

SolarCoin

A blockchain-based solar energy incentive



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1. Executive Summary

Blockchain technology is driving innovation and scale-up in the energy, climate, and environmental sectors. SolarCoin, a blockchain-based digital asset and currency, is designed to accelerate the transition to a clean energy economy. As a blockchain based technology, SolarCoin is global and decentralized, with similarities to cryptocurrencies like Bitcoin. SolarCoin stands out, because unlike these, SolarCoin 'binds' the disbursement of digital coins to useful economic and environmental activity - verifiably produced solar energy.

SolarCoin uses the unique characteristics of blockchain technology to create a phenomenon that is:

1. a free, additional reward for solar energy producers
2. the first digital currency to protect natural capital
3. the first global, decentralized, non-governmental solar energy incentive program

SolarCoin, an open community project, was created in 2014 by a group of founders and volunteers working together as the SolarCoin Foundation. The SolarCoin Foundation rewards solar energy producers with blockchain-based digital tokens at the rate of 1 SolarCoin (SLR) per 1 MWh of solar energy produced.

This paper serves as a call to action for governments, NGOs, and the solar industry to recognize and seize the opportunity of SolarCoin, and thus help drive the global clean energy transformation.

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2. Blockchain and SolarCoin

Blockchain technology is driving innovation and scale-up in the energy, climate, and environmental sectors. The technology works as a value exchange protocol. Just as TCP/IP is the foundational protocol for the exchange of digital *information*, blockchain enables the exchange of digital *value*.

A blockchain is a distributed ledger of trusted transactions - a database. Transactions can be transfers of digital tokens representing currency, information, or even the assignment of a library book ID. Blockchains are distributed across large open peer-to-peer networks making them difficult to hack or fail. Because information changes are verified and immutably recorded across a network, records cannot be changed or tampered with.

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All transactions are transparent, and can be viewed by anyone using a blockchain explorer. Because of their distributed nature, blockchains can reduce transaction costs and time. More importantly, blockchain technology is poised to revolutionize the exchange of value, replacing the need for trusted intermediaries such as banks or currency exchanges.

SolarCoins are blockchain-based tokens issued into circulation when solar energy is verified to have been produced. SolarCoins can be transacted among peers. Transactions are collected, verified and summarized in blocks - creating the SolarCoin blockchain. The SolarCoin blockchain is the high integrity data foundation of the project: a decentralized, incorruptible and auditable record of solar energy produced.

3. SolarCoin – a free reward for solar energy producers

The SolarCoin project uses advances in blockchain to support solar energy deployment across the globe. *SolarCoin is a digital asset and currency designed to support the transition from the fossil-fuel economy towards a solar-backed economy.*

The SolarCoin Foundation rewards solar energy producers with blockchain-based digital tokens at the rate of 1 SolarCoin (SLR) per MWh of solar energy produced. SolarCoin is a free additional reward independent of other incentives that the owners of a solar installation might be entitled to (such as government subsidies, feed-in tariffs, green certificates, tax incentives, carbon credits, etc.). Whoever produces solar power - helping to avoid CO_2 emissions - may receive a SolarCoin reward.

SolarCoin is global, decentralized and independent of any government. SolarCoin has similarities to cryptocurrencies like Bitcoin but unlike these, **SolarCoin 'binds' the disbursement of digital coins to real world useful economic and environmental activity: verifiably produced solar energy.**

3.1 Earning and spending in the SolarCoin economy

SolarCoin Supply: The owner of a solar power plant is eligible to receive a SolarCoin as a free reward for generating solar energy. For systems smaller than 20kW, it is the user of the solar electricity, not the financial owner, who is entitled to the coins. The SolarCoin Foundation grants 1 SolarCoin for each 1 MWh of solar electricity produced to verified solar power plant owners/users. §97.5 billion SolarCoins have been created to be granted to energy producers until 2050 - as of publication, there are approximately 38 million in circulation. The rest are expected to be disbursed over the coming 35 years (until the 2050s). SolarCoin granting is retroactive to January 1st, 2010.

To receive a SolarCoin grant, plant owners register their solar power system with the SolarCoin Foundation. This can be done directly through the Foundation website or via a registered SolarCoin affiliate or monitoring platform. Registration includes supplying proof of ownership of the installation, grid connection documentation (third-party independently verifiable), solar power

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1 This figure varies slightly over time due to of stake rewards. All circulating and non-circulating SolarCoin are visible at all times using a blockchain explorer.

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production data (e.g. meter readings) and KYC ("know-your-customer") data. Once registered, the Foundation issues SolarCoins directly to the owner's digital SolarCoin wallet. SolarCoins are issued every 6 months to registered plant owners.

How does SolarCoin work?

1. User produces solar energy
2. User registers solar system to the SolarCoin Foundation
    a. Provides power purchase agreement
    b. And the amount of solar MWhs generated
    c. KYC
3. Claim is approved by the SolarCoin foundation
4. SolarCoins are disbursed to the user
5. User can spend / use solarcoins

SolarCoin Demand and Use: SolarCoins can be collected, redeemed, or used as digital currency. Importantly, they can be traded for government currencies (fiat) 24/7 on global cryptocurrency exchanges. SolarCoins are an increasingly liquid asset, transparently issued and tracked on a blockchain that can be kept in digital (on computers or mobile devices) or offline (paper) wallets. The SolarCoin community develops use cases and business models for SolarCoin users, which are detailed in the Appendix.

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4. SolarCoin – a currency protecting natural capital

SolarCoin is more than a reward system for solar energy production, Solarcoin puts protecting natural capital at its foundation. The concept of "natural capital" aims to value the world's stocks of natural assets (geology, soil, air, water and living things) by making it investable. As SolarCoins are originated when a solar MWh is produced, the protection of natural capital is inherent to its value.

When used as a currency, the user is choosing to bring environmental concerns to the very foundation of economic activity. SolarCoin's blockchain uses a low energy proof of stake algorithm designed to use less than 0.001% of the power of Bitcoin when compared on similar scale. SolarCoin is truly an environmentally friendly currency.

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5. SolarCoin – a global incentive program for solar energy

As the project succeeds and the price of the coins appreciate, claiming SolarCoins becomes an additional and relevant revenue stream for solar power producers. Solar owners or generators could use/sell the solar electricity they generate, and also receive SolarCoins that can be redeemed, used, or exchanged for fiat currency. SolarCoin would thus become a significant incentive for solar energy investors to install more generation capacity. Investors make the financial decision to invest in solar power based on (a) the capital cost of the system, (b) the price for the solar electricity they generate, plus (c) the expected revenue from any additional incentives they receive (such as the price of the SolarCoins awarded). SolarCoin would become a **unique, borderless incentive program for solar energy, independent of any national or local incentives**.

6. SolarCoin Opportunity - A Call to Action

SolarCoin is a:

1. a free, additional reward for solar energy producers
2. the first digital currency to protect natural capital
3. the first global, decentralized, non-governmental solar energy incentive program

The purpose of this paper is to make a formal **call to action** to those with potential stake in SolarCoin, including governments, NGOs, international organizations and the solar industry. We are asking these entities to **endorse SolarCoin as a means of contributing to a global energy transition.**

6.1 Government opportunities

Register facilities to receive SolarCoins: At this moment, national and sub-national governments around the world own and operate thousands of MWs of large and small scale solar projects that are eligible to receive SolarCoins. From the school or firehouse with an array on the roof, to the large-scale installation already offsetting a town's carbon footprint, these existing power plants are eligible to begin receiving free SolarCoins.

These publicly-owned solar facilities could generate millions of dollars in SolarCoin. Governments at the local, state and federal level can claim SolarCoin retroactively back to January 1st, 2010. Examples of such facilities include schools, universities, hospitals, and municipal buildings. To begin this process, governments are encouraged to:

1. Inventory government-owned or used solar installations
2. Register systems with the SolarCoin foundation
3. Receive and use SolarCoins

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2 Bitcoin is estimated to require $5-6 bn USD in energy resources as of dec 2017.

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To give an indication of the funds available to government: every 100 MW of installed solar capacity could yield SolarCoins worth $70,000-$1,300,000 per year. The SolarCoin Foundation refrains from price speculation of any kind, so this number is just indicative. Current SolarCoin prices can be confirmed at https://coinmarketcap.com/currencies/SolarCoin/.

Use and accept SolarCoin: Public administrations may also accept SolarCoin as a means of payment for public services using 3rd party gateways to eliminate forex risk. A focus can be on those services contributing to climate change mitigation at first, before the system goes mainstream.

Re-distribute SolarCoin: SolarCoins may be re-distributed for “good actions” (i.e. donating SLR to people in "energy poverty" to help pay their bills, assisting smaller solar producers, assisting solar projects in the developing world, funding renewable energy research etc.), allowing for SolarCoins to circulate in the economy.

Government entities using SolarCoin could make a major impact on the current state of SolarCoin. Because SolarCoin is based on verifiably produced solar energy it is less volatile than many other blockchain tokens, and more government participation in the project will help curtail short-term speculation, enhancing its attractiveness to other investors and boosting its long-term value. By participating now, government entities can support the SolarCoin Foundation’s mission of a 40-year global solar energy incentive while helping stabilize the price of SolarCoins for the long term.

6.2 Solar Plant Owners and Operators, Utilities

Register facilities to receive SolarCoins: Any individual, solar company or energy utility that owns and operates solar installations is invited to register their solar installations to receive free SolarCoins.

Accept SolarCoins as means of payment: Solar installation companies are invited to accept SolarCoin as means of payment at the current face value quoted by market exchanges (Bittrex/Lykke) and have their goods/services paid in SolarCoins. Solar companies are invited to encourage partners and customers to accept SolarCoins as means of payment

Use SolarCoins: Solar companies are invited to circulate SolarCoins by granting the digital asset to charity programs, customer reward programs or other projects. Partners can be rewarded with SolarCoins - it all helps to build the ecosystem.

6.3 International Organisations, NGOs, and Industry Associations

Accept SolarCoins as means of payment/fundraising: Organizations and associations are invited to accept SolarCoin as means of payment at the current face value quoted by market exchanges (Bittrex/Lykke) and have their services or membership fees paid in SolarCoins. SolarCoins are an ideal means for fundraising of any kind, as coins can easily be sent with low transaction costs.

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Re-distribute SolarCoin: SolarCoins may be used for projects and programs. They can be re-distributed for “good actions” (i.e. donating SLR to people in "energy poverty" to help pay their bills, assisting smaller solar producers, assisting solar projects in the developing world, funding renewable energy research etc.). Organisations and associations can lead the way, inviting other stakeholders to tag along and donate their SolarCoins into projects suggested.

Spread the word: Organizations and associations are likely to quickly recognize the value of SolarCoin in the quest to promote solar energy around the globe. They are invited to actively communicate about SolarCoin to their members and the general public. Since blockchain and SolarCoin still need a lot of awareness raising, these organizations and associations are well positioned to support this cause. Organizations and associations that recognize the value of a global, government independent solar support scheme, are particularly invited to make this point towards political decision makers to gain support.

7. Conclusion

Harvard Business School professor Clayton Christensen defines disruption as “an innovation that creates a new market and value network and eventually disrupts an existing market and value network, displacing established market leading firms, products and alliances”.

SolarCoin ticks these boxes - it blurs lines that existed between formerly separate phenomena. SolarCoins are a **reward** for solar energy producers, a digital **currency**, and they act as a global solar energy **incentive** - a disruptive innovation among these established markets. With the endorsement of governments, international organizations, NGOs, and the solar industry, **SolarCoin is a disruption poised to accelerate the global clean energy transition.**

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Appendix

8. How SolarCoins get their value

8.1 Currency as a shared protocol of value

Currency is a distributed shared belief protocol that works a bit like a language in terms of positive externalities accruing based on ongoing participation. The more people who agree to use a language ('accept it'), the more value that language or specific form of communication protocol has.

As more users link up or support using a protocol, more value is supported by that protocol. The links form a network. Users of a currency informally agree to accept a currency protocol for value representation and transaction. This is done to reduce trade friction.

Currency is an informational value protocol expressed as pieces of metal, paper and electronic entries in bank accounts. Many argue a currency has value only if it is redeemable into gold or something else by the issuer upon demand. However, many. major world currencies like the Dollar, Euro and Yen aren't backed or redeemable for anything - for example, the US Dollar lost its gold-backed redemption feature in 1971.

Some users think and speak "value terms" to each other in Dollars, Yen or Euros. The more people who use a protocol, the more value emerges from that network of protocol users. Currencies are social protocols. Gold, Yen, Dollars, Euros and SolarCoin are all social protocols using different physical and electronic means to link up users up into networks enabling value exchange.

	Users (mm)	Value ($bn)	Value User	Adjusted for GDP
USD	1.000	$3,874	$3,874	$3,874
EUR	742	$1,300	$1,752	$3,019
WON	51	$91	$1,784	$3,700
RMB	1,379	$1,050	$761	$5,281
Gold	7,000	$7,710	$1,101	$6,119
BTC	18	$120	$6,667	$6,667
SLR	0.004	$0.016	$4,000	$4,000

Each exchange protocol has an estimated total network of users/believers. Each protocol also has a fairly well known circulating value equivalent to M0. The value created/emergent per user / believer acceptor of that protocol is trivial to calculate. Neither Gold, Yen, Dollars, Euros nor SolarCoins have any intrinsic value.

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Currencies are unitized social protocols for facilitating economic value transactions and flows between nodes or agents. Table 1 above shows the value per user of a few well known socio-economic protocols.When looking at the numbers it becomes apparent that the quotient of the total network circulating value and the nodes in the network are in very similar regions for USD, BTC, EUR and also SLR. Note the participants using a protocol can be larger or smaller than the issuing polity.

The value of a currency is determined by the faith of its users in utility across the network and over time. Like other communication protocols, the value of a currency increases proportionate to the number of users / acceptors / believers in that a currency protocol reduces friction and uncertainty in transactions, thus increasing trade flow across the entire system.

8.2 SolarCoin vs. ICOs, Ponzi and Pyramid schemes

An Initial Coin Offering (ICO) is an unregulated means to help startups that want to bypass regulated capital-raising processes. More than two billion dollars ($2B USD) was collected from investors through ICOs in 2017 alone. ICO usually work in a way that a percentage of the cryptocurrency is sold to early backers of the project. Often, projects trying to raise capital through ICOs only describe ideas in a white paper—the technology, product, or service doesn't even exist yet. Some ICOs have negatively impacted the reputation of cryptocurrencies, as they represent Ponzi or pyramid schemes produced by nefarious characters attempting to rope people in with promises of returns to maximize their own short-term profits.

The SolarCoin project is not related to token sale projects. **SolarCoin has not and will never offer coins or tokens in a public sale (ICO)**. SolarCoins are freely available to the producers of solar energy, and the SolarCoin Foundation does not charge claimants of SolarCoins. The SolarCoin Foundation relies on data to issue coins, ie: grid connection documentation and proof-of-ownership of the solar installation.

Unlike other projects, SolarCoin does not reserve large amounts of Coins for founders or other privileged entities. 99.4% of all SLR (§97.5 Billion SolarCoins) are stored in the SolarCoin Foundation non-circulating publicly visible generator pool account. These are exchanged for ongoing claimed "proof of work" of solar electricity generation. 0.6% of SLR have been utilized to get the network started, or are reserved in the genesis pool account and represent environmental charities, early volunteers, advisers, builders and maintainers of the SolarCoin infrastructure.

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3 Note "users" are not bounded by national boundaries. A currencies' belief/user footprint may be greater or smaller than the citizenry of the issuing state or entity.

4 M0 is standard economic forms of near money or currency equivalents expressed typically as notes, cash and bills in circulation. These often include electronic equivalents.

5 Gold has some physical functional value in electronics but is easily substitutable in most applications.

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9. The SolarCoin Ecosystem

The SolarCoin Foundation

SolarCoin was created in 2014 as an open community project run by volunteers and the founders of the SolarCoin Foundation, a Delaware (U.S.A) registered Public Benefit Corporation.

The SolarCoin Foundation distributes SolarCoins to generators of solar electricity using verified solar facilities as the "proof-of-work". As opposed to Bitcoin, SolarCoin is granted for the proof of energy production from the the solar installation. SolarCoin's blockchain uses a low energy proof of stake algorithm designed to use less than 0.001% of the power of bitcoin when compared on similar scale. The SolarCoin blockchain itself is a public ledger detailing each SolarCoin given out to solar electricity generators.

Founding members are Nick Gogerty and Joseph Zitoli, who represent the SolarCoin Foundation.

SolarCoin Affiliates, Advisors, and Volunteers

The SolarCoin Foundation works closely with affiliates who help to verify SolarCoin claims information. Affiliates are usually organized as for-profit companies, whose services significantly contribute to building the SolarCoin Ecosystem. Affiliates usually receive SolarCoins from the SolarCoin Foundation for each claim they verify and facilitate for claimants from a separate pool reserved for these services by the SolarCoin Foundation.

Current SolarCoin Affiliates are:

- Solcrypto - www.solcrypto.com
- ElectriCChain - www.electricchain.org

SolarCoin Advisors

The SolarCoin Foundation works with several advisors supporting its mission that do not receive payment for their services. Current advisors include:

- Oliver Gajda European Crowd Funding Network
- Paul Johnson Columbia University New York
- Kevin Sara Nur Energy
- Christopher Altman IHRO
- Hazel Henderson Ethical Markets

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6 Delaware Benefit Corporation

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SolarCoin Volunteers

Many volunteers improve the onboarding process for solar power producers. They comprise experts in the fields of IT, Marketing, Business Development etc.
The main channels for communication within the SolarCoin Community are:

- Facebook page - https://www.facebook.com/groups/SolarCoin/
- Slack Channel - https://SolarCoin-group.slack.com/messages/C0YSWLMHU/team/U7WKVLZ6G/
- Telegram -

  SolarCoin https://t.me/joinchat/Ab_ThgkSoV7d53yuI1RqUA

SolarCoin Development Team

The SolarCoin development team is embedded in the community of users and developers.

The SolarCoin project is **technology agnostic** and allows for forking (updating), using current state of the art methods and scaling to newer versions of Blockchain technology.

10. SolarCoin Use Cases

The following is a non-exhaustive list of use-cases for SolarCoin as a reward/ incentive-mechanism and/or through the Blockchain data layer:

1. SolarCoins can be **exchanged** through online exchanges such as Bittrex and Lykke (www.bittrex.com; www.lykke.com) for other digital assets (such as Bitcoin) and/or fiat currencies (EUR, USD…)

2. SolarCoins are starting to be accepted for **payments**, like other digital currencies. The SolarCoin community is aiming for an integration of SolarCoin as a payment network for goods and services.

3. SolarCoin offers **marketing opportunities** for brands positioned on ecological values and environmental protection. Early adopters and first movers are expressing the wish to use SolarCoins for payments, be it in environmental conscious contexts (organic food etc.), energy sector or NGOs.

4. SolarCoins can be used as a **reward for customers** and could be used as a loyalty program to allow them to benefit from the appreciation of the coins.

5. SolarCoins could be developed further to serve as equivalent of avoided CO2-emission certificates. With the Paris Agreement and international action to mitigate climate change at hand, SolarCoins could play a role in a revived carbon trade system via **crypto carbon credits.**

6. The SolarCoin blockchain can be used as a trusted **data layer** reporting solar power production data. Such data layer could certify solar components. This has been demonstrated by some companies to certify solar power plant due-diligence reports inside the immutable SolarCoin blockchain.

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7. The SolarCoin blockchain can provide a “Know-Your-Device” (KYD) anchor data provenance layer for providing more security when monitoring solar power produced.

8. The SolarCoin blockchain is an Open-Community data resource. Anyone may publish solar energy data, a Global Solar Macroscope may act as a decentralized solar energy monitoring platform. This can have two levels of data, on-chain public data, and off-chain private login data for each specific solar plant added into the decentralized monitoring protocol. Some open data can be used at specific intervals for solar power production data according to geographic region, taxes (when billed in SolarCoin) and financial tools (solar energy derivatives and exchange platforms). Some closed or private data can be extended to point to off-chain logins for specific internet layer solar monitoring platforms such as Wattmon.live, Enphase and others.

11. Reference Papers and Further Reading

SSRN papers

1) Gogerty, Nick and Zitoli, Joseph, DeKo: An Electricity-Backed Currency Proposal (January 4, 2011). Available at SSRN: https://ssrn.com/abstract=1802166 or http://dx.doi.org/10.2139/ssrn.1802166
2) Johnson, Luke Patrick and Isam, Ahmed and Gogerty, Nick and Zitoli, Joseph, Connecting the Blockchain to the Sun to Save the Planet (December 11, 2015). Available at SSRN: https://ssrn.com/abstract=2702639 or http://dx.doi.org/10.2139/ssrn.2702639

Energy Calculations and Developing Country Calculations about the SolarCoin Blockchain

1) The Proof of stake calculation POW vs. POST and the Energy Expenditure for Consensus

https://docs.google.com/spreadsheets/d/1QzIA5Nd3pVRGn2c48Oc_dqpImrOfYlwp74UzHXjArdE/edit?usp=sharing

2) Kenya M-Kopa SolarCoin model using Metcalfe’s law Network Theory of Value

https://docs.google.com/spreadsheets/d/1xfeV4sqnVrkvim-vZg_7w9JfR_GdN_q29fmlgF-r3is/edit?usp=sharing

Website: SolarCoin.org

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7 Certifying solar due-diligence reports in the SolarCoin blockchain https://www.sunpulse.net/report-status/

8 The ELCCpv1 protocol is outlined here: https://github.com/lpninja/ELCCpv1

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