PURPOSE INVESTMENTS & PATCH

Achieving Carbon Neutrality with Cryptocurrencies

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1.0 INTRODUCTION

Carbon Neutral Crypto

Over the last decade, climate change has risen to the top of the list in global agenda as some of its effects intensified along with projections that signal even worse. As people became more cognizant, their choices from consumption to investment changed to include this externality. That alone has impacted government policies, shifting funds toward ideas that take the environment into account and to those that offer solutions to what we face.

Coincidentally, blockchain technology – that allows peer-to-peer transactions without an intermediary – emerged during this period. As a result, it has faced its fair share of criticism when it comes to energy consumption and whether it offers enough positive in social and governance aspects of ESG to counteract the effects on environment. This has made environmentally conscious investors reluctant, irrespective of their views on the future of cryptocurrencies.

Without going too much into the debate of whether they are actually bad for the environment, we pose a solution by offering investors exposure to cryptocurrencies – Bitcoin and Ether, in particular – without the associated carbon emissions. We take the environmental aspect out of the equation, allowing investors to invest in cryptocurrencies with a clear mind.

2.0 CLIMATE CHANGE

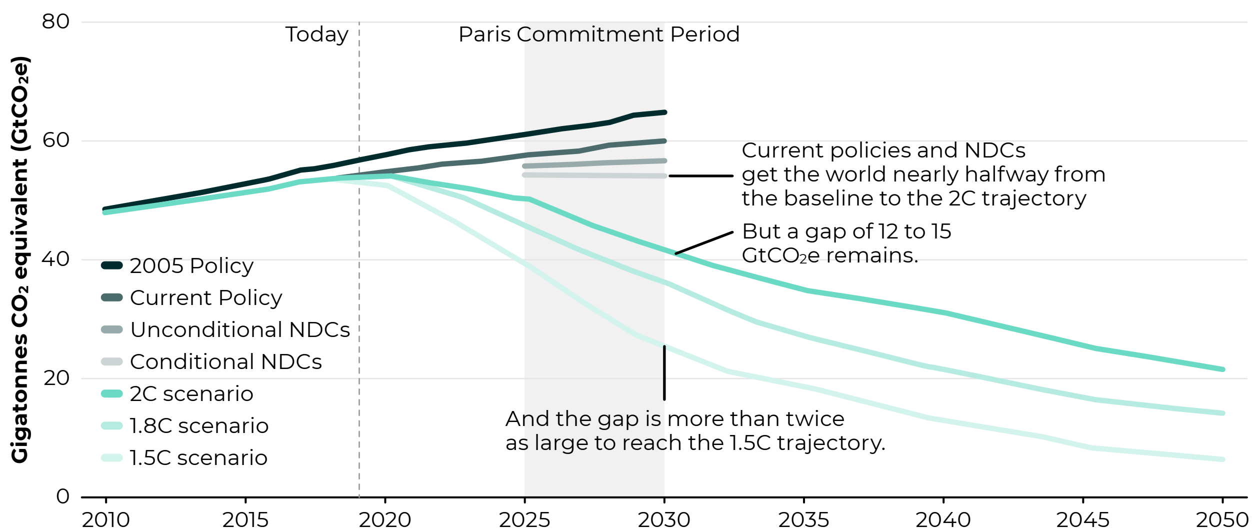
The development of our civilization came with the cost of pumping greenhouse gases into the atmosphere, which has recently become clear as something with serious downstream consequences.

In recent years, global warming and its associated problems have risen to the top of the agenda, like The Paris Agreement – a monumental example of collaboration by almost all nations to limit temperature increases to around 1.5°C, or 2°C in the worst case scenario.[1]

To achieve this, we need to figure out ways to alter or reimagine processes to prevent emissions or minimize them if current technology doesn't make elimination possible. However, the current path we are on doesn't look optimistic: our trajectory is off from the 2°C scenario and far away from ideal 1.5°C scenario. We still have a long way to go if we are to achieve a meaningful reduction in emissions, as evident in the chart.

For activities where total reduction of emissions is not possible with our current technology, we could complement them with processes that have negative emissions, which is achieved by taking carbon out from the atmosphere. This can help us balance out unavoidable emissions, as well as keep us under the limit, while we try to transition into a low emission economy, which will take time.

This is where carbon credits and offsets come into play. Carbon credits are simply the right to emit carbon, while offsets represent a reduction or prevention of carbon emissions in the first place (*more details here*). They also include negative emission offsets that actively take carbon out from the atmosphere. The idea is to have a decreasing carbon budget – measured by carbon credits – to incentivize emission reduction over time, which can be complemented by having offset credits to balance out excessive emissions. In addition, these offsets can be used by individuals and institutions to balance out their footprint voluntarily.



Source: https://www.carbonbrief.org/unep-1-5c-climate-target-slipping-out-of-reach ; Retrieved on 09/22/2021

3.0 CRYPTOCURRENCIES AND ENERGY USAGE

Cryptocurrency is a digital asset that leverages blockchain technology to serve as a decentralized form of payment for the online exchange of goods and services.

Among the thousands of different cryptocurrencies, the two with the largest market cap are bitcoin and ether.[2] Here we will focus on how they work and their overall energy consumption.

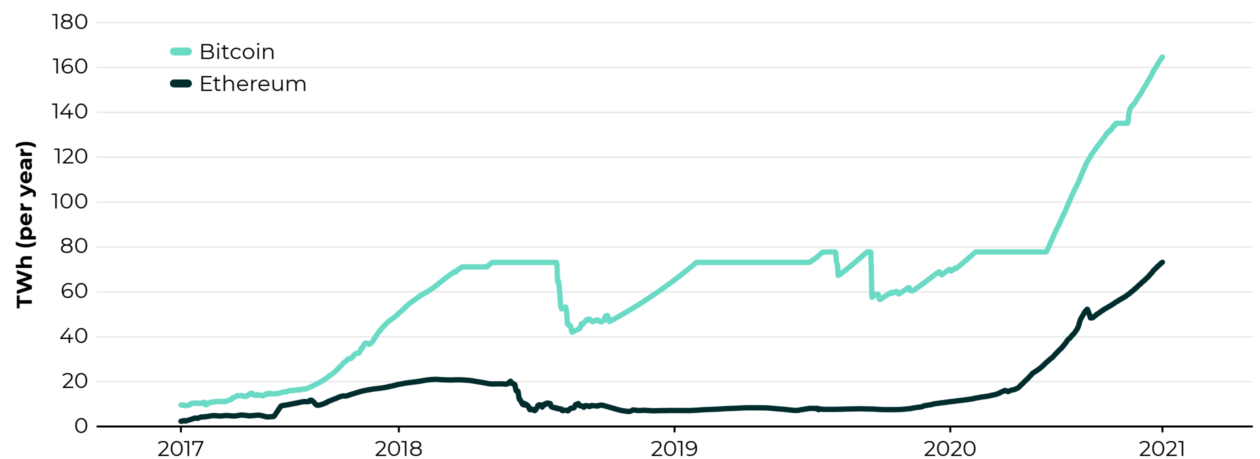
Each network has a "mining" process that is responsible for approving transactions as well as the addition of new blocks (and coins) to the existing chain. Depending on the cryptocurrency, this process could involve other particulars as well (more details *here*). Mining is the key process in achieving a truly decentralized network.

Currently, both Bitcoin and Ethereum use the Proof of Work (PoW) consensus mechanism in which miners use specialized computers to compete to solve a computational puzzle. The amount of work (computing) done by a particular miner determines the possibility of solving the puzzle first, which means earning the reward. As you add more computing power to the system, the network increases the difficulty of the "problem" to keep the hurdle relatively constant. As a result, a single entity must achieve a share of 51% of the overall computing power in order to control the authentication process and manipulate it.

The nature of PoW makes it very difficult for transactions to be manipulated while achieving a truly decentralized system, which is also its Achilles heel when it comes to energy consumption. As miners compete to solve the puzzle, one can argue that those unable to solve it in time have expended energy that didn't amount to anything, other than providing security for the whole network.

Bitcoin's energy expenditure is estimated to be around 164 TWh, while Ethereum's is around 73 TWh.[3,4] However, these numbers are not meaningful in absolute and next we're going to take a look at how they compare.

Energy Consumption of Bitcoin and Ethereum



Sources: Bitcoin: https://digiconomist.net/bitcoin-energy-consumption; Ether: https://digiconomist.net/ethereum-energy-consumption ; Retrieved on 09/22/2021

3.0 CRYPTOCURRENCIES AND ENERGY USAGE

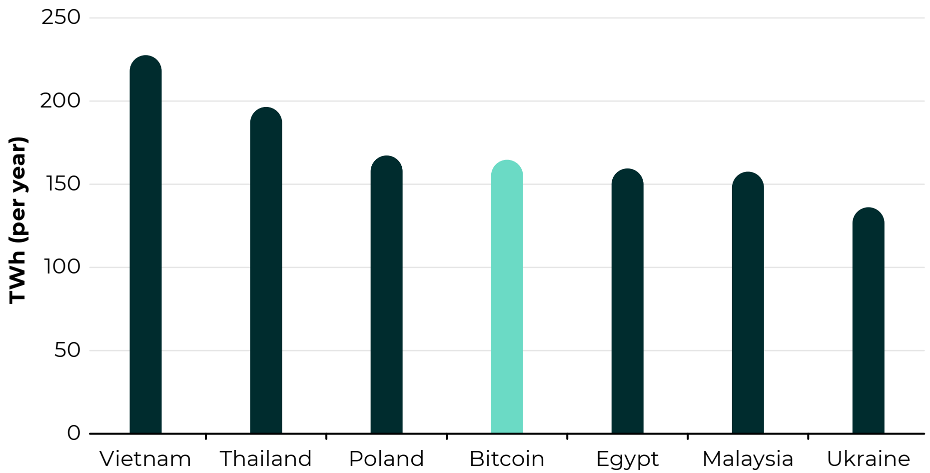
How Do They Compare?

The energy consumption numbers make more sense when contextualized. As highlighted below, Bitcoin's energy consumption is estimated to be higher than countries such as Ukraine and Egypt.[3] On the other hand, Ethereum is a little further down the list – 41st – but still higher than Czech Republic and Colombia.[4]

These comparisons are essentially the reason for criticism regarding the amount of energy expended to 'revolutionize finance' as we struggle with climate change. At the end of the day, it is not the numbers themselves, but having a system consume more energy than countries or even continents.

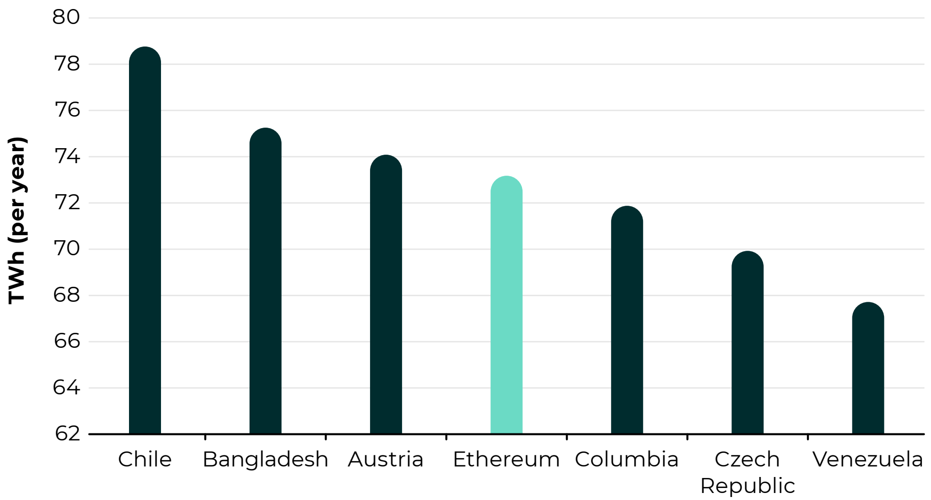
While the comparison is effective, it's not necessarily an apt one. Ultimately, cryptocurrencies are replacing – or planning to replace – conventional banking systems. So long as cryptos are competitive with the banking system and our need for a financial system continues, the energy consumption may be a necessary evil.

Bitcoin's Energy Consumption Relative to Countries



Source: https://digiconomist.net/bitcoin-energy-consumption ; Retrieved on 09/22/2021

Ethereum's Energy Consumption Relative to Countries



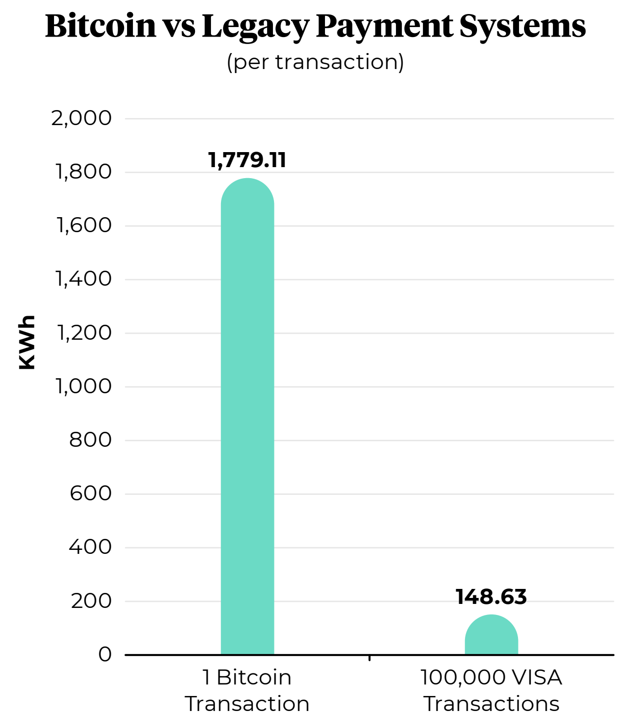
https://digiconomist.net/ethereum-energy-consumption ; Retrieved on 09/22/2021

3.0 CRYPTOCURRENCIES AND ENERGY USAGE

According to reports, the banking system and gold consumes two times more energy than Bitcoin.[5] This makes it seem like energy consumption shouldn't even be considered when talking about cryptocurrencies given how much conventional systems use.

However, if we look at the energy consumption attributable to a single transaction, it may paint a different picture. Highlighted here, it appears that Bitcoin requires considerably more energy per transaction compared to Visa.[6] Still, this may not be a good comparison due to unknowns such as the total value transacted, or emissions attributed to the security or cooling infrastructure. For example, Bitcoin's mining operation can be considered in the scope of a transaction, but it also provides security to the whole network while a Visa transaction may not involve externalities.

Therefore, it is important to note that there isn't a widely accepted and regulated way of measuring these values, making it difficult – or perhaps incorrect –to directly compare the results of these studies. However, it is safe to say that cryptocurrencies, like any other industry, need to improve their emission standards to meet long-term climate goals.



Source: https://www.statista.com/statistics/881541/bitcoin-energy-consumption-transaction-comparison-visa/ ; Retrieved on 10/25/2021

4.0 REMEDIES

Renewables

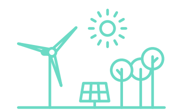
One clear option for "cleaning" mining operations is having a greater share of renewable energy in the electricity it consumes. Bitcoin Mining Council estimates this number is currently around 56%, but this must be taken with a grain of salt since it is a voluntary survey that is potentially open to sampling and other biases.[7] Nevertheless, if we simplify things and look at the share of renewables in global energy production – which is around 29% – we can use that as a proxy for Bitcoin's (or other cryptos) renewable energy share.[8] Because Bitcoin's mining power isn't distributed equally, as well as the types of renewable energy available around the world, we should reiterate that it is indeed a simplified number.

Changing How We Mine

We previously mentioned PoW and how the mechanisms that make it decentralized and secured also requires it to consume a lot of energy. Here we will discuss an alternative: Proof of Stake (PoS). PoS is an alternative consensus mechanism that works by selecting validators – not miners – in proportion to the amount of said cryptocurrency they hold (more information *here*). Because of this difference, they tend to require less computing power. Additionally, Ethereum is planning to transition into PoS in late 2021 or early 2022. This move is expected to reduce the energy consumption of Ethereum network by around 99%.[9] If their claims are true, it would drastically reduce its energy consumption, while achieving a similar level of decentralization and security.

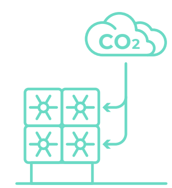
Carbon Offsets

As previously mentioned, we can balance out unavoidable carbon emissions by using carbon offsets. Carbon offsets can be achieved by two types of projects: [10,11,12,13]



Avoidance Offsets
Reduce the amount of CO_2 being produced elsewhere.

Examples: Renewable energy, methane abatement, energy efficiency and fuel switching.



Carbon Removal and Sequestration
As the name suggests, it actively take out carbon from the atmosphere and sequester it.

Examples: Direct air capture, biomass, mineralization, forestry, ocean fertilization, soil management.

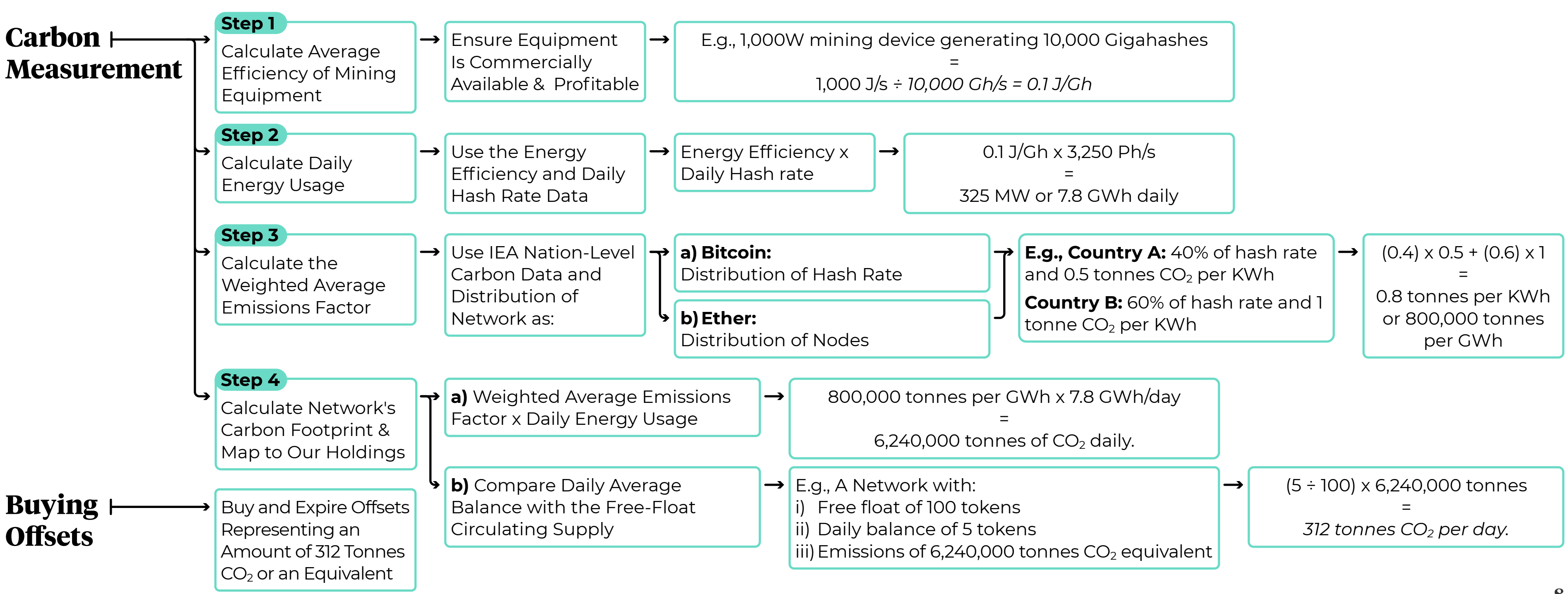
These are further discussed *here*.

5.0 OUR METHODOLOGY

Our approach to achieving a carbon neutral state has two parts. First, our partnership with Patch allows the measurement of the carbon footprint of our portfolio, whether for bitcoin or ether. Then, we buy an equal amount of carbon offsets to balance these emissions. Here, we will go into the details of this process.

Partnership with Patch

Patch brings together companies in need of a carbon-removal solution with those who provide them. They find high-trust projects, with minimum secondary effects, that produce carbon offsets, purchasable by companies or portfolios that have unavoidable emissions (further Patch info *here*). There is a crucial step before one purchases these offsets: calculating the footprint of the portfolio. This a relatively new area without strict regulation, so we expect other institutions to approach from different angles. While none of these methods are perfect, and it is difficult to say one is correct, our goal is to achieve a net zero state while minimizing possible negative downstream effects.



Part 1 MEASURING CARBON EMISSIONS

Before we jump in, let's start with an overview of the measurement process:

The process starts by estimating the **average efficiency of mining hardware** used in the network, which is then used with **daily hash rate** data to **calculate daily energy expenditure**.

Given the unequal nature of carbon emissions across the world, the **weighted average emissions factor** for the network is calculated using the distribution of mining power and national level carbon emission data.

Combining both the **daily energy expenditure** and **weighted average emissions factor** gives the **daily emissions** for **each network**.

Finally, this value is mapped to our cryptocurrency holdings based on our ownership share of the total circulating supply.

If you are ready, let's jump into a more detailed version.

Step 1: Average Efficiency of Mining Equipment

Patch computes the efficiency of a network's mining equipment on a given day by taking the simple average of all commercially available hardware that can be run profitably given market conditions.

Hardware is said to be profitable if the expected value from block rewards over the course of a day is greater than the cost to run the machine for 24 hours.

Due to challenges with data availability, capital expenditures or other operational costs are not considered when calculating profitability.

In order to account for latency in mining operators switching machinery on and off as market conditions change, profitability is computed using a 7-day moving average.

Also, Patch **assumes** that the global average electricity price is 0.05 USD/KWh and constant over time. This figure comes from large mining operators.[14]

Putting this all together, the efficiency of a profitable piece of hardware is calculated by dividing its power by its hash rate. To provide an example:

E.g., a 1,000W mining device that generates 10,000 Gigahashes per second has an **efficiency** of:

1,000W = 1,000 Joules per second

1,000 J/s ÷ 10,000 Gh/s = ***0.1 J/Gh***

Step 2: Daily Energy Usage

The hardware efficiency number and daily network hash rate allows the calculation of the **daily energy usage**.

E.g., with a hash rate of 3,250 PH/s and energy efficiency of 0.1 J/Gh:

3,250 x 0.1 x 1,000,000 = 325,000,000 J/s

*which equals to **325 MW** or **7.8 GWh** daily.*

As a final correction, the energy usage is multiplied by a power usage effectiveness (PUE) factor of 1.1 to account for incremental energy usage for additional IT infrastructure (such as cooling in data centers). This PUE is derived from conversations with mining operators.

Step 3: Weighted Average Emissions

This process involves a top-down geographical analysis of the **distribution of mining power** for Bitcoin and Ethereum networks separately. Then International Energy Association's **national level carbon intensity data** is used to compute the **weighted average emissions** for each network.

Bitcoin: Distribution of hash rate across the world is used.

E.g., For a scenario with two countries:

- *Country A: 40% of hash rate and 0.5 tonnes CO_2 per KWh*
- *Country B: 60% of hash rate and 1 tonne CO_2 per KWh*

The weighted average emissions is:

*(0.4) x 0.5 + (0.6) x 1 = **0.8 tonnes per KWh** or **800,000 tonnes per GWh***

Ether: The same principle is used, but the global distribution of nodes is used as a proxy for the distribution of mining power.

Step 4: Network's Carbon Footprint

To calculate the **daily carbon footprint**, **weighted-average emissions factor** is multiplied with **daily energy consumption**.

E.g., 7.8 GWh/day x 800,000 tonnes per GWh = 6,240,000 tonnes of CO_2 daily.

The final step is to map network level daily emissions to our holdings.

For both networks, our daily average balance is compared to the free float circulating supply. Free float circulating supply excludes tokens that are provably lost or in accounts subject to escrows. This approach assumes emissions responsibility grows linear in the number of tokens held for a given network. This approach also assumes all token holders equally benefit from the network security provided by miners.

E.g., For a network with 100 free float tokens:

- *If we own 5 of the tokens and the daily network CO_2 is 6,240,000 tonnes*

(5 ÷ 100) x 6,240,000 tonnes = 312,000 tonnes CO_2 per day

To learn more about the methodology, a more detailed outline can be accessed *here.*

Part 2 OFFSETTING CARBON EMISSIONS WITH NEGATIVE EMISSIONS

Now that the math is over, let's get into the fun part. Once we have a number for how much carbon is attributed to our holdings, as Purpose, we can buy and expire an equal amount of offsets to balance it out.

While we invest in both types of offsets, as they can help to balance carbon emissions, carbon removal offsets tend to be more effective in reducing total emissions since they actively take carbon out from the atmosphere while avoidance offsets simply prevent the addition of more carbon.

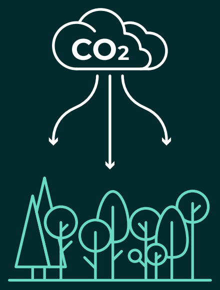
The typical negative emission projects we invest in include:

- Direct Air Capture
- Biomass
- Mineralization
- Forestry
- Ocean Fertilization
- Soil Management

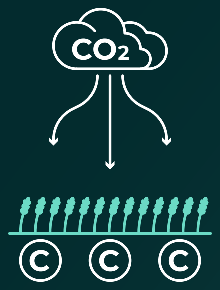
Once we buy the offsets from voluntary markets and expire them, they can no longer be tradeable. Furthermore, we take every precaution possible to ensure they have the highest quality by today's standards and continue to monitor and adapt to evolving standards.

Possible approaches for negative emissions

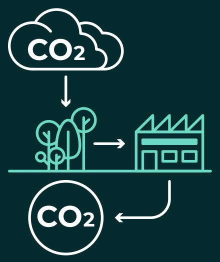
Afforestation, reforestation, forest management and wood utilization
Trees remove CO_2 from the air as they grow. The CO_2 can be stored in trees, soil and wood products.



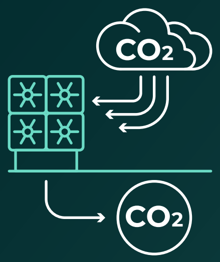
Soil management (incl. biochar)
The introduction of carbon (C) into soils, e.g., through crop residues or vegetable carbon, can accumulate C in the soil.



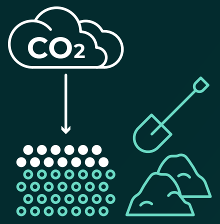
Bioenergy with carbon capture and storage (BECCS)
Plants convert CO_2 into biomass, which provides energy. CO_2 is captured and stored underground.



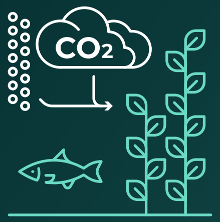
Direct air capture carbon capture and storage (DACCS)
CO_2 is extracted from the ambient air by chemical processes and stored underground.



Enhanced weathering
Crushed minerals bind CO_2 chemically and can then be stored in products, in the soil or in the sea.



Ocean fertilization
Iron or other nutrients are added to the ocean to increase the absorption of CO_2 by algae.



Source: https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/emission-reduction/negative-emissions-technologies.html
Retrieved on 09/22/2021

6.0 EXAMPLE PROJECTS

Kootznoowoo Improved Forest Management

Type: Forestry

The Bluesource – Kootznoowoo Project protects 20,159 acres of forest across 4 project areas in Alaska. Approximately 8,000 acres of the project property is old growth forest, a historically significant timber source for the Japanese market. The project is owned by the native Kootznoowoo people and managed in common with the U.S. Forest Service. This project ensures the long-term sustainable management of the area, which could otherwise undergo significant commercial timber harvesting.

CarbonCure

Type: Mineralization

CarbonCure's carbon dioxide removal (CDR) technology offers permanent, verifiable, and scalable carbon reductions for the concrete industry. The retrofit technology is installed in hundreds of concrete plants globally, and the company is continuing to launch new innovative products and technologies. CarbonCure's technology won the grand prize in the $20 million NRG COSIA Carbon XPRIZE competition, selected as the most scalable breakthrough technology to convert CO_2 emissions into usable products. CarbonCure was also recognized as Cleantech Group's North American Company of the Year in 2020.

Running Tide Kelp Sequestration

Type: Oceans & Kelp

Running Tide is harnessing the power of the ocean to build a climate positive future.

Kelp forests remove CO_2 from the ocean as it grows (20x faster than trees!). Running Tide is building the most efficient carbon removal system in the world by scaling this natural process. Their solution relies on photosynthesis, ocean currents, and gravity to remove and store carbon in the deep ocean. Running Tide's system offers permanent and scalable carbon removal at low cost and without high land use.

7.0 CONCLUSIONS

It took our society a while to understand the potential consequences of dumping greenhouse gases (GHGs) into the atmosphere, some of which might be irreversible.

The good news is that we are now aware of it and making an effort to change it as we try to come up with relatively "cleaner" processes to replace conventional ones. We are also trying to come up with processes that can take carbon out of the atmosphere and sequester it. We must accept that we may not achieve a full decarbonization in some processes and, even if we do, the time it takes could mean we end up pumping more GHGs than we should to avoid a runaway global warming scenario. As a result, it may make sense to utilize a multi-faceted approach rather than fixating on one. One thing is clear: we have used up most of the buffer the Earth has provided us as we developed as a civilization.

One of the newer developments is the blockchain technology that enables transfer of funds or assets in a decentralized network consisting of individual users, functioning through the use of a consensus mechanism. The poster child of blockchain is Bitcoin – along with Ethereum – which currently uses a Proof of Work system that has been in the limelight due to the amount of energy it uses.

Some of the potential remedies include transitioning into a different consensus mechanism such as Proof of Stake, which is what Ethereum plans to implement. Another option is to decarbonize the energy supply – while already underway, it will take some time. Finally, we have negative emissions that take out carbon from the atmosphere, which can be coupled with cleaner processes to achieve a net neutral stage, or perhaps a stage with net overall negative emissions.

To bring these ideas into investing – alleviating environmental concerns attached to blockchain investing – we partnered with Patch and estimate the carbon emissions attributable to the portfolio, which can then be coupled with carbon offset projects that create offsets. We then buy and expire these offsets to balance out the footprint of our portfolio.

We acknowledge that this area is quite new, which may result in different approaches to solve the emission problem. There are rightful concerns around some of the projects that may simply shift the emissions downstream, such as having forestation in one area causing deforestation in a nearby area. In addition, projects like renewables might cause secondary emissions or damages to the environment that are not considered in the equation when offsets are bought and expired. These are problems associated with carbon credits and offsets in general that we are aware of. We do not claim that offsets are the perfect solution with no negative externalities or downstream effects, they are simply the best option we currently have. This is critical to accept as we do not have the luxury of waiting for the industry to develop while we get closer to the 2050 deadline. Just like any new sector or industry, carbon credits and offsets will achieve greater reliability and accountability over time – and we will be sure to stay abreast for best available solution.

8.0 APPENDIX

1 Ibid, https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf

2 CoinGecko (retrieved on October 19th, 2021), https://www.coingecko.com/en

3 Digiconomist (As of September 22nd, 2021), https://digiconomist.net/bitcoin-energy-consumption

4 Digiconomist (As of September 22nd, 2021), https://digiconomist.net/ethereum-energy-consumption

5 Cointelegraph, https://cointelegraph.com/news/banking-system-consumes-two-times-more-energy-than-bitcoin-research

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11 American University, https://www.american.edu/sis/centers/carbon-removal/what-it-is.cfm

12 The Climate Trust, https://climatetrust.org/avoidance-and-removal-offsets-are-needed-equally/

13 World Resources Institute, https://www.wri.org/initiatives/carbon-removal

14 Cambridge Bitcoin Electricity Consumption Index, https://cbeci.org/index/methodology

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