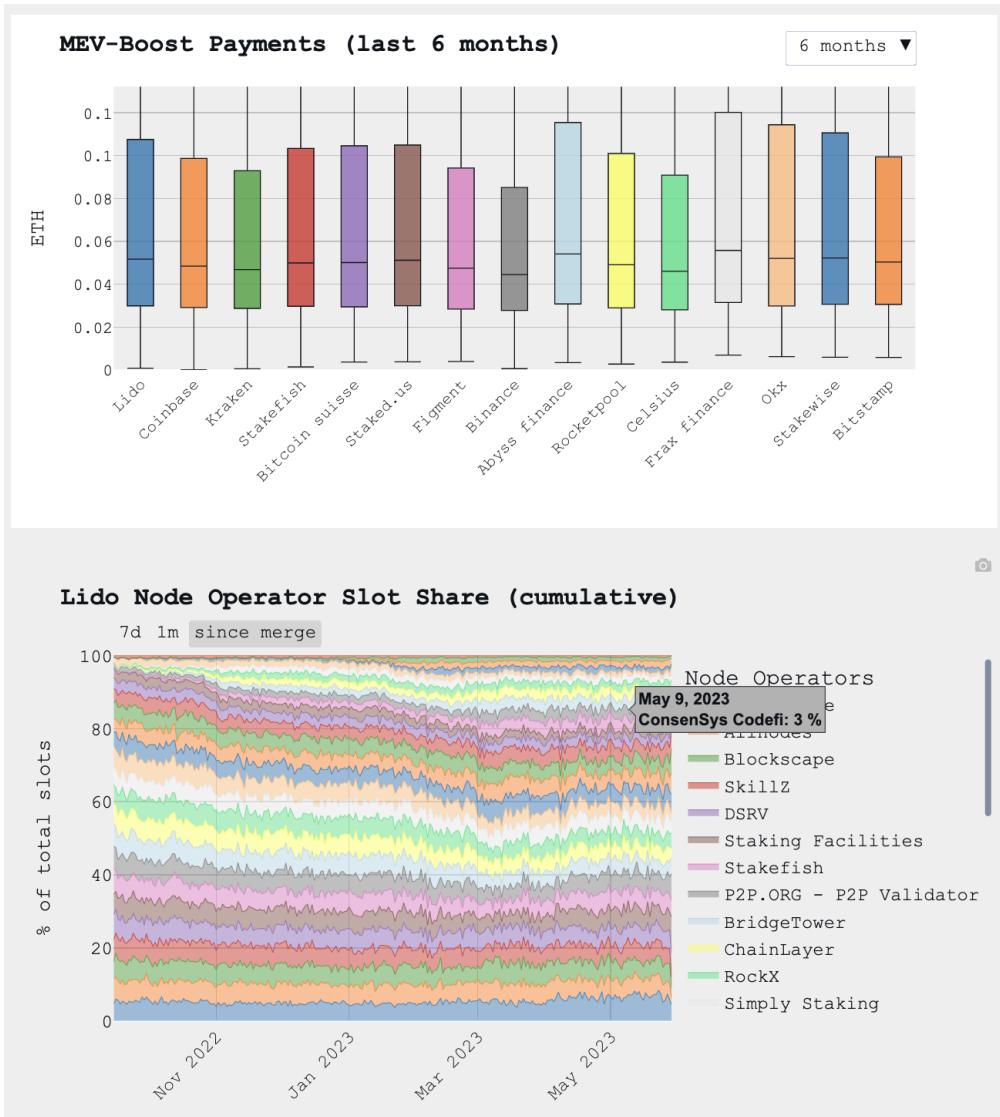


Figure 111: Validators Dashboard - MEV-Boost payments (select from time ranges: 48 hours, 7 days, 30 days or 6 months) and cumulative total of Lido node operator slot share (select time range: 7 days, 1 month or since merge). Mevboost.pics.(29 May 2023)

Validators Overview		
Validator	Validators	Blocks (since merge)
Lido	161,989 (28.46%)	500,129 (27.10%)
Coinbase	57,077 (10.03%)	233,131 (12.63%)
Kraken	26,417 (4.64%)	129,525 (7.02%)
Binance	25,544 (4.49%)	107,454 (5.82%)
Stakefish	16,717 (2.94%)	54,921 (2.98%)
Staked.us	11,118 (1.95%)	43,207 (2.34%)
Figment	12,701 (2.23%)	43,164 (2.34%)
Bitcoin suisse	13,675 (2.40%)	43,101 (2.34%)
Rocketpool	6,400 (1.12%)	24,407 (1.32%)
Celsius	4,943 (0.87%)	18,117 (0.98%)
Abyss finance	6,522 (1.15%)	14,228 (0.77%)
Huobi	1,112 (0.20%)	9,486 (0.51%)
Ookx	3,118 (0.55%)	8,184 (0.44%)
Stakewise	2,074 (0.36%)	6,958 (0.38%)
Bitstamp	1,709 (0.30%)	6,106 (0.33%)
Frax finance	3,361 (0.59%)	5,772 (0.31%)
Stkr	1,333 (0.23%)	5,688 (0.31%)
Stakehound	1,172 (0.21%)	4,317 (0.23%)
Gate.io	37 (0.01%)	3,353 (0.18%)
Infstones	838 (0.15%)	3,131 (0.17%)
Bitpie	816 (0.14%)	3,040 (0.16%)
Kucoin	827 (0.15%)	2,995 (0.16%)

Figure 112: Validators Dashboard - Validators overview with Staker/Validator, number of validators and number of blocks proposed by the staking entity since the merge. Mevboost.pics.(29 May 2023)

Data Sets

Dataset Name	Description	Size	License	Download
eth_data	Slots table with Boosted slots. Boosted slots are slots with proposer_pubkey, relay, builder_pubkey, mevboost_value, builder, validator. info			Table columns: date, slot, block_number, relay, builder_pubkey, proposer_pubkey, mevboost_value, builder, validator.
pubkey_mapping	Validator public keys mapped to known entities such as Lido, Kraken ect.	...	CC BY-SA 4.0	Coming Soon
tc_txs	Tornado Cash related transactions	...	CC BY-SA 4.0	Coming Soon
staking_txs	Deposit transactions to the ETH2 Deposit contract	...	CC BY-SA 4.0	Coming Soon

Figure 113: Raw data can be downloaded from Mevboost.pics. Currently only the first dataset is available for download. (29 May 2023). The public key mapping dataset is now also available and will be updated daily (30 May 2023)

teku-besu-ohio-mainnet-archive-01

We are able to retrieve some rich data from the archive node `teku-besu-ohio-mainnet-archive-01` using API endpoints. For example, the data of the validators retrieved according to their status (as seen in the call statement) includes the *validator index*, *balance*, *effective balance*, *slashed flag*, *activation eligibility epoch*, *activation epoch*, *exit epoch* and *withdrawable epoch*

- `/eth/v1/beacon/states/finalized/validators?status='active'`
For each of the entries the sub-status is listed, i.e. ‘active_ongoing’, ‘active_exiting’, or ‘active_slashed’. Alternatively a call can be made directly for one of these sub-statuses, e.g.
`/eth/v1/beacon/states/finalized/validators?status='active_ongoing'`
- `/eth/v1/beacon/states/finalized/validators?status='pending'`
The two sub-statuses are: ‘pending_initialized’ and ‘pending_queued’.
In a similar manner to the above sub-status call, we could run a query to extract only a specific sub-status:
`/eth/v1/beacon/states/finalized/validators?status='pending_initialized'`
- `/eth/v1/beacon/states/finalized/validators?status='exited'`
Exited status also has two sub-statuses that can be called directly: ‘exited_unslashed’ and ‘exited_slashed’
- `/eth/v1/beacon/states/finalized/validators?status='withdrawal'`
Withdrawal has two substatuses: ‘withdrawal_possible’ and ‘withdrawal_done’, which can be called directly.

Graphs of validator data

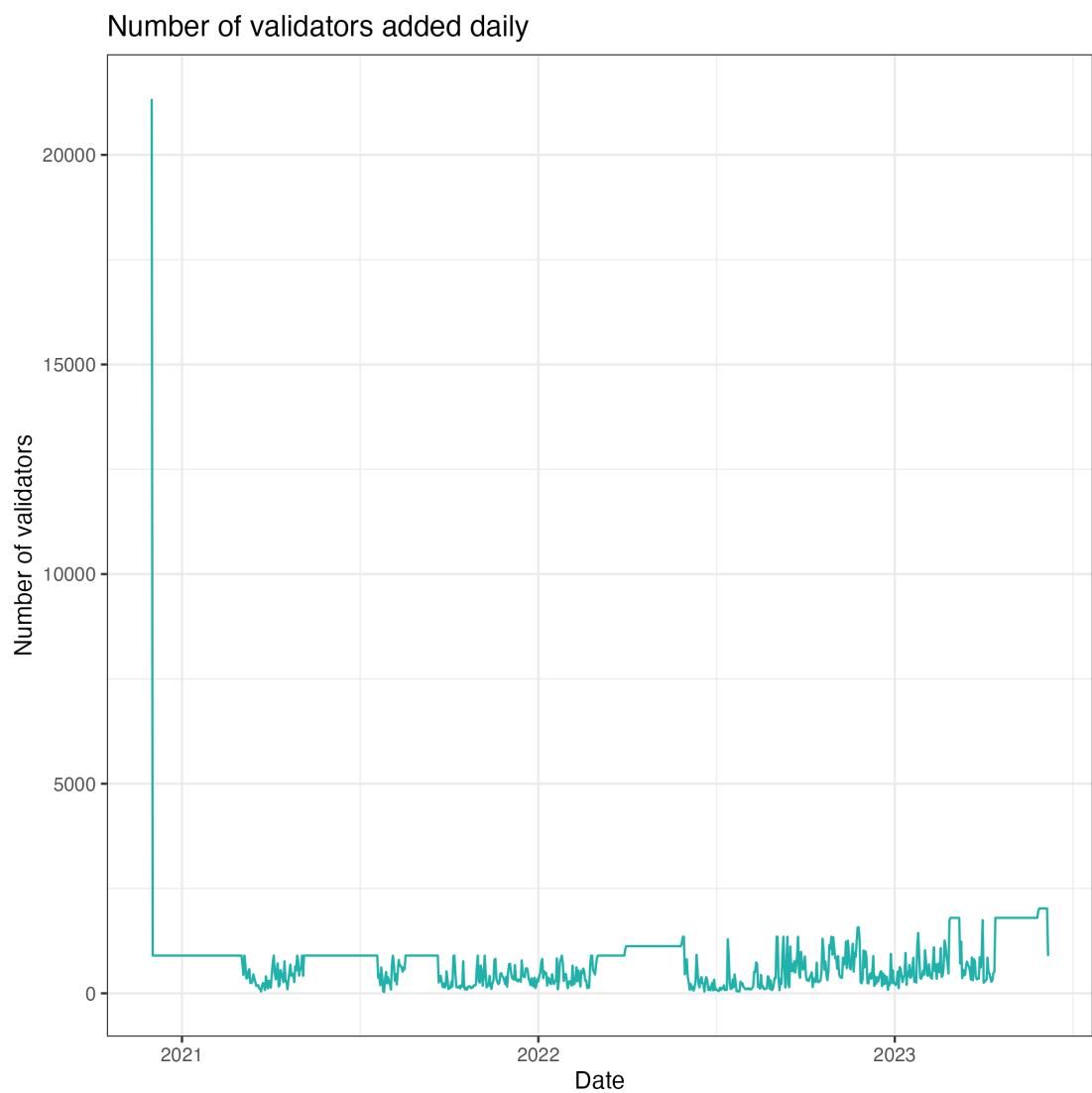


Figure 114: Number of validators added daily

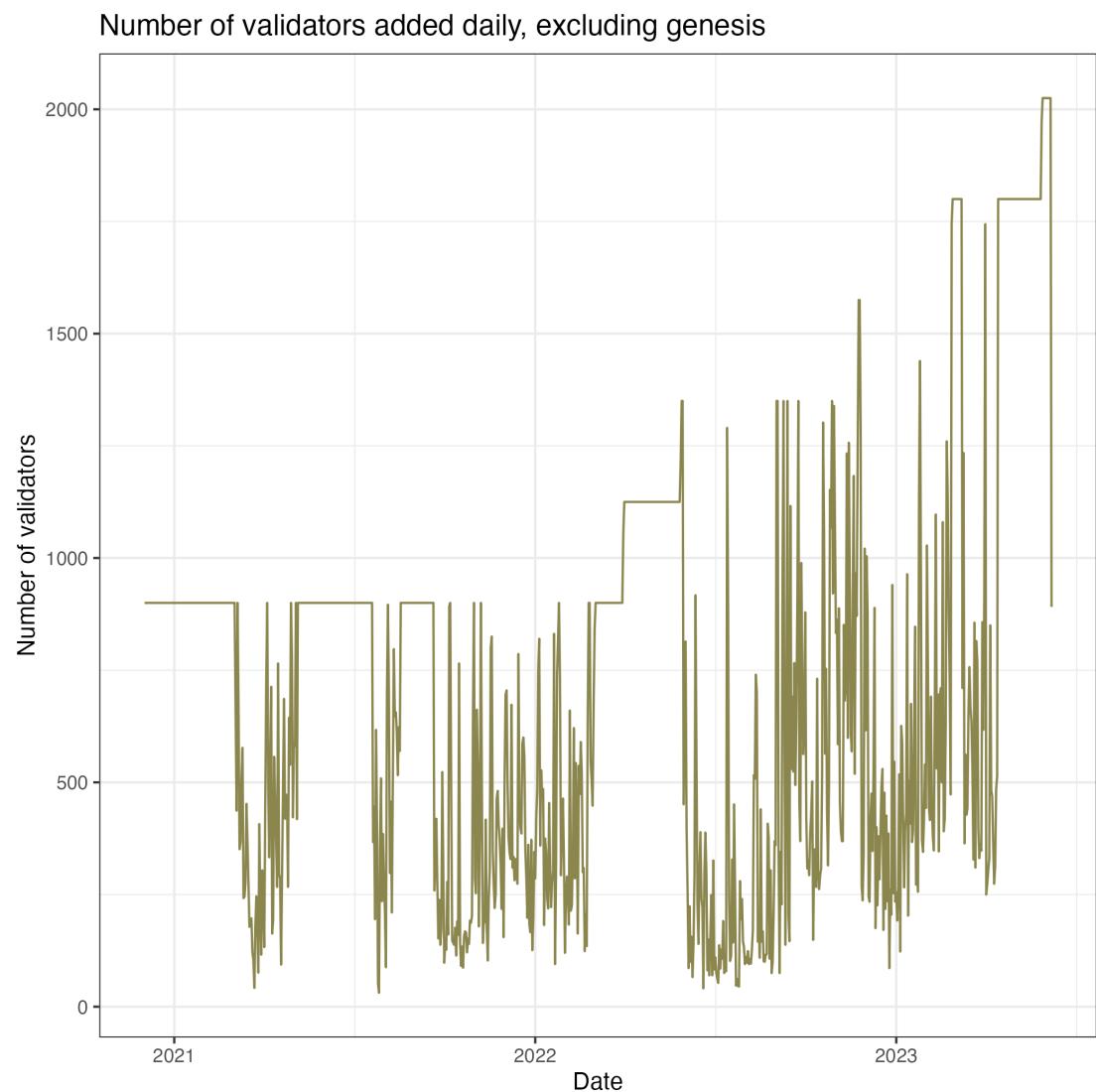


Figure 115: Number of validators added daily, excluding genesis

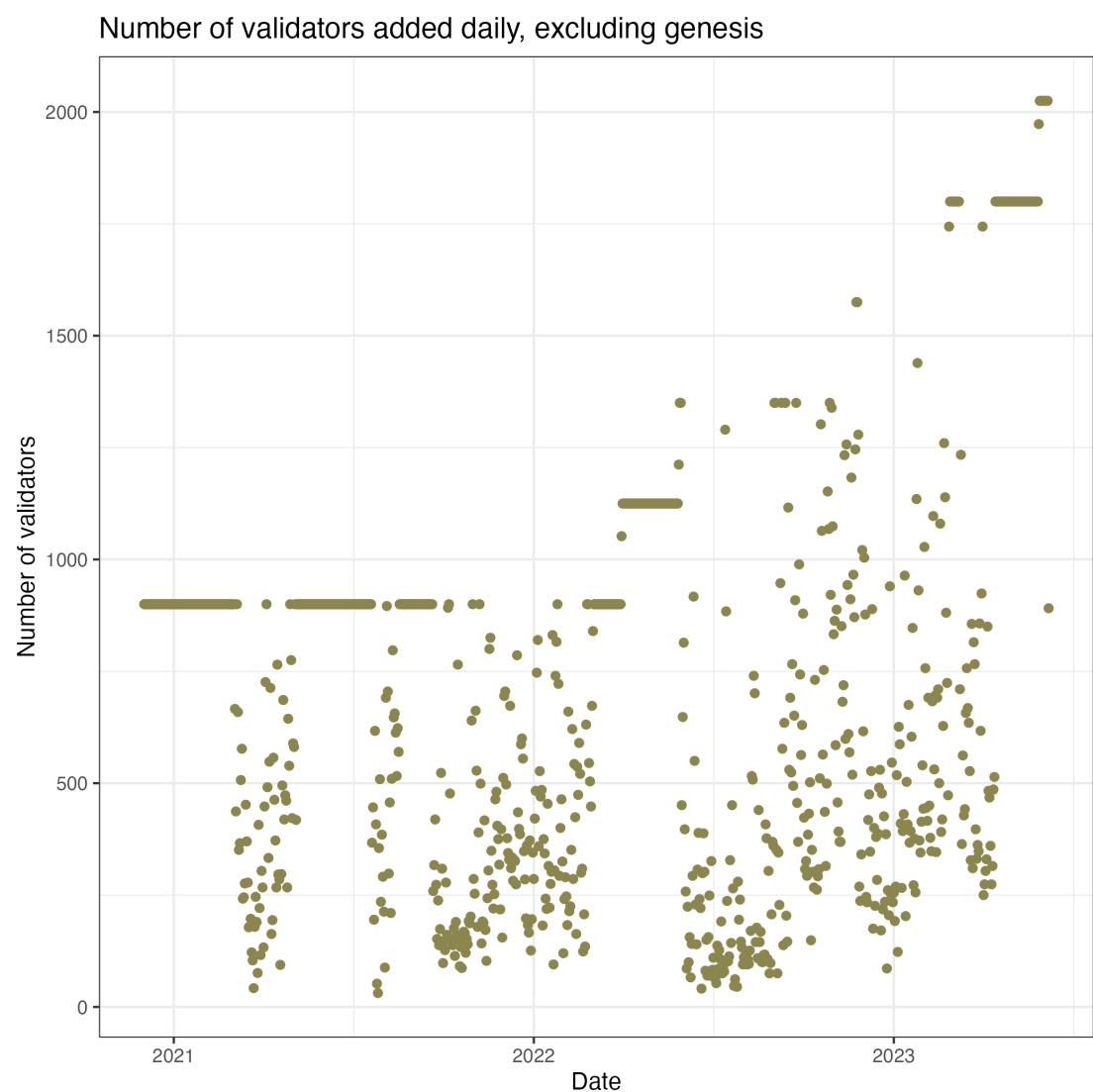


Figure 116: Number of validators added daily, excluding genesis

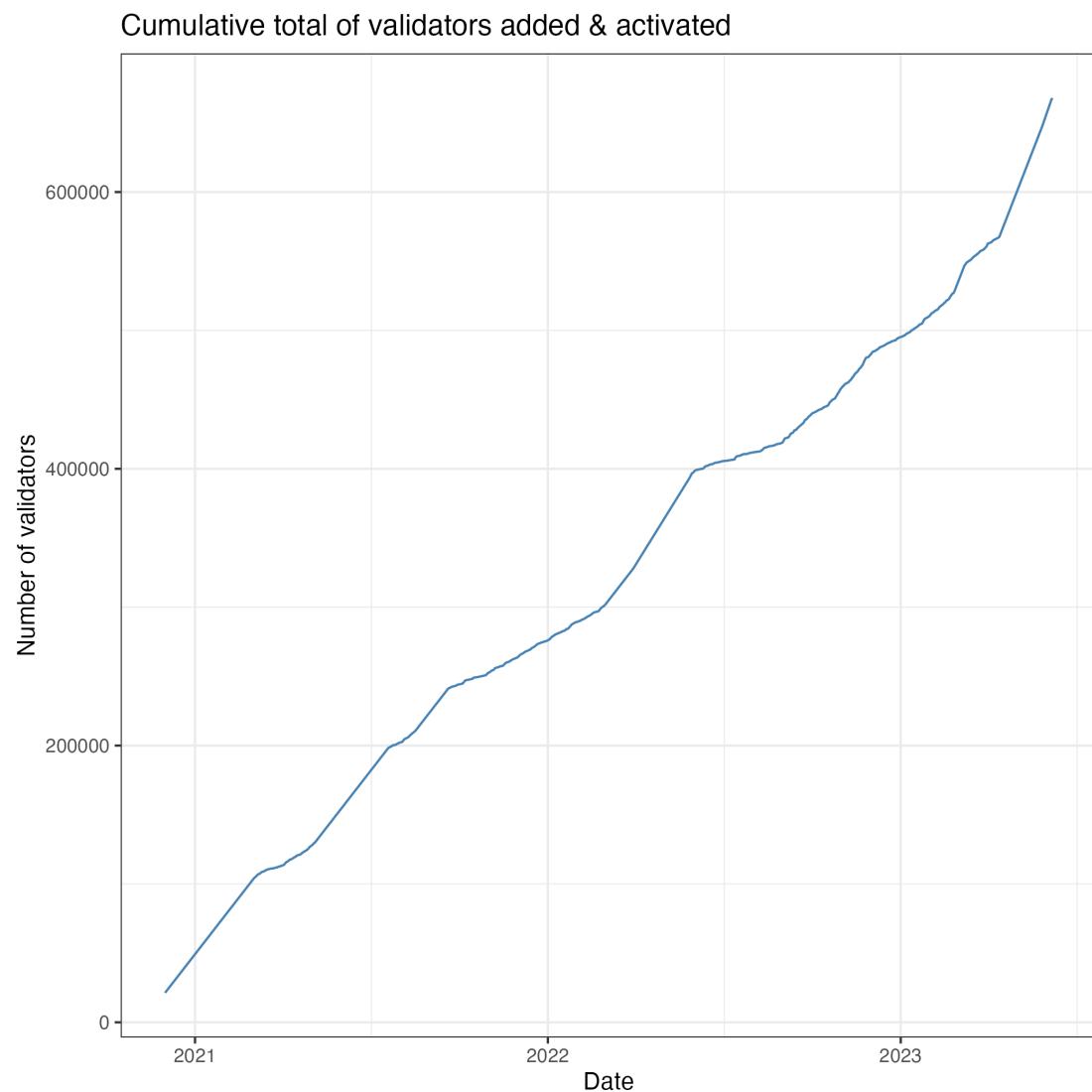


Figure 117: Cumulative total of validators added & activated

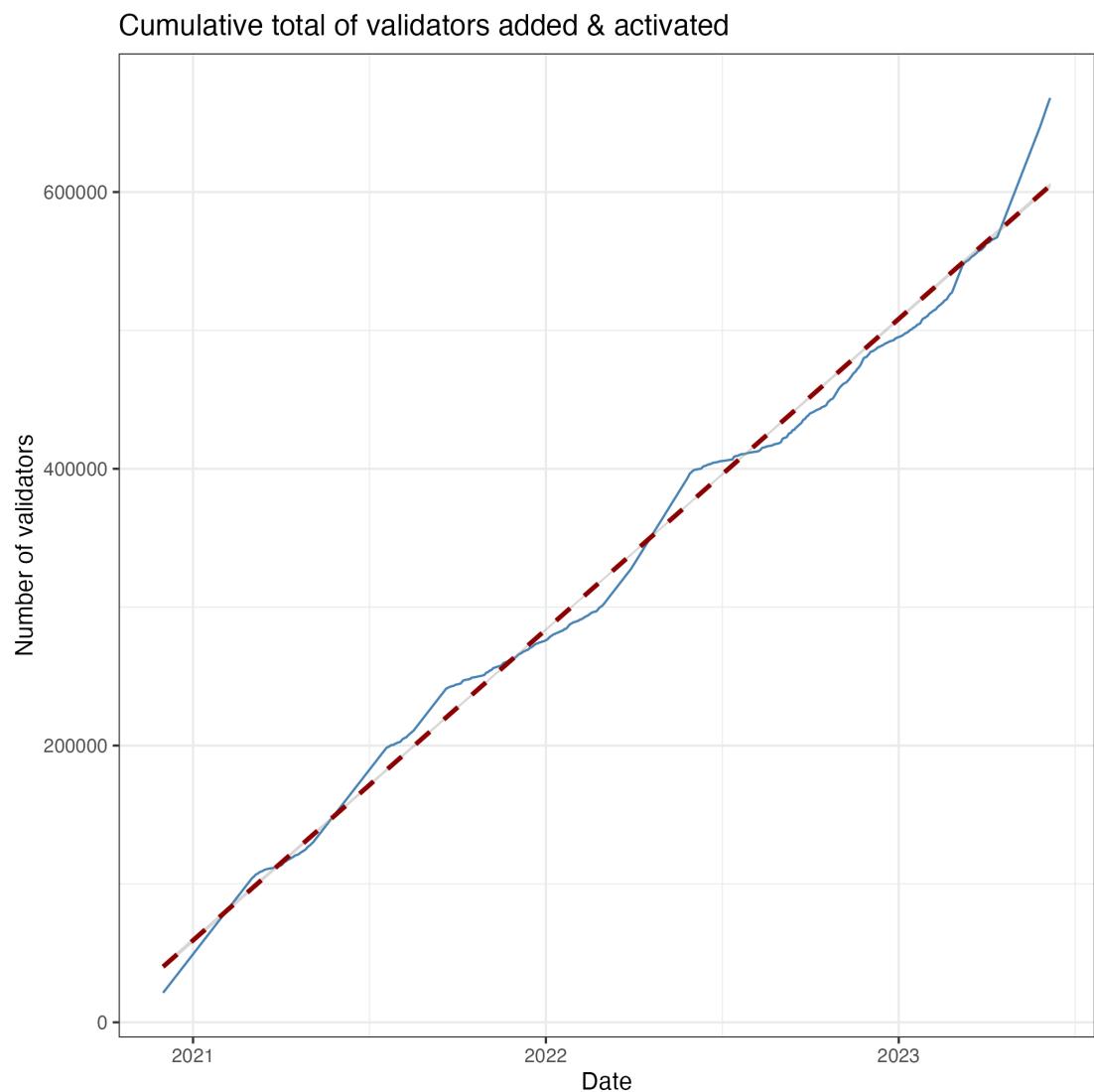


Figure 118: Cumulative total of validators added & activated with regression line fitted

3 Bibliography