

Sustainable Bitcoin Certificate (SBC): An Environmental Commodity Designed for the Bitcoin Network

Sustainable Bitcoin Protocol
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Abstract. The Bitcoin Whitepaper was published at the height of the 2008 financial crisis. Today we face another global crisis that Bitcoin has the potential to help solve, climate change. However, at present, Bitcoin miners are not incentivized to use clean energy, posing a challenge in aligning with the growing demand from institutional investors for environmentally responsible investments. Both bitcoin miners and bitcoin investors lack a direct mechanism to support clean energy bitcoin mining —until now. SBP bridges this gap, making clean energy not just an option, but a sustainable and profitable strategy for the future of Bitcoin mining and renewable powered infrastructure. Sustainable Bitcoin Protocol (SBP) innovatively enhances the Bitcoin ecosystem without altering its fundamental workings. By building upon Bitcoin's existing data structures, SBP harnesses the environmental externalities of Bitcoin mining, channeling them towards positive climate impact. This is achieved through the creation of Sustainable Bitcoin Certificates (SBCs), validating and incentivizing the use of renewable and clean energy in mining. Moreover, SBP drives a self-reinforcing cycle of clean energy financing: SBP fosters the creation of additional SBCs by purchasing Renewable Energy Certificates (RECs) and other Energy Attribute Certificates (EACs) corresponding to the Bitcoin network's current day's energy use; this creates a flywheel effect where the more energy the Bitcoin network uses, the more financing of renewable energy is required to create an SBC, aligning real-time network consumption with positive environmental benefits. SBP thus emerges as a complementary layer, reinforcing Bitcoin's robustness while steering its energy narrative towards sustainability, proving that Bitcoin's growth can coexist with environmental responsibility.

1. Introduction

As the world's first energy-native digital asset class (derived from energy and computation), Bitcoin has a unique potential for sustainability and transparency. As a highly flexible energy buyer, Bitcoin mining can adapt to the availability of clean energy, pause operations without systemic risk for exceptional demand response, and operate in diverse locations, making it ideal for harnessing otherwise wasted energy sources like curtailed renewables and stranded methane. SBP enhances this incentive to utilize clean energy by enabling bottom-up, transparent accounting that imbues the voluntary decision to procure clean power with transferable economic value. By targeting the energy consumption choices of miners, SBP aims to accelerate the network towards not just a sustainable future, but one that is a uniquely powerful tool to aid the clean energy transition, aligning Bitcoin's revolutionary financial technology with the future of our planet.

2. A Pioneering Environmental Commodity

Sustainable Bitcoin Certificates (SBCs) are a novel incentive for miners using verifiable clean energy, fostering a transparent, verified, and data-rich picture of Bitcoin's energy consumption. SBC not only reward sustainable energy use but also amass a detailed dataset, illuminating the environmental footprint and benefits of Bitcoin mining. This data empowers investors to directly support Bitcoin's positive ecological contributions, bridging the gap between clean energy mining operations and institutional investment.

SBC functions as an environmental asset and is expected to gain financial value as its production difficulty escalates. This increase in production difficulty not only enhances the asset's financial worth but also amplifies its positive impact on the environment over time.

Each SBC is divisible to 100 million 'Kyotos,' aligning with a single Bitcoin's 'Satoshis'. Like Bitcoin itself, there is a cap of 21 million SBC, exclusively generated through measured environmental benefits. SBC is only created from positive environmental impacts, and therefore there are no tokenomics or pre-allocations. This represents a groundbreaking environmental commodity, unique in its creation and potential for positive change, a true Proof of Clean Work asset.

3. Proof of Clean Work

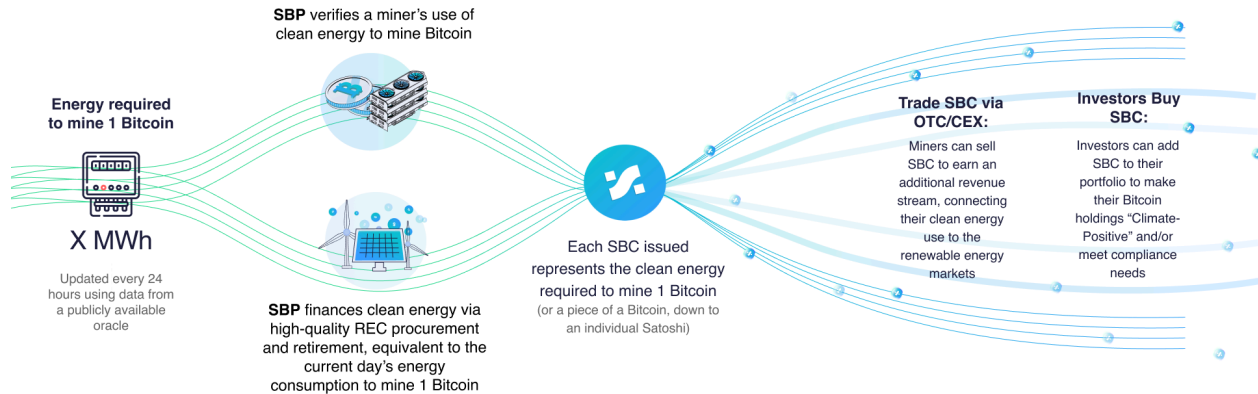
SBC are only created from one of two measured environmental impacts: clean energy Bitcoin mining and the financing of renewable energy equating to the present-day network's energy consumption.

Therefore, the theoretical value of each Sustainable Bitcoin Certificate (SBC) is anchored in the verified clean energy contributed by participating miners as well as the data derived from directing capital into clean energy markets. This process not only fosters the growth of sustainable energy sources but also ensures that the SBC's worth is deeply intertwined with the clean energy markets.

To guarantee transparency and trust, comprehensive data regarding SBC creation and its underlying clean energy metrics will be recorded on a public ledger. This digital record is immutable and fully auditable, ensuring that all stakeholders can verify the integrity and environmental contribution of each SBC.

Sustainable Bitcoin Certificate

SBC connects the Bitcoin Network to the Clean Energy Markets



4. SBC Value and Supply Creation

SBC are issued to miners that use verified clean energy. However, because there are currently less than 1.6 million coinbase rewards left to be mined between today and around 2140, the protocol would face an SBC supply challenge such that there will never be enough depth and liquidity to meet the demands of institutional investors. By solving this supply problem, an opportunity is created. For additional SBC beyond what are issued to BTC miners, SBC are created when dollars are invested into RECs or other EACs, equivalent to the Bitcoin network's current energy consumption.

For example, if the network currently requires 500 MWh to mine a single bitcoin on average¹, the protocol purchases and retires 500 MWh of high quality EACs on behalf of the historical footprint of the network, and mints an SBC, in effect, financing the same amount of clean energy as would be required to sustainably mine a Bitcoin today.

As an example, the cost to create one Sustainable Bitcoin Certificate (SBC) can be expressed as follows:

- Per-Bitcoin average energy consumption = X MWh
- Protocol purchases = X MWh of high-quality EACs
- Average price of high-quality EAC = \$Y
- Cost to create or intrinsic value of an SBC = X MWh x \$Y/MWh
- Example: At present, X = 500MWh and Y = \$3, so intrinsic SBC price is \$1,500

¹ SBP uses the leading publicly available datasets for Bitcoin mining energy consumption, including from Cambridge University Center for Alternative Finance, S&P Global, and CoinMetrics.

Thus, the foundational cost of an SBC is directly linked to the amount invested in clean energy, pegging its value to the energy requirements of the Bitcoin network.

To illustrate this further, if three years from now, the Bitcoin network is consuming 900 MWh to mine a single BTC, the cost to create an SBC will equal $900 \text{ MWh} \times \$3$, or \$2700 without factoring a likely increase in EAC prices. This represents a price increase of 80% from current levels.

We consider the above formula the theoretical value of an SBC, derived from the clean energy markets and the Bitcoin network's energy consumption.

This means that the minimum value of an SBC earned by a miner should also equal the cost price to create an SBC, rooting the value of the SBC firmly in the clean energy markets and directly tied to Bitcoin's energy consumption. This also means that the "difficulty" or cost to produce an SBC is directly tied to the Bitcoin network's energy consumption.

Therefore, as the Bitcoin network consumes increasingly more energy, the cost to create an SBC will increase, meaning more capital is flowing to clean energy projects. In effect, the SBC is a climate financing flywheel derived from the Bitcoin network.

5. BTC, SBC, and Achieving Climate Positivity

SBC establishes two levers that reduce and reverse the climate footprint of Bitcoin mining: a fully fungible 'green premium' for Bitcoin miners to use verified clean energy sources and a mechanism to drive clean energy financing via high-quality EAC retirement, benchmarked to the Bitcoin network's current energy consumption, as described in section 4 above. The first 17 million Bitcoin to be mined between the Genesis block and April 2018 consumed on average 4 kWh. As of the writing of this whitepaper, mining a single Bitcoin requires 502 MWh², a 12,500,000% increase.

SBC that are not earned by a miner are created from financing the same amount of clean energy required to sustainably mine a Bitcoin in the present day, therefore each SBC immeasurably overcompensates for the energy consumption of each BTC. For example, an SBC created today can be paired with any of the first 17 million BTC and overcompensate by more than 12 million percent. An SBC minted at any point in the future will always overcompensate for a BTC that was mined today. In the event that the network reduces energy consumption for a given period of time, such as following a quadrennial halving or a nation-state ban, the protocol average renewable energy financing of each SBC will always overcompensate for the average of any given BTC. This allows an owner of both a BTC and a SBC to make data backed claims of sustainability or environmental compliance, and ensures that their Bitcoin holdings are backed by enough clean energy to mine a BTC at any given point in time, present or future. SBC allows the holder to directly support the clean energy transition while owning Bitcoin. The end effect of establishing the SBC as a clean energy complement to BTC means that as the network grows, the aforementioned climate-positive flywheel only grows stronger.

² Data from Cambridge University Center for Alternative Finance

6. Clean Energy and Transparency

As noted in the introduction, Bitcoin mining is a novel buyer of energy and therefore requires a unique framework to account for its clean energy usage, however, there is simply no need to fully reinvent the wheel. For miners purchasing electricity from the grid or behind the meter, SBP follows the Greenhouse Gas Protocol, the most widely accepted framework for renewable energy procurement and accounting.

To strengthen the impact of the SBC, the protocol also incentivizes the capture and utilization of methane—typically wasted or stranded— turning a potent greenhouse gas into an energy source for Bitcoin mining, and in turn significantly reducing methane's environmental impact. For miners converting wasted or stranded gas into electricity, SBP has developed a proprietary methodology for what constitutes the sustainable use of stranded gas in consultation with leading climate experts.

SBP verifies the use of clean energy down to the individual facility level. A miner's energy consumption data is voluntarily submitted for each of their facilities and stored by the protocol.

Details of the above noted requirements can be found in the Appendix.

7. Bitcoin Mining Rewards and SBC Issuance

To determine how many SBC a miner has earned, the protocol monitors their Bitcoin rewards directly from a mining pools API which must be voluntarily connected by the miner. For example, if the miner has earned 100 Bitcoin during the period of January 1st-31st, and their energy consumption data for that same period is 100% renewable, the miner will earn 100 SBC. If the miner has been verified to use 80% clean energy during the same time frame, they will receive 80 SBC, truncated to 8 decimal places.

Miners are rewarded with SBCs for the total BTC mined for the period inclusive of transaction fees. We believe that transaction fees will start playing a more pivotal role in the total reward structure for miners over time and for that reason, we maintain a hard floor of 20% of total SBC issuance reserved for our mining partners with a potential to increase it to 25% in the future. The balance 75-80% will be reserved for SBC issuance via the financing of clean energy through the purchase and retirement of RECs or other EACs. So, for every 1 SBC issued to miners as a certificate of verified clean work, we will on average be financing 3-4 SBC's worth in the clean energy markets thereby giving the SBC credibility as a claim to matching or exceeding Bitcoin energy consumption in perpetuity.

8. BTC and SBC Fungibility

One of Bitcoin's core value propositions is its fungibility, not only in terms of its economic value but its environmental footprint as well. Despite the genesis block requiring less than 15 kWh of energy to be mined and the current block requiring nearly 500 MWh, a more than a 3,000,000 percent increase, every Bitcoin that exists importantly shares the exact same environmental footprint. This holds true because the fungible nature of Bitcoin and its use as a store of value is derived from the ongoing security of the network, meaning without each subsequent block being mined, all Bitcoins that exist lose value, irrespective of how much energy was spent to mine it in the first place. Any sustainability solution for the asset class must recognize this critical facet, and therefore it is not possible for any individual Bitcoin to be characterized as "green" or "non-green", as they all share the exact same impact.

Similarly, SBC is a fully fungible environmental commodity that is designed for Bitcoin. Each SBC or Kyoto that is produced represents that one BTC or Satoshi could have been mined in a carbon neutral or negative manner. All Bitcoins are interchangeable because every unit represents the exact same store of value, so it is therefore possible to decouple the sustainability attributes from Bitcoin and recouple it with a different Bitcoin, ultimately, the sustainability benefits are not lost but transferred. This is generally referred to as a mass balance system.

9. Conclusion

SBP is fundamentally rooted in the clean energy markets and tied to Bitcoin's unique energy consumption characteristics. Voluntary participation in SBP offers miners the opportunity to be compensated with SBCs by using clean energy and contributing essential data. The value of each SBC is anchored to the network's per Bitcoin energy consumption and the clean energy markets. SBC influences the Bitcoin network's environmental footprint through incentivizing miners but does not affect the network in any way. Through SBP, Bitcoin's ascent is harnessed to accelerate the clean energy transition, intertwining the future of finance with the future of our planet's climate.

Appendix:

Sustainable Energy Requirements for the Issuance of SBC

SBP Follows four important principles to ensure credibility and sustainability:

1. Don't Trust, Verify: All clean energy claims must be verified, i.e. 'Proof of Clean Work'
2. Unique and Exclusive Claims: Miners need to be the sole claimants for each kWh of clean power that they are using to receive SBC
3. Data and Transparency: Miners need to provide data demonstrating that they are using clean energy
4. Additionality & Impact as a North Star: While we only require miners to meet existing clean energy procurement standards, we aspire to drive the industry toward best practices such as 24/7 carbon-free energy, unlocking Bitcoin's potential as the world's most transparent and sustainable asset class

In order to demonstrate that Bitcoin mining can be a powerful energy transition technology, SBP certifies Bitcoin mining operations based on their ability to meet the same standards that every other energy-intensive industry, and notably the data center industry, is held to. SBP requires miners to meet the [Greenhouse Gas Protocol Scope 2 Guidelines](#) in order to receive SBC, which is the global standardized accounting framework for corporate clean energy procurement. This follows market-based accounting standards that use contractual instruments known as Energy Attribute Certificates (EACs), which can take the form of Renewable Energy Credits (RECs), Guarantees of Origin (GOs), or International Renewable Energy Certificates (I-RECs) - that represent the environmental attributes for a MWh of clean energy generation.

While we recognize that Bitcoin miners often co-locate with clean energy assets or site themselves in grids with high levels of renewable penetration, this does not mean that miners are able to make clean energy claims from a market-based standard. To be clear, miners who make location-based claims are not 'unsustainable', they simply cannot make claims of clean energy use in line with other industries. This is because the green attributes associated with the power that they consume could have been sold to another party (e.g. you are mining at a hydropower plant but the Renewable Energy Certificates (RECs) associated with that power are sold to another company).

Bitcoin miners are able to make verifiable clean energy claims and receive SBC so long as they meet minimum GHG Protocol requirements through actions such as:

- A. Procuring EACs such as RECs, Guarantees of Origin (GOs), or I-RECs
- B. Green Tariffs, whereby a power provider retires EACs on behalf of the Bitcoin mining customer
- C. Physical and Virtual Power Purchase Agreements (PPAs), which are contracts with a power producer that enable organizations to purchase electricity directly from clean energy assets
- D. Self-generation, whereby a miner has their own on-site green energy generation and has ownership of its associated energy claims
- E. Demonstrating that no contractual instrument exists for the MWh of green electricity you are using and that there is no double claim of clean energy use, with examples including:

- a. Buying electricity in a wholly green grid that does not participate in any EAC markets which can be documented ([RE100 Technical Guidance 5.2](#))
 - b. Buying surplus green power that would otherwise be curtailed and is not associated with a contractual instrument
- F. Other novel cases that meet SBP's four principles for credibility and sustainability

Bitcoin Miners can also receive SBC for the use and mitigation of waste methane gas, which has immense energy transition benefits, despite not falling under the purview of GHG Protocol guidelines. Methane miners that wish to receive SBC need to demonstrate that they meet the following sustainable methane mining principles:

- A. **Additionality:** the methane gas would have been vented/flared and is deemed wasted (e.g. there is a lack of pipeline and geo-specific regulations imply additionality)
- B. **Preventing a Moral Hazard:** The utilization of the methane gas does not further incentivize the production of methane emissions as demonstrated by gas value of <5%
- C. **Efficiency & MRV:** Miners should meet minimum combustion efficiency requirements (99%) and be able to demonstrate emissions reduction through Measurement, Reporting, and Verification