Mandatory information on principal adverse impacts on the climate and other environment-related adverse impacts of the consensus mechanism

N	Field	Content
General Information		
S.1	**Name**	Zillion Bits Ltd
S.2	**Relevant legal entity identifier**	254900FESD7AF56FOQ37
S.3	**Name of the crypto-asset**	Toncoin (TON)
S.4	**Consensus mechanism**	The Open Network (TON) operates on a multi-layer Proof-of-Stake (PoS) consensus mechanism designed for scalability, security, and energy efficiency. TON utilizes a Byzantine Fault Tolerant (BFT) protocol, eliminating energy-intensive mining operations associated with Proof-of-Work systems. The network's validators stake TON tokens to secure the blockchain and validate transactions, with validator influence proportional to stake size. TON employs an adaptive dynamic sharding architecture, enabling the blockchain to automatically split or merge shardchains according to transaction load. This model provides horizontal scalability, while maintaining security through a distributed validator assignment across shards. Validators, randomly selected based on stake weight, propose and validate blocks, preventing dominance by any single entity. The consensus process involves randomly selected validators proposing new blocks, after which the wider validator network verifies and votes on their validity. Upon receiving confirmations from a supermajority (typically two-thirds), blocks become finalized and appended to the blockchain, safeguarding network integrity against malicious actors or technical faults. To further secure the network, TON applies strict slashing penalties for dishonest behavior or extended downtime, incentivizing honest participation and consistent validator availability. Validator nodes operate using standard server-grade hardware, significantly lowering environmental impact

		and energy consumption compared to traditional PoW-based blockchains.
S.5	**Incentive mechanisms and applicable fees**	Validator participation represents the primary economic mechanism securing the TON network. Validators must deposit stakes in the form of TON tokens to become eligible for block generation and validation. These stakeholders are then assigned to various shards in a deterministic pseudorandom manner. For each block, validators propose candidates, verify their validity, and reach consensus through an efficient Byzantine Fault Tolerant (BFT) protocol. Upon successful block generation, validators share the transaction fees included in the block plus newly minted tokens, creating a direct financial incentive for honest participation. The TON network incorporates robust economic security measures through its slashing mechanism. If validators sign invalid block candidates or engage in malicious behaviour, they face automatic penalties including partial or complete stake forfeiture, alongside potential temporary suspension from the validator set. This economic deterrent helps maintain network integrity by making dishonest behaviour financially prohibitive. A distinctive aspect of TON's economic model is its approach to storage fees. The system imposes costs for maintaining data in the blockchain's persistent storage, with each block declaring rates for cell and raw byte storage. These rates apply to account data, including smart contract code and persistent information. To prevent blockchain bloat, accounts must pay for storage usage, with payments collected when accounts become active. If an account's balance would become negative after storage payment deduction, the account is destroyed, encouraging efficient resource utilisation and compensating validators for maintaining network state. The messaging system between blockchains represents another fee-bearing mechanism in TON. Messages transfer value and information between accounts across shardchains, with each message potentially having cryptocurrency attached.
S.6	**Beginning of the period to which the disclosure relates**	2024-01-01
S.7	**End of the period to which the disclosure relates**	2024-12-31
	Mandatory key indicator on energy consumption	
S.8	**Energy consumption (kWh/year)**	1360236.33267

	Sources and methodologies	
S.9	**Energy consumption sources and methodologies**	The energy consumption methodology for the TON token integrates a multi-layered approach to estimate annualised electricity usage tied to network operations. The process begins by cataloguing the global validator infrastructure, including node count, hardware specifications, and operational uptime. Validator locations are mapped to regional energy grids using geolocation data from public blockchain explorers and node participation surveys. Hardware power demand is derived from technical specifications of common server-grade equipment, validated against manufacturer disclosures and third-party efficiency benchmarks. Energy consumption is calculated by aggregating the power draw of all active validators over time, adjusted for network load fluctuations and idle-state consumption. A critical assumption is that validators operate at peak efficiency during active validation cycles, with idle periods factored into annual uptime estimates. Data on regional electricity grids is sourced from the International Energy Agency (IEA) and the European Environment Agency (EEA), supplemented by national energy statistics where available. The methodology assumes uniform hardware profiles across validator cohorts unless location-specific data indicates divergent practices, in which case weighted averages are applied.

Supplementary information on principal adverse impacts on the climate and other environment-related adverse impacts of the consensus mechanism

	Supplementary key indicators on energy and GHG emissions	
N	**Field**	**Content**
S.10	**Renewable energy consumption (percentage of the total amount of energy used per calendar year)**	20.016624
S.11	**Energy intensity (energy used per validated transaction in kWh)**	0.00002

S.12	**Scope 1 DLT GHG emissions – Controlled (in t CO2eq per year)**	0.00000
S.13	**Scope 2 DLT GHG emissions – Purchased (in t CO2eq per year)**	461.46359
S.14	**GHG intensity (emissions per validated transaction in kg CO2eq)**	0.00001
	Sources and methodologies	
S.15	**Key energy sources and methodologies**	The energy mix analysis prioritises transparency in tracing electricity sources to their generation origins. Validator locations are cross-referenced with regional grid composition data from intergovernmental databases, such as the IEA's World Energy Balances and the United Nations Framework Convention on Climate Change (UNFCCC) emissions inventories. Renewable energy penetration rates are determined using country-level reports from the International Renewable Energy Agency (IRENA) and the Global Wind Energy Council (GWEC). For regions lacking granular data, the methodology applies default grid mixes based on the World Bank's Energy Sector Management Assistance Program (ESMAP) profiles. A key assumption is that validators procure electricity proportionally to their geographic distribution, with no preferential access to renewable energy contracts unless verified through public disclosures. The renewable share is expressed as a percentage of total consumption, incorporating adjustments for temporal variations in grid composition (e.g., seasonal hydropower availability).
S.16	**Key GHG sources and methodologies**	Greenhouse gas (GHG) emissions are quantified using a location-based approach, aligning with the GHG Protocol's Scope 2 guidance. Emission factors for electricity generation are sourced from the EEA's CO_2 Intensity of Electricity Generation reports and the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID). Regional factors are weighted by validator distribution, with cross-border electricity trading accounted for via ENTSO-E transparency platform data. The methodology assumes validators lack direct control over energy sourcing (e.g., no verified power purchase agreements), necessitating reliance on grid-average emission factors. Methane and nitrous oxide emissions from fossil fuel-based generation are included using IPCC Tier 1 coefficients. Uncertainties arising from incomplete validator

		location data are mitigated by applying conservative estimates from the IEA's Global Energy Review. The results are presented as annual CO_2-equivalent emissions, with a clear distinction between Scope 1 (direct) and Scope 2 (indirect) contributions, though Scope 1 is typically negligible for PoS networks.