
energyweb

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About EWF: Energy Web Foundation (EWF) is a global, non-profit organization, promoting and developing new technologies and applications, especially in the fields of new open and decentralized software architectures, with a focus on the promotion and development of the Energy Web Platform. Not to be confused with the Energy Web network governance and operation, which is decentralized, currently evolving from validators to all token holders and a multitude of other operational and supporting bodies and functions, such as Collators and Nominators. For more, please visit https://energyweb.org

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- The Energy Web Token may lose its value in part or in full. You may lose the entire amount you invest; crypto-assets can be extremely volatile.
- The Energy Web Token is not covered by deposit guarantee or investor compensation schemes.
- Transferability and liquidity of the Energy Web Token are not guaranteed; there may be no or limited secondary market.
- Using the crypto-asset, including the Energy Web Token, may have tax implications.
- Technology and operational risks (including smart contracts, bridges, keys) may cause loss or unavailability of the Energy Web Token.
- The Energy Web Token does not entitle its holder to any ownership, profit, or dividend rights.
- The Energy Web Token may not be exchangeable against any goods or service described in this Yellow Paper, especially in the case of failure or discontinuation of goods and services that use the Energy Web Token.

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Executive Summary

In 2025, a decentralised global network of publicly known and geographically diverse, energy sector-focused entities, serving as validators governing and operating the Energy Web blockchain platform approved a technology and governance upgrade that transforms the platform from a public but permissioned proof-of-authority to an open, public and permissionless, nominated proof-of-stake network. The Energy Web technology platform now leverages on-chain governance powered by blockchain (Energy Web X - EWX) and Verified Compute Cloud (VCC), an innovative, AI-optimised off-chain business logic computation with on-chain finality, supporting verification, automation and auditability for sustainable, mission-critical enterprise solutions.

The Energy Web platform is operated by (i) Chain Collators, parachain validators, which collect user transactions to produce parachain blocks (state transition proofs), maintaining a distributed network consensus; (ii) Nominators that support the network security by assigning stake to validators, sharing in the staking rewards but also bearing the risk of losing their stake (slashing) if the validator they nominate malperforms, and (iii) Polkadot Relay Chain Validators that verify the validity of blocks produced by EWX Collators, further buttressing the EWX network security. Other prominent participants are decentralised solution (dApp) providers and their users.

EWT, the Energy Web Token, is a native first-layer utility token used to access decentralized digital services of the Energy Web platform. It does not grant ownership, profit, or dividend rights. EWT was not and is not marketed to the public, which aligns with MICA's regulation and FINMA's utility-token regulatory guidance. EWT serves several utility functions, including supporting network security, serving as means of payment for diverse dApps (in addition to other tokens enabled by multichain interoperability), and enabling governance and treasury allocations for all EWT token holders. With the 2025 Upgrade, in addition to deployment on the Polkadot network, EWT is also deployed as ERC-20 (not wrapped) representation on Ethereum for broader access. The initial supply of EWT ERC-20 deployment mirrors the legacy minted supply at the August 2025 supply freeze on EWC (minting disabled), preserving 1:1 conservation across networks (locked conversion). No new tokens are issued upon upgrade. The lifetime EWT supply cap, approved by validators at the EWC launch, remains 100,000,000 EWT, delimiting any and all EWT issuance. Post Upgrade, staking reward is issued automatically at preset intervals by the Energy Web Bridge, a native protocol that enables communication, token transfer and data exchange between the Ethereum and the Polkadot network. EWC-EWX mobility is limited to one-way token flow, facilitating token lift to the upgraded network version. There is no direct EWC-Ethereum bridge and no unilateral action can alter the network's functionality. Additional technology milestones include enabling low-cost, standardized EWT operations across the Polkadot network via Polkadot Asset Hub, expanding ease of asset acceptance and conversion via BYOT facility, liquid staking, and further enhancements towards interoperability, security and on-chain governance.

1. Introduction

This document elaborates the Energy Web 2025 technology architecture and governance model, including security, compliance, and risk management measures, The document has been prepared by the Energy Web Foundation (EWF), a Swiss nonprofit foundation registered in 2017 pursuant to Swiss Civil Code with a mission to promote and develop new technologies and applications, especially in the fields of new open and decentralized software architectures. Energy enterprises worldwide have deployed solutions on Energy Web technology, validating its real-world applicability. A network of distributed validators has operated and governed the Energy Web blockchain platform, while EWF provides administrative technical support and significantly contributes to the development of a shared technology infrastructure.

At the launch of the Energy Web Chain (EWC) in 2019, the platform validators, predominantly consisting of global energy industry entities, approved the creation of 100 million EWT as well as an initial plan for the distribution of such EWT by a set of on-chain smart contracts. At this time, 21.2 million EWT were allocated to 102 entities (including some individuals) from different regions of the world that provided funds to the EWF to develop the blockchain platform, many of whom became members and continued to support and co-create decentralised applications (dApps) tailored for the energy industry and enterprise decarbonisation. All were accredited entities, subjected to a KYC/AML review, and were required to agree to a lock-up in order to purchase EWT. Additional funding was earmarked to EWF, including the operational team, EWF Founders and for further development. The EWC 2019 launch ensued after a period of dedicated research, development and testing, including support to the first Proof-of-Authority (Kovan) blockchain network and the establishment of Volta testnet, and it was followed by further innovation, governed by EWC validators. The Energy Web vision was first elaborated in the 2018 White Paper titled The Energy Web Chain: Accelerating the Energy Transition with an Open-Source, Decentralized Blockchain Platform. The ecosystem grew and multiple applications were deployed, ranging from renewable energy certificate platforms to grid balancing and other solutions. The 2023 launch of EWX as a Polkadot parachain was a technical milestone enabling the roll-out of features in the current upgrade. In August 2025, the critical Zurich Hard Fork on EWC was executed by the validators, evolving the core platform from a public but permissioned proof-of-authority blockchain (EWC) to a public and permissionless, nominated proof-of-stake network (EWX), freezing the EWT token supply and paving its migration to multichain utility, starting with ERC-20 standard implementation on Ethereum. Today, the Energy Web platform leverages on-chain governance powered by blockchain (Energy Web X - EWX) and Verified Compute Cloud (VCC), Energy Web's innovative, AI-optimised off-chain business logic computation with on-chain finality, supporting verification, automation and auditability for sustainable, mission-critical enterprise solutions.

2. Energy Web Technology Architecture Overview

Energy Web's upgraded technology architecture consists of two primary layers – the **core blockchain layer (Energy Web X)** and the **Verified Compute Cloud**, off-chain business logic computation layer (VCC) – jointly termed Energy Web technology platform (or Energy Web platform), complemented by interoperability interfaces, including cross-chain bridges and token abstraction mechanisms for an enhanced user experience and thereby higher technology and token utility, as illustrated in Figure 1:

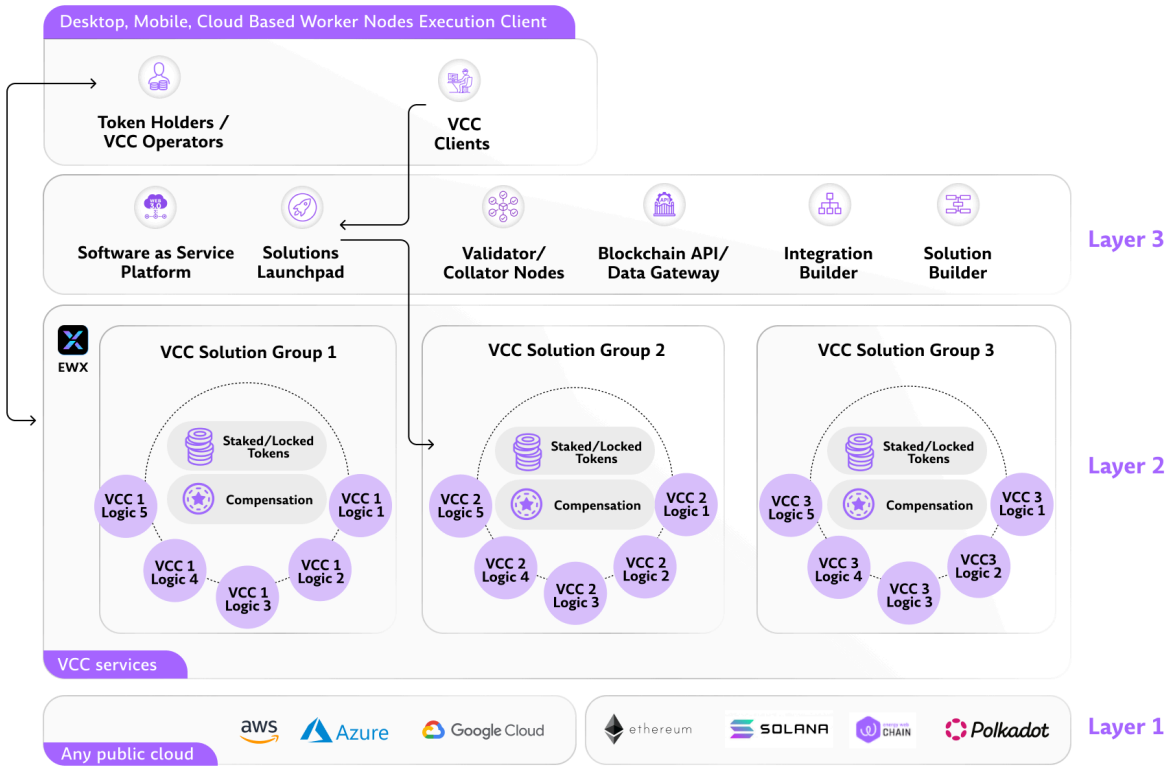

Figure 1: Energy Web Platform High Level Architecture (2025)

2.1 Energy Web's technology platform **design principles** integrate cutting-edge innovation and lessons learned from real-world deployments:

- Programmable Execution Guarantees: Provide automated, auditable and enforceable execution of off-chain business logic with on-chain finality. The system is built to ensure that if multiple parties engage in a complex workflow (e.g. balancing an electrical grid or verifying carbon credits), the rules are followed and any deviation triggers transparent on-chain consequences (service remuneration or penalties).
- Open Governance Participation: Transition from a permissioned public network to an open, permissionless public network.

- Governance Transparency and Community Control: Implement on-chain governance so that network upgrades, parameters, and treasury allocations are decided by token holders rather than a set of approved validators.
- Regulatory Compliance by Design: This entails a fixed EWT token supply cap (no uncapped issuance), on-chain auditable token movements (bridges and any new token issuance are transparent), with clearly defined token utility (avoiding any implication of profit-sharing), and full alignment with MiCA disclosure standards and FINMA's utility token criteria. The platform also incorporates optional identity and permissioning features (without compromising decentralization) as ancillary technical solutions to meet jurisdictional legal requirements for diverse applications.
- Chain-Agnostic Utility & Interoperability: Recognizing that enterprises and users wish to access multiple blockchain ecosystems (Ethereum, Polkadot, etc.). Energy Web's solution is not tied to a single chain; instead, bridges and bring-your-own-token (BYOT) functionality allow value flow across chains.
- Enterprise-Grade User Experience: Lowers the barriers for businesses to use the platform by abstracting blockchain complexity.

2.2 Energy Web X (EWX) is a **Substrate-based blockchain (Polkadot parachain).** Whilst EWX has been operational since 2023, the original Energy Web Chain (EWC), launched in 2019, was available in parallel. With the 2025 upgrade, EWC will operate in archive mode, transferring governance and all functionality to EWX as the Energy Web technology backbone for network security, on-chain governance, and cross-chain interoperability. Key features of EWX include:

- **Nominated Proof-of-Stake (NPoS) Consensus:** EWX uses a PoS-style collator selection pallet: collators produce parachain blocks and nominators back select collators/validators with stake. Finality is provided by Polkadot's Relay Chain validators that verify the validity of blocks produced by EWX Collators, further buttressing the network security.
- **On-chain Governance and Treasury:** EWX implements Polkadot's Open Governance (OpenGov) model governance framework, enabling any token holder to propose referenda on upgrades or parameter changes.
- **Built-in Modules (Pallets):** EWX includes custom pallets for core functionalities (over time, these pallets may evolve into smart contracts, adapting to the blockchain programming advancements):
    - **Worker Node Network Pallets:** manage the Verified Compute Cloud operators registry, staking, task attestation (business logic / workflow definition), and communicating finalization logic for on-chain validation.

- **Bridge Pallets:** enable native bridging for EWT, with lock/unlock on layer one blockchains (initially EWC and Ethereum) and corresponding mint/burn on the EWX parachain.
- **BYOT Pallets:** handle cross-chain asset acceptance and conversion logic for remuneration in non-EWT tokens.

- **Bridges and Topology** (illustrated in Figure 2):
  - Terms used:
    - Lift = move tokens into EWX (lock on source chain and mint on EWX).
    - Lower = move tokens out of EWX (burn on EWX and unlock on the destination chain).
  - Before ERC-20 activation, EWC ↔ EWX follows a two-way:
    - Lift (EWC → EWX): lock on EWC → mint on EWX.
    - Lower (EWX → EWC): burn on EWX → unlock on EWC.
  - After ERC-20 activation:
    - EWC → EWX is one-way token flow (lift only; no lowering back to EWC).
    - EWX ↔ Ethereum is two-way communication flow:
      - Lift (Ethereum → EWX): lock the ERC-20 EWT in the Energy Bridge escrow on Ethereum and mint EWT on EWX.
      - Lower (EWX → Ethereum): burn EWT on EWX and unlock the ERC-20 EWT on Ethereum.

This topology preserves a single, unified supply across networks, keeping supply control under EWX governance, and enabling a safe phaseout of legacy EWC while consolidating activity and liquidity on EWX and Ethereum.

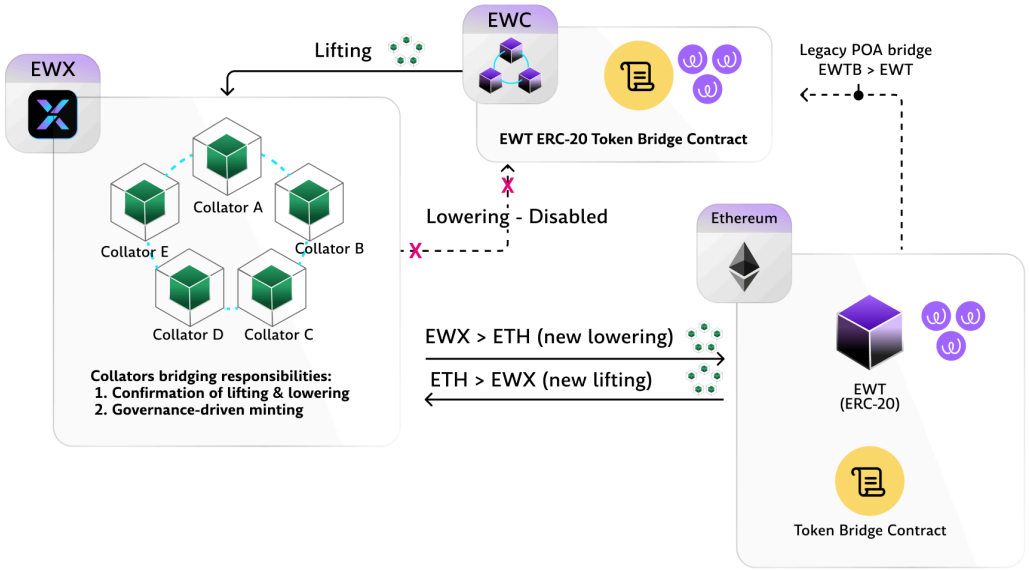

Figure 2: Energy Web Bridge Topology (EWC, EWX, Ethereum interoperability)

- **Interoperability Across Blockchains:** As a Polkadot parachain, EWX benefits from Polkadot's **shared security** and can use **XCM (Cross-Consensus Messaging)** to interact with other chains in the ecosystem.
- **Smart-Contract Compatibility & EVM Support:** EWX will expose EVM-compatible interfaces and tooling regardless of the underlying execution approach by providing Ethereum-compatible smart-contract support via a pluggable execution layer. EWX guarantees RPC parity, predictable gas/weight mapping, and stable precompile interfaces into VCC, Bridge, and BYOT modules, with optional fee abstraction in non-EWT tokens via BYOT.

2.3 Verified Compute Cloud (VCC) Service has been developed by the Energy Web Foundation as a blockchain layer 2 solution for off-chain business logic computation, complementing and interacting with EWX for on-chain finalization. Key VCC aspects include:

- **Verified Compute Cloud Solution Groups (VCG)** comprise VCC Operators and Stakers providing a service pursuant to a select VCC Protocol determined by the VCC Client.
- **VCC Clients** are users of the VCC service that determine the VCC Protocol and pay for the service.
- **VCC Operators:** Independent, distributed node operators technically leveraging Energy Web's Worker Node Pallets, opting in to execute tasks defined by a given business logic (e.g. computing an energy load forecast or validating a batch of renewable energy certificates), communicating the outcome for subsequent on-chain verification and finalisation pursuant to a pre-agreed set of rules (VCC Protocol).
- **VCC Stakers:** EWT token holders providing a slashable collateral as a service to support the enforcement of VCC Protocol requirements. This service does not confer ownership, revenue rights, nor does it guarantee yield.
- **VCC Protocol:** Each registered VCC solution comes with a deterministic business logic specification that defines both the computation tasks and the rules for participation and achieving consensus on results; for instance, the rules may include:
    - Required stake per VCC operator, acceptable identities or certifications for data management (if any),
    - Number of VCC operators that need to agree (quorum threshold like majority or supermajority),
    - Time windows for task execution and result submission,
    - Fee for successful execution and penalties for faults/disagreements, etc.
- **Verifiable Execution and Attestation:** When engaged for a select solution, multiple VCC operators execute the same task in parallel, to ensure multi-party redundancy. For AI/ML computations, this provides cross-validation; independent VCC operators must converge on the same result. Each VCC operator produces an attestation of the

result, which could be a full computation outcome or a cryptographic commitment like a hash or Merkle root of the outcome. These attestations are submitted on-chain to EWX within a defined time period.

- **On-Chain Tally and Finality:** The EWX chain records and tallies the attestations. If a quorum or consensus is reached based on the predetermined protocol, the result is considered final and recorded on-chain. At that point, fees are paid out to performing, protocol-abiding VCC operators (and possibly to the party that requested the computation if the outcome has wider benefits), and penalties/slashing are applied to VCC operators that malperformed and produced deviations (e.g., reported an incorrect result or failed to report). The final on-chain event can also trigger next steps in a broader workflow (e.g., releasing a certificate or payment).
- **Dispute Resolution and Process Security:** The multi-operator (or multi-node) VCC design ensures security by redundancy – even if one or several VCC operators are faulty or malperforming, as long as a supermajority is performing, the correct outcome prevails. For highly critical tasks, the quorum can be set to unanimity or include additional verification steps. Optional challenge periods or dispute resolution hooks can be built in, though the preferred model is to have objective computation that does not require subjective dispute resolution. In comparison to non-blockchain alternatives, this mechanism avoids a single point of failure and mitigates malicious acts, whilst compared to other blockchain computation alternatives. Verified Compute Cloud does not rely on specialized hardware (as Trusted Execution Environments do), nor does it require heavy on-chain computation or validity proofs as with zero-knowledge proof cryptographic protocols. Instead, VCC leverages economic incentives and redundancy to cover a broader range of off-chain actions efficiently and securely, including workflows involving external data, timing, and real-world effect.
- **Data Privacy and Security:** VCC solutions can be designed such that sensitive data is not broadcast on-chain, but only hashes, anchoring proofs of what was agreed upon or computed. Furthermore, identity requirements (using decentralized identifiers, etc.) can be imposed to regulate data access. Finally, as with all digitisation tools, data anonymisation and encryption may be deployed to further secure data.

In summary, the Energy Web technology architecture is **modular** and **interoperable**: a Polkadot-based chain for core ledger and governance, a flexible off-chain business logic computation layer for extending trust outward, and connectivity to other ecosystems to ensure wider functionality and applicability.

3. EWT Token Economics

Energy Web Token (EWT) is a **native first-layer utility token**, used to access decentralized digital services of the Energy Web platform, including participation in network governance and security. It does not grant ownership, profit, or dividend rights. Post 2025 upgrade, EWT circulates as an **ERC-20 token on Ethereum mainnet** (for broad accessibility) in addition to circulating on EWX (for staking and operations), with two-way token flow via the bridge. EWT is the universal token for this interoperable, multichain system, avoiding double accounting and maintaining the total supply cap.

3.1 Roles and Utility of EWT: EWT is a **utility token** that fuels and secures the Energy Web platform. Its functions include:

- **Unified Token across Chains:** EWT exists simultaneously on EWX and Ethereum (and any residual on EWC until EWC deprecation) and always as the **same asset**. The applied bridging logic guarantees **1:1 equivalence and conservation of supply** across networks. For example, if 10 million EWT are on Ethereum and 50 million on EWX (with the rest locked on EWC), the total EWT circulation is ~83 million, and that cannot change except by a token mint up to the approved cap. Publicly available token tracking dashboards and on-chain data records allow verification of these balances.
- **Transaction Fees (Gas Fees):** EWT is used to pay transaction (gas) fees on EWX both for smart contract execution and standard transactions. These fees either compensate the Collators for processing transactions and/or are allocated to the treasury, pursuant to predefined parameters approved by on-chain governance. Staking for Chain Operational Security: EWX's chain validators (Collators) and their Nominators earn staking rewards in EWT for securing the network's nominated proof-of-stake (NPoS) consensus. These rewards initially come from two sources: network transaction fees and any additional, governance-authorized issuance from the headroom below the fixed cap. Staking rewards are parameterised by governance and may change over time; no specific rate is promised. This approach jump-starts security incentives without exceeding the EWT supply cap.
- **Verified Compute Cloud Operation:** EWT is locked and staked by VCC operators to guarantee their performance in off-chain business logic computational tasks. Successful task execution yields EWT remuneration fees (paid by the solution provider for which tasks are executed or from the network emissions if the work flow benefits a wider, shared cause), whereas faulty execution can lead to slashing of the locked tokens as stake. Solution providers assigning VCC tasks (VCC clients) can also explicitly require VCC operators to commit EWT stakes and can denominate remuneration fees in EWT, or another token by using BYOT (see more below).

- **Access to Services:** In general, EWT is required to access decentralized services on the Energy Web platform. For instance, to deploy a smart contract on EWX requires paying gas fees in EWT, or to participate in certain identity-verified actions one might need to hold a certain amount of EWT, etc.
- **Governance:** Holding EWT confers the right to participate in on-chain governance. **Bridging and Interoperability:** EWT acts as the medium for value transfer across Energy Web's connected chains. For example, if an enterprise starts with EWT on Ethereum, they can bridge it to EWX to use in staking or paying fees, and vice versa.
- **Bring-Your-Own-Token (BYOT):** To render the platform more accessible for those who hold other tokens, EWX facilitates that additional tokens be used, such as for example USDC for any VCC service fees payable to VCC operators. Initially, the BYOT function is to be limited to Polkadot Asset Hub tokens via XCM.

EWT does not convey any ownership rights, dividends, or profit share in any organization. It is not a debt instrument, nor does it entitle holders to any guaranteed return. Its value may rise or fall based on adoption and demand for the network's services. Holders have the right to use EWT as described (participate in Collator/Nominator security functions, access services by paying fees, vote, etc.) and the obligation to abide by network rules (e.g., if staking, one must accept the slashing conditions).

3.2 Fixed Supply and Issuance Policy: Energy Web adheres to a fixed-cap token model to ensure predictability and scarcity. The maximum supply of EWT is 100,000,000 (one hundred million) tokens. The path to enforcing this cap involves a coordinated migration in 2025:

- **Zurich Hard Fork (Locking Legacy Supply):** In August 2025, the EWC legacy chain executed a blockchain technical upgrade termed the "Zurich Hard Fork" which fully transferred the Energy Web platform governance from EWC to EWX and **halted all new block rewards**, effectively freezing the EWC chain's supply at **83,261,028.5549297 EWT** (approximately 83.26 million). This figure became the initial circulating supply baseline for the new system. No further EWT were created on EWC after this point; any remaining block reward schedule was canceled.
- **ERC-20 Deployment on Ethereum:** Following the freeze, a **new ERC-20 contract** for EWT was deployed on Ethereum. Exactly **83,261,028.5549297 EWT** (ERC-20-wrapped) were minted on Ethereum, equal to the fixed minted supply on EWC at the time of the freeze. To preserve 1:1 conservation across ledgers, an amount equal to the EWT already outstanding on EWX is held in the Energy Web Bridge escrow on Ethereum at initialization; the remainder is freely circulating on Ethereum. These ERC-20 tokens are considered **native EWT**, since Ethereum now hosts the canonical ERC-20 contract for EWT. This operation did not impact or require migration of any holder's balances; it simply relocated them; e.g., if a user held EWT on EWC, these can now convert to the ERC-20 version on Ethereum via the native bridge with

no dilution. Concurrently, **on legacy EWC, only total supply was frozen**; accounts can still perform transfer and lock their EWTs to receive them on EWX parachain (one-way bridge).

- **Governance-Controlled Headroom:** The difference between the EWT token cap (100M) and the initial supply (~83.26M) is about **16.74M EWT** of **headroom**. These tokens do not exist yet; they are the maximum that could be minted in the future, **only via on-chain governance approval**. In other words, there is **no automatic inflation**. Instead, the community can decide to mint new EWT (up to the cap) for specific purposes like funding the treasury, providing staking rewards, or other network needs. Any such decision will require a formal governance referendum and, if approved, results in a transparent on-chain mint event. The **minting process** post-approval is the following:
    1. The approved amount is **minted on Ethereum** (the authoritative ledger for token creation after the migration).
    2. Those tokens are then immediately **bridged (lifted) into EWX**, meaning they get locked on Ethereum and minted on EWX.
    3. The tokens are then **distributed according to the governance motion**; e.g., transferred to the on-chain treasury account or drip-released to Collators as additional staking incentives.
- This process ensures full auditability, since each new token is traceable to a governance proposal ID and cannot exceed the authorized amount. The chain's code will reject any mint that would push the total token supply above 100M.
- **Governance-Authorized Issuance for Staking Incentives (Within Cap):** As part of the 2025 Upgrade, a portion of the headroom has been dedicated to bootstrap NPoS. Future motions may allocate a portion of the available headroom to fund staking rewards and all such issuance is bound by the 100 million cap and can be adjusted, paused, or discontinued. No specific rate or duration is committed, and it will be regularly reassessed. The token could transition to a fully fixed supply (zero issuance) earlier, or the community might continue a minimal issuance beyond that with broad consensus by repurposing some tokens from one intended use to another. In summary, EWT's supply is capped and mostly static, with a small, governed issuance possible to support network growth, unlike a multitude of other cryptocurrencies with ongoing issuance.
- **No New Token Offering:** It is emphasized that the 2025 technology upgrade EWT migration did not involve a public sale or an Initial Coin Offering (ICO). Since there was no exchange of tokens for capital raising, and no change in the token's fundamental utility, the migration is unequivocally considered a technical change This also means **no dilution** occurred to holders; their share of the maximum token supply remains the same.

3.3 Staking and Slashing Mechanisms: Participating in platform security comes with both incentives and risks and involves the following roles:

- **Collators** must provide a self-bond (minimum EWT stake) and can also gather backing from Nominators. Collators earn block rewards and a portion of transaction fees, and potentially also additional rewards from governance-minted allocations (as described above). If a Collator malperforms (e.g., double-signs conflicting blocks or stays offline extensively), a portion of their stake (and their Nominators' stake) is slashed. Slashing is calibrated to the level of malperformance, such that equivocation (presenting conflicting or inconsistent information) might incur a higher slash than mere downtime. Slashing not only penalizes malperformance but also helps keep the system safe by economic deterrence. The network governance can adjust staking parameters like reward rate, slashing percentages, and validator set size if needed.
- **Nominators** share in the rewards of the Collator (minus the Collator's commission) and also share in any slashing penalties if that Collator is penalized. Therefore, Nominators are incentivized to choose Collators who perform well and act in accordance to the set rules.
- **Verified Compute Cloud (VCC)** operators stake EWT when registering for a particular computation. The VCC protocol can define various malperformance outcomes that would be penalised e.g. submitting a wrong result (detected by being in minority), failing to submit a result on time, or other protocol violations. If those occur, the VCC operator's stake is partially or fully slashed as per defined workflow rules. The slashed amount might go to an affected party or to the treasury, depending on context. In contrast, and occurring more regularly, if the VCC operator performs correctly and the job finalizes successfully, the operator stake remains plus a VCC service fee payout.
- **Liquid Staking (stEWT)** allows EWX users to stake EWT without locking it, by depositing into a pooled nominator managed by the Liquid Staking Pallet and receiving liquid stEWT in return. stEWT stays fully transferable and usable across the ecosystem, including for participating in Verified Compute Cloud groups (VCGs), while continuously accruing staking rewards. Those rewards are automatically restaked, increasing the stEWT:EWT exchange rate over time without minting new tokens. This simplifies the staking process for users, removes the need to manage delegations and restake rewards while compounding utility, safeguarding network security and avoiding excessive concentration of stake. stEWT will remain bound by the overall EWT supply cap.

4. Governance and Upgrade Process

Energy Web's governance has transitioned from a permissioned validators-led approach (2019–2022, where a set of validators representing diverse energy sector stakeholders decided on upgrades) to a community-governed on-chain model that opens the governance to any EWT token holder, including a public debate on governance proposals. The aim is to achieve a governance system that is transparent, accountable, and resistant to capture, while retaining sufficient efficiency to manage a mission-critical blockchain and support development of decentralised enterprise solutions.

4.1 On-Chain Governance (OpenGov): The governance framework on EWX shall draw from Polkadot's OpenGov model, which is continually evolving to embed best practices:

- **Referendum-Based:** Any change (runtime upgrade, monetary policy change, parameter tweak, treasury spend, etc.) is to be done through a referendum where all EWT holders can vote.
- **Stake-Weighted Voting:** Votes are weighted by the amount of EWT and the **conviction** (how long the voter is willing to lock their tokens after voting). Longer lock-up periods signal stronger conviction.
- **Multiple Tracks:** Proposals are categorized. For instance, a Root track for critical upgrades, a Treasury track for funding proposals, an Emergency track for urgent flawed code fixes, etc. Each track can have its own voting threshold (majority, supermajority) and timeline based on the impact of decisions. Tracks can additionally be curated by selecting framework development priorities that support the development of solutions for the energy transition.
- **Decision Deposits and Fellowship:** To avoid spam, proposing a referendum may require depositing a certain amount of EWT (refunded if the proposal passes) and possibly endorsement by a Fellowship (a group of technical experts) for select technical changes. This ensures quality and security in proposals.
- **Forkless Upgrades:** One of the powerful technical features of the Polkadot network is the ability to enact runtime upgrades via governance without needing a hard fork of the chain software. Once a referendum to upgrade passes, the new runtime code can be automatically enacted on chain (with the Relay Chain's validation since EWX is a parachain). This means the network can evolve quickly and safely under governance without disruptive chain splits.
- **Treasury Management:** With the full implementation of the technical and governance upgrade initiated in August 2025, the on-chain treasury, funded by a portion of transaction fees and slashed stakes, is to be managed by community on-chain governance. Community members (meaning any and all EWT token holders) can submit technical upgrade proposals, or treasury allocation proposals (e.g., grants for building new features, community events, audits). If approved by an on-chain vote,

funds are disbursed accordingly. This aligns expenditures with token holder interests and supports ecosystem growth.

4.2. The **Energy Web 2025 Upgrade** (Zurich Hard Fork, covering the migration to ERC-20, NPoS activation, VCC, etc, as described above) was approved by a supermajority of EWC validators, triggering:

- Deployment of new parachain runtime versions on EWX enabling NPoS and governance modules/pallets implemented via Relay Chain governance in Polkadot.
- Minting of ERC-20 EWT on Ethereum, implemented by the bridge contract on Ethereum, which is currently controlled by the EWX parachain collators, and in the future will be subject to on-chain governance motions within the supply cap.
- Opening of governance mechanics, including staking on EWX and enhancing mobility with liquid staking and BYOT, made available to the public in stages, ensuring full compliance with regulation and the highest level of security, including implementation of security audits.
- EWX utility was reinforced with layer 2 Worker Node Pallet integration, facilitating the Verified Compute Cloud service. Further upgrades will follow the new, broader on-chain governance mechanism.

4.3 Governance Powers and Limitations: The open governance process has an embedded set of checks and balances to protect the platform integrity:

- The 100 million EWT supply cap is hard-coded and would require extensive multiple upgrades across smart contract and chain runtimes to be modified.
- EWX governance process cannot be used to arbitrarily take tokens from users except via the rule-bound processes (slashing or if a required code fix cancels erroneously create tokens, and even then only with community on-chain agreement).
- Emergency Mechanisms: In case of critical issues (security vulnerabilities, etc.), there is an Emergency track in governance that can fast-track proposals with higher majority thresholds and shorter voting periods. This ensures the network can respond to crises like a major hack or chain halt swiftly, while still requiring on-chain community approval (as a rule, these emergency proposals are accompanied by opinions of technical committee members that have reputational trust).

4.4 Future Governance Evolution: The governance model itself can evolve. For example, the community might decide to introduce delegated voting (liquid democracy), or create a bicameral system with a representative council (comprising diverse experts and/or majority token holders) and a wider public (all token holders), or adjust conviction weights. Any such changes would be implemented via the same referendum process. In essence, Energy Web's governance is self-amending; the community can change how it governs itself, within the bounds of the underlying blockchain framework.

5. Example Use Cases and Applications

Here presented are representative use-cases that are enabled or enhanced by the Energy Web Platform, applicable across industries, from aviation to maritime transport.

- **Energy Web Digital Spine (Grid Orchestration):** In modern electric grids, especially with high penetration of distributed energy resources (DERs like solar panels, heat pumps, batteries, etc.), coordination is challenging. The Energy Web Digital Spine refers to a shared, decentralized system where multiple parties (regulators, grid operators, aggregators and utilities, asset owners) coordinate tasks by accessing and managing data in a secure, privacy-preserving fashion. Digital Spine enables solutions like Dynamic Operating Envelopes (network-aware control on distribution level), also facilitating Virtual Power Plant coordination, with solutions for flexibility markets, energy communities and demand response applications, as well as grid services procurement, emissions tracking and more. This approach is being demonstrated in projects like Project EDGE – a pioneering marketplace pilot by AEMO, Australian energy market operator, to enable distributed energy resources to provide services to the grid. In Project EDGE, Energy Web's Verified Compute Cloud could be used in conjunction with the Digital Spine to execute grid orchestration algorithms (like matching a battery to a demand response event) across participants, ensuring fairness and reliability. Disputes can be minimized by encoding the rules like dispatch instructions and penalties for non-performance. This would unlock collaboration in flexibility markets, increasing interoperability whilst protecting data privacy and security.
- **Energy Web Green Proofs:** Energy Web has pioneered blockchain-based frameworks for commodity market decarbonisation actions that leverage book-and-claim schemes, transparent digital certificates and audit trails to drive accountability. Verified Compute Cloud powers a distributed, independent claims validation, triggering actions like certificate issuance via on-chain consensus. Here AI/ML would be used for anomaly detection or classification, while multi-operator consensus attests that results are reproducible and explainable to auditors. VCC is leveraged to validate that certificate issuance requests originate from qualifying producers, effectively conducting a real-time, continuous audit of each platform user's holdings and environmental claims. Multi-party attestations and penalties for malperformance are natively provided, preventing falsification of records and double counting of renewable claims, thereby bringing real accountability to environmental reporting.
- **Sustainable Processing (Carbon-Aware Computing):** Large data center operators or industrial facilities could reduce their carbon footprint by **carbon-aware scheduling**, shifting workloads to times or places with cleaner power. Using Energy Web's VCC verifiable business logic computation, companies can set up sustainable procedures, such as to only run batch processing when grid carbon intensity is below a certain level, or automatically purchase offsets when using non-renewable energy, etc. These can be combined with Green Proofs certificates, serving as inputs for carbon footprint calculations. Beyond energy, the Energy Web Technology architecture can apply to any multi-party workflow that needs automated, verifiable and more secure business logic execution supporting **supply chain traceability**, **digital identity verification and data management**, etc.

6. Security and Risk Mitigation

Operating a blockchain network with cross-chain bridges and off-chain execution entails technology and operational risks. Below is a description of principal risk categories and the accompanying mitigation measures:

- **Smart Contract & Bridge Risk:** As with any blockchain, bugs (flaws or errors in computer code that causes a program to behave unexpectedly, produce incorrect results, or crash) in smart contracts (including runtime pallets or bridge contracts) could potentially be exploited. Bridges are especially sensitive since they maintain custody of tokens across chains. A failure in the bridge logic could lead to token loss or imbalance between ledgers. Mitigation measures: All critical components (bridges, staking process, core pallets) undergo **independent security audits** before deployment. **Rate limits and monitoring** are in place on bridge operations, so that any anomalous large transfer can be flagged or temporarily halted. The on-chain governance has an **Emergency track** to quickly pause or upgrade a faulty module if a severe vulnerability is discovered.
- **Consensus & Staking Risk:** In NPoS networks, there is a risk of validator collusion or low participation that may lead to network instability. Also, Nominators might lose funds due to slashing if they or the validators they back (Collators) malperform through misconfiguration or attacks. Mitigations measures: The NPoS system is designed with **conservative parameters** initially, involving Collators with high reputational scrutiny, envisaging gradual increase that continues to ensure a sufficient and increasing network decentralisation, while maintaining the required checks and balances supported by parameters set by on-chain governance. **Slashing amounts are to be calibrated** not to be overly punitive for minor lapses (e.g., a small penalty is imposed for a brief downtime) but significant for equivocation (a malicious act where a validator or miner broadcasts conflicting information or messages to different parties within the network).. **Diversity in nominations** is encouraged (guidelines provided so that Nominators spread stake across Collators to deter centralization). The EWX on-chain finality, achieved through Polkadot's Relay Chain, also benefits from the robust security of Polkadot's validators.
- **VCC Execution Risk:** The VCC approach, while novel, introduces risk of discrepancy between off-chain processes and on-chain records**.** For example, if multiple VCC operators collude to falsely report an off-chain outcome, they could cause an incorrect on-chain result (and perhaps profit from it). Mitigation measures**:** VCC by design requires **multiple independent operators**; collusion becomes difficult if operators are economically and geographically decentralized. Furthermore, the **stake requirements** mean colluders have an economic deterrent. VCC applications can involve real-world oversight (e.g., regulators or auditors could be among the VCC

operators). Random audits and/or additional challenge mechanisms can also be requested as part of the requested workflow monitoring, including triggering a re-execution with more operators if any collusion is suspected. Over time, a **reputation system** can be added for participating VCC operators, as well. VCC protocols can also pin model versions and require reproducible inference to mitigate AI model drift or unapproved changes. Finally, since VCC tasks typically anchor to physical data; to the extent possible, trustworthy data sources are integrated (like authenticated IoT data, digital signatures from devices), further reducing the scope for error.

- **Governance Risk:** With on-chain governance, there is a risk of low turnout or governance attacks where a malicious faction swings a vote to pass harmful changes (e.g., spend funds on a cause that does not benefit the wider community or in the extreme case initiate a token mint to benefit a small group, or disable security features). Mitigation measures: **Conviction voting** encourages committed long-term holders to have more weight, reducing the influence of short-term speculators. Parameters like required supermajority for certain actions protect against rushed changes and limit influence of large token holders. The Energy Web community will also pursue **community education and transparency**. As described above, proposals are to be discussed publicly, inviting community scrutiny, while soliciting expert opinions through technical committees and other types of deliberation and informed decision-making support.
- **Market and Liquidity Risk:** EWT's value is market-driven. There is risk of high volatility or low liquidity, which could affect holders and the network's perceived stability. For instance, if liquidity is low, large holders might not be able to exit without crashing the price, or conversely new investors face slippage. Mitigation measures: The evolution of EWT into ERC-20 token on Ethereum, facilitates its listing on all major exchanges, as well as participation in DeFi, which is expected to increase liquidity and market depth. The fixed EWT supply cap and the 2025 upgrade process transparency aim to build market confidence (no surprise dilution). Importantly, **no price or investment promises** are made; the focus is on utility and disclosure. The espoused multi-venue strategy (EWT on both Ethereum and EWX) also spreads market access; if one market has issues, another can serve users (for example, if a centralized exchange faces a problem, users can still trade via decentralized exchanges on Ethereum, etc.). As detailed in the Disclaimer presented at the beginning of this Yellow Paper, current and prospective EWT token holders should be aware that EWT may lose its value in part or in full and that it is not covered by deposit guarantee or investor compensation schemes. Likewise, EWT transferability and liquidity are not guaranteed; there may be no or limited secondary market.

- **Regulatory Risk:** The regulatory environment for crypto assets is continually evolving. There is a risk that new laws or interpretations could classify EWT differently or impose requirements that impact usability or compliance. Another risk is that the regulator may not understand the decentralised governance approach, including that the EWT Issuer/Offerer is not a single legal entity but a set of distributed validators, even if this is frequent practice for decentralised projects. Mitigation measures: From the outset, **EWT has been designed as a utility token.** The platform and token use have also been fully documented, following Swiss FINMA guidelines (no profit rights, functional network, etc.) and now also incorporating the MiCA framework. EWT is and remains a **utility token**, as its sole purpose is to provide digital access to a service/infrastructure (the Energy Web decentralized services) and it was **functional at issuance** (i.e., EWT has been usable for transactions and network staking from the start, never circulating with a promise of future functionality).
- **AML/KYC:** Energy Web's base network is permissionless – anyone can create an address and transact. This means **that no designated entity performs KYC on token holders** (similar to how Ethereum works). However, when interfacing with regulated exchanges, payment providers and certain enterprise applications users may undergo identification checks. Energy Web technology does offer optional identity frameworks (using decentralized identity standards) that allow participants to present verifiable credentials on-chain if needed. The existence of such identity layers means the **platform can adapt to regulatory requirements** with little friction and without sacrificing base-layer decentralization: the chain will not enforce one global whitelist, but specific use cases can and do. In terms of AML, EWF as a supporting organization does not intermediate token transfers. The open nature of EWT means it could potentially be used by sanctioned persons or in illicit ways (like any cryptocurrency), which is a general risk; however, law enforcement can trace on-chain activity. Finally, if regulations require adjustments (like delimiting certain jurisdictions or instituting on-chain allowlists for regulated participants / users of selected dApps deployed on EWX), on-chain governance can also introduce those measures by upgrading the runtime.
- **Operational Risks:** These include important access and process actions like key management (participants losing keys or having them hacked), node outages, network attacks, and user errors.

  For transparency, EWF currently holds certain multi-signature admin keys for the new smart contracts (the ERC-20 token contract on Ethereum and the Energy Web Bridge). These keys are **temporary safeguards** intended for emergency use only (such as halting a malfunctioning contract or applying a security patch). **They do not confer any central control over EWT**. EWF cannot arbitrarily mint tokens, alter balances, or block transactions. All token issuance and bridge operations are

executed by the protocol (collators and on-chain governance) under predefined rules. EWF has committed to relinquish or decentralize these administrative powers as the system progresses to full community governance, ensuring that **no single entity can control the token or network** and that community funds are used exclusively for development and community benefit. Mitigation measures: There is **extensive documentation and guidance** on secure key management (like recommending hardware wallets, multisig for treasury), on setting up secure node operation infrastructure (using sentry node architecture to prevent network attacks, etc.). The Collators use advanced and most secure crypto keys (ED25519/SR25519 keys for Substrate). There is also a **monitoring** system in place: EWF in its administrative technical support role, and the community run monitoring services to detect network health issues (if a collator is down or blocks aren't finalizing, alerts are sent). This is currently implemented by using the Discord channel but may evolve to a different monitoring mechanism. In case of severe issues, the emergency process can be invoked. Importantly, there is also an emphasis on **testing** in practice – any and all upgrades are tested on testnets and with a small group before broad deployment, while more significant operational changes also require independent security audits. To date, the following independent audit reports have been published:

- The Energy Web Chain Audit Report, by ChainSecurity, June 2019 [Link]
- EWC - EWX Bridge Audit Report, by ChainTroopers, April 2024 [Link]
- Worker Node Pallet Assessment, by Trail of Bits, June 2024 [Link]
- Worker Node Pallet, by ChainTroopers, May 2025 [Link]
- EWC Zurich Hard Fork, ChainTroopers, July 2025 [Link]
- EWT ERC20 & Ethereum Bridge Smart Contracts, by Hashlock, July 2025 [Link]
- EWX Parachain Node: Dual Bridge & Staking Pallets, by Hashlock, August 2025 [Link]

Furthermore, system contract addresses are publicly available for audit:

- Ethereum EWT ERC-20 Contract Address: 0xB66a5D30D04f076E78ffB0d045C55846Fdcde928
- Energy Web Bridge Contract Address (Ethereum): 0x5dDed30f8cd557257CcDC4a530cB77AC45f0259D
- Polkadot Parachain ID for EWX and code hash of initial runtime (for reference of on-chain code).
    - Parachain #3345
    - 29766d86a021bbbe9bbf95948f23190570a8a603a53c73015903cab7a0c7ea11
- Energy Web Chain System Contracts GitHub Repository: https://github.com/energywebfoundation/ewc-system-contracts

7. Energy Web 2025 Upgrade: The Roadmap

Energy Web's platform upgrade is executed via a phased roadmap, approved by the EWC validators, aligning technical milestones with ecosystem adoption and governance readiness. This roadmap is subject to change, but as of this writing (Q4 2025), the plan is as follows:

- **Q3 2025 – Post-Zurich and ERC-20 Launch Tasks:**
  - **Initialize the ERC-20 EWT contract with the frozen EWC minted supply**. Legacy EWT are moved to ERC-20 via the native bridges (EWC → EWX → Ethereum) at 1:1 ratio. **No new tokens are issued/minted**.
  - **Initiate public staking on EWX** progressively and with caution: Upon the upgrade roll-out, a set of collators was elected (including known entities who have previously served as validators and contributed to platform's development) to bootstrap the process. Following comprehensive security audits and system tests of the upgraded platform features, the eligibility will open to more collators that signal interest and meet staking requirements, with the objective of enhancing platform decentralisation and security. Nominator functionality is also to be opened gradually to avoid any single Nominator controlling too high a stake at this early governance transition stage. A user interface is to be developed to facilitate decentralisation.
- **Q4 2025 – BYOT Expansion and Liquid Staking:**
  - **BYOT via Asset Hub**: A set of **Polkadot Asset Hub tokens** (starting with USDC and later expanding to BTC, and any other ERC-20 tokens deemed relevant) is to be enabled for use on EWX. Enterprises that deploy VCC solutions will thereby be able to pay VCC operator fees in tokens such as USDC-stablecoin, enhancing user experience.
  - **Liquid Staking (stEWT):** This is EWX specific implementation of liquid staking protocol, which allows users who stake EWT against chain validators (collators) to receive an equivalent amount of **stEWT** representing their stake.
- **Q1-Q3 2026 –**
  - **Advanced Slashing and Dispute mechanism:** An important upgrade to the EWX will be audited and deployed in order to bring advanced configuration and execution for different types of slashing and dispute initiation and resolution. This is crucial for larger adoption of the Verified Compute Cloud across use-cases and varied enterprise applications. While slashing provides economic guarantees for the VCC accountability and accuracy, it could also be configured to enable a dispute mechanism with its own economic guarantee in case of a majority attack scenario. This is where governing entities of a particular VCC solution group would define who and how can initiate a dispute,

the required deposit amount to initiate a dispute process, how re-computation would be automatically triggered and how a dispute result will be finalised and slashing applied to recover any incurred losses by affected parties.

- **Fiat Ramps:** An integration with existing fiat-ramps would be enabled in order to be able to pay for VCC using legacy payment methods that would be converted to USDC to pay fees to compensate VCC operators who have successfully provided the compute service.
- **Verified Compute Cloud (VCC) General Availability:** In 2026 and after successful achievements of all objectives for VCC solutions within the context of multiple production applications, Energy Web Worker Node pallets enabling VCC will be **fully unlocked for general use**, pursuant to respective terms of service. This means that enterprises and developers subscribing to this service could register their own VCC service requirements on-chain (with initial guidance facilitated by EWF's technical team to ensure quality, transitioning over time to a fully automated process).

- **Mid/Long-Term (Late 2026 onward):**
  - **L1/L2 support expansion:** Energy Web's Verified Compute stack will also move toward deployment on Layer1 blockchains, starting with Ethereum. This could be undertaken either by providing L2 rollups on networks like Base or natively on Ethereum mainnet, via a set of smart contracts.
  - **EWX Ecosystem Growth:** Diverse **third-party applications** are expected to launch on Energy Web X, leveraging the system efficiency, security and enterprise-grade solution readiness.
  - **Permissionless collators management and governance:** The objective is to enable a fully permissionless collators/validators onboarding and governance process by early 2027, including by optionally implementing certain KYC/KYB methods on top of meeting minimum required token deposits.
  - **Continued Upgrades:** As technology evolves, including improvements in blockchain programming and features such as zero-knowledge proofs,, Energy Web governance will deliberate on these and integrate accordingly.

The overarching goals are **enhancing utility** (more real-world transactions flowing through EWX/VCC and decentralised applications - dApps), **ensuring ecosystem stability and security** (no major failures, maintaining user functionality), and **adhering to regulatory and market developments** to meet global enterprise and regulatory requirements. Progress updates are to be regularly published via Energy Web Foundation's official channels and any material deviation or major new milestone will be reflected in updated documentation.

8. Glossary

Bridge (Lift/Lower): Mechanism to transfer EWT across chains. To **lift** is to move **from Ethereum to EWX** (locking ERC-20 in the Energy Web Bridge escrow on Ethereum, minting on EWX). To **lower** is **EWX to**

Bring Your Own Token (BYOT): The capability for Energy Web to accept **non-EWT tokens** for certain uses (VCC fees, staking rewards). Initially limited to Polkadot ecosystem assets via the XCM programming language. BYOT tokens are converted to EWT value for actual settlement to ensure EWT's role remains central. BYOT broadens the Energy Web platform usability.

Collator: The parachain block producer on EWX (distinct from Relay Chain validators). Collators are selected based on stake and must adhere to rules or face slashing.

Conviction Voting: A mechanism in governance where voters can lock their tokens for a longer period to increase their voting power (each doubling of lock time can increase vote weight, up to a limit). Ensures long-term aligned voters have more say.

Energy Web Chain (EWC): The legacy blockchain launched in 2019 using Proof-of-Authority consensus. Post-2025 Energy Web Upgrade, it serves only as an on-ramp (via one-way bridge to EWX) and will operate in archive mode, without new activity or block rewards.

Energy Web X (EWX): The main Energy Web blockchain network; a Polkadot parachain using Nominated Proof-of-Stake, supporting on-chain governance, Verified Compute Cloud, and bridging EWT to Ethereum and other blockchain platforms for wider utility. It is the hub for Energy Web platform's operations and governance post-2025 system upgrade.

Energy Web Foundation (EWF): The global non-profit organization (foundation organised under Swiss law) promoting and developing new technologies and applications, especially in the fields of new open and decentralized software architectures, with a focus on the promotion and development of the Energy Web Platform. Not to be confused with the Energy Web network governance and operation, which is decentralized, currently evolving from EWC validators to all token holders and a multitude of other operational and supporting bodies and functions, such as Collators, Nominators, and others. EWF's role is roughly analogous to the Ethereum Foundation's role for Ethereum – a steward and supporter, not a controller of the platform and the token.

Energy Web Technology Platform (or Energy Web Platform)**:** Energy Web's upgraded technology architecture consists of two primary layers – the **core blockchain layer (Energy Web X)** and the **off-chain business logic computation layer (Verified Compute Cloud)**,

complemented by interoperability interfaces, including cross-chain bridges and token abstraction mechanisms for an enhanced user experience.

Energy Web Token (EWT): The native first-layer token of Energy Web. Initially launched on EWC (2019), now a native token on Ethereum (ERC-20) and operating on EWX via bridges. Fixed cap of 100M. Used for staking, fees, governance, and as the value unit in the ecosystem for purchase and sale of deployed services.

EWX Launchpad: A user interface for configuring and deploying Verified Compute Cloud (VCC) solutions and provisioning EWX shared services and decentralised applications (dApps) on EWX. It allows registration of VCC solutions and defining of accompanying scope and protocol, onboarding of VCC operators, configuration of staking and BYOT procedures, and management of services such as collators, VCC, RPC endpoints and integrations, either via procurer's cloud or Energy Web–managed infrastructure.

ERC-20 EWT: The Ethereum-based representation of EWT. Not a wrapped token – it is EWT. Essentially, Ethereum is a host for EWT representing the same asset that exists on EWX.

Nominated Proof-of-Stake (NPoS): On EWX, Collators produce parachain blocks and Nominators back them with stake; finality is provided by Polkadot Relay Chain validators. Provides security through economic stake and slashing.

Nominator: A token holder who stakes EWT in favor of one or more Collators, to support them and share in risks and rewards. Nominators help decentralize validation without running a node themselves.

On-chain Governance (OpenGov): The governance system on EWX where decisions are made by token-weighted voting on proposals, with transparent rules and on-chain enactment. OpenGov refers to the evolved governance model initially developed by Polkadot and improving over time with implementation across the Polkadot and other ecosystems.

Verified Compute Cloud (VCC) is Energy Web's off-chain business logic compute framework with on-chain consensus to deliver enterprise solutions operated by governable, decentralized automation of mission-critical workflows.