Energy Efficiency Coin (EECoin)
A Blockchain Asset Class Pegged to Renewable Energy Markets

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ABSTRACT:

Energy Efficiency Coin is a blockchain asset class designed to have a positive ecological impact, and to track a weighted aggregate of real-world renewable energy markets, offering token-holders the opportunity to vote on which renewable asset markets will be included in the weighted average price. Energy Efficiency Coin is a *pegged asset* where the price is linked to a weighted super-index of constituent green stock and bond indices, where maintaining the price index peg becomes the incentivized trading strategy and revenue stream for the token equity holding company, ensuring future funding for capital management and technical platform development.

By utilizing energy-efficient Proof-of-Stake consensus protocols and devoting the equity to purchasing green financial instruments, usage and funding of Energy Efficiency Coin promotes the creation of renewable versus non-renewable energy, as opposed to blockchain token systems which utilize Proof-of-Work protocols, where higher utilization and coin market prices mean more incentive for "miners" to burn electricity to gain the tokens. The for-profit structure of the equity-holding company allows Energy Efficiency Coin long-term fiscal solvency, avoiding an initial token-sale and then burn-down of funds for development followed by reliance on volunteer developers that characterizes non-profit tokenization efforts. Energy Efficiency Coin utilizes blockchain industry-standard design protocols for Byzantine Fault Tolerant Delegated Proof-of-Stake consensus based on Merkle-Tree data-storage for transaction and token data, and Tendermint Application Blockchain Interface for "smart-contract" functionality such as state-machine memory storage and state transitions, including an internal voting mechanism whereby token-holders are granted a periodic vote based on proportional holdings in the total number of outstanding issued tokens.

I. Introduction.

The usage of digital currency and tokenization of value in distributed ledger or "blockchain" systems dates back to the nineteen-eighties, with early precursor technologies such as Chaumian Cash[1] and HashCash[2] based on mathematically asymmetric key-pairing[3, 4] and cryptographic hash-functions[5], eventually being eclipsed by more a more advanced and completed implementation called Bitcoin[6]. The paired application of Byzantine Fault Tolerant[7-12] (BFT) consensus and computational "proof-of-work" functions[13] led to a completely unexpected and historic breakthrough in computer science and applied cryptography: a formal solution to the Byzantine General's Problem[8], an achievement that echoed into the world of business finance technology in the form of global distributed Hashchain ledgers, or "blockchains". The market has evolved yet again, with the latest competitors offering Turing-complete logic and state machine access via "smart-contracts"[14], decentralized autonomous organizations (DAOs)[15], automated tracking of futures/options and share ownership of smart property[16, 17], zero-knowledge proof systems[18-20], decentralized computing/application platforms[21-24], notarization and immutable timestamping[25], unique triple-entry accounting schemes[26-29] and "sidechains"[30, 31] with ultra-low transaction fees, and real-world asset-pegging[32].

One compelling negative issue with traditional blockchain technology is the environmental aspect, the amount of electrical energy burned in proof-of-work (POW) consensus schemes, and the amount of toxic waste generated by quickly obsoleted mining hardware. One goal of the Energy Efficiency Coin (EECoin) is to offer a blockchain network and payment layer that has minimal electrical energy usage, minimal hardware turnover, and even a positive environmental impact. To that end, Energy Efficiency Coin utilizes an energy-efficient delegated proof-of-stake (DPOS) BFT consensus mechanism.

Equity placed into EECoin upon purchase becomes devoted to buying financial instruments linked to the generation and development of renewable energy and renewable energy technology. EECoin-invested capital becomes transparently placed into a modified (user-defined) market cap weighted index fund of renewable energy stock and bond index funds with a portion remaining in liquid assets for liquidity to maintain a market peg. Maintaining the EECoin Energy Index Price peg enables EECoin to become a less volatile, more price-stable asset class than traditional blockchain asset classes. This mechanism also allows the equity-holding company to fund asset management and technical development of the EECoin node and online platform, theoretically in perpetuity, without reliance only on funds from initial crowd-funded token-sale or volunteer development after a burn-down of initial funds that characterizes token platforms run by non-profit foundations.

EnLedger, Corp. acts as an equity-holding entity, transparently allocating funds that have been put into EECoin according to the modified market cap weighted allocation formula, minting new EECoins in batches of 10,000 which are then distributed to buyers who purchase at the EECoin Energy Index Price. The modified market cap weighted indexing structure frees EnLedger from much of the decision-making in asset management, whereby allocation of input funds is done according to a pre-set formula, and token-holders of EECoin will be offered a periodic vote on whether new green energy stock or bond sub-indices should be added to the super-index (EECoin Energy Index Price), which constituent sub-indices should be added, and what weighting coefficients should be used for newly added sub-indices.

Energy Efficiency Coin offers the public a new, energy-efficient blockchain asset payment network, and a way to directly support new renewable energy hardware installations and research into renewable energy technology that can be quantized by the amount of new renewable energy MWHrs produced. Token holders are offered no redemption and the token is not "backed" by the assets held by the equity-holding company, only by the token-holder's interest in supporting renewable energy and faith and understanding that EnLedger will act in its own best interest to maintain the EECoin Energy Index Price market peg. EECoin is not a security, swap, or share, but a new experiment in pegged asset classes with the goal of building a model whereby society can use blockchain tokenizations to support socially and environmentally desirable outcomes via implicit behavioral incentives.

II. Node Implementation

EECoin runs on EnergyChain, a custom blockchain node implementation written in GoLang, using a Byzantine Fault-Tolerant delegated proof-of-stake (DPOS) consensus mechanism, and predefined messaging protocol for token transactions, smart-contract, and voting functionality, based on a customized Tendermint Application Blockchain Interface[22] (ABCI) base and unique genesis block. EECoin may be used as a "gas" or payment for internal EnergyChain functionalities such as registration of energy grid-attached appliances, automated power exchange, dividends / payments for energy production or phase regulation service contract fulfillment, and notarization of energy industry-related datasets. EECoin itself will be minted by EnLedger, Corp., according to the modified market cap weighted index value-formula, when new funds are deposited and verified in the equity account/s.

EnergyChain itself has a private validator network, whereby only corporate affiliates of EnLedger may be approved to run "delegate" nodes which participate in the consensus approval or rejection of energy industry-related transactions. By maintaining a private blockchain only for energy industry-related data and transaction sets, with pre-set defined functionalities rather than a full Turing-complete virtual machine, we maintain a blockchain with minimal data "bloat". This strategy enables EnergyChain transactions to remain completely private and fully data-accessible only to authorized entities at an atomic level, and for EnergyChain transactions to be processed at fee levels which we expect to remain orders of magnitude lower than public blockchains with full Turing-complete processing capabilities.

III. Transactions and Block Forging

As per protocol under the ABCI, the EnergyChain node and EECoin asset class will adhere to certain standards in terms of the format of the transactions and consensus protocol, and also has unique mechanisms for storing and processing data within the nodes for memory and state-machine transitions including functional logic capabilities for EnergyChain capabilities. Memory storage and computational access will be priced in EECoin "gas" in an open bidding market by the node operators, whereby node operators can charge a minimum computational rate or refuse to execute functional logic and state-transitions if the offered rate is below their bid threshold. Tendermint ABCI-based blockchains, and thus EnergyChain, have the capability to skip forging of blocks that contain no transactions, another mechanism by which blockchain data "bloat" is reduced. EnergyChain supports the ability to eventually offer multiple asset classes on the same blockchain, with an expected Renewable Energy Credit (REC) tracking system to be overlaid. Via Tendermint Inter-Blockchain Protocol (IBC), EnergyChain supports cross-chain atomic swaps with other blockchain asset-classes, enabling the possibility of automated exchange and settlement of EECoin into other blockchain asset classes via smart-contract or built-in logic functionalities.

III. Monetary Structure

Energy Efficiency Coin is backed by the promise that when you buy an EECoin at the EECoin Energy Index Price, the funds invested will be transparently allocated into renewable energy assets, and that EnLedger will act in its own best interest to maintain a market value-peg according to the price-weighting formula, via re-capitalization across multiple markets as necessary. EECoin is not a security, future, or share, it is not a guarantee of ownership in a company or any underlying assets, or a claim against any consumer rights as guaranteed by EnLedger. The goal of this structure is to offer the public a way to participate in an energy-efficient blockchain network and to provide capital to renewable energy projects, increasing price competition for renewable energy assets and thereby enabling society to directly provide a market incentive for production of renewable forms of energy as opposed to non-renewable ones.

EnLedger acts to mint the supply of EECoin in batches of 10,000 at a time, and to sell them at the EECoin Energy Index Price calculated according to a modified market cap weighted index pricing mechanism. We will use a modified (user-defined) market cap weighted indexing, whereby pre-chosen weighting coefficients determine the EECoin Energy Index Price based on the price of a curated index of renewable energy assets. The index of renewable energy asset funds will be publicly listed and operate according to similar dynamics as current mcap-weighted indexes in traditional markets, such as NYSE-500 or Blue-Chip indexes, with user-defined fractional weighting coefficients. In the simplest case, the modified market capitalization weighted price P_t of an EECoin at time t is determined by the formula:

(0.a) $$P_t \equiv \sum_i c_i p_i \Big/ Divisor$$

for the following variable definitions:

Divisor: index scaling divisor

n : number of asset classes in the index

c_i : market cap weighted coefficient for asset class i

p_i : price of asset class i at time t

A direct analog to (Formula 1) from Standard & Poor Dow Jones Indices *Index Mathematics Methodology*[33] represented as:

(0.b) $$Index\,Level = \frac{Index\,Market\,Value}{Divisor}$$

In the full modified market cap weighted EECoin Energy Index Price calculation, index constituents have a user-defined weight in the index. Renewable energy company corporate actions are not anticipated to affect the EECoin Energy Index price, as the constituents are themselves weighted indices and include their own rebalancing mechanisms to maintain stable index prices. Rebalancing of EECoin user-defined weighting coefficients is only required during the addition, removal, or internal spin-off, merger/acquisition, or delisting of a constituent green energy stock or bond index. New user-defined weighting coefficients during new constituent index additions may be voted on by EECoin token-holders in proportion to their fractional holding of the total assets and the number of votes received, enabling a degree of control over correlation and exposure between the EECoin Energy Index Price and various international renewables markets.

The Index Market Value becomes an Adjusted Market Value via inclusion of Adjustment Weighting Factor (AWF_i) for each asset class i where:

(0.c) $$AdjustedMarketVal = \sum_i AWF_i c_i p_i$$

Divisor adjustments are made according to Standard & Poor's *Index Mathematics* where "Index maintenance - reflecting changes in shares outstanding, capital actions, addition or deletion of stock to the index - should not change the level of the index.", where our corresponding parallel statement is that any change in stocks in the index that alters the total market value of the index while holding *token* prices constant will require a divisor adjustment. Divisor adjustment are done according to the additive method described by S&P, enabling independent adjustment of terms for each indexed asset when asset classes are added or deleted from an index which would cause a Change in Market Value (CMV):

(0.d) $$Divisor_{new} = Divisor_{old} + CMV \Big/ IndexLevel$$

and the AWF for each constituent, i, on rebalancing date, t, is calculated by:

(0.e) $$AWF_{i,t} = \frac{Z}{AdjustedMarketVal} W_{i,t}$$

for constant Z set for the purpose of deriving the AWF and, thus, the weighting coefficient for each constituent sub-index. The EECoin Energy Price Index is not altered by the index rebalancings, however the divisor will change during rebalancings, where:

(0.f) $$Divisor_{after} = \frac{AdjustedMarketVal_{after}}{AdjustedMarketVal_{before}}$$

The total number of outstanding EECoin tokens in issuance at given time, N_{EEC}, monotonically increases as equity is added into the EECoin equity pool via users buying EECoin from EnLedger at the token price defined by equation (1.c):

(0.g) $$N_{EEC} = \sum_{t} C_t P_t$$

for C_t a user buy-in amount of C at time t, given price P_t at time t. The total number of EECoins that could ever exist is unbounded as they are minted in response to user demand with no pre-set end date for the token sale, this does not lead to inflationary losses for token-holders as long as the EECoin Energy Index Price is maintained, in fact EECoin has no internal monetary inflation mechanism at all, as it is designed to be non-volatile and purely track the modified market cap weighted index formula price.

By owning an amount of EECoin, a user is conferred with the opportunity to vote on types of asset classes to be included in the indexes with voting options for new asset types curated EnLedger on a periodic basis, whereby new asset classes may be added to the basket and included in the market-cap weighted EECoin index price. A user's vote will count proportionally to the number of tokens held in the address which corresponds to the private key used to sign the voting transaction, where the vote weight:

(0.h) $$V_{weight} = {N_{tok}}/{N_{REC}}$$

for a user holding N_{tok} number of tokens. The most popular voted option by weight will be adopted after each round of voting, and this may include the option to make no change. Tokens may also be spent as "gas" in to pay for smart-contract computational cost on EECoin nodes, with a real-time bidding market for the cost of computation or traded via sidechain or cross-chain atomic swap onto other blockchains supporting the IBC protocol.

EnLedger is able to peg the price and affect exchange prices via some transparent trading mechanisms. For example, if an exchange price for EECoin against another asset falls below P_t at any time t, EnLedger is able to liquidate renewable energy assets at the expected pegged price P_t on traditional markets, then buy EECoin on the exchange up to price point P_t (providing upward market pressure) while turning a profit. Conversely, if the exchange price rises above P_t, EnLedger can use its own capital to buy EECoin at P_t, issue itself coins from the most recently minted batch and take them to market above price point P_t (providing downward price pressure), while turning a profit. Less drastic then outright supply manipulation techniques, EnLedger can also trade markets using non-predictive trading algorithms designed to reduce the volatility of holdings with low risk, such as "slow market mover" algorithms with zero/infinite trading boundaries, providing a stabilizing influence on exchanges.

The last detail that might affect EnLedger's liquidity and ability to maintain the EECoin Energy Index Price in the short-term will be the percentage of holdings kept in liquid capital at any given time, which may fluctuate during market "bear runs", and while EnLedger rebalances the asset / cash holdings equity mix. Low liquid reserves may allow the exchange price to stray from P_t in the short-term, providing opportunity for speculators. It's in EnLedger's best interest to trade promptly but not instantaneously on the underlying asset markets in response to user buy-ins or redemption events, to limit liability but also obscure the predictability of our trading patterns and buy/sell at the most opportune times, including divisor adjustment during market close times.

Using EECoin, we demonstrate application of modern standard blockchain technology and finance theory towards the goal of achieving environmentally beneficial and socially desirable outcomes via inherent behavioral incentives. Usage of EECoin incentives the production of renewable versus non-renewable energy, on EnergyChain, an energy-efficient blockchain platform designed for decentralized energy-industry usage.

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