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The Bitcoin Standard: The Pursuit of Sound Monetary and Environmental Management Systems

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Abstract

The adoption of blockchain technology as a medium for monetary and management systems creates an opportunity for an environmentally conscious economic system. This paper discusses how Bitcoin and blockchain would provide a socio-economic management system better aligned with a society's eco-friendly aims and to address the extent of environmental degradation. Unfortunately, our ecosystems are not being protected or restored reflective of the value they provide. Economic models also ignore the varied costs of polluting our ecosystems. Advancements of blockchain-based technology enable a decisive move from current legacy market structures and incentives. Efforts in environmental policy and regulation have ultimately been insufficient accounting for and pricing in positive and negative externalities. Chapter one provides an overview of ecosystem health and its perceived numerical but neglected marketed value. This is followed by qualitatively analyzing human contributions to environmental destruction and degradation in the form of consumerism's pervasive energy consumption. Chapter two develops moral frameworks through the Environmental Justice movement. Upon this ethical foundation, chapter three inserts an economic lens to attempt numerical estimates of ecosystem values to be factored in through concepts of Environmental Economics. Fundamentals of blockchain and Bitcoin are discussed in Chapter four. In addition, the capability to align one's values with the environment, and positively incentivize our socio-economic behavior to harbor environmental mindfulness are detailed. Examples of digital currencies as an alternative store of value, blockchain systems aiding renewable energy projects and supply chain management are included as well. Adoption successes and challenges are addressed in Chapter five. Lastly, further recommendations on blockchain implementation to catalyze environmentally conscious societies are suggested.

Keywords: Blockchain, Bitcoin, Environmental Economics, Consumerism, Sound Money, Environmental Justice, Renewable Energy, Supply Chain Management, Externalities

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Introduction: The Digital and Environmental Intersection

"It is well enough that people of the nation do not understand our banking and monetary system, for if they did, I believe there would be a revolution before tomorrow morning."[1] It is far too easy to fall victim to complacency and gravitate to corners of comfort. We are, at this very moment, on a gigantic hamster wheel, guided and ruled by inadequate, ineffective operating systems. If we could understand the depth of negligence and harm current monetary and management systems (ie. governments, regulators, industries, etc.) are fostering, there surely would be an uprising before dawn. Optimistically, I believe people are well intentioned. Unfortunately, even the most well intentioned can lose their 'sight' when blinded by the lure of money and deceptive policies resulting from self-interest and greed. Governing entities and their fiat money have over-promised and under-delivered for decades. The traditional financial industry is at best crumbling, as was made painfully clear during The Great Recession. When money is broken, the entire system, regardless of industry, is corrupted. It is not surprising then, that our relationship with the environment is also in peril. We cannot even begin to include the environment if we are either ignorant or overwhelmed by human-centric problems. The first challenge is to redefine what money is and alter the understanding of how dishonest money (ie. fiat) distorts human incentives and morals that shape our very society. Secondly, we must adopt a sound monetary standard that is honest. Sound Money, first and foremost is a reliable store of value, for it holds the essence of one's life work. The pseudonymous creator of Bitcoin, Satoshi Nakamoto has given humanity a real opportunity to seize back a sound money paradigm. Simultaneously, he gave birth to a new operating system mankind can adopt for various uses, blockchain technology. The revolution is just starting.

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[1] "Henry Ford Quote," A-Z Quotes, accessed May 9, 2021, https://www.azquotes.com/quote/99149.

In this thesis I will demonstrate how to create an environmentally inclusive socio-economic community through environmental ethics, environmental economics, Bitcoin, and blockchain technology. A genuine approach to a sustainable relationship with the ecosystems is the way for us to operate on a shared time preference with our earth. Chapter one will focus on modern conspicuous consumerism which has enabled unadulterated energy production and use. This issue is presented through the lens of environmental externalities that are pervasive, but opaque in contemporary capitalism. Chapter two will dive into the morality emergent from the models and incentives we live by and for. It is necessary to start at the core of ethical principles to cultivate and uphold a symbiotic relationship with our ecosystems. In attempts to acknowledge and account for externalities, the success and challenges of environmental economics are discussed in chapter three. In chapter four blockchain basics are laid out as a foundation to understanding how individuals, businesses, and states/nations can harness the capabilities of this technology to hone their environmental aims. The first known digital asset of its class, Bitcoin, and its underlying protocol is explained and then recommended for adoption. Furthermore, the case for a return to sound money is made. Understanding the failing of legacy fiat currency and redefining man's relationship with time, energy, and money presents the common man with an alternate perspective. Blockchain solutions are offered in energy production & consumption along with supply chain management solutions to mitigate externalities. Finally, for authorities and regulators, a governance model on a blockchain protocol is prescribed for trustless mediation through providing transparent accountability on an immutable digital record. In conclusion, the preceding chapters are encapsulated to formulate a globally adaptable framework; one which citizens, businesses, and directorates can participate in, contribute to, and ultimately utilize to guide their environmentally focused decision making.

Chapter One: Negative Externalities and Monetary Systems

In 2005 writer and thinker, David Foster Wallace, gave a commencement speech at Kenyon University:

> There are these two young fish swimming along and they happen to meet an older fish swimming the other way, who nods at them and says, "Morning, boys. How's the water?" And the two young fish swim on for a bit and then eventually one of them looks over at the other and goes "What the hell is water?".

In his words, "the point of the fish story is that the most obvious, important, realities are often the ones that are the hardest to see and talk about". While Wallace asked the graduating seniors that day to think about fish and their relationship with water, I ask you to think about your own relationships with our earth and, as Wallace also asked, "bracket for just a few minutes your skepticism of the totally obvious" and reconsider "what is real and essential, hidden in plain sight all around us all the time."[2]

Our Ecosystems. Nature is the essence of our earth. She is inevitable, forever pervasive, ruthless yet kind, dynamic and thus ever changing. Today, our communities and lifestyles have adapted to advancing technologies and modern ideals of comfort. Suffice it to say that there has been a monumental shift towards modernization through degradation and elimination of our surrounding environments. Grocery/consumer shopping, boarding a flight to visit a friend, or even sitting at home watching the newest Netflix flick all have consequences beyond the immediate intended outcomes. These realities are squarely in the crosshairs of our lens, but we refuse to or are unable to focus on them. The thunderous warnings and disappointment of the

[2] Ross, L Stevens. *2020 Shareholder Letter*. PDF file. December, 2020. https://www.microstrategy.com/content/dam/website-assets/collateral/bitcoin-downloads/Stone-Ridge-2020-Shareholder-Letter.pdf. 2.

Earth manifest in extreme weather events such as worldwide flooding, raging forest fires and Texas literally freezing over for a week. The environments we live in are in serious jeopardy; it is crucial to develop a relationship to foster sustainable initiatives to support the health and beauty of the planet.

In another way, we are faced with a new challenge, Covid-19. You may ask how the coronavirus pandemic is at all an environmental issue? Put succinctly, the destruction of borders between ecosystems and human activity become perfect breeding grounds for human-animal/insect cross contamination. It is estimated that a 5% loss of forestation in Brazil's Amazon led to a 50% increase in malaria cases as the loss of trees provided an excess of sunlit puddles ideal for mosquito propagation.[3] Similarly, Covid-19 allegedly started in one of China's many 'wet markets' where there are hundreds of species that nature did not intend to bring together.[4] Before detailing how the human species has wreaked havoc with nature and what we can do about it, let's take a step back and ask some questions. What exactly are ecosystems? Why should we all actively care about and for them? What is the actual current state of these ecosystems?

To begin, we must understand that ecosystems are not distinct and separate from us. We are very much a part of *their* fabric. We all play a vital role in how we interact and sustain our environment and vice versa. Our well being is quite literally dependent on the services provided. Generally, there are four ways to understand ecosystems. First, they support us through nutrient recycling, soil formation, ozone layer protection, etc. Secondly, they provide food, water, and raw materials. Next, regulation by ecosystems is provided in the forms of climate, water

[3] Tyler, G. Miller and Scott, E. Spoolman, *Living in the Environment 19th ed.* (Boston, Ma. Cengage Learning Inc, 2016), 450.
[4] Alex Shaw, "Back inside the Wuhan market where Covid-19 was first traced," *bbc.com*, January 22, 2021, accessed May 10, 2021, https://www.bbc.com/news/av/world-asia-china-55757084.

purification, and flood control, to name just a few. Lastly, cultural services are derived through the recreational capabilities of our environment; have you recently enjoyed a visit to the beach? Undeniable aesthetic properties and abundant educational opportunities are supplied[5]. The sum of all these services allow us to have a healthy, socially cohesive, and safe life.

Estimates have been aggregated by R. de Groot et al. of the value of ecosystem services per biome (10 biomes were evaluated) in monetary units. Based on data from the proceeding geographical locations (28% from Asia, 26% from Africa, 14% from Europe, 12% from Latin America and the Caribbean, 12% from North America, and 8% from Oceania) global ecosystem services amount to an average of 618,187int$/ha/year[6]. That is, 600K+int$, per hectare of biome per year. For context, there were about 12.2 billion hectares of biologically productive area on land and water in 2019[7]. The global population in 2019 was 7.7 billion people which equals about 1.6 global hectares per person[8]. One interpretation could be to say we are each responsible for 1.6 hectares, at an average valuation of 960K (int$) each. Another way to interpret this data is to say we are afforded 960K in productive land/water mass from which we can derive shelter, food, and entertainment. Either way, even though we can numerically express estimated averages of ecosystems, from a uniquely human perspective the sentimental and social value that biologically productive lands provide are surely unquantifiable.

How do humans engage in said ecosystems? We bring indirect and direct change.[9] Indirect change can be largely understood through technological advancement and the implementation of economic policies/agendas, and the sociopolitical landscape of how one is

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[5] Ecosystems and Human Well-Being: General Synthesis. *Millennium Ecosystem Assessment*, (Washington, DC: Island Press, 2005), Vi.
[6] Rudolf, de Groot et al., *Global estimates of the value of ecosystems and their services in monetary units.* PDF file. July, 2012. https://www.sciencedirect.com/science/article/pii/S2212041612000101?via%3Dihub. 54-55.
[7] "Glossary," Global Footprint Network, accessed April 28th, 2021, https://www.footprintnetwork.org/resources/glossary/.
[8] Ibid
[9] Ecosystems and Human Well-Being: General Synthesis. *Millennium Ecosystem Assessment*, Vii.

expected/allowed to cultivate their relationship with the environment. Drivers of direct change are then the harvesting of natural capital, technology use, land use, and external outputs of things we produce and then consume[10]. The overview below highlights how the world's biomes and landscapes have been altered due to human activity and have not only negatively affected the environment, but have also impacted local communities…

- Approximately 20% of the world's coral reefs were lost and an additional 20% degraded in the last several decades of the twentieth century; also approximately 35% of mangrove area was lost during this time[11].
- The number of species on the planet is declining. Over the past few hundred years, humans have increased the species extinction rate by as much as 1,000 times over background rates typical in the planet's history[12].
- The early 1990's collapse of the Newfoundland cod fishery due to overfishing resulted in the loss of tens of thousands of jobs and cost at least $2 billion in income support and retraining[13]. .
- The best research currently available estimates that there are over 150 million tonnes of plastics in the ocean today. In a business-as-usual scenario, the ocean is expected to contain 1 tonne of plastic for every 3 tonnes of fish by 2025, and by 2050, more plastics than fish (by weight)[14].
- Estimates suggest that 60% to 80% of marine debris is plastic, and more than 90% of all floating debris particles are plastic[15].

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[10]Ibid
[11] Ecosystems and Human Well-Being: General Synthesis. *Millennium Ecosystem Assessment*, 2.
[12] Ecosystems and Human Well-Being: General Synthesis. *Millennium Ecosystem Assessment*, 3.
[13]Ecosystems and Human Well-Being: General Synthesis. *Millennium Ecosystem Assessment*, 6.
[14]World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, *The New Plastics Economy — Rethinking the future of plastics.* PDF file. 2016. http://www.ellenmacarthurfoundation.org/publications. 17.
[15]"Science & Case Studies," EPA, accessed April 25th, 2021, https://www.epa.gov/trash-free-waters/science-case-studies.

- 90% of the plastics in the pelagic marine environment are microplastics (less than 5 mm in diameter)[16].
- An average of 6 million hectares of forests have been lost each year for the last 30 years due to commercial and agricultural use[17].
- According to the Global State of Air Initiative, 6.67 million lives were lost in 2019 due to Air Pollution alone[18].
- It would cost an annual $22,000,000,000 to preserve all wildlife that must remain living for ecosystem order[19].

Peak Consumerism. Though there are many deserving candidates, one definitive driver for environmental pollution and destruction can be attributed to modern day consumerism. In so much as people are obtaining their basic daily needs there is no pressing issue. For that matter, we must all engage in securing an equitable share of resources and services to live a quality life. When we "lose sight of what's important in the quest for stuff" is when we endanger our ecosystems and by extension ourselves[20]. The effects of consumerism are extremely dire. Take for example, the story of Jdimytai Damour from New York. In November 2008, on 'Black Friday' when the doors at Wal-Mart opened, Damour was trampled to death by a stampede of shoppers[21]. So eager to get their hands on 'things' these shoppers, even if just for a moment, lost their humanity while grabbing deals that would later be described by employees as "crazy... the deals weren't even that good"[22]. Research conducted by the New Economics Foundation in the UK produces what they call a Happy Planet Index every few years. This index measures

[16]"Toxicological Threats of Plastic," EPA, accessed April 25th, 2021, https://www.epa.gov/trash-free-waters/toxicological-threats-plastic.
[17] FAO, *Global Forest Resources Assessment 2020*. PDF file. 2020. https://doi.org/10.4060/ca8753en. 2.
[18]"Global Health Impacts of Air Pollution," State of Global Air, accessed March 10th, 2021, https://www.stateofglobalair.org/health/global#Millions-deaths.
[19]Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 188.
[20] Annie Leonard, *The Story of Stuff* (New York, NY: Free Press, 2010), 95.
[21] Ibid.
[22] Ibid.

sustainable well-being in each country where well-being, life expectancy, inequality of outcomes are divided by the nation's ecological footprint[23]. The USA ranked 105th in 2012 and in 2016, slid down 3 places to 108th out of a list of 140 countries. Meanwhile Costa Rica topped the charts for the 3rd time in 2016[24]. Of the 32 countries behind the USA, 28 are either in Africa or emerging countries from post communist regimes[25]. Of the top 20 countries, 16 belonged to the South American and or Asia Pacific regions[26]. What this implies about western civilization isn't is not encouraging. Though 'the west' may enjoy a 'higher' standard of living underlined by copious consumption, it does not seem to make happiness more of a reality.

Pointing out consumption by individuals is not meant to blame or discourage their economic right. It is to point out how entranced with 'things' we are. How did we get to this point? "In America in the 1950s, the chairman of President Eisenhower's Council of Economic Advisors stated, "The American economy's ultimate purpose is to produce more consumer goods[27]". By the 1970s, consumption had taken a leading role both culturally and economically. Most of us alive today have been raised on the assumption that a consumption-driven economy is inevitable, sensible, and good"[28]. This inception of consumer driven economics paints a gloomy world where plastic will outweigh fish in the ocean by 2050[29] and 3.8% of global forests (that is equivalent to the size of Libya) will be lost every 30 years[30]. Sly but creative marketing strategies have led us to believe that it is the consumer that can stop over indulgent behavior and thus prevent environmental degradation, while that same ad tries to sell you something you don't

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[23]Saamah Abdallah, Karen Jeffrey, and Hanna Wheatley, *The Happy Planet Index 2016*. PDF file. July 2016. https://static1.squarespace.com/static/5735c421e321402778ee0ce9/t/57e0052d440243730fdf03f3/1474299185121/Briefing+paper+-+HPI+2016.pdf. 1.

[24]Abdallah, Jeffrey, and Wheatley, 4.

[25] Ibid.

[26] Ibid.

[27] Leonard, 97.

[28] Leonard, 98.

[29] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, *The New Plastics Economy — Rethinking the future of plastics*. 17.

[30] FAO, *Global Forest Resources Assessment 2020*. 1-2.

need. The onus has been moved from the producer to the consumer, stretching all the way back to the 50's in America. Founded in 1953, by the packaging and beverage industry, KAB (Keep America Beautiful) and their deep pockets disseminated a massive media strategy that directed waste management responsibilities to " individuals' littering, rather than exposing corporate responsibility for producing this litter in the first place"[31]. Fundamentally, there are two schools of thought on how to manage consumption and thereby waste. To alter and educate consumer behavior or to regulate and disincentivize companies from producing environmentally negative externalities. I propose a method with which both stakeholders (consumers and businesses) can be effectively addressed simultaneously.

Externalities. Externalities is the term economists and environmentalists use when considering our impact on our natural resources. It is when one person's or entity's actions affect another without permission[32]. There are both positive and negative externalities. If I watch a movie on maximum volume, my neighbor must listen to the movie as well; this is a negative externality[33]. Air pollution caused by cars emitting CO_2, toxic waste run off from a production plant, and city lights obscuring a beautiful tapestry of stars in the night sky are a few others. A classic example of a positive externality is bee pollination, where beekeepers are sustaining flower and crop reproduction. What is tricky about externalities is that they are incredibly hard to quantify and thus have underappreciated impacts on both our ecosystems and their inhabitants. Thankfully, awareness is growing and there have been some attempts at realizing these effects. See Fig. 1, for a simplified example of how an economy interacts with our environments.

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[31]Alice Delemare Tangpuori, George Harding-Rolls, Nusa Urbancic and Ximena Purita Banegas Zallio, *Talking Trash*. PDF file. 2020. https://talking-trash.com/wp-content/uploads/2020/09/TalkingTrash_FullReport.pdf. 92

[32]Charles D. Kolstad, *Environmental Economics Second Edition* (New York, NY: Oxford University Press, Inc., 2011), 93

[33] Ibid.

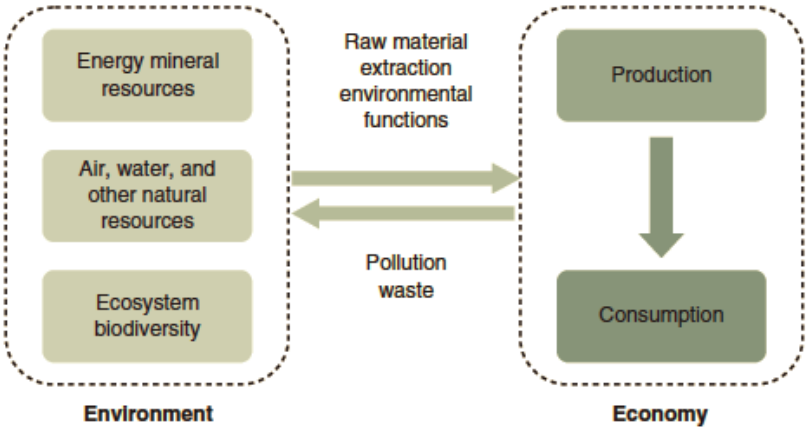

Fig. 1 Interactions between an Economy and Environment. (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 10.)

Human economic activity has a definitive correlation to environmental degradation. There are two ways in which we contribute: production and consumption. Making things is generally dirty, but we don't often see how the sausage is made, and therefore take an 'out of sight out of mind' attitude towards the impacts of manufacturing goods and services. What is more obvious, but often forgotten, is that these things are being made to satisfy a demand. We are at some serious fault in this regard. In addition, though consumer demand is high across the globe, most are concentrated in the developed nations that enjoy higher level standards of living. Enjoying elevated standards of living correlates to "higher levels of consumption (and therefore higher levels of production) [which] require larger inputs of energy and material [inevitably] generat[ing] larger quantities of waste byproducts[34]. This leaves behind those who, in large part, are part of the production cycle to endure the 'messy' work and strip their ecosystems of precious resources . Luckily for those higher up on the ladder of economic wealth "at the national level brings increased utility at the individual level; people are more affluent and thus

[34]Carlo Orecchia and Pietro Zoppoli, *Consumerism and Environment: Does Consumption Behaviour Affect Environmental Quality?*. PDF file. November, 2007. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1719507. 2.

able to purchase goods and services that enhance their quality of life"[35]. Quantitatively speaking this is understood as a nation's GDP. Growing levels of consumption and its negative effect, compounded by an explosion in the human population, has yet to be incorporated in our economic calculations. Likewise, positive externalities such as mothers at home raising children and educating the young so they may be productive members of society in the future are absent.

A method proposed by Orecchia and Zoppoli is to examine the relationship between CO_2 emissions and consumption in terms of their share of total GDP[36]. This would include a consideration of our ecosystems, rather than an omittance, through the addition of our negative externalities (CO_2). This example is most apt and can be dated back to 1952 in London when the Great Smog took over their city skies. A "temperature inversion, in which a layer of warm air high above the surface trapped the stagnant, cold air at ground level" had allowed the sulfur dioxide, carbon dioxide, and smoke particles to settle closer to the ground rather than float up into the atmosphere[37]. London at the time had largely relied on burning coal for energy. Usually, these 'fogs' would hang around for two days or so then dissipate, but this one lingered for 5 days causing an estimated 8000 to 12000 deaths of which 4000 were seriously harmed immediately[38]. Hospitals were overwhelmed and understaffed with quickly diminishing resources. One might ask, would the response to the smog have been more effective had these externalities been accounted for in the beginning? Sufficient funding and emergency resources could have been readily available instead of waiting on parliamentary action. Effects of the sulfuric cloud were felt into 1953 and a few years later the Clean Air Act of 1956 was enacted[39]. This was one of the first documented pieces of legislation to regulate environmental externalities in the world.

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[35]Orecchia and Zoppoli, *Consumerism and Environment,* 4.
[36]Ibid.
[37]Christopher Klein, "The Great Smog of 1952," *History*, August 22, 2018, accessed March 8, 2021, https://www.history.com/news/the-killer-fog-that-blanketed-london-60-years-ago.
[38]Ibid.
[39]Ibid.

While government and local regulations as well as internalized cost for the price of externalities are helpful to realize the ubiquitous nature of environmental externalities, it most likely will not suffice nor be enacted quickly enough. Waiting on reorganization and adoption by legacy systems/companies would mean to accept lagging reports and to trust economically non-incentivized actors to step up. In order to effectively and fundamentally address environmental externalities we must build and manage our lives on a new operating system.

Blockchain: A new Operating System. The results of The Great Recession were catastrophic. Unemployment in the U.S. reached ten percent, spiking by more than five percent and these effects were long felt as 45.5% of unemployed in 2010 were 'long term unemployed' (27 weeks or longer)[40]. Globally, 205 million people were unemployed[41]. Government bailouts may have 'saved the day' but were widely seen and interpreted as a bandaid fix at the cost of the average taxpayer. The real slap in the face was that there were no consequences for the leadership responsible. Amidst the largest economic disaster in sixty years[42], unbeknownst to many of us, Satoshi Nakamoto[43] was working on the operating system of our future.

> "I've been working on a new electronic cash system that's fully peer-to-peer, with no trusted third party." - Satoshi Nakamoto (2008-10-31 18:10:00 UTC)[44]

Fast forwarding 13 years to present day, Nakamoto's creation is still on the periphery for many, but is maturing as an idea and asset known as Bitcoin. Since its birth, Bitcoin has sailed

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[40]Evan Cunningham, "Great Recession, great recovery? Trends from the Current Population Survey," *Monthly Labor Review,* U.S. Bureau of Labor Statistics, April 2018, accessed March 10, 2021, https://doi.org/10.21916/mlr.2018.10.

[41]United Nations Department of Economic and Social Affairs, *The Global Social Crisis: Report on the World Social Situation 2011*. PDF file. 2011. https://www.un.org/esa/socdev/rwss/docs/2011/rwss2011.pdf. 28

[42]Verick, Sher and Islam, Iyanatul, *The Great Recession of 2008-2009: Causes, Consequences and Policy Responses.* PDF file. 2010. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1631069. V.

[43]To this day, the true identity of Satoshi Nakamoto is unknown. To learn more about the pseudonymous creator and early history of Bitcoin explore here.

[44]Satoshi, Nakamoto, "Bitcoin P2P e-cash paper" *metzdowd.com*, October 31, 2008, accessed March 12, 2021, https://www.metzdowd.com/pipermail/cryptography/2008-October/014810.html.

through a tsunami of media headlines and assumptions on its very purpose and capabilities. Some notable phrases and words associated are: Bubble or Real?, Criminal Money, E-Gold, New Money or too Volatile?. In the Bitcoin community, the fear(F), uncertainty(U), and doubt(D) of the 'non-coiners' (people who do not own any bitcoin or are only digesting clickbait news titles) have been referred to as FUD. A few of the frequently asked FUD questions will be addressed later. While it is quite clear Bitcoin has not taken over the world as the first "peer-to-peer" monetary system (a top 5 FUD topic), its success has given birth to another technology being quickly adopted worldwide: blockchain technology. This is the underlying technology behind Bitcoin that has captured the attention of many academics, institutions, and individuals.

The origins of blockchain technology can be traced back to some notable contributors such as David Chaum, Stuart Haber & Scott Stornetta, and Ralph Merkle. Through their conceptualization of the many pieces Nakamoto put together, they went on to invent the first blockchain. Simply put, blockchain is a distributed ledger technology (DLT) that stores and communicates data without a trusted third party. Ledgers of all sorts have been around for centuries helping us keep track of all sorts of things. What makes blockchain unique is that it is 'trustless'; meaning one does not need to rely on a third party entity to verify or secure transactions on the chain (ledger). Today's big name ledger intermediaries are companies such as Visa, Mastercard, Paypal, and any bank you want to name. While they play an integral role, specifically in the financial sector of the economy, each one of the aforementioned are centralized. They create a focal point for attacks and as we saw in The Great Recession, the propensity for global catastrophe is immense should there be mismanagement of assets or malpractice.

In contrast the lack of an authoritative entity in the blockchain ecosphere makes it decentralized and yet the 'peer-to-peer' nature of a network still allows for distributed-ness (see Fig.2). In the case of Bitcoin, a permissionless blockchain is run[45]. This makes the information stored on the chain public and accessible to anyone compared to a permissioned blockchain that would grant access upon request (more commonly used by private organizations who need not have their data be public)[46]. Though there is no intermediary (which would make it centralized), there are checks and balances that the chain abides by called the consensus protocol. The consensus protocol takes the place of what a central authority would have done - namely to verify and secure transactions.[47] The protocol allows independent actors engaging on the 'trustless' chain to act in an intermediary free, human to human, machine to human, or even machine to machine transactional environment.

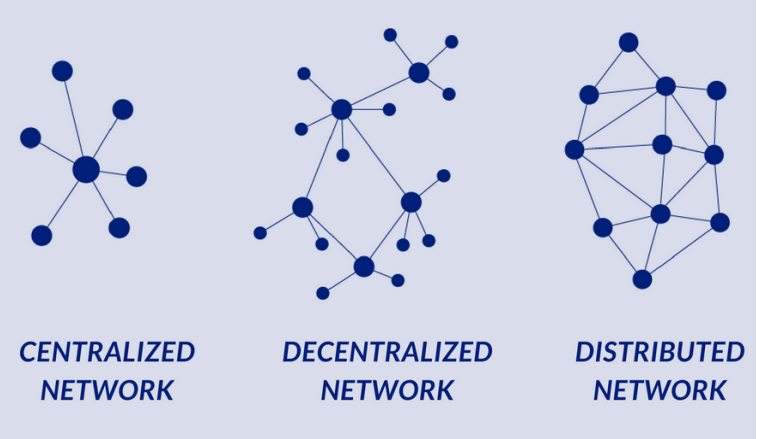

Fig 2. Network Structures. ("UN Supports Blockchain Technology for Climate Action," United Nations Climate Change, January 22, 2018, accessed March 13, 2021, https://unfccc.int/news/un-supports-blockchain-technology-for-climate-action.)

Although the blockchain system in Bitcoin was initially geared towards alleviating past issues and ushering in a new financial/monetary transaction model, its potential does not stop there. In a modern world our appetite for data, its consumption, and computation has become

[45] Mark van Rijmenam and Philippa Ryan, *Blockchain: Transforming Your Business and Our World* (New York, NY: Routledge, 2019), 69.
[46] Ibid.
[47] van Rijmenam and Ryan, *Blockchain*, 75-77.

bottomless; blockchain will ultimately revolutionize the way in which we utilize said data in our physical (the environment) and digital world. The bridging of the environment and the Internet of Things (IoT) is long overdue. Thanks to Nakamoto and blockchain technology we can inherently change the relationship between man and his/her ecosystems to achieve a harmony never seen before. To reach a meaningful level of harmonious equanimity with nature, one must first assess and then direct what our values as a society and individual are. For this we can look no further than to some of the best thinkers in the environmental justice & ethics space.

To personalize and invite participation from pedestrians, Pavegen has developed technology to capture kinetic energy from footfall (ie. walking/running). By connecting the physical and digital world, Pavegen is introducing clean renewable electricity through single steps at a time[48]. They specialize in creating energy tiles which when stepped on harvest and convert the kinetic energy from pedestrians into electricity. Their mission is to have every person realize their potential as a renewable energy source through active participation (such as walking)[49]. Not only will citizens produce their own clean electricity but they will also generate data by relaying footsteps via the wireless API embedded in the tiles[50]. This data is aggregated on a blockchain that will mint a native token or digital currency for the user[51]. The digital currency then can be used to redeem items or be kept as a form of investment in the idea/ethos of the project[52]. "Pavegen's efforts are specifically aimed to ensure that communities start to recognize the potential and importance of renewable energy" to encourage a smart cities' revolution[53]. The application of Pavegen tiles goes beyond pedestrians. Any 'floor' can be

[48] June Javelosa, "Pedestrians Can Generate Data, Lighting, and Digital Currency With Just a Single Step," *Futurism*, November 11, 2016, accessed March 14, 2021, https://futurism.com/pedestrians-can-generate-data-lighting-and-digital-currency-with-just-a-single-step.
[49] "Cleantech that engages and incentivises your audience, while providing emotional insights," Pavegen, accessed March 15, 2021, https://pavegen.com/.
[50] Javelosa, "Pedestrians Can Generate Data, Lighting, and Digital Currency With Just a Single Step."
[51] Ibid.
[52] Ibid.
[53] Ibid.

replaced with these energy tiles to capture any and all types of kinetic energy. If the entire global system of roads were to be replaced with Pavegen tiles, the scale at which the planet could produce clean electricity would be unprecedented.

Furthermore, a DLT will propagate a transparent, verifiable, and trusted (albeit through a trustless method) ecosystem of its own for humans to engage in their socio-economic activities whilst being conscious of the environmental impact. The subsequent chapters will first outline how one ought to think about his/her relationship to earth and align it with beliefs suitable for consideration and respect. Then the paper will discuss attempts made by environmental economics to price and realize externalities quantitatively. This is followed by a detailed look at the inner workings of a blockchain operating system. Examples of blockchain adoption and implementation are examined to see how it compares to tangible, but largely academically focused economic theories. Its potential is then retrofitted to and assigned at three levels: the individual, businesses, and governing entities. Finally an overall suggestion and recommendation will be provided based on successive findings.

Chapter Two: Environmental Justice

Justice for All: The Good. The nature we reside amongst is omnipresent. Beyond respect for its value and consideration of the power of its pervasive capacities, we simply ought to revere its intrinsic essence. Akin to saying, "Love me for who I am, not for what I can do for you", our ecosystems must be cared for prior to, during, and after extracting value from them. This should not only be a conditional, transactional relationship. In development of a moral structure to guide us we must consider an aptly succinct, thorough, and rational one compatible with both the best scientific (objective) and ethical (subjective) ideals.[54] First we would be remiss to not

[54]Christine Pierce and Donald VanDeVeer, *The Environmental Ethics & Policy Book, 3rd ed.* (Belmont, CA: Wadsworth, 2003), 15.

contemplate some basic questions: Should we respect nature and why? and What does it mean to be morally considerable in the present? in the future?. Though there are many influential and foundational thinkers in the environmental ethics & justice space, for the purpose of seeking a modern approach we will begin with the environmental justice (EJ) movement of the 1980s. An overview of EJ is followed by the introduction of critical EJ (CEJ) developed by David Pellow who critiques conventional EJ as an insufficient form of social justice. EJ has matured as an actionable social justice movement through Pellow's contribution .

Many thinkers throughout history have pondered what the 'right' or 'correct' moral principles should be. Most often these were anthropocentric views which satisfied our curiosity and alleviated guilt, but limited the scope of imagination to the human species. From this point of view our responsibility to the environment is based solely on how our actions may help further or actualize human values and rights.[55] In efforts to include the biotic community into our moral consideration, a life-centered ethic is necessary. In this mode, ecosystems and non-human entities are regarded, protected, or promoted for *their* sake and ultimately realized "*as an end in itself*".[56] For us to adopt a 'new operating system' it is essential we start here with ethics grounding our beliefs. In this way, I propose we no longer consider the consequences of our actions exclusively from the vantage point of advancing the good of our singular species. In short, we must cultivate and engage in a moral attitude inclusive of nature.

When fashioning a moral attitude of respect for the many biospheres one may encounter and interact with, two principles must be considered in order to recognize the inherent worth of ecosystems: intrinsic value and ethical consideration. Data points and statistics are an easy way to understand the 'worth' of something, albeit in strictly quantitative terms. As outlined in

[55]Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 202.
[56] Ibid.

chapter one, it is clear ecosystems provide value in many forms: some examples are carbon sequestration, local climates regulation, varying sources of food, and aesthetic beauty for us to enjoy.

Ultimately there is more to life than assigning numbers to things and ordering them in a meaningful manner. What does it mean to have value? Is value only attributed in relation to the human species? It seems quite obvious that we, as sentient, rational and moral beings possess a *good*; that is a state of welfare or well-being[57]. We then can understand that this good is possessed by all forms of sentience and communities of life which can be helped or harmed without reference to another entity. Stated differently, what is good for an entity's *good* is when it is furthering or sustaining its life in "full development of its biological powers" and bad, when detrimental effects are realized to its well-being[58]. It is then no leap to consider that non-humans and biotic communities also have a *good*.

With the aforementioned conditions, rational agents see the *good* in other forms of beings and can then realize the principle of intrinsic value. Irrespective of the type or creed of the entity we regard, as a member of "Earth's community of life" its *good* ought to be recognized as inherently worthy[59]. That is to say any being possessive of a *good* merits deliberation of moral agents, who then interpret this *good* as worthy "...as an end in itself and for the sake of the entity whose good it is"[60].

Combining the prior with principles of moral considerability enables us to truly manifest the foundational ethic needed to accept changes in our mental and physical lives. We found above that the only condition necessary for rational agents to recognize an entity for an end in

[57] Ibid.
[58] Ibid.
[59] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 203.
[60] Ibid.

itself is to possess a *good*. Similarly, the criterion to be morally considered need not be exclusive to sentience, rational capabilities or capacities to *feel* pain or pleasure[61]. "Nothing short of the condition of *being alive* seems to… be a plausible and nonarbitrary criterion"[62]. This is where the move from an anthropocentric vantage point to a biocentric one is seen. In doing so, we, as moral agents, expand the sphere of moral inclusion to biosystems themselves. This is not to say that moral *rights* are being assigned to all entities, rather they are being given participatory inclusion and subsequent ruminations on its *good*. For the purposes of this paper, the issues of *rights* assignment will be kept open. However, it is noteworthy to perceive that while it may be arbitrary to draw a circle of exclusion beyond rational humans regarding moral consideration, it does suffice to draw the line there for moral responsibility[63]. In short, as *the* moral agents on this planet, we have been tasked to contemplate what we ought to morally consider. By accepting the status of *good* in all forms of life we can adapt and adhere to a biocentric ethic.

(Critical) Environmental Justice. The environmental justice (EJ) movement, though not as human specific, addresses distributive, participatory, political and cultural avenues of justice through a multi-disciplinary approach[64]. Modern EJ found its footing in the 1980s sparked by an incident in Warren County, North Carolina[65]. In 1982 over 500 arrests were made for a non-violent civil disobedience protest against a toxic landfill located within a largely African American community[66]. Despite the protests, the landfill remained for decades only coming to a close on January 12th 2004[67]. According to different estimations an excess of $18 million was recommended in reparations[68]. Thanks to the attention brought forward by the protests at Warren

[61] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 183.
[62] Ibid.
[63] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 185.
[64] J. Baird Callicott and Robert Frodeman, *Encyclopedia of environmental ethics and philosophy* (Farmington Hills, MI: Macmillan Reference USA, 2009), 341.
[65] Callicott and Frodeman, *Encyclopedia of environmental ethics and philosophy*, 342.
[66] Ibid.
[67] Ibid.
[68] Ibid.

county in 1983, the Government Accountability Office launched an investigation titled, “Siting of HazardousWaste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities"[69]. This study produced a string of investigations looking into the levels of environmental toxicity in poor and minority communities. Most notably, the “Toxic Waste and Race in the United States" (1987) conducted by the UCC (United Church of Christ’s Commission on Racial Justice) outlined the reality of race playing a larger role in unfair burdens placed upon minority communities rather than their socioeconomic status[70]. This gave rise to concepts such as environmental racism and discrimination[71]. The contribution of the UCC brought into focus the three dimensions of EJ we know today:

- Distributed Justice: Pertaining to the principles of distributive fairness. How are environmental benefits and externalities spread across different sectors of population & societies? How, if at all, are these inequalities being accounted for? What are the acceptable criteria for the social, physical and moral burdens put forth onto people?[72]
- Participatory: Inclusion of those who would be adversely affected into the decision making process thereby allowing for self determination in whether the environmental burden is worth the proposed socio economic and political project put forth[73].
- Recognition: “Recognition refers not only to the individual right to self-recognition but, most importantly, to the recognition of collective identities and their particular concerns, needs, and livelihoods in relation to nature and the environment”[74]

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[69] Ibid.
[70] Callicott and Frodeman, *Encyclopedia of environmental ethics and philosophy*, 343.
[71] Ibid.
[72] Callicott and Frodeman, *Encyclopedia of environmental ethics and philosophy*, 342.
[73] Callicott and Frodeman, *Encyclopedia of environmental ethics and philosophy*, 345.
[74]Mary Menton et al., *Environmental justice and the SDGs: from synergies to gaps and contradictions*. PDF file. April 9, 2019. https://doi.org/10.1007/s11625-020-00789-8. 1624.

The three dimensions triangulate a fairer, case specific and dignified approach to EJ. Yet, it makes no mention of how one might provide justice for ecosystems. Ecological justice, which contends justice for nature, argues that even our modern approaches to EJ remain heavily anthropocentric. Therefore, a newer version of EJ has been recommended by David Pellow - Critical Environmental Justice (CEJ). Pellow aims to dig deeper than the socio political causes which only lead to policy/regulation reforms of environmental injustices. He argues this does not change the power structure that produces the very externalities and injustices[75]. In his effort to be attentive to modern EJ deficiencies Pellow constructs four pillars of focus:

1. Intersectionality[76] - "greater attention to how multiple social categories of difference are entangled in the production of environmental injustice, from race, gender, sexuality, ability, and class, to species which would attend to the ways that both the human and the more-than-human world are affected by and respond to environmental injustice and related forms of state-corporate violence;"[77]
2. Multi-Scalar Approaches[78] - "an embrace of multiscalar methodological and theoretical approaches to studying EJ issues in order to better comprehend the complex spatial and "temporal causes, consequences, and possible resolutions of EJ struggles (and by "multiscalar" I mean that we should be paying attention to how EJ struggles may simultaneously function through many spatial and temporal scales); "[79]
3. Embeddedness[80] - "a deeper grasp of the entrenched and embedded character of social inequality – reinforced by the power of the state – in society and therefore a reckoning

[75] Ibid.
[76] Ibid.
[77] David Naguib Pellow, *What is Critical Environmental Justice?* (Medford, MA: Polity Press, 2018), 52.
[78] Menton et al., *Environmental justice and the SDGs*, 1624.
[79] Pellow, *What is Critical Environmental Justice?,* 52-53.
[80] Menton et al., *Environmental justice and the SDGs*, 1624.

with the need for transformative (rather than exclusively reformist) approaches to realize environmental justice. In other words, Critical EJ Studies seek to push our analyses and actions beyond the human, the state, and capital via a broad anti-authoritarian perspective;"[81].

4. Indispensability[82] - "an intensified focus on the ways that humans and more-than-human actors are indispensable to the present, and necessary for building sustainable, just, and resilient futures. As EJ Studies has had difficulty promoting a productive and transformative vision of change, indispensability is a key ingredient in that effort."[83]

These four pillars reiterate the ubiquitous presence of our environment: *We are always within and never without it.* Therefore, any injustice experienced in the human world can also be found to affect non-human actors in our ecospheres. Our urbanization or 'built environments' are still, in every respect, a part of nature. The modernized assembly of urbana and architectural feats are what urban ecologists call "socionatures" where the intersectionality of our society and nature inevitably mesh[84]. Urban built environments are socionatures as there is no delineation from the human to non-human imprint in terms of where 'nature' starts and where "humanity" ends and vice versa[85]. This concept brings into focus the scale of CEJ. This is to consider the spatial and temporal association of effects brought about; that is, to not limit the scope solely to the neighborhood where the coal burning factory is located, but to scale inclusion to a global level if necessary. This allows us to contemplate EJ at the appropriate level, "... for example, [how] persistent organic pollutants produced thousands of miles away from the Arctic end up in high concentrations in the breast milk of indigenous Nunavik women."[86] To take the spatial and

[81] Pellow, *What is Critical Environmental Justice?*, 53.
[82] Menton et al., *Environmental justice and the SDGs*, 1624.
[83] Pellow, *What is Critical Environmental Justice?*, 52.
[84] Pellow, *What is Critical Environmental Justice?*, 57-58.
[85] Ibid.
[86] Pellow, *What is Critical Environmental Justice?*, 58.

temporal aspect of EJ seriously, one must consider implications for future generations as well as those peoples and communities that are discriminated against.

For EJ to move forward in the 21st century, it must be acknowledged that social inequities, whether they be environmental racism/discrimination or anthropocentrism, are unfortunately deeply inherent in our power structures. Why do we and should we really expect states and governing entities "to deliver justice, to police themselves, and to regulate industry?"[87] Thus far, as studies have demonstrated consistently and conclusively, the track record of state-based regulation and enforcement of environmental and civil rights legislation in communities of color has not been promising.[88] Hence, we must ask ourselves how we might build a society environmentally sustainable and socioeconomically equitable beyond the state rather than within it. The merry-go-round of political power shifts witnessed today merely propose a facade of a *different model* approach which only provides a short term effect as they are inevitably undone by the incoming party's agenda in the proceeding election cycle.[89] Lastly, CEJ builds on the previous pillars to articulate the perspective and positions of the "excluded, marginalized, and othered populations."[90] The concept of indispensability can be understood in two forms: racial and socioecological[91]. Racial, when referring to people of color or ethnic minorities and socioecologically when referring to the broader community of life across the planet. It brings forth the reality that there is an interconnectedness between all beings (sentient or not) and that each have the capability to contribute in the making of our collective futures[92]. Moreover, all (human or non-human) have a role to play, and a meaningful one at that, in the

[87] Pellow, *What is Critical Environmental Justice?*, 63.
[88] Pellow, *What is Critical Environmental Justice?*, 64.
[89] Ibid.
[90] Pellow, *What is Critical Environmental Justice?*, 70-71.
[91] Pellow, *What is Critical Environmental Justice?*, 62.
[92] Pellow, *What is Critical Environmental Justice?*, 64.

creation of our hereafter. Dr. Martin Luther King, Jr. touched on this in his landmark "Letter from a Birmingham Jail", with regard to racism and the future of the US:

> Injustice anywhere is injustice everywhere. … In a real sense all life is interrelated. All men are caught in an inescapable network of mutuality, tied in a single garment of destiny. Whatever affects one directly, affects all indirectly. Never again can we afford to live with the narrow, provincial "outside agitator" idea.[93]

In this manner, environmental justice is, at its core, a social justice movement and can be thought to include justice for the larger community of life and not confined only to humans.

Next, to what end are future generations owed or deserving of our current deliberations on how to engage with our environment? To start, let us agree that we are moral beings who find ourselves ethically responsible. This can then be summed as the capability to comprehend and be cognizant of our actions, ability to produce said actions, have the choice to do otherwise and ultimately perceive a value for said consequences.[94] If the above is accurate we can then see how the issue of posterity becomes clearer. Advances in science and technology have no doubt furthered mankind's prosperity. This has simultaneously allowed man to see the extent to which he/she might be affecting the Earth, thus disavowing previous notions of being too 'small' or 'insignificant' in the larger scheme of the planet's health.[95] Effectively, we are all too aware of the potentially negative impact our development as a species might have on future generations. We must also note that this is a burden we cannot escape so long as we continue to accept the scientific and technological wonders that have revolutionized our world.[96] Extensively we must also admit that to do nothing is also a choice made in consciousness. However, the best

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[93] Pellow, *What is Critical Environmental Justice?*, 73-74.
[94] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 428.
[95] Ibid.
[96] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 429.

principles and concepts put forth such as libertarianism, utilitarianism or communitarianism do not warrant discussion here as they omit the prerequisite we are aiming for - namely to include our biotic community and resources.[97]

Consumption Ethics. Though we are capable of thinking about our own future, it seems less obvious and more motivationally complex to consider future generations in the same manner. As outlined above, we can admit knowing that our actions today may cause harm or degrade the quality of life of those who come after us. Yet, it does not easily convey to us how one shall manifest this issue of exercising moral responsibility to posterity. Some problems that arise when contemplating future generations are as follows: Can we have duties to nonexistent beings?, and What are the implications of assigning rights to non-existent persons? We can neither be rewarded nor punished by future generations and thus find the relationship non-reciprocal. Who is it that we are considering specifically? And should we say that we are improving the lives of some specific persons in the future by doing something now, are we not then "causing different individuals to be born in the future[?]"[98] The existential complications are immense and most certainly overwhelming for most to effectively deliberate, let alone solve (such a topic surely deserves its own paper). For this paper, the views for and against moral accountability towards posterity should not be the crux of the issue. Where one may find solace and sufficient reasoning to justify moral responsibility to future generations should be the moral *ought* we instinctively feel towards the *good* of the community of life. As Kant put it, "*ought* implies *can.*"[99] To reiterate, if one criterion of moral responsibility is 'capacity', then we need

[97] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 432.

[98]Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 429.
[99]Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 428.

not go beyond (for now) the philosophical/ethical entanglements of future generations and genuinely put our best foot forward to allow room for what we *can* do for posterity's sake.

Green Consumerism. Consumption was mentioned earlier to demonstrate how present day prerogatives have shifted to become such that less is no longer more, but more is better. Consequently, this shift in mindset has made us objectively less sensitive to how we are impacting our communities. It is then necessary in this chapter, to examine reconciling our new norm with Aldo Leopold's "Land Ethic". In short, a land ethic entails that one should integrate an ethical component when considering land use and management.[100] As Douglas Maccleery put it in the *Forest History Today*, as the U.S. enjoys increased levels of economic well being and thus raises per capita consumption, the "dirty little secret" is that we've only been shifting the strain and externalities to lands outside the US.[101] Such ecological transfer effects may on the surface appease the commoner who merely ingests environmental topics as the media outlets cover them without noticing the outright disguised presentation of his/her consumptive behavior. Importantly, "reduction in harvests in one area transfers the effects, under constant consumption, to other ecosystems."[102]

"Since the first Earth Day in 1970, the average family size in the United States has dropped by 16 percent, while the size of the average single family house being built has increased by 48 percent."[103] Imagine the impact and trajectory of such consumptive gluttony should such trends continue. We would surely run out of space let alone resources to make everybody's 'dream home'. Maccleerly proposes we ought to complement Leopold's Land Ethic with a Consumptive Ethic. Without addressing the "consumption side of the natural resource

[100]Douglas W. Maccleery, *Aldo Leopold's Land Ethic: Is It Only Half a Loaf Unless a Consumption Ethics Accompanies It?*. PDF file. 2000. https://foresthistory.org/wp-content/uploads/2016/12/Maccleery_aldo-leopolds-land-ethic.pdf. 39.
[101] Ibid.
[102]Maccleery, *ALDO LEOPOLD'S LAND ETHIC*, 40.
[103] Ibid.

equation", we diminish environmental ethics efforts in achieving justice to our ecosystems to a sophisticated form of *NIMBYism* (Not In My Back Yard).[104] In the end, it is not as simple as respecting or giving credence to the 'land'. We ought to bring forth and manifest the ethic into our individual lives for the *good* of the planet. Conscious and deliberate consumptive behavior is and has been a crucially neglected piece of the puzzle.

Thus far we have established: the inherent value of nature, why we ought to consider the environment's *good* as part of our moral responsibility, our capacity to also consider future persons *good* and found certain theories (such as the land ethic or established ethics which do not even mention the environment) to be terribly insufficient. In light of this, we are in dire need of a new structure to model our behavior and ultimately guide these moral aims. In keeping with the issue of consumption I put forth the practice and contextualization of Green Consumerism to be most appropriate.

Green Consumerism is sustainable consumerism and refers to individuals and entities who concern themselves with and are willing to change their socio-economic behavioral patterns to match those of our environmental ethic and needs.[105] They consume 'green' products which are made available by companies and businesses that have a favorable reputation for reducing or eliminating negative externalities to the environment. For example, LED lights avoid the use of toxic chemicals, are long-lasting, and produce virtually zero harmful UV emissions.[106] Green outlets are another product which allows for complete cut off of electricity flow to outlets when not in use.[107] Common outlets are known as 'vampire power' as they drain electricity even when

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[104] Ibid.
[105] Punita Duhan and Ruchika Singh Malyan, *Green Consumerism: Perspectives, Sustainability, and Behavior* (Waretown, NJ: Apple Academic Press Inc., 2019), 42.
[106] Trevor Gould, "Top 10 Green Products," *energydigital*, May 17, 2020, accessed March17, 2021, https://energydigital.com/smart-energy/top-10-green-products.
[107] Ibid.

the products are not in use.[108] These attitudes and actions mirror the ethic called for earlier and "are governed by the behavioral patterns such as values, ethics, motives, and so forth [as previously discussed].[109] To elaborate further on motives, there are 3 main factors at work . First and foremost is a basic but essential environmental motivation.[110] That is to first make it a personal issue to care about the natural resources surrounding us. Secondly, and perhaps most powerful, is technology.[111] Its ability to derive green products and drive solutions for issues of climate change, resource depletion, species extinction and so on is something we all marvel at and take interest in. Moreover, it is innately understood that we value the use of cutting edge technologies that provide for a better standard of living.[112] Lastly and least accredited are the motivations sourced from media marketing, consumer education and experiential sentiments.[113] This paper, as outlined, will focus on the second, technology, as a motivation and solution. Though an environmental motivation/ethic is integral and educational opportunities are abundant, to cultivate an individual and thereby create an environmentally conscious society will most likely take generations. I urge and argue for an even more powerful force in propelling the communities of life's *good*, namely blockchain technology and Bitcoin. In Duhan's words, "When the consumers will start caring for the environment, the transformation will follow, creating a movement by the people, for the people, and with the people."[114]

However, as iterated, the vector of change need not be unfairly placed on the consumer or solely the realm of mere consumption. It needs to have a pervasiveness much like the ecosystems we live amongst. Significantly, corporations, businesses, and governing bodies should again, not

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[108] Ibid.
[109] Duhan and Malyan, *Green Consumerism*, 71.
[110] Duhan and Malyan, *Green Consumerism*, 44.
[111] Ibid.
[112] Ibid.
[113] Duhan and Malyan, *Green Consumerism*, 45.
[114] Duhan and Malyan, *Green Consumerism*, 69.

be let off the hook or distracted from their equitable share of responsibility. For this reason, in the coming sections we will discuss how to best integrate an ubiquitous operating system incorporating a distributed ledger to harmonize all levels of life: the individual, businesses, and directorates. A combined effort in curtailing environmental externalities at each level, for each stakeholder, will result in an efficient strategy to manage our biotic *good*.

Chapter Three: Environmental Economics

Basics of Environmental Economics. While the previous sections concentrate qualitatively on the theories of ethics, Chapter three examines approaches which lean towards quantitative disciplines used to curtail environmental externalities. In the space of environmental policy there are two basic questions to answer: *How much environmental protection? & What is the desired level of economic involvement in our environments?*[115] First, it is important to establish that even in the realm of environmental economics (EE), the decisions made are largely societal ones. That is, it is separate from individual decisions as EE will inevitably affect a large sum of people. Furthermore, EE concerns itself with specific decisions such as whether to use land as a developmental opportunity or to preserve it for species protection.[116] As stated in chapter two, much in the same way that environmental justice is a social justice movement, EE also does not live in a vacuum and can be understood to have a social justice component. In short, EE pertains to the decision making in such instances whilst addressing two new questions: *What is the environmental consequence? & What is the cost of providing environmental protection?*.[117] Stated differently, there is always a cost to be paid for improvement or protection. Situations where there is no cost need not be debated; everyone would be in favor. Unfortunately,

[115] Kolstad, *Environmental Economics*, 43.
[116] Kolstad, *Environmental Economics*, 44.
[117] Ibid.

there is no such consensus when it comes to how and to what degree we consider our ecosystems. What can also be said is that despite the quantitative might economics represents, fundamentally, at its core, economics is first rooted in the study of behavioral theories which are expressed numerically for efficiency's sake. Yet, outside of economics, such numerical expressions of behavioral phenomenon may not be the best medium to understand and interpret human activity. Nonetheless, further ruminations on what it means to be environmentally economical will only be employed to find its inadequacies. Although the intention is to give fair scrutiny to various disciplines, the ultimate aim is to disrupt each category of the modern human experience of the individual, business, and governance with blockchain technology.[118]

In efforts to address and value our natural resources, economics is often found to be the adversary. "Afterall, it's all this 'economic activity' that's leading to the destruction of our planet", one might utter facetiously. Stop to consider the following:

> If society consists mostly of people who prefer a weekend in front of the TV to a weekend hiking in the wilderness then it should come as no surprise that when an economist measures willingness-to-pay for wilderness protection, the number is not large. Conversely, if society consists of individuals who would much rather hike than vegetate, the answer will be different.[119]

The hope is that the prior outlay of moral consideration on the *good* and development of a biocentric ethic might derive further utility and application here. That is to say, without an appropriate appetite for environmental protection and actual engagement beyond thought

[118] Blockchain with uppercase 'B' will denote Bitcoin's protocol whereas blockchain with lowercase 'b' labels the technology more broadly.

[119] Kolstad, *Environmental Economics*, 45.

experiments, we may soon find ourselves ‘vegetating’. At the core, biocentric views must center our value systems so as not to place ourselves at the top of the hierarchy.

In economics, goods (i.e. merchandise/property) can generally be separated into two types: excludability and rivalry.

Excludability - The *possibility* of rationing individual use of the good through pricing.[120]

Rivalry - If rationed use by individuals through prices or other means is *desirable*.[121]

A good is said to be excludable if it is able and within the means to specify certain consumers to consume the good after an appropriate price is paid.[122] Similarly, a *bad* is excludable if it is able and within the means to specify certain consumers to avoid consumption.[123] Simply put, excludability allows for the market to deny participation in the good or bad if the price is not paid. For example, a local park or hiking trail is a nonexcludable good, as anyone can opt to enjoy the park, or hike on the trail. Urban air pollution is also a nonexcludable good.[124] We cannot control who consumes (breathes) the contaminated air . Should air pollution be excludable then only those who agree to and are compensated would consume it.[125] A common example of an excludable good is garbage (the household/business type).[126] We cannot simply throw away our garbage onto the street or out the window. We pay for services, institutions or governments to pick up, sort, and dispose of it.[127] We exchange money for garbage. Thus in a price system such as capitalism, we use concepts of excludability to assign and delegate possession of a good or bad. A good is a rival if its consumption by one decreases the amount of

[120] Kolstad, *Environmental Economics*, 95.
[121] Ibid.
[122] Ibid.
[123] Ibid.
[124] Kolstad, *Environmental Economics*, 96.
[125] Ibid.
[126] Kolstad, *Environmental Economics*, 96-97.
[127] Kolstad, *Environmental Economics*, 97.

the good available for other consumers.[128] On the other hand, if consumption does not lessen availability of said good, it is considered nonrival. Garbage would be considered a rival bad, since my consumption of a bag of garbage reduces the amount of garbage others need to tolerate.[129] Air pollution is then nonrival; for when I take a deep breath in Manhattan I do not reduce the ability for others to also "enjoy" the air pollution.[130] Furthermore, rivalry can be defined in the context of opportunity costs. Should I consume a sandwich, an opportunity cost arises from my consumption towards others.[131] I am reducing the number of sandwiches available and may even prompt the producer to have to produce more. In contrast, should I enjoy a flower garden I do not create an opportunity cost for others.[132] That is, simply because my consuming of the flowers does not diminish another's ability or the availability to do so. The key here, perhaps not intuitively so, is an economist's favorite word: efficiency. To appropriately price goods and bads we must be able to price incremental use of rival and nonrival goods. No costs would entail a free for all as seen in less regulated sections of the world. To recap, there are two types of goods, public and private goods where their derivatives are rival and nonrival goods. These can then be further distinguished by the concept of excludability. Markets have a hard time efficiently pricing non-excludable goods whereas nonrival goods "suggest that a market would be undesirable."[133]

Governments and subsequent regulators typically police their constituents and firms' negative externalities with environmental regulation and protection. These become social costs rather than production costs because they take place outside of the market mechanisms and are therefore not accounted for. Some basic regulatory instruments consist of Prescriptive Regulation

[128] Kolstad, *Environmental Economics*, 98.
[129] Ibid.
[130] Ibid.
[131] Ibid.
[132] Ibid.
[133]Kolstad, *Environmental Economics*, 99.

(PR) and Economic Incentives (EI).[134] In PR, regulators will define and specify to individual polluters on how to regulate and solve their environmental pollution. This is by far the dominant strategy in most countries. The Clean Air Act in the US required that the EPA determine for every major polluter the guidelines on how best to curtail and/or ban certain practices or products altogether.[135] PR regulators decide on many of the controls firms abide by and thus restrict a firm's choice.[136] EI consists of three parts: fees, marketable permits and liability.[137] Fees are simply a charge per unit of pollution emitted. Marketable permits allow for a marketplace for buyers and sellers to transact in pollution "allowance". Trading for or selling your permits incur a cost or transaction fee, thus making the very act of polluting expensive. Lastly, liability works largely by saying, "Do whatever you wish, but should an accident occur, we will find the socially desirable level of precaution; if you were not taking that level of precaution you will be responsible for all of the environmental damage from the accident."[138] The threat alone of negligence lawsuits is often enough for firms to engage in at least the minimum level of socially desirable levels of precaution. This relationship is graphed below in Fig 3, where X* denotes

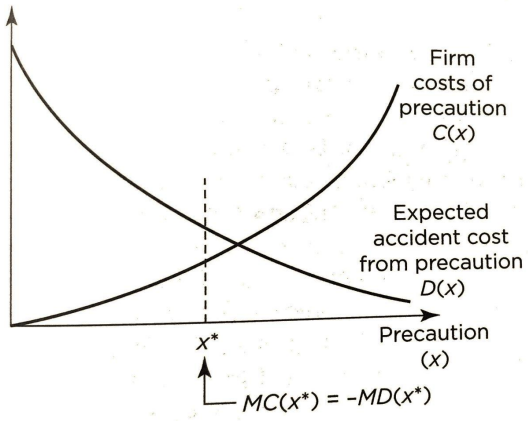

Fig. 3 Precaution and Liability. (Charles D. Kolstad, *Environmental Economics Second Edition* (New York, NY: Oxford University Press, Inc., 2011), 229.)

[134]Kolstad, *Environmental Economics*, 223.
[135]Kolstad, *Environmental Economics*, 224.
[136]Kolstad, *Environmental Economics*, 237.
[137]Kolstad, *Environmental Economics*, 226.
[138]Kolstad, *Environmental Economics*, 229.

"... some socially desirable level of precaution at which the marginal cost of taking more precaution is offset by reduction in marginal damage from taking more precaution."[139] It can be said that EIs are less restrictive to a firm's autonomy as they simply provide incentives for each polluter to find the best way to reduce pollution.[140] In the end, PR has the advantages of policy makers designing and targeting specific goals by their very prescription of rules on firms. In contrast, EIs are much more cost effective as the market allows for these incentives to play out in a manner which benefits firms and individuals from environmental pollution. The combination of our highly complex environmental relationships (between humans, ecosystems, pollutants) and consideration of time and spatial components which make it difficult to discern precisely how much ambient pollution (the concentration of pollution at any given time/space) firms are responsible for. As a result, regulators often succumb to cost-effective approaches rather than goal achieving approaches, or better yet, efficient regulation.[141] The web of intricacy governments and policy makers must navigate can be seen below in Fig. 4.[142]

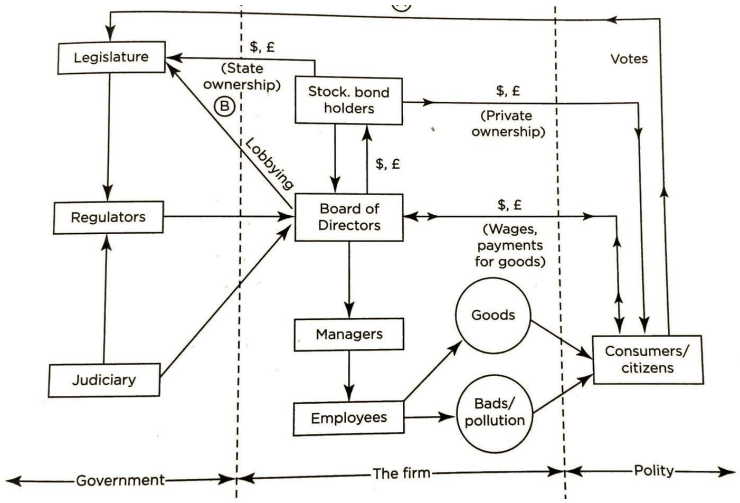

Fig 4. Dynamics of Government, Polluting Firms, and Consumer Citizens. (e.g. where in the USA... - Legislature = Congress, Regulator = EPA, & Judiciary = Federal Courts). (Charles D. Kolstad, *Environmental Economics Second Edition* (New York, NY: Oxford University Press, Inc., 2011), 221.)

[139] Ibid.
[140] Kolstad, *Environmental Economics*, 237.
[141] Kolstad, *Environmental Economics*, 238.
[142] Kolstad, *Environmental Economics*, 221.

Market Failures and Externalities. Keeping in mind the terms and concepts above, we will now examine the mechanisms in economics that apply to environmental issues. Market failures occur when an economy is not efficiently accounting for certain benefits or demerits. There are two market failures of major concern: Negative Externalities and Tragedy of the Commons (Common Pool Resources).[143] First on the docket, we will examine how inefficient markets produce 'failures' in the form of environmentally negative externalities (refer to Fig. 5 to refresh yourself on externalities).[144] Then a discussion on the Tragedy of the Commons, which pertains to the phenomena of economically unrecognized public goods (i.e. air/atmosphere which has no robust marketplace) whose consumption often leads to degradation and overuse.

Issue	*Culprits*	*Victims*
Pollution	Few and specified (factories)	Few and specified (local residents)
Automobile exhaust gas	Many and unspecified (numerous drivers)	Few and specified (roadside residents)
Tropical rainforest destruction	Few and specified (residents in tropical regions)	Many and unspecified (people around the world)
Climate change	Many and unspecified (current generation)	Many and unspecified (future generations)

Fig. 5 Negative Externalities. (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 35.)

To begin, refer to Fig. 6 below.[145] This illustrates how producers and consumers in a free market maximize the utility of each through price action, whilst environmental externalities go unpriced or 'un-marketed'. Given that externalities come in many shapes and forms, and are spatially and temporally unique to each specific case, it is extremely difficult to numerically express accurately and include in our economic mechanisms. However, a graphical illustration can be quite useful. Consider a typical demand and supply graph, Fig. 7.[146] Point E is where the

[143] Kuriyama and Managi, *Environmental Economics, 34.*
[144] Kuriyama and Managi, *Environmental Economics,* 35.
[145] Kuriyama and Managi, *Environmental Economics,* 34.
[146] Kuriyama and Managi, *Environmental Economics,* 36.

market is in equilibrium. Harmony between supply and demand are met at price P* and supply X*. The total surplus of this good/service is denoted by ΔABE.[147]

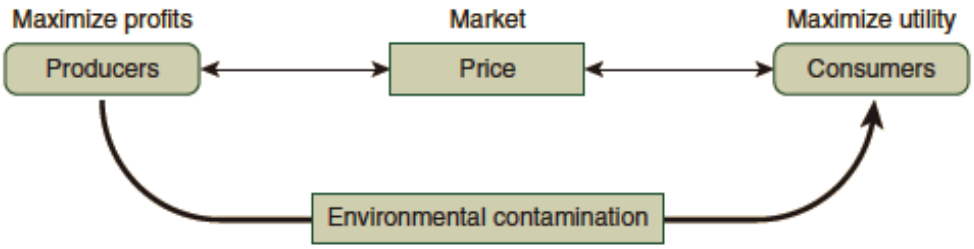

Fig. 6 Current Market Structure. (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 44.)

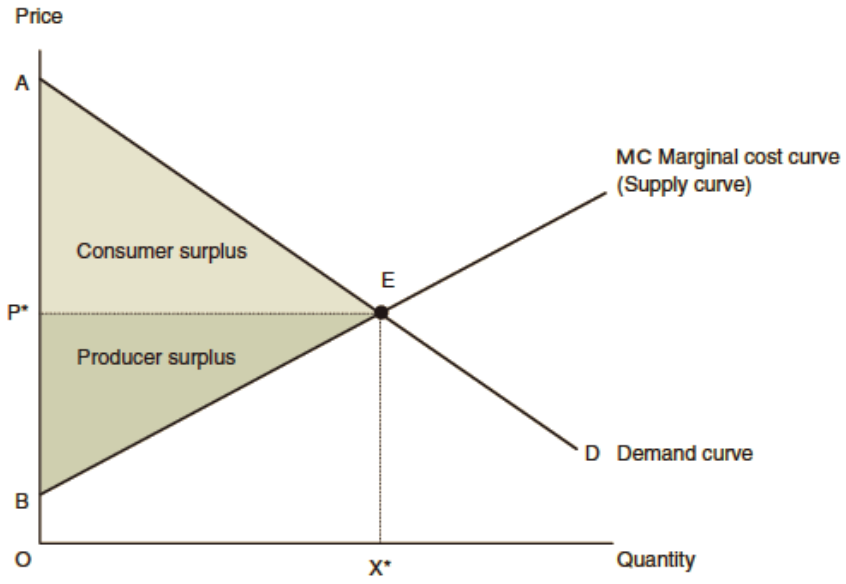

Fig. 7 Supply & Demand. (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 36.)

Unfortunately, to be blunt, this model is utterly inadequate for our purposes. Much like the ethics we mulled over in the prior section, the inclusion of environmental consideration is missing. Suppose Fig. 7 depicts the demand and supply for an electricity market where the power generation is via burning coal. Also consider that we incorporate externalities from coal burning

[147] Ibid.

in the form of CO_2 emittance which accelerates the rate of climate change via air pollution. First, let's see how externalities in this scenario might be drawn. Examine Fig. 8.[148] As the consumption of electricity increases so does the marginal externality cost (MEC); the more electricity we consume, the more coal is burned, resulting in increased air pollution.

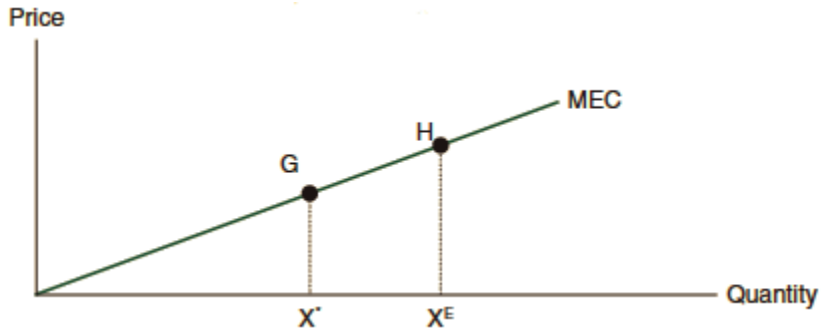

Fig. 8 Marginal Externality Cost (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 37.)

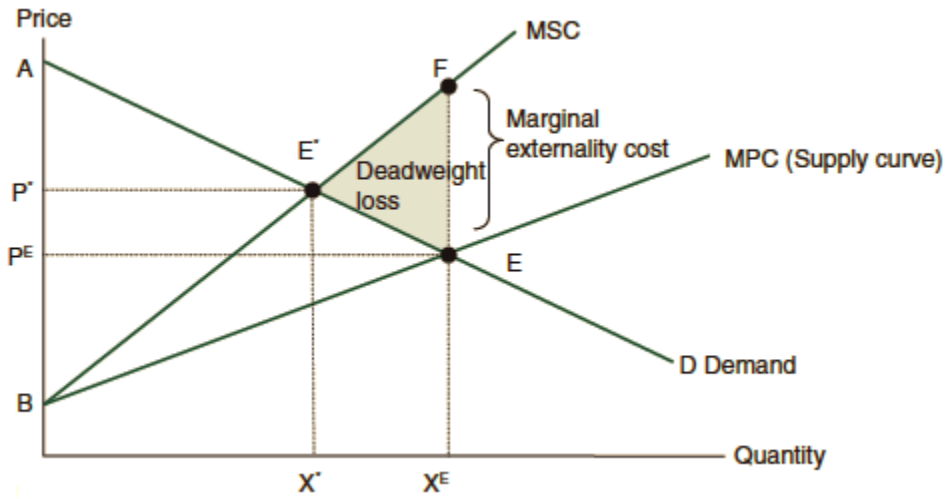

Fig. 9 Demand & Supply with Externality Cost (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 37.)

Fig. 9 above adds to the standard demand and supply graph by adding the marginal externality cost to the marginal private cost (MPC) to give us the aggregate marginal social cost (MSC).[149]

[148] Kuriyama and Managi, *Environmental Economics,* 37.
[149] Ibid.

Stated differently by taking X^EH (above) and adding X^EE (below) you produce the MSC.[150] Fig. 9 thus allows for us to provide a graphical representation of one way in which we can tangibly express externalities by assessing both the total private cost (such as the electricity plant production cost) and incorporate the social cost of air pollution.[151] The socially optimal price is P^* for supply X^*. However, since most markets do not include externalities or integrate the MSC curve in Fig.9, they over produce in some area between X^* to X^E. A loss in both consumer and producer surplus can be seen compared to Fig. 7 where the total area of ΔBEE^* is the magnitude or cost for environmental consideration. However, do not mistake an absence of externality inclusion as a total gain of ΔBEE^* as the overproduction stated earlier results in its own loss defined as the *deadweight loss* (DWL).[152] The DWL is both a product of market failure and our unwillingness to adapt our models. Modeling in a MSC curve to account for the externality cost is known as internalization. Note, there were no numerical values mentioned in the above exercise. This is largely due to the highly complex and difficult nature (please excuse the pun) of valuing ecosystems' services and their environments. That is not to say, however, that we cannot assign numerical values into the graph or exercise. In the end when market externalities are present the overwhelming result is inefficiencies resulting in overproduction and forfeited surpluses.[153]

Valuing Ecosystems. The method of internalization has merit and potential for curbing and disincentivizing unneeded externalities for businesses. As mentioned, however, obstacles such as cost, lack of data and guidance from local and federal levels leave this method largely unutilized. Authorities and regulators can surely be more demanding of their standards.

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[150] Ibid.
[151] Ibid.
[152] Kuriyama and Managi, *Environmental Economics,* 38.
[153] Ibid.

However, ultimately those very standards are set by their constituents, the common folk whom we alluded to before are arguably finding themselves in increasingly 'vegetative' states.

Attempts have been made to numerically express ecosystem services and more generic environmental values. Examples such as Payment for Ecosystem Services Systems or Biodiversity Offsetting exist.[154] Other more subjective and intricate evaluations are made in environmental valuation methods, most notably stated vs. revealed preference methods and in environmental assessment methods, willingness to pay (WTP) vs. willingness to accept (WTA). We'll examine each briefly and then examine their efficacy in real world application. In simple terms, WTP & WTA are as follows and further outlined in Fig. 10… [155]

- Willingness to Pay → "... the maximum amount of monetary contribution that one wouldn't mind paying regarding a change to the environment"[156]
- Willingness to Accept → "... the minimum amount of monetary compensation that one would be open to receive for a change to the environment"[157]

	Environmental improvement	*Environmental degradation*
Willingness to pay	The maximum amount one does not mind paying to improve environmental quality	The maximum amount one does not mind paying to prevent environmental degradation
Willingness to accept	The smallest amount of monetary compensation one would demand upon conceding to the repeal of environmental improvement countermeasures	The smallest amount of monetary compensation one would demand for environmental degradation

Fig. 10 WTP & WTA. (Koichi Kuriyama and Shunsuke Managi, *Environmental Economics* (New York, NY: Routledge, 2017), 131.)

In WTP & WTA we see both sides of the valuation are covered- the benefit to and harm of our environments. When valuing utility (direct) vs. non-use values (non-direct) in ecosystems,

[154] Kuriyama and Managi, *Environmental Economics,* 189-90.
[155] Kuriyama and Managi, *Environmental Economics,* 131.
[156] Ibid.
[157] Ibid.

economists and individuals tend to have a hard time procuring a monetary value. Take a forest for an example. When we use the trees as lumber, the direct value is numerically expressed in the price of lumber and derivative products.[158] When the same forest is used for aesthetic or recreational enjoyment, that is a non-direct use.[159] One major deficiency of traditional economics is that the non-direct use values do not have a developed market or price association. This is where WTP and WTA can be useful. Essentially, both methods allow for individuals in an economy to 'put their money where their mouth is' by providing quantitative values to be placed on what qualitative attributes they value in the environment. In other words, a maximum and a minimum boundary can be attributed to either direction of environmental impact. In the manner in which individuals might be willing to degrade the environment (WTA) the externalities are accounted for, albeit in detriment of the environment. To the extent that individuals are willing to pay for environmental protection (WTP) externalities can be said to be avoided or mitigated.

With regards to the substitution effect, where one good can be replaced by another private good, WTA and WTP can diverge significantly in expressed value.[160] Examine Fig. 11 below.[161]

[158] Kuriyama and Managi, *Environmental Economics,* 130.
[159] Ibid.
[160] Kuriyama and Managi, *Environmental Economics,* 139.
[161] Kuriyama and Managi, *Environmental Economics,* 138.

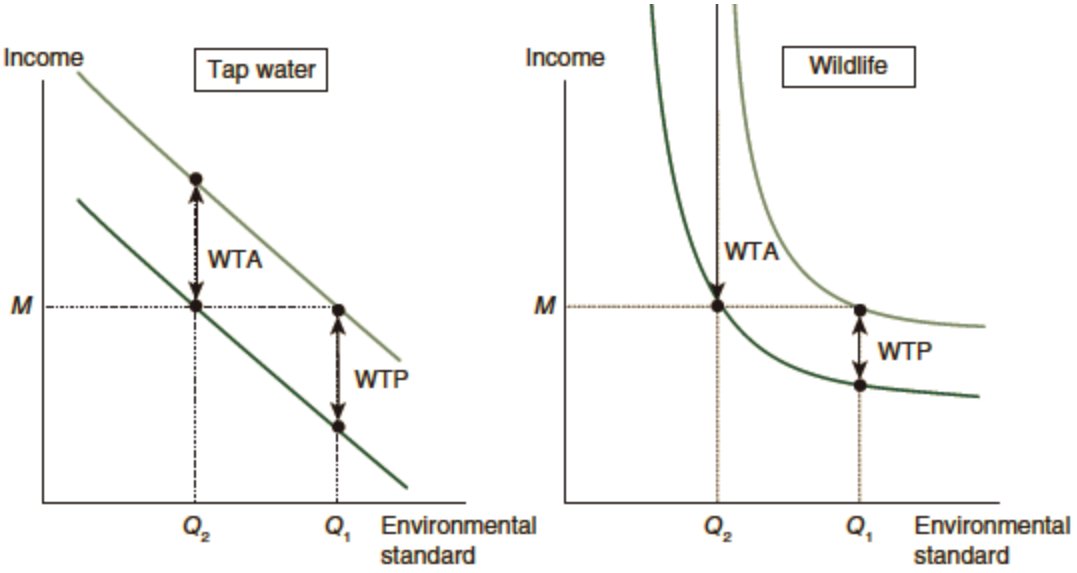

Fig. 11 Substitution Effect: WTA & WTP Divergence (Kuriyama and Managi, *Environmental Economics, 138.)*

Using examples of tap water quality and wildlife extinction we can see how WTA and WTP have sizable divergences. On the left, since there are alternatives to tap water such as bottled water or purifying filters (both private goods), even though environmental standards decline WTA and WTP are still correlated in parallel, thus converging in value depicted by the arrows. In contrast, when environmental standards decline and wildlife extinction rises, a concave indifference curve is seen where divergence between WTA and WTP are notable (in fact WTA goes off the graph!).[162] Stated differently, since an extinction of a particular species cannot be replaced by any private good or method, the graph on the right reflects this change in the difference between the value of WTA and WTP in the size of the arrows.

While both WTA and WTP are helpful to understand how much an individual might value direct and non-direct use of environmental resources, it is still highly subjective, thus making the accuracy and efficiency of deploying such a method extremely difficult and

[162] Kuriyama and Managi, *Environmental Economics,* 137.

unreliable. Similarly but distinct, Stated vs. Revealed preference methods are another medium in which we can derive metrical value.

- Stated Preference (SP)→ assess the value of the environment through direct inquiries to individuals.[163]
- Revealed Preference (RP)→ assesses the value of an environment by estimating the impact of said environment on economic behavior.[164]

Under RP, the travel cost method (TCM) and hedonic pricing method (HPM) are utilized. TCM estimates the recreation value contingent on the relationship of travel cost and visitation frequency.[165] HPM evaluates various environmental risks and harms one may be subject to by land prices and incomes.[166] Both methods have an advantage of utilizing data that is easily available and interpretable, but cannot be readily used to price non-use values in our environments. SP can enlighten policy makers and regulators on what their public values are in the environment based on direct inquiries. SP methods include the contingent valuation method (CVM) and conjoint analysis (CA).[167] CVM and CA are opposite sides of the same coin. CVM evaluates an individual's WTA/WTP regarding policy that changes our environments, whereas CA evaluates the individual's preference on candidates of environmental policies that can replace existing ones.[168] SP can be used to evaluate non-use values making them more useful for protecting non-use value portions of the ecosystems. However, since these preferences are analyzed and aggregated by questionnaires, the results potentially yield bias.[169] Compared to RP

[163] Kuriyama and Managi, *Environmental Economics,* 129.
[164] Kuriyama and Managi, *Environmental Economics,* 144.
[165] Kuriyama and Managi, *Environmental Economics,* 145.
[166] Ibid.
[167] Kuriyama and Managi, *Environmental Economics,* 146.
[168] Ibid.
[169] Kuriyama and Managi, *Environmental Economics,* 152-153.

which is a more quantitative and direct approach, SP methods intertwine policy alterations and ultimately issuance which results in a multidimensional approach.

As exemplified above there are various techniques and methods to which the environment and the subsequent effect to it can be measured and/or valued. Some present biases such as SP and WTP vs. WTA. While the MSC (Marginal Social Cost) approach to internalizing externalities has merit, economic actors are not incentivized enough to make this method a standard. Furthermore, economists have consistently been stubborn about what measures should be used to depict well-being. Neva Goodwin makes a poignant observation regarding neoclassical economics, "because utility is difficult to measure, economists almost always use instead the goal of maximization of consumption (GDP) as a proxy."[170] Maybe it is as simple to then educate and hire more environmentally forward economists. However, that too will most likely be deemed inefficient and too costly when in the meantime the incumbent will merely ponder and suggest tactics that yield no meaningful results. Before leading into the next portion let us summarize with another Goodwin quote:

> The failure of economists to elevate the concept of well-being to an importance equal to that given to wealth is related to the loss (from most important writing in economics since that of Alfred Marshall) of an appreciation of the salience of moral issues to economic behavior. It may be said that the basis of human morality is human values - our identification of what matters. In the mainstream, neoclassical economics paradigm the single value admitted to was efficiency. Efficiency however is only a means. When pressed to name the end to which efficiency is a means, neoclassical economists offer the maximization of utility.[171]

[170] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 422.
[171] Pierce and VanDeVeer, *The Environmental Ethics & Policy Book*, 421-422.

Blockchain Basics. In order for economics (and for that matter humanity) to reach its potential beyond goals of efficiency and academic idealism, the embracement of technology is imperative. It is widely accepted and understood that the Industrial Revolution was the first event to catapult an improved standard of living. The crux of it laid in man harnessing dormant energy through advancement in technology to power daily tasks and jobs. Examples starting from hydro and wind to power early mechanics to then the steam engine, combustion engine, fossil fuel burning, etc. have all enabled an increase in human prosperity. This is mostly recognized in the world's population explosion from the early 1800s to the 2000s. We have gone from barely a billion people in all of human history to nearly 8 billion people as of April 2021.[172]

I propose that a 'Blockchain Revolution' can present us with the next necessary technological might and tools to *propel humanity, along with the plane*t forward. Bitcoin, backed by a blockchain protocol, will change humanity's relationship with the environment through the reconstruction of money.[173] A blockchain operating system for directorates would entail that accountability and transparency are backed by immutabile records to ensure citizens' societal (and thereby environmental) interests (*good*) are prioritized over corrupt and opaque political undertakings. Businesses can now adopt blockchain in a wide array of applications and purposes to optimize and account for environmentally conscious decision making.

Digitization and technology heavy instruments have led to seismic advances in human prosperity and productivity; the Blockchain Revolution can provide the means to achieve it for the planetary *good* and not just mankind. To recap, Blockchain or as banks like to call them DLTs (Distributed Ledger Technology) are akin to how a ledger would function, except it is fully

[172] "Current World Population," Worldometer, accessed March 20, 2021, https://www.worldometers.info/world-population/#pastfuture.
[173] Bitcoin with uppercase 'B' will denote the protocol,software,and community,whereas bitcoin with lowercase 'b' labels units of the currency itself.

digitized. An important distinction between the two is that a Blockchain does not only store and communicate data but also intrinsically hosts a protocol (rules & standards) for how the ledger will be updated and operated.[174] In the same manner that a newly bound ledger is blank, so are the contents of newly minted blocks.[175] To illustrate this, Bitcoin (only one of many types of blockchain networks), will be discussed in further detail in subsequent sections. Again, public ledgers are permissionless in that there is no central authority to approve of a participant's creation of a block (page) and subsequently there is no permission needed to receive or send data/funds over such networks.[176] When a new block is created, all pending transactions on the network are bundled together to form said block and are settled in the same way Visa or Mastercard settles your card activity. Private or permissioned ledgers are often used by businesses that have already identified and know the users in the network. A permissioned network does not need a 'native token' such as bitcoin to operate, nor does it necessarily need a protocol to 'mine' (the creation of the next page if you will) blocks. In a business or private setting, there are typically laws and rules agreed upon where code is not law; for Bitcoin code is law and there is no potential for antagonistic participants that need to be kept in check.[177] Any misbehavior can be caught easily and dealt with accordingly to the private institution's discretion. A common criticism of private vs. public ledgers is that an open and permissionless system is undoubtedly superior, much like how the internet is open and permissionless therefore being the dominant network compared to an intranet (where only permissioned entities can access private data).[178] This is far from the truth. There is plenty of value to be derived from private ledgers, it simply depends on your expressed purpose and needs. The internet, for that

[174] Anthony Lewis, *The Basics of Bitcoins and Blockchains*, (Coral Gables, FL: Mango Publishing Group, 2018), 524.
[175] Lewis, *The Basics of Bitcoins and Blockchains*, 525.
[176] Lewis, *The Basics of Bitcoins and Blockchains*, 526.
[177] Lewis, *The Basics of Bitcoins and Blockchains*, 530.
[178] Ibid.

matter, unbeknownst to most, is a combobulation of private networks of internet service providers (ISP) that cooperate through agreed upon terms with other ISPs making it not so 'open' as one might imagine it to be.[179] In brief, private and public blockchains operate through different ecosystems and are designed for different needs making one or the other more suitable for varying situations.

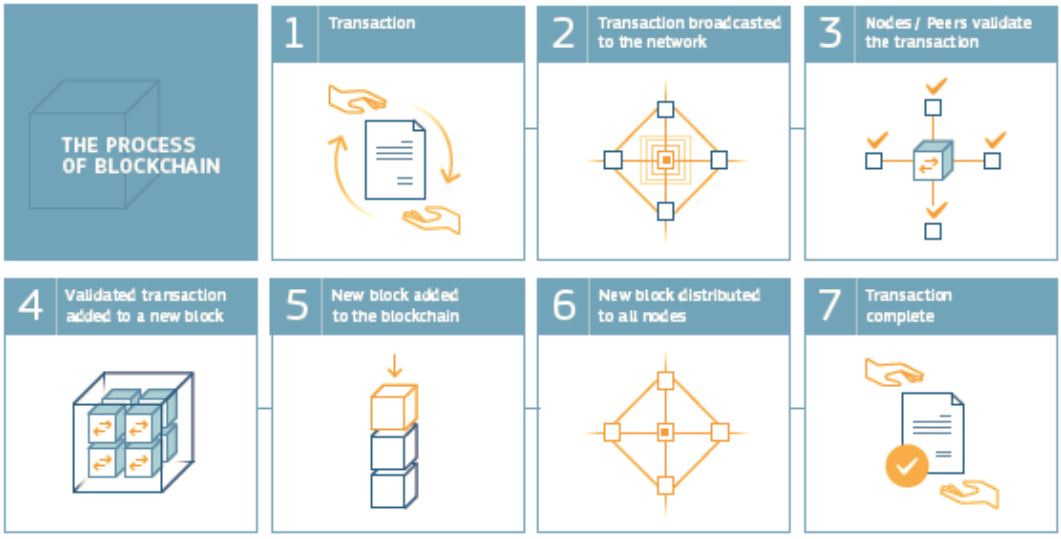

Fig. 12 The Process of Blockchain. (Nascimento S. et al., *Blockchain Now And Tomorrow: Assessing Multidimensional Impacts of Distributed Ledger Technologies – executive*. PDF file. 2019. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjN14qhrMDwAhWi2-AKHccOCUYQFjAAegQIAxAD&url=https%3A%2F%2Fpublications.jrc.ec.europa.eu%2Frepository%2Fbitstream%2FJRC117255%2Fblockchain_executive-summary_online.pdf&usg=AOvVaw0FweEev1sCTiMgsPzp-NH_.)

Let us break down and reiterate key components of the Bitcoin Blockchain (see Fig. 12 for a visual illustration).[180] As stated above a blockchain acts as a form of digital ledger for record keeping. The records are irreversible, verifiable and traceable. Much like a physical ledger the data/transactions are stored chronologically, time stamped and securely linked together cryptographically as each new block is mined. The program is public and decentralized in nature.

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[179] Lewis, *The Basics of Bitcoins and Blockchains*, 531.

[180]Nascimento S. et al., *Blockchain Now And Tomorrow: Assessing Multidimensional Impacts of Distributed Ledger Technologies – executive*. PDF file. 2019. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjN14qhrMDwAhWi2-AKHccOCUYQFjAAegQIAxAD&url=https%3A%2F%2Fpublications.jrc.ec.europa.eu%2Frepository%2Fbitstream%2FJRC117255%2Fblockchain_executive-summary_online.pdf&usg=AOvVaw0FweEev1sCTiMgsPzp-NH_.

Anyone can go to "https://bitcoin.org/en/full-node", download the application and start participating.[181] It is not for any *one* person but is for everyone. In this way it is inclusive and the network is inherently additive and not subtractive. You do not need a prior relationship with the on-chain process or even an invitation. It is truly open and available for anyone who wishes to engage. Every node, or user has the full history of the entire blockchain which can be held by anyone running the program, anywhere. You do not need the best or most recent hardware to do this. Trust in the system is achieved through the *consensus mechanism*. This protocol enables participants to trust the network's integrity based on the rules and regulations set forth by the blockchain program to verify, validate and add transactions.[182] The consensus mechanism in a blockchain ecosphere acts as the banks or settlement companies in legacy systems. They are vital to the functionality of the ledger in that they allow for decision making (transactions) to take place on a peer-to-peer basis. There are many forms of consensus mechanisms that can be programmed into a blockchain. Bitcoin uses *Proof of Work* (PoW). Ethereum started out as a PoW network, but is now transitioning into a *Proof of Stake* (PoS) protocol.[183] Other perhaps lesser known protocols are: *Proof of Importance, Proof of Activity* (a combination of Pow & PoS) and *Proof of Elapsed Time*.[184] In essence, the beauty of a blockchain protocol is that the creator can code in whatever mechanism they see fit to propagate the network in their vision. Perhaps in the near future, a *Proof of Environment* or *Proof of Sustainability* protocol might emerge. For now projects such as ECOcoin and Bitgreen are leading the way on a PoS protocol (discussed further in chapter four). Nevertheless, the results of the aforementioned are a

[181] van Rijmenam and Ryan, *Blockchain*, 69.
[182] van Rijmenam and Ryan, *Blockchain*, 67.
[183] Ozora Ogino et al., "Proof-of-stake(PoS)," *ethereum.org*, April 15, 2021, accessed April 20, 2021, https://ethereum.org/en/developers/docs/consensus-mechanisms/pos/.
[184] Rokkex, "PoS, PoW, and 12 Other Blockchain Protocols You Didn't Know About," *medium.com*, March 15, 2019, accessed March 29, 2021, https://medium.com/hackernoon/pos-pow-and-12-other-blockchain-protocols-you-didnt-know-about-3634b089d119.

decentralized peer-to-peer network in which transactions are settled almost instantaneously without intermediaries.

In his white paper, *Bitcoin: A Peer to Peer Electronic Cash System*, Nakamoto demonstrated (in extreme simplicity) how the chain of blocks would operate as illustrated in Fig 13.[185] It may be useful here to do a deep dive into why Nakamoto's development of the PoW consensus mechanism is revolutionary. Participants on a blockchain can exchange value without needing to verify or trust the sender/receivers identity or trust worthiness. A key reason we've needed intermediaries is because of what is known as the *double spend problem*. Over the internet, data can be perfectly replicated. This presents challenges with authenticity and thereby the integrity of the product (say music, art, certificates, ID's etc). Money adds another layer of

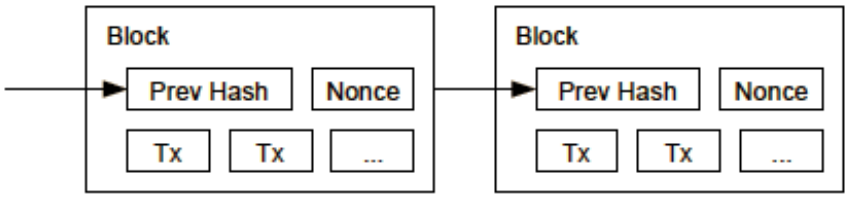

Fig. 13 Chain of Blocks. (Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*. PDF file. October 31, 2008, https://bitcoin.org/bitcoin.pdf. 3)

complexity where, should Satoshi send Hal $1 he must be trusted to do exactly so and not have the same $1 bill in his 'possession'. Simply put, money "can't exist in both places, let alone multiple places.[186] "[There arises] a risk of your spending a unit of digital currency in two places and having one of them bounce like a bad check."[187] Afterall, once you've spent your $1, you should not be able to 'spend' the same bill again elsewhere. The resolution? Nakamoto created a *consensus mechanism* (PoW) in which he solved the double spend problem probably better than

[185] Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*. PDF file. October 31, 2008, https://bitcoin.org/bitcoin.pdf. 3
[186] Alex Tapscott and Don Tapscott, *Blockchain Revolution: how the technology behind bitcoin is changing money, business, and the world,* (New York, NY: Portfolio/Penguin, 2016), 191.
[187] Ibid.

any intermediary and by doing so has made such third parties obsolete.[188] On the Bitcoin ecosystem a block is time stamped so that when a particular Bitcoin is spent, it cannot be spent again. The transaction data accumulated by the network is then aggregated by network participants known as miners.[189] Miners compile and settle the next block by aggregating said transactions. This process happens on average every 10 minutes without change in block size or processing time and is always referred to the previous block (Fig 13.) for authentication. Each block is time stamped with a unique number or *nonce*, only used once, which provides the miners a specific value to mine for. In brief, that is how the Bitcoin DLT works. This data is public, traceable and immutable. *Consensus* is achieved through distributed participants who have equal opportunity to the 'right' in updating the network through PoW. PoW can be understood as the labor needed to create the next block, but it is also creating value in the form of bitcoins. In a peer-to-peer, decentralized network we cannot, nor do we need to, trust the identity or intentions of miner participants. PoW provides incentives for each participant to solve a complicated computational puzzle using computer hardware and electricity.[190] Whoever solves this mathematical quiz gets to 'mine' the next block. Ultimately, miners gather all pending transactions (up until the max data load a block can handle) in the network and digest the data through a cryptographic function called the secure hash algorithm (Bitcoin uses the SHA-256 algorithm).[191] Finding the correct hash value is immensely difficult yet easy to verify, making it a uniquely capable tool in verifiability. In a hash function, any one input only creates one output. Unfortunately for miners, this output is near impossible to reverse, meaning the output value cannot be inverted to produce the original input. The number of guesses on average for a block to

[188]Tapscott, *Blockchain Revolution*, 192.
[189] Ibid.
[190] Tapscott, *Blockchain Revolution*, 194.
[191] Ibid.

be mined as of November 2015 is 350 million trillion.[192] That is an incredible amount of guessing that needs to be done, albeit by a computer. Also, as the number of miners competing for Bitcoins rises, the protocol increases the difficulty (called the *difficulty adjustment*) to find the input accordingly.[193,194,195] Suffice it to say, it takes an incredible amount of computational work to create the next block. Fittingly, the miners' costs of hardware, electricity, and time spent to compile and solve for the next block is rewarded by the protocol's native token, which in Bitcoin's case are, of course, bitcoins. It is important to note here that miners do not validate the transactions. This is done by the nodes or users running the full program and blockchain ledger. "Rather, miners preserve the distribution of power—the power to decide which transactions to include in each block, the power to mint coins, the power to vote on the truth."[196] "Under the hood, proof-of-work mining converts kinetic energy (electricity) into a ledger block. By attaching energy to a block, one gives it 'form', allowing it to have real weight and consequences in the physical world."[197]

In short, instead of trusting big-tech or governments to be arbiters of integrity Nakamoto enabled a few lines of code to eliminate third parties and instead created a "platform that ensures trust in transactions and recorded information no matter how the other party acts."[198] Listed below are the top characteristics which make Bitcoin Blockchain a powerful technology:

- Immutable Records (data cannot be altered or tampered with)
- Security (via PoW, eliminating centralized 3rd party intermediaries)

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[192] Tapscott, *Blockchain Revolution*, 195.
[193] See here for more on mining difficulty and adjustments
[194] To compensate for increasing hardware speed and varying interest in running nodes over time, the proof-of-work difficulty is determined by a moving average targeting an average number of blocks per hour. If they're generated too fast, the difficulty increases." - (Nakamoto, *Bitcoin*, 3.)
[195] Even amidst periods of surging demand for Bitcoin, Bitcoin miners have no ability to mine Bitcoin faster, making unexpected inflation impossible. Forever. (Stevens, *2020 Shareholder Letter*, 7.)
[196] Tapscott, *Blockchain Revolution*, 643.
[197]Yassine Elmandjra, "Debunking Common Bitcoin Myths," *ARKINVEST.com*, June 26, 2020, accessed April 9, 2021, https://ark-invest.com/analyst-research/bitcoin-myths/.
[198] Tapscott, *Blockchain Revolution*, 197.

- Decentralized Nodes (the data ledger is distributed to anyone who wants access)
- Faster Settlements (as there is no intermediary)
- Unanimous Consensus (network nodes agreement is easy to reach and verify)
- Anonymous (no personal information is needed)

The socio-political implications are extensive. Being able to trust digital data and collaborate on such a massive scale has never, ever, been realized to this extent before. Who owns this land? Where did those carrots come from? Is that his or her intellectual property? Did Mr. A or Mr. B create this artwork? All of these questions and answers can be stored, verified, and shared worldwide in a true decentralized and distributed manner. Moreover, one can curate environmentally relevant questions such as: How much pollution did firm A emit in 2021?, What percentage of your energy consumption was renewable?, Are your products from sustainable and traceable sources?, How did company Z curtail or eliminate their carbon footprint in 2021?, and so on. Most imaginable data, quantitative and qualitative, can be stored, transacted upon, and accessed publicly to guide socio-economic decision making. The OECD (Organization for Economic Co-operation and Development) published 3 key areas in which blockchain can increase environmental sustainability. The first use case is through a decentralized financing infrastructure.[199] Through the blockchain platform investors can directly fund projects and be rewarded for future utility or by increased native token values as the projects become successful. The second use case can be seen in raising efficiency and accuracy in emissions credit trading.[200] Blockchain based management systems can effectively monitor quota rules, certificate circulation, see real time carbon emissions, and promote market integrity all the while

[199]OECD Financing Climate Futures-Rethinking Infrastructure, *Blockchain Technologies as a Digital Enabler for Sustainable Infrastructure.* PDF file. September 5, 2019. https://www.oecd.org/finance/Blockchain-technologies-as-a-digital-enabler-for-sustainable-infrastructure-key-findings.pdf. 4.
[200] Ibid.

automating the transaction process.[201] Regulatory, compliance and administrative functions can be programmed, making it an ideal tool for multinational agreements such as the Paris Agreement. Lastly, an underlying blockchain operating system can support governance, as well as monitor infrastructure standards and compliance.[202] Since governments and policy makers need reliable and up to date data on much more than just financials, blockchain can also help standardization and reporting on ESG related performance.[203] Furthermore, Bitcoin and its blockchain " takes advantage of the nature of information being easy to spread but hard to stifle", making it one of the most tamper proof and decentralized electronic monetary networks ever.[204]

Nakmato's intentions were clear. He wanted to create a secure, decentralized, peer-to-peer financial system in which participants interact in a permissionless environment. At the risk of Bitcoin maximalist's ire, the Bitcoin network can, contrary to its description, be interpreted as intermediated. The nodes (users) and miners together verify, aggregate and labor at the expense of network security and integrity prior to any transaction reaching final settlement through PoW. Perhaps the Bitcoin ecosystem can then be understood more accurately as... *Peer-to-node/miner-to-Peer* or alternatively *Peer-to-node-to-Peer／Miner*. Whatever interpretation you choose, the reach of Nakamoto's work, whether intended or not, is far beyond financial applications. As stated in chapter one, Nakamoto's true genius was in combining an array of disciplines to create the Bitcoin blockchain. (As an aside, but on a related note, Nakamoto never even called the mechanism a blockchain in his white paper - only referring to the mechanism as "chain of blocks" or "... blocks are chained after it").[205] A combination of computer engineering, game theory (behavioral economics), mathematics, and cryptography

[201] Ibid.
[202] Ibid.
[203] Ibid.
[204] Satoshi Nakamoto, "Bitcoin open source implementation of P2P currency," *p2pfoundation.ning.com*, February 11, 2009, accessed April 11, 2021, http://p2pfoundation.ning.com/forum/topics/bitcoin-open-source.
[205] Nakamoto, *Bitcoin*, 3,7.

were forged in the fiery depths of The Great Recession to birth Bitcoin from the ashes of our legacy fiat systems. While there are many principles of what makes the Bitcoin Blockchain the superior modern day ledger, chapters four and five will address those which are pertinent to and desirable for engaging in environmental challenges such as ecosystem degradation, externalities and assigning accountability. Externalities that are monitored closely are carbon and GHG emissions because of their devastating effects on the degradation of our atmosphere and air quality. To further incentivize compliance and establish responsibility, the UN has taken a keen interest in blockchain's utility in the carbon markets as part of its decision framework and architecture. Similar to the OECD, the UN and Paris Agreement, all have expressed interest in safeguarding environmental integrity through robust accounting.[206] To ensure integrity of reporting and data is also to ensure the success of any initiative put into motion. Therefore, blockchain as an operating system for data aggregation is ideal.[207] Blockchain, is after all an reinvented system for data storage and communication. Furthermore, blockchains ability to create native tokens allows for tokenization of credit emissions which can be traded on chain and eliminate the chance of double counting or corruption of transactional history at any point after settlement.[208] This immutability feature has the advantage of fostering consistency into the history of participants and creates a permanent chain of transparency and accountability.[209] Lastly, disintermediation and thereby having no host nation, party in charge, or lead organization have sole access and verification privileges thanks to the distributed nature of blockchains, there is no central point of failure or target for attacks.[210]

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[206] Laura A. Franke, Marco Schletz, and Søren Salomo. *Blockchain Application for the Paris Agreement Carbon Market Mechanism—A Decision Framework and Architecture*. PDF file. June 22, 2020. https://doi.org/10.3390/su12125069. 3.
[207] Frank, Schletz, and Salomo, *Blockchain Application for the Paris Agreement Carbon Market Mechanism*, 4.
[208] *Blockchain Application for the Paris Agreement Carbon Market Mechanism, 7.*
[209] Ibid.
[210] *Blockchain Application for the Paris Agreement Carbon Market Mechanism, 8.*

Chapter Four: Bitcoin and Blockchain

Money, Energy & Time Preference. Now that the basics of Bitcoin have been presented, consider the three topics that should/could be tied together: B/bitcoin, Blockchain, and the *good* of the environment. First we must examine the current fiat system and then address why bitcoin is a viable alternative currency/store of value (SoV). Next, we will look at how Bitcoin is used and can potentially accelerate the environmental *good*. Keep in mind that the technology enabling this is Nakamoto's "chain of block," the original Blockchain. Bitcoin as a SoV will be the ground floor enabling the individual to participate in blockchain technology. A specific use case example of Blockchain and bitcoin will be given at the intersection of energy and the environment. Then the adoption of Blockchain schematics in the energy industry will be addressed in conjunction with its environmental impact. This will be the business level of participation. To end, we will explore the potential for smart contracts on a Blockchain network for governmental and regulatory/policy infrastructure geared towards achieving eco-friendly projects.

The medium of money has served as 'technology' for storing the value of work over time and space, where work is defined as the transfer of energy. In other words, *money is quite simply stored energy*. It is an authentication of past work done to claim future resources. Our first introduction to a use case of SoV was when fire was discovered; through combustion, raw material (SoV) was transformed into heat (the transfer of energy) allowing for robust energy consumption. Then gravity was harnessed via hydro powered mechanisms such as the water turbine. Next, pressurized energy was captured through air compression, and so on:

> All through human history - since a million years ago to today - it's really the story of intelligent people looking around for; Where is the energy coming from? And how do I channel it in a network in order to achieve something harder, smarter, faster, stronger?[211] - Michael Saylor

As Saylor portends, human history has literally been about channeling energy. If we can reconstruct our perspective on money as our expressed token of energy we can then see how to best channel our prized energy. It also can open our eyes to see the deficiencies in fiat currencies, (i.e. money). Note that the average global GDP to debt ratio in 2019 (weighted by country, expressed in USD) is at a staggering 226%.[212] That is for every 1 unit of currency, 226 units are owed. Stated differently, all fiat money is debt multiplied by 226. That $20 bill you used today, debt. The $100 bill youare waving around on Instagram, debt. It is owed to somebody, somewhere, who then most likely owes another somebody, somewhere and on and on. Deficit spending is made possible by issuing sovereign debt which leads to money printing (though not all debt issuance finds its way to circulate in the broad money market supply via 'printing'). The consequences of overspending through increasing money supply can be dire. As pockets become flush, demand for goods/services rise and in a classical sense prices rise as well. The top most concern is inflation. Look no further than Venezuela or Turkey whose Bolivar and Lira respectively have suffered the ultimate consequence; debasement resulting in hyperinflation. Yet, such deficit spending at the risk of inflation is an arbitrary topic to most. A recent text conversation (between a friend and I) about inflation and deficit spending yielded this statement, "I don't care about federal debt anyway, at this point it's not real", speaking

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[211] Stephen Chow, "The Saylor Series | Episode 3 | Technology Themes through History — Harder, Smarter, Faster, Stronger," *medium.com*, February 19, 2021, accessed April 1, 2021, https://chowcollection.medium.com/the-saylor-series-episode-3-technology-themes-through-history-harder-smarter-faster-bfea8f250818.

[212] Xuehui Han, Paulo Medas, and Susan Yang, "The Pre-Pandemic Debt Landscape—and Why It Matters," *blogs.imf.org*, February 1, 2021, accessed April 19, 2021, https://blogs.imf.org/2021/02/01/the-pre-pandemic-debt-landscape-and-why-it-matters/.

specifically about the US national debt. I argue the debasing of fiat by spending far beyond our means *has immense moral and environmental ramifications* in addition to the obvious economic one. What is more, a manipulated and hypothecated money supply perverts economic and societal incentives for both individuals and markets at large. The understanding of how money plays a role in our lives will lead us to reflect on why we act the way we do in the current construction (unsound money) and how Bitcoin (sound money) and blockchain can restore balance to our relationship with the environment:

> Money Is a human invention, a social construct that only works since we collectively believe in it. In fact, the term "fiat money"is derived from the Latin word "fiat," which means "an act of will that creates something without further effort." It's a decree.[213,214] - Kjell Inge Røkke

Money is deeply spiritual. Even the story of salvation in the Bible is woven through the language of money; payment, debt, forgiveness, redemption and so on.[215] It's pervasive in nearly every aspect of our lives; jobs, expenses, leisure, relationships (business and personal) etc. We engage in the economy and our relationship to others often through monetary means. It is ingrained in our lives because it simply does one extremely complex thing. It finds *consensus*. At the same time, it can be the ultimate solution to having a lack of consensus. Before gold was the medium through which people bartered (found consensus), people of neighboring countries could not interact efficiently, or sometimes could not negotiate for trade at all. Gold brought consensus and let the market know, this amount of gold gets you a chicken, or a bag of rice. Before gold, you would barter between goods, i.e. a bag of rice for a chicken. However, problems quickly arose as soon as one party bargained for fractions of something which could

[213] Kjell Inge Røkke. *Dear Shareholders*. PDF file. March 8, 2021. https://www.seetee.io/static/shareholder_letter-6ae7e85717c28831bf1c0eca1d632722.pdf. 8.

[214] To read Aker's shareholder letter click here.

[215] Robert Breedlove et al., *Thank God For Bitcoin: The Creation, Corruption & Redemption of Money*, (Bitcoin and Bible Group, 2020), preface.

not be feasibly portioned (ie. half a chicken). In short, money acts as three things: a medium of exchange, a store of value, and a unit of account (uncorrelated to its quantity).[216] What matters most when putting those qualities together is that money provides purchasing power - the right to consume resources in the future. Should your purchasing power be debased, our *time preference* follows suit. Time preference is paramount to our understanding of money's function because it is a concept of understanding individual decision making.[217] It is the "ratio at which individuals value the present compared to the future."[218] Take for example the marshmallow experiment (below) conducted by psychologist Walter Mischel in the 1960s:

> [He] would leave children in a room with a piece of marshmallow or a cookie, and tell the kids they were free to have it if they wanted, but that he will come back in 15 minutes, and if the children had not eaten the candy, he would offer them a second piece as a reward. In other words, the children had the choice between the immediate gratification of a piece of candy, or delaying gratification and receiving two pieces of candy. This is a simple way of testing children's time preference: students with a lower time preference (LTP) were the ones who could wait for the second piece of candy, whereas the students with the higher time preference (HTP)could not. Mischel followed up with the children decades later and found significant correlation between having a low time preference as measured with the marshmallow test and good academic achievement, high SAT score, low body mass index, and lack of addiction to drugs.[219]

A lowered time preference allows for one to make investments on longer time horizons such as the environmental health for our children. Delayed gratification separates humans from the

[216] Saifedean Ammous, *The Bitcoin Standard: The Decentralized Alternative to Central Banking*, (USA: John Wiley & Sons Inc, 2018), 181.
[217] Ammous, *The Bitcoin Standard*, 166.
[218] Ibid.
[219] Ammous, *The Bitcoin Standard*, 173.

passions, impulses and greed that constrain animals. Most animals can be said to have a high time preference; they eat when the opportunity arises, sleep when the urge hits and procreate instinctively. A lower time preference allows humans to be less 'animalistic' and impulsive.[220] Generally speaking, there is a consistent daily struggle between higher and lower time preference activities as the future is uncertain in both its outcome and existence - as death could be around the corner. How does money affect our time preference? Well, one of "the most important economic decisions to any individual's well-being are the ones they conduct in their trade-offs with their future self."[221] That is, those with a lower time preference make those investments for the future self whereas the higher time preference individual does not. Another example might be whether you decide to spend money or to save it. Consider another, whether to acquire a skill over a period of time for a higher paying job, or to take a lower paying job now. In context to the environment, this can be attributed to many examples as well - i.e. Do we pollute now for production and consumption today, or utilize the same energy/capacity to invest in the future? Similarly, money, should it lose value over time, would incentivize most economic actors to spend it quickly before its value is lost. The US dollar for example, has lost purchasing power every single year for the last 100 years (Fig. 14).[222] With money in such a state, it is no mystery that we've welcomed and even championed a consumption based economy. In the end, money is a prime factor in how we fashion our time preference and thereby align our individual values and incentives.

[220] Ammous, *The Bitcoin Standard*, 168.
[221] Ammous, *The Bitcoin Standard*, 174.
[222] U.S. Bureau of Labor Statistics, "Consumer Price Index for All Urban Consumers: Purchasing Power of the Consumer Dollar in U.S. City Average [CUUR0000SA0R]," *fred.stlouisfed.org*, Apr 13, 2021, accessed May 4, 2021, https://fred.stlouisfed.org/series/CUUR0000SA0R.

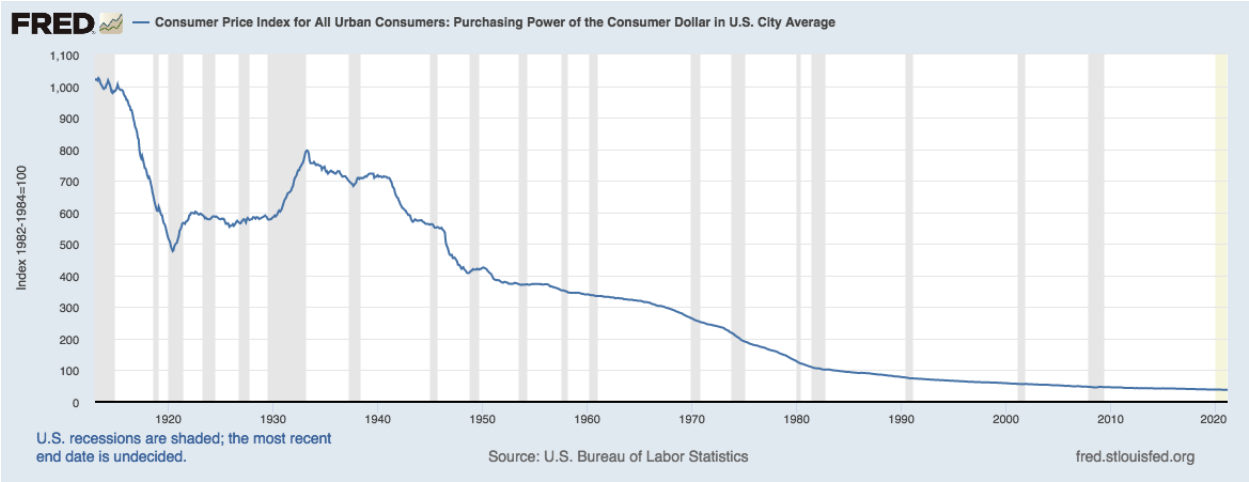

Fig. 14 Purchasing Power of the Dollar. (U.S. Bureau of Labor Statistics, "Consumer Price Index for All Urban Consumers: Purchasing Power of the Consumer Dollar in U.S. City Average [CUUR0000SA0R]," *fred.stlouisfed.org*, Apr 13, 2021, accessed May 4, 2021, https://fred.stlouisfed.org/series/CUUR0000SA0R.)

Refer to Fig. 15. This graphic includes some milestones on the decreasing purchasing power of the U.S. dollar. President Nixon famously took the U.S. off the gold standard in 1971.[223] It effectively permissed irresponsible money printing without having to back the dollar with sufficient gold or assets, unleashing the dollar from the 'gold standard'.

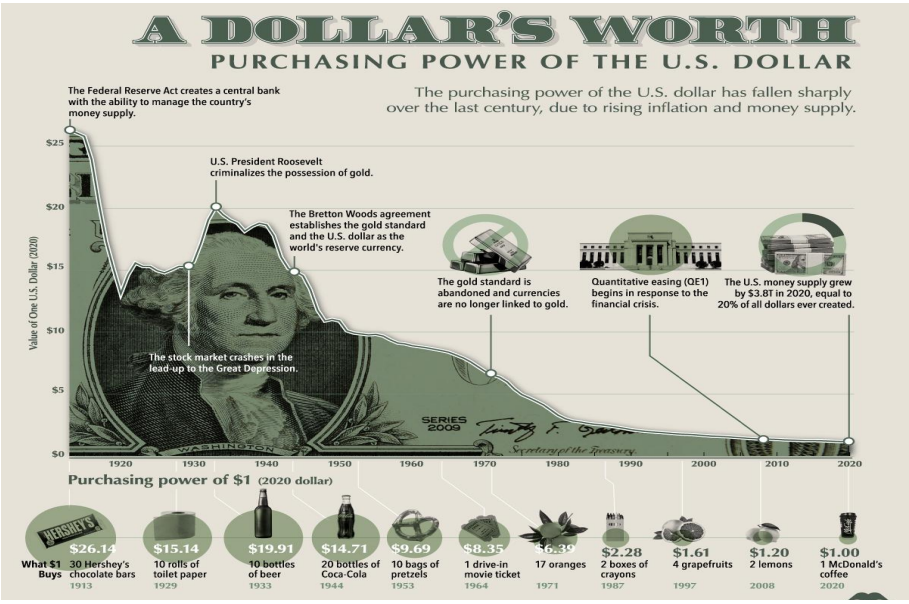

Fig 15. The Purchasing Power of the U.S. Dollar. (Govind Bhutada, "Purchasing Power of the U.S. Dollar Over Time," visualcapitalist.com, April 6, 2021, accessed April 30, 2021, https://www.visualcapitalist.com/purchasing-power-of-the-u-s-dollar-over-time/.)

[223] Govind Bhutada, "Purchasing Power of the U.S. Dollar Over Time," visualcapitalist.com, April 6, 2021, accessed April 30, 2021, https://www.visualcapitalist.com/purchasing-power-of-the-u-s-dollar-over-time/.

To contextualize, "$1 in 1913 had the same purchasing power as $26 in 2020."[224] Most recently, the Covid-19 pandemic caused catastrophic damage and irreconcilable interruption to the global economy. The U.S. (in addition to many other nations), in an effort to curtail economic collapse, resorted to flooding the markets with liquidity (money), thereby further increasing the money supply and ultimately debasing the currency yet again. Unlike the quantitative easing during The Great Recession in 2009, where a credit crunch severely restricted dollars from reaching the broad money supply, the Covid-19 pandemic saw a direct issuance of dollars into the hands of the individuals. While the Fed and Fed Chair Jerome Powell are adamant they have inflation under control (even stating that any inflation to come should be transitory) it is most likely too early for the real effects to be seen just yet.[225,226] The three stimulus checks U.S. citizens received totaled $3200 to the tune of $867 billion in aggregate (when including checks for children) of which a significant portion can be assumed to find its way to the broad money market.[227] Furthermore, the total stimulus packages were a combined $5.59 trillion in the U.S. alone and more than a quarter of 2019 GDP.[228,229] Consult Fig. 16 to see how much countries have spent (denominated in GDP) on relief for their pandemic rescue packages compared to that of the 2009 financial crisis.[230] The Great Recession saw M2 money supply increase roughly 13% from 2007-09 compared to nearly 29% in a one year span from February 2020 to March 2021(Fig.

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[224] Ibid.
[225] Ann Saphir, "EXCLUSIVE Fed Chair Powell says won't allow 'substantial' overshoot of inflation target - April 8 letter to U.S. senator," *reuters.com*, April 20, 2021, accessed April 28, 2021, https://www.reuters.com/business/usa-fed-powell-exclusive-urgent-pix-2021-04-20/.
[226] Irina Ivanova, "Federal Reserve calls inflation "transitory" as it keeps interest rates near zero," *cbsnews.com*, April 28, 2021, accessed April 28, 2021, https://www.cbsnews.com/news/interest-rates-inflation-federal-reserve-transitory/.
[227] The Peter G. Peterson Foundation, "What to Know About All Three Rounds of Coronavirus Stimulus Checks," *pgpf.org*, March 15, 2021, accessed March 30, 2021, https://www.pgpf.org/blog/2021/03/what-to-know-about-all-three-rounds-of-coronavirus-stimulus-checks.
[228] The World Bank, "GDP (current US$) - United States," *data.worldbank.org*, accessed April 17, 2021, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=US.
[229] Gabe Alpert, "A breakdown of the fiscal and monetary responses to the pandemic," *investopedia.com*, April 28, 2021, accessed May 2, 2021, https://www.investopedia.com/government-stimulus-efforts-to-fight-the-covid-19-crisis-4799723.
[230] Ziyad Cassim, Borko Handjiski, Jörg Schubert, and Yassir Zouaoui, "The $10 trillion rescue: How governments can deliver impact," *mckinsey.com*, June 5, 2020, accessed April 23, 2021, https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-10-trillion-dollar-rescue-how-governments-can-deliver-impact#.

17).[231] While no two recessions and global events and their effects are the same, the pace at which the money supply is increasing is alarming.

Admittedly, money is not the only factor which affects time preference. However, it is the most pertinent one for our discussion. In short, the better money is at keeping its value, the more it catalyzes people to have a lower time preference. A sound money which holds its value can also bring out the best moral practices in man: in this paper's case a serious, consistent consideration of the environmental *good*. An economic or societal actor who thinks in the long-term is less likely to cheat, steal, or lie as they understand the short term gains are outweighed by the long term rewards.[232] As a currency's purchasing power decreases and individuals are incentivized to spend more than they save, not only is their time preference altered, but it most likely affects everything else in their lives (i.e., the destruction of the environment through wonton consumption).[233] It can then be said that the deficiencies in unsound money lead to a more present oriented inclination leading to higher cases of moral failings, such as not caring about the environment and the probability of engaging in conflict/destruction (propagating negative environmental externalities).[234] The tragedy of Damour (referenced in chapter one) reiterates how horridly consumerism distorts human incentives, morals and values.

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[231] Board of Governors of the Federal Reserve System (US), "M2 Money Stock," *fred.stlouisfed.org*, March 2021, accessed April 25, 2021, https://fred.stlouisfed.org/series/M2SL.
[232] Ammous, *The Bitcoin Standard*, 179.
[233] Ammous, *The Bitcoin Standard*, 180.
[234] Ibid.

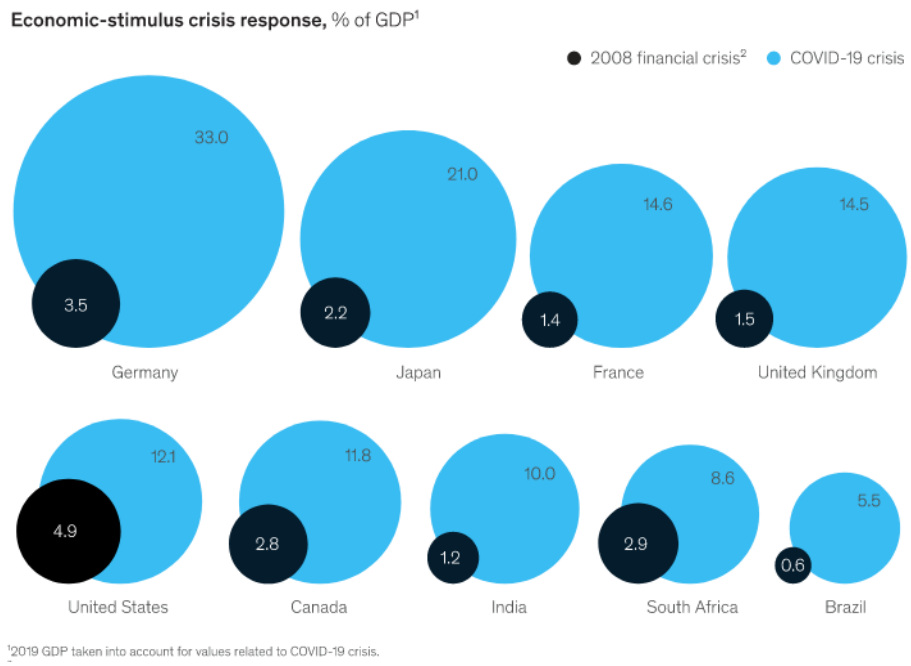

Fig. 16 Stimulus for Covid-19 vs. The Great Recession. (Ziyad Cassim, Borko Handjiski, Jörg Schubert, and Yassir Zouaoui, "The $10 trillion rescue: How governments can deliver impact," *mckinsey.com*, June 5, 2020, accessed April 23, 2021, https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-10-trillion-dollar-rescue-how-governments-can-deliver-impact#.)

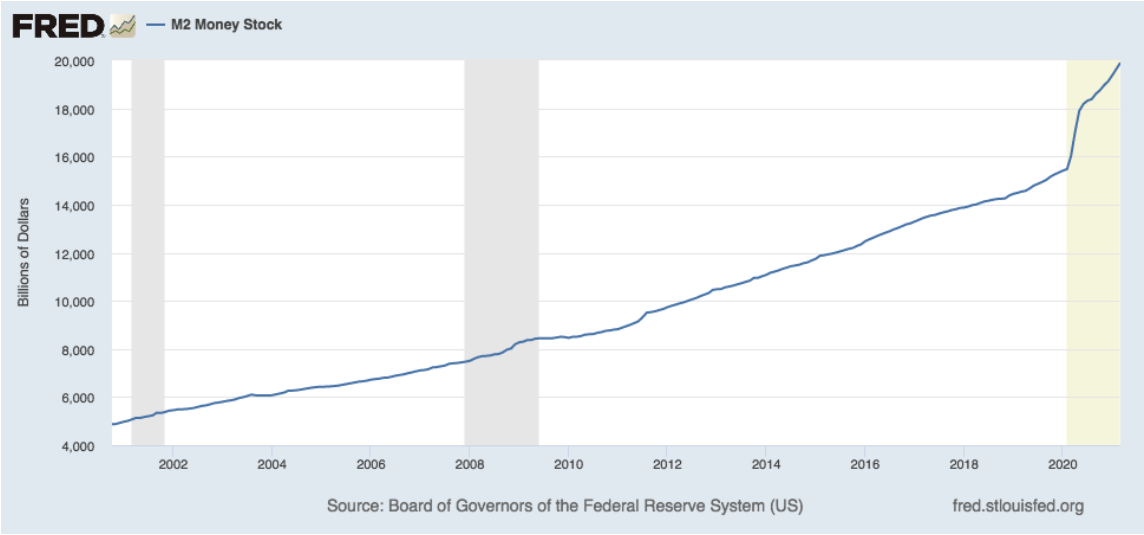

Fig. 17 M2 Money Supply. (Board of Governors of the Federal Reserve System (US), "M2 Money Stock," *fred.stlouisfed.org*, March 2021, accessed April 25, 2021, https://fred.stlouisfed.org/series/M2SL.)

Bitcoin.

"In the same way a stock certificate is title to company capital, money is title to human time. People sacrifice their time for money, which enables them to trade for commensurate sacrifices from others. When prices are distorted, we are each inhumanely robbed of making fully informed personal choices with our time."[235] - Ross Stevens

Understanding money as energy and how the legacy fiat systems have led to severe consequences, we can appreciate bitcoin as the purest form known to man for storing purchasing power (energy). It adheres exceptionally well to the first law of thermodynamics: conservation of energy. Meaning it is the most efficient SoV we have to keep said value, and thus the best asset known to man to replace fiat. It does not lose energy in the same way fiat money does when inflated. In fact, in the long run, it does not lose value whatsoever. Since it has a fixed supply of 21 million coins, the value of the coinage is only debased at the current rate of block creation.[236] Remember that when each block is mined (when a transaction is approved by consensus), a block reward is given to the miner. The supply schedule for bitcoin is predetermined and the supply is halved every four years or 210,000 blocks. This makes bitcoin inflationary much like current fiat monies in the short term. However, unlike fiat, bitcoin's maximum supply is capped and its inflation rate decreases every halving and is therefore on a deflationary schedule (sometime in the year 2140 the final coins will be mined). The most recent halving occurred on May 11, 2020 where the block reward halved from 25 to 12.5.[237] Refer to Fig 18 where the x-axis is the number of blocks mined with the corresponding block rewards depicted right above the block numbers decreasing by half every 210,000 blocks.[238] There is no such thing as creating

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[235]Stevens, *2020 Shareholder Letter*, 4.
[236] The 21 million cap is hardwired into the code of the Bitcoin network and the supply schedule follows the halving pattern every 210,000 blocks until all 21 million coins are mined through block creation on average of 10minutes at a time.
[237] Buy Bitcoin Worldwide, "Bitcoin Clock," *buybitcoinworldwide.com*, accessed May 5, 2021, https://www.buybitcoinworldwide.com/bitcoin-clock/.
[238] Ibid.

'another bitcoin'. It is not possible, at least in a meaningful way.[239] Why is it meaningful that bitcoin cannot be printed the same way fiat can be? It comes down to maintenance and use of your life's essence, *energy/money*. It can safely be assumed that the work of one's hard earned money (and thereby your energy) devaluing over time through inflation and money printing is unacceptable. In this way, inflation can be understood as continuous taxation on our work outside of the taxes we already pay. Stated differently, inflation is theft as it destroys the work we put into creating something out of nothing - which we understand as value. By increasing the money, supply governments are not doing any of the necessary work to create value. They are arbitrarily duplicating existing value out of thin air and thus debasing and stealing from all pre-existing value bearing assets. Work adds value whereas theft destroys value.[240] Why would anyone store their precious life energy in something that was purposefully losing value? We need to untether ourselves from soft fiat money and move to a hard, sound money - The Bitcoin Standard. Adoption of Bitcoin will help us lower our time preference and perceive our morals better to see that our ecosystems are in desperate, imminent need of our help and attention:

> The question of which money humans will choose, therefore, boils down to which good, or goods, any individual believes will best store the sum total of their lifetime of daily labor (i.e., their life force).[241] - Ross Stevens

[239] To change the Blockchain protocol of Bitcoin one would need to copy and modify the existing Bitcoin Blockchain code. Such an event would create a separate and distinct network (called a Hard Fork) which would thereby birth another native token (currency) than bitcoin. Its success would rely on the network effect of this new protocol's utility. The best example of this phenomena is when Bitcoin Cash was created via a hard fork in 2017 through what is now being called the Blocksize Wars. A hard fork can be understood as a "developer [cloning] the Bitcoin's blockchain to make a new blockchain and cryptocurrency by modifying the original code" (https://thenextweb.com/news/bitcoin-hard-fork-useless).
[240] Breedlove et al., *Thank God For Bitcoin*, 8.
[241] Stevens, *2020 Shareholder Letter*, 3.

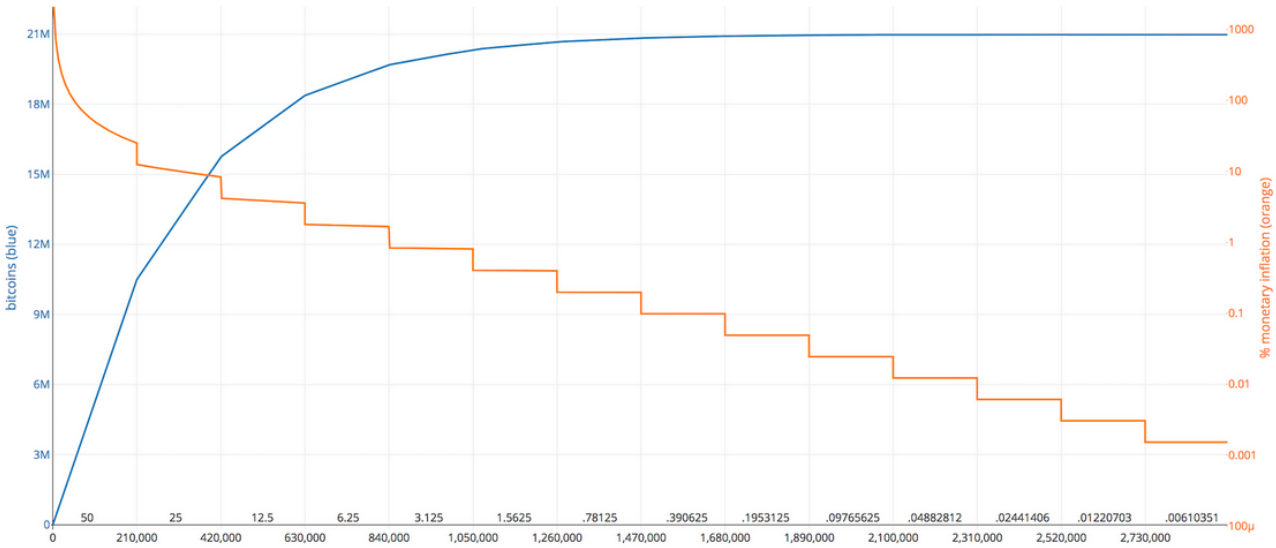

Fig. 18 Bitcoin Supply Schedule. (Buy Bitcoin Worldwide, "Bitcoin Clock," *buybitcoinworldwide.com*, accessed May 5, 2021, https://www.buybitcoinworldwide.com/bitcoin-clock/.)

Though there may arise a 'better' digital currency than bitcoin, for now it is our best use case example. A distinction between currency to spend and make transactions must be separated from a store of value. In a Bitcoin maximalist world, bitcoin is the base layer and everything is denominated in Satoshis (one hundredth millionth of a bitcoin, the smallest unit of bitcoin one can hold). However, perhaps in a more pragmatic world where Bitcoinization has taken place, both a currency (day to day transactional money) and bitcoin (SoV) exist. Though bitcoin was intended to be a currency, it most likely has a better chance of becoming the settlement layer than the transactional layer.[242] That is, blocks settled on the Bitcoin network will work akin to how Visa, Mastercard and American Express settle our current fiat transactions wherein we interact with digital dollars or physical fiat in our day to day life. This currency can still very much be "dollars", but would fundamentally cease to be the currency we are actually using, as bitcoin would replace it at the settlement layer. These two systems, I believe, can co-exist in parallel. Furthermore, individuals would store their wealth in bitcoin and spend for their day to day

[242] Saifedean Ammous, "Economics of Bitcoin as a settlement network," *thesaifhouse.wpcomstaging.com*, May 19, 2017, accessed on April 10, 2021, https://thesaifhouse.wpcomstaging.com/2017/05/19/economics-of-bitcoin-as-a-settlement-network/.

activities in bitcoin denominated “dollars”. To further gauge bitcoin's superiority over fiat examine Fig 19.[243]

Traits of Money	Gold	Fiat (US Dollar)	Bitcoin
Fungible *(Interchangeable)*	High	High	High
Non-Consumable	High	High	High
Portability	Moderate	High	High
Durable	High	Moderate	High
Highly Divisible	Moderate	Moderate	High
Secure *(Cannot be counterfeited)*	Moderate	Moderate	High
Easily Transactable	Low	High	High
Scarce *(Predictable Supply)*	Moderate	Low	High
Sovereign *(Government Issued)*	Low	High	Low
Decentralized	Low	Low	High
Smart *(Programmable)*	Low	Low	High

Fig. 19 Traits of Money. (Cryptoavli, “The $5,000 Bitcoin: The Trends,” *cryptoavli.com*, April 17, 2017, accessed on April 21, 2021, https://cryptoavli.com/2017/04/17/the-5000-bitcoin-the-trends/.)

Money has many characteristics, as outlined in Fig. 19. Fundamentally, most economic actors understand the characteristics which are of their utmost concern. They are: *divisibility* (denominations of money units, i.e. $100, $1, 5cents... etc), *portability* (ability to transport), *scarcity* (a lower supply makes it more valuable), *durability* (can it withstand natural elements, degradation of time and use) and lastly *recognizability* (the ease to which one can know the authenticity of the currency). As shown, Fig. 19 clearly outlines the strength of bitcoin as a currency (not to mention its monetary network benefits of Blockchain technology) compared to legacy mainstays such as gold or our failing fiat. Bitcoin is *highly divisible* (as mentioned it can be divided into one hundred millionth of a unit, 0.00000001 BTC/Satoshis), *extremely portable*

[243] Cryptoavli, “The $5,000 Bitcoin: The Trends,” *cryptoavli.com*, April 17, 2017, accessed on April 21, 2021, https://cryptoavli.com/2017/04/17/the-5000-bitcoin-the-trends/.

(as it is digital data and thus salable through time and space at the speed of light), *highly durable* (there is no degradation of bitcoin through space and time the same way physical currencies are susceptible to external elements), *perfectly scarce* (fixed 21million supply cap), *easily recognizable* (you could not fake a bitcoin or a bitcoin transaction without some serious non-economic consequences). The one trait bitcoin scores low on, sovereign, is actually not a demerit, but an unrealized advantage in this new definition of money. Governing authorities worldwide are so powerful in part due to their grip on monetary policy and proximity to the mint. A low sovereign constraint/power dynamic is ideal for a more egalitarian money, hence society, and is necessary for Bitcoin's consensus mechanism to thrive.

'Goldbugs' will defend the value of gold until the end of days because it withstood the test of time for thousands of years, while fiat proponents have too much at stake to let another currency replace them and cannot fathom the utility of an 'internet money ponzi scheme'. Look no further than Microstrategy, Square,Tesla, Aker, MassMutual, and Nexon all converting portions of their treasury assets to bitcoin.[244,245,246,247,248,249,250] These are some of the most innovative companies on the planet in varying industries that have embraced Bitcoin, first and foremost for a SoV. The list of companies above shows us Bitcoin adoption is becoming a major strategy in corporate businesses protecting their shareholder value. In addition to corporations,

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[244] Microstrategy Incorporated. *MicroStrategy Adopts Bitcoin as Primary Treasury Reserve Asset*. PDF file. August 11, 2020. https://www.microstrategy.com/content/dam/website-assets/collateral/financial-documents/press-release-archive/MicroStrategy%20Adopts%20Bitcoin%20as%20Primary%20Treasury%20Reserve%20Asset.pdf.

[245] Square Inc., "Square, Inc. Invests $50 Million in Bitcoin," *squareup.com*, Oct 8, 2021, accessed May 4, 2021, https://squareup.com/us/en/press/2020-bitcoin-investment.

[246] United States Securities and Exchange Commision, "ANNUAL REPORT ON FORM 10-K FOR THE YEAR ENDED DECEMBER 31, 2020" sec.gov, February 8, 2021, accessed April 20, 2021, https://www.sec.gov/Archives/edgar/data/1318605/000156459021004599/tsla-10k_20201231.htm.

[247] Røkke. *Dear Shareholders*.

[248] Massachusetts Mutual Life Insurance Company, "Institutional Bitcoin provider NYDIG announces minority stake purchase by MassMutual," *massmutual.com*, December 10.2020, accessed on April 27, 2021, https://www.massmutual.com/about-us/news-and-press-releases/press-releases/2020/12/institutional-bitcoin-provider-nydig-announces-minority-stake-purchase-by-massmutual.

[249] NEXON Co., Ltd.. *Nexon Purchases $100 Million Worth of Bitcoin*. PDF file. April 28, 2021. https://pdf.irpocket.com/C3659/bxTh/SDDC/wbxu.pdf.

[250] More from Microstrategy, Square, Tesla, Aker, MassMutual and Nexon.

individuals are making the same move, albeit on a smaller scale. NFL player, Russell Okung converted half of his salary to bitcoin in 2020 and the NFL's top overall draft pick for 2021, Trevor Lawrence has invested his entire signing bonus into bitcoin and other blockchain projects.[251,252] Gradually, then suddenly, blockchain backed products will take over the world:

> Google is what happens when we pool information energy on a software network. Facebook is what happens when we pool social energy on a software network. Everyone understands this. Bitcoin is what happens when we pool monetary energy on a software network. Few understand this.[253,254] - Michael Saylor

Bitcoin, Blockchain, and the Environment. To continue, why and how does the soundness of money matter to the environment? To reiterate the concept of time preference, it affords individuals the ability to concern themselves with long term projects rather than immediate wants which often are not the best representation of human capacity or will. This in turn affords us to better align ourselves with our values such as propagating the health of our ecosystems.Also, the faster a currency debases the faster we tend to spend and decrease our working capital which could otherwise be used to further the protection and integration of our ecosystems rather than arbitrary spending leading to negative environmental externalities. This rampant consumerism was discussed in chapter one.

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[251] William Foxley, "Panthers' Russell Okung Becomes First NFL Player to Be Paid in Bitcoin," *coindesk.com*, December 29, 2020, accessed on April 11, 2021, https://www.coindesk.com/panthers-russell-okung-becomes-first-nfl-player-to-be-paid-in-bitcoin.

[252] Kevin Helms, "No. 1 NFL Draft Pick Trevor Lawrence Puts His Signing Bonus in Cryptocurrencies, Estimated Worth $24 Million," *bitcoin.com*, May 2, 2021, accessed May 14, 2021, https://news.bitcoin.com/no-1-nfl-draft-pick-trevor-lawrence-signing-bonus-cryptocurrencies/.

[253] Michael Saylor (@michael_saylor), "#Google is what happens when we pool information energy on a software network. Everyone understands this. #Bitcoin is what happens when we pool monetary energy on a software network. Few understand this.," Twitter, October 24, 2020, 1:42p.m., https://twitter.com/michael_saylor/status/1320058141686616064?lang=en.

[254] Michael Saylor (@michael_saylor), "#Facebook is what happens when we pool social energy on a software network. Everyone understands this. #Bitcoin is what happens when we pool monetary energy on a software network. Few understand this.," Twitter, October 21, 2020, 11:43 a.m., https://twitter.com/michael_saylor/status/1318940941827383297?lang=en.

There are abundant reasons and examples to believe that Bitcoin (and thereby blockchain) can not only be the next preferred SoV but that it will propagate positive social and environmental goals. The proceeding sections will detail how Bitcoin is now and could further accelerate adoption of renewable energy production by first examining bitcoin's innate ability to harness non-rival energy.[255] Specific examples of bitcoin mining curtailing environmental externalities by transforming said externalities to the best SoV known to man (sound money) can be seen worldwide. A supply chain solution to alleviate Tragedy of the Commons in the oceans as well as addressing a social environmental justice issue will be examined. In addition, the tethering of Bitcoin, to the individual, energy, and businesses will be exemplified through a solar panel project that is thriving in Brooklyn, NY.

Bitcoin's network energy consumption has been one of the most contentious topics of 2020-21. Suffice it to say, it ranks as the #1 FUD of the cryptocurrency naysayers. This FUD will be addressed specifically in chapter five. For now we will examine how Bitcoin is aligned with negating negative environmental externalities. Energy production and consumption has taken its toll on the planet. Ozone degradation, air pollution, and climate change all stem from one form or another of toxic energy intake and outtake. While there are efforts to increase renewable energy use worldwide, there is also a vast swath of unutilized energy being wasted. Energy waste in itself is a double negative for the environment, especially if the origin was non-renewable. There are claims of Bitcoin mining 'boiling the oceans', but in reality, it is helping the case for renewable energy adoption and use. Bitcoin mining rigs are typically left on to capture as much computing power as time allows before the hardware becomes obsolete due to chip technology advancements. This means they utilize some form of energy 24/7. What many do not know is

[255] Nic Carter, "Noahbjectivity on Bitcoin Mining: A response to Noah Smith," *medium.com*, March 29, 2021, accessed April 7, 2021, https://medium.com/@nic__carter/noahbjectivity-on-bitcoin-mining-2052226310cb.

that a significant portion of Bitcoin mining is powered by renewable energy. Moreover, not only do a sizable amount of mining operations favor renewables, they also make use of nonrival energy. Nonrival energy can be understood as surpluses of energy that would not hinder or limit others' consumption nor raise the price of energy per unit by its use.[256]

Specifically, Bitcoin miners will go out to find "structural surpluses of energy" that aren't being captured by existing grid structures. Not only are renewable energy sources such as solar and wind cheaper than oil or coal, they are often left unused due to a problem known as intermittency.[257] The sun doesn't always shine and the wind doesn't always blow, making solar and wind power inconstant. In opposition to the greatest amounts of sunlight during the day, most electricity use occurs at the end of the day when the sun sets, driving a widening gap between generation and consumption. Furthermore, due to current grid structures, most stranded or nonrival energy does not make it to the average household.[258] Many wind and solar farms are built in rural areas where sunlight and wind is abundant.[259] However, rural areas do not have a high quantity of end power users and the energy often causes grid congestion and finds no use.[260] This is exactly where bitcoin mining can be of utility. Due to its unmatched appetite for energy and franky economic need by the miner, Bitcoin can help absorb nonrival energy into its network. This is currently happening worldwide, but the majority of it happens in China and the US. Consider the four provinces of Xinjiang, Sichuan, Inner Mongolia, and Yunnan. Together they only have about 12.7% of China's population but create outsized proportions of renewable energy.[261] As miners seek out the cheapest forms of energy (to achieve the best mining cost

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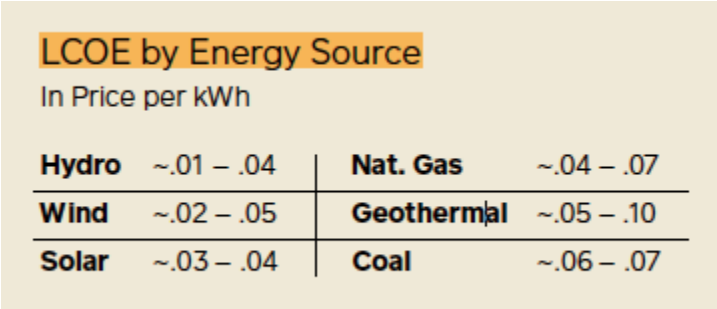
[256] Ibid.
[257] Bitcoin Clean Energy Initiative Memorandum. *Bitcoin is Key to an Abundant, Clean Energy Future*. PDF file. April 2021. https://assets.ctfassets.net/2d5q1td6cyxq/2D2BnksJjavw4a6SUvAPwZ/c42a9e3a520b0cc3b230cda3b43eead5/BCEI_White_Paper_.pdf. 2.
[258] Ibid.
[259] Ibid.
[260] Ibid.
[261] Carter, "Noahbjectivity on Bitcoin Mining."

efficiency, which currently is solar and wind: refer to Fig. 20) it should come as no surprise that those four provinces attract many bitcoin miners.[262,263]



LCOE by Energy Source

In Price per kWh

Hydro	~.01 – .04	**Nat. Gas**	~.04 – .07
Wind	~.02 – .05	**Geothermal**	~.05 – .10
Solar	~.03 – .04	**Coal**	~.06 – .07

Fig. 20 Cost of Energy by Source. (Bitcoin Clean Energy Initiative Memorandum. *Bitcoin is Key to an Abundant, Clean Energy Future*. PDF file. April 2021. https://assets.ctfassets.net/2d5q1td6cyxq/2D2BnksJjavw4a6SUvAPwZ/c42a9e3a520b0cc3b230cda3b43eead5/BCEI_White_Paper_.pdf. 2.)

When taking a look at the available capacity vs. peak demand for energy in those provinces you can see the correlation clearly. All four provinces' peak demands are not nearly enough to meet supply (Fig 21 + 22).[264] Energy curtailment aided by the abundant hydro power during the wet season in Sichuan and Yunnan can be seen in Fig. 22, where decreases in curtailment is seen from 2017 to 2018 when bitcoin rallied in price. What is clear is that there is more than an excess of renewable energy being harnessed in these areas and one could argue that perhaps Bitcoiners should run more mining rigs to capture any surplus to help monetization of renewable energy and capture the rewards of the best performing asset of the last decade and SoV rewards in bitcoin.[265] It should be clear now, that Bitcoin is not 'boiling the oceans' but rather purposefully seeking out the cheapest forms of energy which are generated via renewable sources with supply surpluses going to waste. Bitcoin mining utilizing and finding sources of energy which they can better

[262] Bitcoin Clean Energy Initiative Memorandum. *Bitcoin is Key to an Abundant, Clean Energy Future*, 2.
[263] Levelized Cost of Energy (LCOE) is the total lifetime cost of building and operating a power plant divided by the total amount of energy it produces (measured incents / kWh).
[264] Carter, "Noahbjectivity on Bitcoin Mining."
[265] Martin Young, "BTC was best-performing asset of past decade by 1,000%," *cointelegraph.com*, March 15, 2021, accessed April 26, 2021, https://cointelegraph.com/news/btc-was-best-performing-asset-of-past-decade-by-900.

harness is only the first order effect. Second order effects are the propagation and use of environmentally friendly energy sources which in turn produce a third order effect of reducing externalities such as harmful carbon and chemical pollution. Though bitcoin's PoW mining is not quite literally eliminating pollution from our atmosphere, its second and third order effects are more than what fiat currencies can attest to in curbing dirty energy production (a la the petrodollar).

Fig. 21 Peak Demand vs Available Capacity. (Nic Carter, "Noahbjectivity on Bitcoin Mining: A response to Noah Smith," *medium.com*, March 29, 2021, accessed April 7, 2021, https://medium.com/@nic__carter/noahbjectivity-on-bitcoin-mining-2052226310cb.)

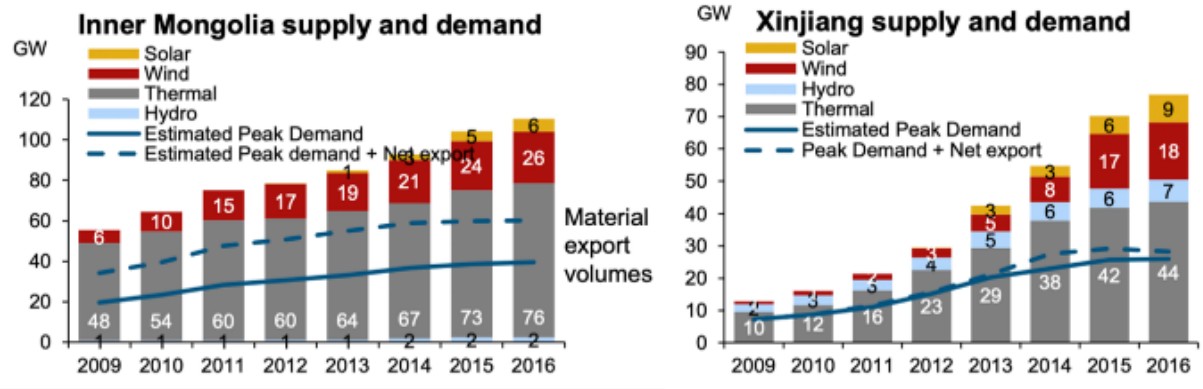


Fig. 22 Demand and Supply Xinjiang & Inner Mongolia. (Nic Carter, "Noahbjectivity on Bitcoin Mining: A response to Noah Smith," *medium.com*, March 29, 2021, accessed April 7, 2021, https://medium.com/@nic__carter/noahbjectivity-on-bitcoin-mining-2052226310cb.)

Crusoe is another example of Bitcoin mining mitigating energy loss and eliminating pollution. It is a U.S. based company specializing in capturing stranded energy from oil rigs to perform advanced energy intensive computational projects.[266] In other words, Crusoe specializes in commodifying stranded energy whereas the mining in China commodified excess clean energy. A match made in heaven for miners. Notably, they are capitalizing on the byproducts of oil and gas production which vent methane gas through its operation. Oil rigs are mandated by law to flare any excess methane that is found during oil discovery. Methane is devastating to the ozone layers protecting us from harmful sun rays. By flaring methane, the gas is transformed to CO_2 which still pollutes the air, but is the lesser of two evils. Unfortunately, this is the best and only way for oil rigs to exercise their portion of social precaution in not further harming the Earth. Together with Bitcoin mining (in addition to AI simulation, graphical rendering and protein folding simulations for COVID-19 therapeutic research) Crusoe is utilizing nonrival, stranded, and otherwise wasted energy to produce value much like the example above.[267] In

[266] Similar to Crusoe, UpstreamData in Canada and Perpetual Industries are also capturing non-rival energy.
[267] Jonathan Shieber, "Crusoe Energy is tackling energy use for cryptocurrencies and data centers and greenhouse gas emissions," *techcrunch.com*, April 26, 2021, accessed April 29, 2021, https://techcrunch.com/2021/04/26/crusoe-energy-is-tackling-energy-use-for-cryptocurrencies-and-data-centers-and-greenhouse-gas-emissions/.

essence, they are abating negative environmental externalities using the high electricity appetite of bitcoin mining. While the mining in China utilizes clean energy to mine, thus promoting a positive environmental externality, Crusoe in turn curtails oil rig's negative externalities in two ways. First, as mentioned they are preventing methane from reaching the earth's atmosphere. Second, they are accelerating renewable energy production. As adoption of renewable energy production increases, attaching a bitcoin mining rig to capture the aforementioned congested and intermittent power created by solar and wind, they are bettering the economics for stranded, marginalized renewables.[268] The "overall... effect... incentivize[s] the addition of more renewable energy sources to the grid.[269] As of April 2021, Crusoe is able to convert 99.9% of otherwise flared methane to various computing projects of which 80% is bitcoin mining.[270] The direct and literal consumption of methane by mining for bitcoin is incredible. The double efficiency of abating negative externalities and also creating a SoV asset with appreciating value cannot be stressed enough. Crusoe aims to expand this arm of its operation by a whopping 150% by next year, which should further curtail methane flaring and increase their bitcoin stack.[271] Furthermore, a 'Pipe-to-Crypto' solution is a net positive for both the environment and economic stakeholders as a "clean, supervised burn in a generator is a net positive from a carbon perspective."[272] When you consider 538 million cubic feet or 1.2% of total U.S. gas extraction in 2019 was flared and that the reported figures are notoriously underreported (experts estimate the actual figures are ten times as much) the potential environmental benefit is massive.[273] What is more, the bitcoin mined can be used as a SoV or perhaps better yet, expensed to further accelerate renewable energy production and subsequent grid integration:

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[268] Ibid.
[269] Ibid.
[270] Ibid.
[271] Ibid.
[272] Carter, "Noahbjectivity on Bitcoin Mining."
[273] Ibid.

> If Bitcoin ends up being worth substantially more in the future (say, by an order of magnitude), then the world will actually have received a discount on its issuance.The energy-externality of pulling those bitcoins out of the mathematical ether will actually have been very low. Bitcoin's energy expenditure may end up looking rather cheap in the final analysis. It's better for the planet that they be issued when the coin price was low, and the electricity expended to extract them was commensurately low.[274]

How Bitcoin can change an individual's time preference has been presented, thereby aligning proportionately their values to considering our environment *good*. Only when we can properly value our time and energy can we be appropriately and internally incentivized to care about low time preference projects. We have also gone over the bitcoin strategy companies have employed not only to store their wealth, but also to reduce negative externalities. The epitome of the two (the individual and business) can be seen thriving on rooftops of New York City. Brooklyn Microgrid (BMG) is a LO3 Energy subsidiary started in 2016 which operates as "an energy marketplace for locally generated solar energy".[275] Their mission is to catalyze the use of renewable energy through their BMG grid for prosumers and consumers. (A similar operation can be found 'down under' in Australia at Power Ledger.[276]) Like Crusoe, they also alleviate stranded and nonrival energy. Its distributed system operator (DSO) which they call Exergy is a fancy name for their blockchain. The BMG Exergy blockchain is permissioned, where you are a

[274] Ibid.
[275] Brooklyn Microgrid, "Brooklyn Microgrid (BMG) is an energy marketplace for locally-generated, solar energy.," *brooklyn.energy*, accessed April 22, 2021, https://www.brooklyn.energy/.
[276] Power Ledger in Australia is also harnessing blockchain to provide microgrid solutions for renewable energy.

known participant to the grid.[277] This allows for community members to put a face to their provider and not just *a face* but potentially a neighbor's face. Furthermore, when you have a community cooperating to support each other's needs this can act as an anchor to reach further levels of local sustainability. Similar to sourcing food and materials locally, BMG has just started their mission to source clean energy locally. Whether you are a consumer, producer or prosumer, interactivity through their app makes the local consumption cost efficient. Prosumers can sell their excess energy back to the grid and consumers can purchase surpluses from EV charging stations or from their fellow neighbors.[278] The localized power source will also enable communities to abate energy shortages and outages such as when Hurricane Sandy hit lower Manhattan in 2012.[279] The result is a resilient and cooperative network of people and energy. In sharp contrast, when intermediaries are present the data and network infrastructure is centralized making it vulnerable and thus costly to maintain and secure.[280] They also slow the flow of energy from grid to consumer whereas a peer-to-peer system such as Exergy can alleviate all of the aforementioned concerns. In an age of mass digitization, we often unwillingly or unknowingly give up data that may compromise our privacy when interacting with intermediaries (think Facebook, any app on your phone, the websites you visit, etc). By transacting on a secure, immutable, and decentralized network not only are your private data troves safe, but so are the data on your daily energy consumption. On a related but tangential note, optimistically in the near future, a world where one can monetize their online data through their discretion will be a constant, lucrative, and passive form of income for individuals; the egalitarian monetization of private data, if you will.

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[277] Brooklyn Microgrid, "Brooklyn Microgrid (BMG) is an energy marketplace for locally-generated, solar energy."
[278] Ibid.
[279] Lucas Mearian, "Blockchain used to power Brooklyn microgrid for solar energy re-sale," *computerworld.com*, April 20, 2017, accessed April 24, 2021, https://www.computerworld.com/article/3191256/blockchain-used-to-power-brooklyn-microgrid-for-solar-energy-re-sale.html.
[280] Ibid.

By now the synergy between money and energy should be clear. Money, a unique SoV is an energy battery technology. The sounder the money, the better it enables us to orient our values and incentives at an individual level - otherwise known as developing a low time preference. Its viability as a SoV was legitimized when bitcoin was adopted as a treasury asset in the aforementioned companies. It is noteworthy that companies such as Aker (a Norweigian energy company) have set up a subsidiary (SeeTee) in light of their discovery of Bitcoin.[281] Seetee will oversee and further investigate green bitcoin mining operations through renewable sources as well as continue to purchase and hold bitcoin as part of their treasury reserves.[282] SeeTee is an exemplification of bitcoin aligning first the CEO (an individual), and then the company's values with the environment. In addition, Crusoe's (and others above) ability to capture nonrival energy thereby eliminating environmental externalities have shown bitcoin mining's potential capability beyond their operating region and industry. From these case studies, mass Bitcoinization at the base level of human interaction, which is currency transactions, will accurately depict and be a true indicator for genuine market value and interest. This not only pertains to the planet's health, but also applies to other project's, product's, and companies' goals. The potentials for blockchain do not stop here.

The adoption of blockchain technology through Bitcoin for the individual and business as detailed herein can have a net positive effect for the environment. As controversial as it may be (to those on the outside looking in, that is) given bitcoin's above average performance throughout its 12 year existence, a nation ought to allocate or at the minimum consider building a position greater than zero. A single percent of their treasury assets to start would suffice. Aker, in their shareholder letter, described their commitment to invest in bitcoin as, "Not investing is the

[281] To read Aker's shareholder letter click here.
[282] Røkke. *Dear Shareholders*. 1.

riskiest decision."[283] While governments, policy makers and regulators can also harness the same attributes from bitcoin, they need not rely solely on Bitcoin's blockchain. The beauty of code and software is that it can be programmed and shared to perfect replication or divergence. To this end, blockchain technology can be curated and coded specifically for environmental goals. Inherently the blockchain is a data ledger. However, it can also be used as a platform to agree upon and finalize contracts, known as *smart contracts* (smart = programmable). Beyond its ability to empower and accelerate environmentally focused initiatives at the individual and business level, blockchain technology can finally bring consensus and thereby accountability back to governance and claim staking (ie. claims such as, "we will flare 50% more methane by year 2050") by corporations/global agreements.

The Paris Agreement (PA) is a prime example to assess the potential of blockchain use cases for governing entities. To overcome problems (time lag, double posting, manipulating numbers) in reporting progress, the UN has outlined a procedure for participants to determine if blockchain will work as the governing operating system to battle environmental issues (Fig. 23).[284] For the UNFCCC and each participating nation to accurately track their performance on Sustainable Development Goals, (SDG), Nationally Determined Contributions (NDC) and their subsequent Measurement - Reporting - Verification (MRV) metrics, a web of data inputs and outputs must be coalesced.[285] This presents a dynamic opportunity for blockchains to map sustainable metrics and create a unified forum for countries to connect with one another and enable more vibrant participation.

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[283] Ibid.
[284] Laura A. Franke, Marco Schletz, and Søren Salomo. *Blockchain Application for the Paris Agreement Carbon Market Mechanism—A Decision Framework and Architecture*. PDF file. June 22, 2020. https://doi.org/10.3390/su12125069. 6.
[285] Juerg Fuessler, Felipe De León, Rachel Mok, et al. *Navigating Blockchain and Climate Action: An Overview*. Climate Ledger Initiative. PDF file. December 4, 2018. https://www.climateledger.org/resources/CLI_Report-January191.pdf. 26.

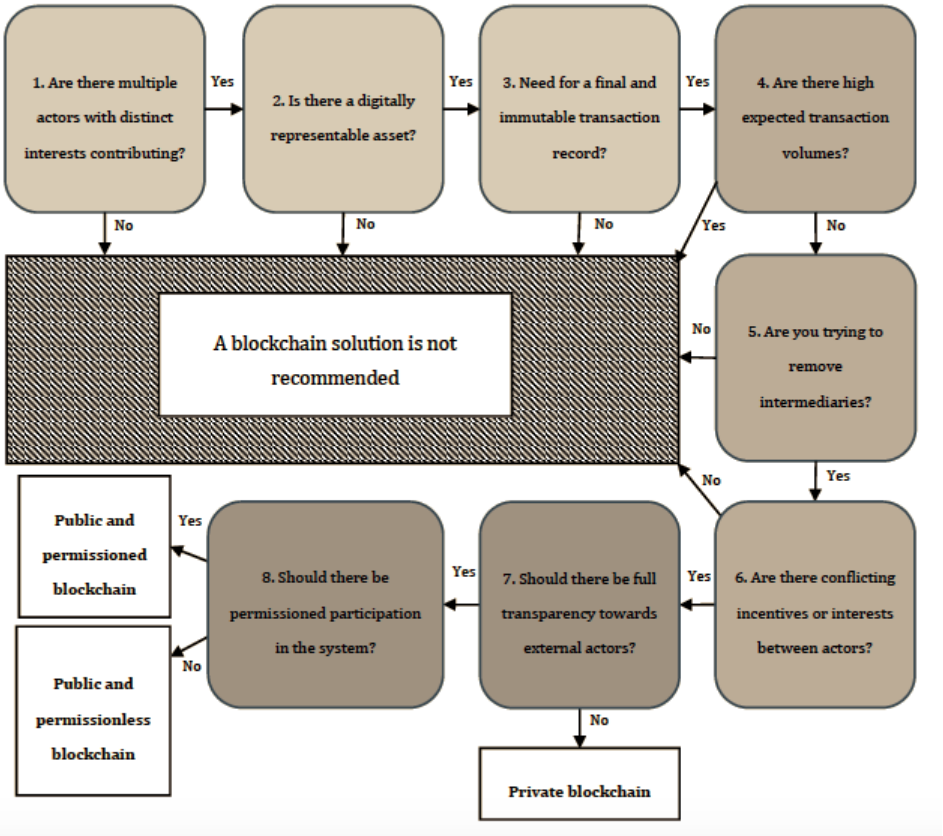

Fig. 23 Blockchain Decision Framework. (Laura A. Franke, Marco Schletz, and Søren Salomo. *Blockchain Application for the Paris Agreement Carbon Market Mechanism—A Decision Framework and Architecture*. PDF file. June 22, 2020. https://doi.org/10.3390/su12125069. 6.)

Since the UNFCCC is the acting aggregator and provider of the consensus method for the PA it should come as no surprise that a blockchain system would be a good fit for their needs. For the PA to succeed there must be transparency (a non-centralized, potentially unbiased or incorruptible source), an exchange of accurate and immutable data, trusted MRV data, and ideally the accessibility to private sector contributions.[286] A blockchain solution can provide data accumulation and access at scale with secure, distributed (transparent & non-centralized), incorruptible data (protected by cryptography and consensus protocol), which are programmable to suit the needs of each project's goal (ie. what type of consensus protocol, PoW, PoS, etc. to use for each set of goals). The rules and guidance set forth by the UNFCCC are an accounting

[286] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 19.

based top down approach. The presentation of progress can then be understood to be a bottom up approach by nations, corporations and citizens. Blockchain affords the UNFCCC to accommodate the complexities of MRV data through NDCs. Furthermore, since blockchain is programmable, use of smart contracts will enable robust accountability enabled by code rather than an intermediary which is both costly and time consuming. Take for example the carbon market. Under Article 6.2 of the PA, countries may sell or trade their carbon credits to each other. This allows for nations who wish to pollute more the credit or allowance to do so. In exchange the nation selling their credits receives a cash settlement. This has been done through what is called the International Transaction Log since the Kyoto Protocol.[287] Though successful, the centralized system is rigid in nature, requires a 506 page Data Exchange Standard, and is costly to operate. Use of Smart Contracts, which are programmable, legally binding contracts coded into the blockchain, would enable faster, consistent standardization for transactions. Smart Contracts in short "are pre-programmed digital forms of agreements and are executed automatically when certain conditions are met."[288] Application of smart contracts within the blockchain would allow for sophisticated functionality beyond sending and receiving of data/ native tokens.[289] Furthermore, smart contracts would not allow for carbon market double spends on their credits as the contract would inevitably require a reciprocal input for an output of a credit being sold/bought.[290] Such smart contract templates can then be used freely within the ecosystem of the blockchain for entities to trade, input MRV/NDC data and reports without the need for costly and potentially erroneous human intermediation.

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[287] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 20.
[288] Tom Baumann, Miroslav Polzer, and Alexey Shadrin. *How Digital Technologies Can Foster Mobilization of SDG Impact Finance?*. Digital SDG Finance Bulletin. PDF file. April 2020. https://ec94d884-4da2-402c-b98f-0cab85f86f83.filesusr.com/ugd/f69cd4_673e0f6fa07140adbe1a82b77a23d596.pdf?index=true. 17.
[289] Ibid.
[290] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 22.

Further digitization of MRV is an essential component to accurately evaluate the scope of success and fundamentally the trustworthiness of a project's claims. For MRVs to be effective, data collection, impact quantification through smart contracts, verification of data & claims, and issuance are four ways blockchain can contribute.[291] The time and cost to collect, transcribe and make data accessible will be an ongoing issue for any industry. The distribution and accessibility of a public blockchain is useful here. To improve calculation accuracy and efficiency, in areas such as carbon markets, blockchain again can alleviate current methods of manual spreadsheet updates and rely instead on pre-agreed upon parameters and rules to conduct and trace carbon market activities.[292] Integrity and verification of MRV metrics can be implemented through AI technology on the blockchain to spot irregularities or to comb through data sets which are easy for computers to process at lightning speed. Use of third party verifiers to do a more robust, real-time audit of reports and claims are also applicable. Similarly to how PoW triggers an issuance of bitcoins, verified and approved environmentally friendly activity inputs on the ledger can allow for issuance of tokens native to the blockchain. This would incentivize on-chain activity as well as reinforce the value of said environmentally beneficial acts.[293] The trio of South Pole, the ixo Foundation (developer of Blockchain for Impact), and Gold Standard (the benchmark standard for climate and development projects) in coordination with Siam Solar Energy have combined their efforts to harness the power of blockchain to monitor, report and verify greenhouse gas (GHG) emissions to better execute carbon credit trading through tokens.[294] So far this project in Thailand has impacted four Sustainable Development Goals or SDGs:[295]

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[291] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 32.
[292] Ibid.
[293] Ibid.
[294]ixo, "South Pole, ixo Foundation, and Gold Standard develop blockchain application for carbon credit tokenization," *medium.com*, September 11, 2018, accessed May 1, 2021, https://medium.com/ixo-blog/south-pole-ixo-foundation-and-gold-standard-develop-blockchain-application-for-carbon-credit-b80a484be3ca.
[295] "Siam Solar Power," *southpole.com*, accessed May 2, 2021, www.southpole.com/projects/siam-solar-power.

- SDG #7: Affordable and Clean Energy
    - Impact: Averaging 148K Mwh generated annually in clean energy
- SDG #8: Decent Work and Economic Growth
    - Impact: 100 new jobs
- SDG #11: Sustainable Cities and Communities
    - Impact: 10 solar plants operating with cutting edge technology
- SDG #13: Climate Action
    - Impact: Averaging 80K tonnes of CO^2 mitigated annually

WWF-Australia and BCG Digital Ventures have launched OpenSC, a platform utilizing blockchain to verify sustainable seafood sourcing, supply chain tracking, and certification for responsible sources (ie. no slavery, no unsustainable fishing practices such as over fishing, etc).[296] Seafood, as delicious as it may be, is notorious for illegal fishing practices. In addition, due to the complex supply chain avenues, the origin and even type of fish are often misreported or intentionally mislabeled. It is estimated some 23 billion dollars worth (roughly 20% of global fishing) is illegal, unreported, and unregulated while two thirds of the entire fish stock is being overfished worldwide.[297] With the help of ConsenSys, a blockchain supply chain platform, fishermen and consumers can benefit from dignified and responsible practices.[298] While the technology used to track any catch throughout its supply chain journey is not new (QR codes, radio-frequency identification tags), what brings this process together is the implementation of

[296] "How blockchain & a smartphone can stamp out illegal fishing and slavery in the tuna industry," *wwf.org.au*, January 8, 2018, accessed April 27, 2021, https://www.wwf.org.au/news/news/2018/how-blockchain-and-a-smartphone-can-stamp-out-illegal-fishing-and-slavery-in-the-tuna-industry#gs.zo91ze.

[297] Benjamin Combes, Mary Davies, Celine Herweijer, Jahda Swanborough and et al.. *Fourth Industrial Revolution for the Earth Series: Building Block(chain)s for a Better Planet*. PDF file. September, 2018. http://www3.weforum.org/docs/WEF_Building-Blockchains.pdf. 15.

[298]"The Most Trusted Ethereum Blockchain Solutions," https://consensys.net/. Accessed April 30, 2021, https://consensys.net/.

blockchain platforms to scale and democratize the information.[299] Fig. 24 encapsulates the journey of a tuna catch from 'bait-to-plate'.[300] Supply chain sustainability, transparency and traceability are crucial when it comes to capturing value on both the catch itself and the monetization of the fisherman's work. The immutable and time stamped nature of blockchain will allow for companies and individuals who claim sustainable practices to prove their evidence in an effortless and verifiable manner. Notably, products can be traceable but not sustainable. Conversely, untraceable products cannot be sustainable as the practices at the origin are what dictates sustainability.

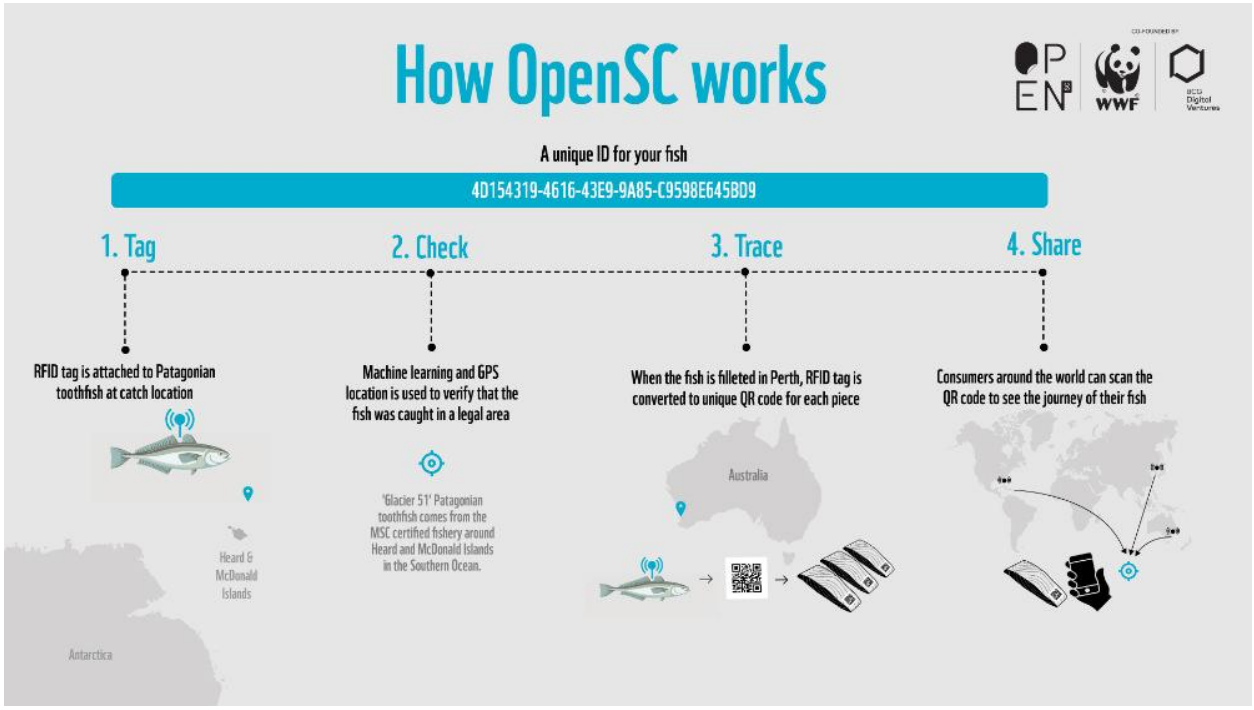

Fig. 24 Bait to Plate. ("WWF-Australia and OpenSC," *wwf.org.au*. Accessed April 30,2021, https://www.wwf.org.au/get-involved/panda-labs/opensc#gs.zo9317.)

BFLO takes a similar approach to OpenSC and Siam Solar Energy. They curated their very own type of consensus, Proof of Reputation (PoR). Their goal is to "make it easier to track, verify and

[299] Quentin Hanich, Candice Visser, "How blockchain is strengthening tuna traceability to combat illegal fishing," *theconversation.com*, January 22, 2018, accessed May 3, 2021, https://theconversation.com/how-blockchain-is-strengthening-tuna-traceability-to-combat-illegal-fishing-89965.

[300] "WWF-Australia and OpenSC," *wwf.org.au*. Accessed April 30,2021, https://www.wwf.org.au/get-involved/panda-labs/opensc#gs.zo9317.

manage sustainable business and investment data."[301] By establishing PoR using data verified by trusted third parties they are "building an interoperable blockchain enabled protocol."[302] This protocol, with a self governing network, tracks commitments and validates claims by public and private organizations. BFLO recognizes that companies and stakeholders are increasingly being held accountable and expected to be involved in ESG (Environmental Social Governance) initiatives. BFLO is capturing a growing marketplace of opportunity by a more ESG conscious generation using their PoR protocol to advance and elevate these goals. Their aim can be understood in two dimensions: to help and reward those who are already acting in accordance with sustainable frameworks through verification and to hold accountable those who claim to be green oriented by affording them a platform to showcase their work. We often hear claims about cutting emissions by 2100 to x% or that company Z donated Y millions to this sustainable project. Yet, there is hardly any follow up in a meaningful manner. PoR changes the dynamic of marketing to consumer ideations of ESG projects and shifts the narrative to action based outcomes. In a PoR network, it would become easier to track and verify sustainability claims as well as to report sustainability metrics. This would incentivize participants to mitigate negative environmental externalities while maximizing positive externalities. Alternatively, those who may choose not to engage in PoR (or any other blockchain that structures accountability) may not enjoy the bump in brand value, and subsequent increase in business. Imagine a world where one could monitor and eventually meaningfully verify Apple's goals to go carbon neutral by 2030 or that they invested (with others) $300 million into developing renewable energy production.[303,304] For now we take each company's word so long as they supply us with the

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[301] "*Proof of Reputation: Decentralizing Sustainable Business & Investment," bflo.io*. Accessed May 4, 2021, https://bflo.io/.
[302] Ibid.
[303] "Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030," *apple.com*, July 21, 2020, accessed May 7, 2021, https://www.apple.com/au/newsroom/2020/07/apple-commits-to-be-100-percent-carbon-neutral-for-its-supply-chain-and-products-by-2030/.
[304] "Apple-launched China Clean Energy Fund invests in three wind farms," *apple.com*, September 24, 2019, accessed May 7, 2021, https://www.apple.com/au/newsroom/2019/09/apple-launched-china-clean-energy-fund-invests-in-three-wind-farms/.

newest gadget, service, or entertainment. In the end, a PoR (or blockchain protocols of suitable infrastructure) will bring accountability into the ESG space and efficiently funnel human and monetary capital into companies with the best PoR status (ie. similar to current ESG ratings of companies and equities).

As the above use cases and potentials grow we can expect a few factors to drive sustainability strategies. First, we start with society at large, from individuals to corporations and governments who wish to meet expectations on being environmentally friendly and contributing to beneficial initiatives will drive social accountability. Secondly, the business and governance case for using blockchain is a 'win-win' as it adds to customer/citizen satisfaction and brand/political reputation when accrediting work or claims from credible, transparent impact data such as PoR.[305] An advantage blockchain initiators have which should entice businesses and governments most is that the protocol itself "defines who can access information, change protocol rules or data, mine tokens or coins, as well as setting required levels of transparency."[306] In other words, while digital ledgers are decentralized and transparent in ethos, businesses and governments need not give up their 'control' over the protocol or data when employing blockchain solutions. In addition, to finance environmentally geared projects the employed blockchain protocol's native tokens can be mined and sold as a source for "funding opportunities for positive externalities."[307] These tokens can, much like bitcoin, be traded amongst fiat currencies or used as a SoV/investment.

Bitcoin is far more than a SoV or a medium of exchange. It is a tool and a technology that can uplift communities. In 2019, an anonymous donor decided to donate his trove of bitcoin to

[305] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 74.
[306] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 86.
[307] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 74.

the community of El Zonte, a beach community on the coast of El Salvador.[308] As a believer in Bitcoin and blockchain the donor decided to fund the Bitcoin Beach Initiative, with Michael Peterson. The idea was to create a community that used bitcoin as their medium of exchange, rather than convert it to fiat. In fact, part of the condition to partner with the Bitcoin Beach initiative was that they would not exchange the bitcoin for fiat and live on a Bitcoin Standard. Quite simply, the vision was to create a sustainable Bitcoin ecosystem. This new system would encompass all commerce in the community (i.e. remittances, tourism, public service and small business) and create a Bitcoin circular economy.[309] Bitcoin and its network allows for the financially oppressed or excluded people of the world to be linked into the broader worldwide commerce of exchange and financial freedom. One of the criticisms of bitcoin was that there was no 'real world utility' to it besides trading it as a speculative asset. Here, in El Zonte, you can use bitcoin to buy a cup of coffee, get a haircut or even pay your utility bills.[310] In fact, in the few years since it's implementation you can now pay for programs for trash removal, road repairs, educational grants, and of course for your basic everyday necessities such as food.[311]

Bitcoin Beach set out to create a sustainable Bitcoin ecosystem, where the majority of residents are unbanked and the local businesses are not integrated into the larger financial fabric of existing financial systems. The younger generations were first to adopt the Bitcoin standard as they were most comfortable with the inevitable technical aspect of interacting with the network. This came in handy when the Covid-19 pandemic necessitated socially distanced commerce and the youth were able to teach the rest of the community through video tutorials. Furthermore, it is estimated that there is an excess of 5 billion dollars in remittances sent to El Salvador annually.

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[308] Tatiana Koffman, "This El Salvador Village Adopts Bitcoin As Money," *forbes.com*, July 14, 2020, accessed May 14, 2021, https://www.forbes.com/sites/tatianakoffman/2020/07/14/this-el-salvador-village-adopts-bitcoin-as-money/?sh=2c6104892044.
[309] Ibid.
[310] Ibid.
[311] Ibid.

The fees associated with wiring money can range from 5-10% not including the time, energy and transportation cost one must expend to make the transfer.[312] With bitcoin, the transaction is near instant and there are negligible fees. Now thanks to Strike, all remittance and commerce via bitcoin is free with no latency. In short, El Zonte actualized a Bitcoin standard economy. It is the first of its kind that will surely be modeled after by communities and nations looking to decouple from the crumbling fiat lecagy. For a community that does not have a supportive banking infrastructure or even a national currency for that matter (they use the U.S. dollar), bitcoin is a way to take back their financial freedom and not be at the mercy of any institution or authority:

> It's great to see youth excited and dreaming about their futures in El Salvador and seeing a path forward here, instead of thinking they need to go to the U.S. They are able to work, help support their families, and go to University...Bitcoin has helped me understand what money really is and has given the resources to impact the lives around me," says Jorge Valenzuela.[313]

Take another example from Aubrey Strobel who grew up in the Navajo Reservation in Chinle, Arizona.[314] In her youth, wowed by the great gifts of the Navajo Reservation, she never quite noticed the community's "economic instability, high rates of poverty and limited access to financial services" which eroded trust in the government and legacy financial institutions.[315] She now sees bitcoin as a path removed from "historically oppressive dominant cultures."[316] Storbel accurately emphasizes bitcoin's underlying characteristics (i.e. capped supply, deflationary trend, consensus protocol, etc.) which make it a better alternative for those who have been disenfranchised for generations in today's "deeply divided reality of America."[317] Significantly,

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[312] Ibid.
[313] Ibid.
[314] Aubrey Storbel, "Bitcoin gets Wall Street's attention. But its power lies in aiding oppressed peoples," *nbcnews.com,* May 7, 2021, accessed May 14, 2021, https://www.nbcnews.com/think/opinion/bitcoin-gets-wall-street-s-attention-its-power-lies-aiding-ncna1266533.
[315] Ibid.
[316] Ibid.
[317] Ibid.

bitcoin allows for those oppressed financially, and otherwise to "separate themselves from the systems that have worked against them."[318]

At the intersection of technology and the humanitarian spirit, one can see how a community's faith in society and hope for a better life can turn into a special project as seen in El Zonte. It isn't just a monetary revolution but a social justice movement for the unbanked and financially disadvantaged. A borderless, indiscriminate, trustless protocol that has no intention other than its mathematical inputs and outputs are changing the lives of those who are still living in the periphery of modern living standards. The same gain a billionaire sees in their bitcoin portfolio in America can and *is* being shared by thousands of people in El Zonte. It truly is borderless and does not discriminate whatsoever. In fact, it cannot discriminate, and that is quite literally coded in permanently. Furthermore, the basic right to financial inclusivity in the 21st century has yet to be realized globally and Bitcoin backed services and economies are disrupting the existing inequalities one person and one community at a time.

In the end, as the examples show, bitcoin and blockchain are not the end-all solution. Rather, they facilitate and direct people to the appropriate solutions that align with their best values. Often, we see that those naturally coincide with and incentivize actions towards environmentally friendly ends. Ironically, blockchain can and is continuing to replace our current intermediaries by acting as such. Though juxtaposed in modern rhetoric, nature and technology in tandem can provide immediate and more efficient solutions to environmental degradation.

Chapter Five: A Digitized, Environmental Future

Bitcoin FUD. For the most part blockchain technology will be used to either replace or create an unbiased and objective intermediary operating on code and network consensus. In other cases such as bitcoin, the technology will protect one's life energy and perhaps be a medium of

[318] Ibid.

exchange. While blockchain and Bitcoin cannot change legacy financial & data systems and their inner workings, it does provide an alternative (a bright golden orange one at that!). It not only affords humanity with a new operating system but with it, the chance to refocus our moral values, energy/money, and incentives. In this way, mass adoption and strategic application of blockchain together with Bitcoin can usher in an environmental paradigm never seen before.

It is only appropriate that this paper address mainstream media's trending topics when it relates to the environment and bitcoin: the bitcoin energy FUD (Fear, Uncertainty, and Doubt). Bitcoin is not boiling the ocean, accelerating climate change, or taking power away from people in need (as seen with the harnessing of nonrival energy from chapter four). Uniquely, bitcoin mining's equipment is highly mobile and hashrate power (the aggregate electricity expended to compete in PoW) can be sourced anywhere at the miners discretion. Miners, bitcoiners, developers and the like do not care where the mining takes place per se. Additionally, as seen in China, mining rigs are moved back and forth between Sichuan/Yunnan and Inner Mongolia/Xinjiang depending on the season to capture the most abundant renewable energy.[319] Integrally, the electricity run through the Bitcoin network is quite simply its network security. Through PoW miners are "allocating significant real-world resources to mining… guarantee[ing] settlement like none other."[320] The first order effect is, of course, to fairly compete for block rewards in bitcoin, but by having more miners compete, the second order effect is that the network becomes increasingly robust and secure.[321] Though there is most likely a point of diminishing returns on the electricity expended versus network security, what better use is there for energy than to secure, create and run a digital money network that reinforces renewably sourced methods? Furthermore, in the same vein, what better use can electricity consumption

[319] Carter, "Noahbjectivity on Bitcoin Mining."
[320] Elmandjra, "Debunking Common Bitcoin Myths."
[321] Carter, "Noahbjectivity on Bitcoin Mining."

have than working through blockchain projects which secure and protect our environmental interests as a planet. As bitcoin exits the periphery of the uninformed (most likely through price appreciation and media hype and hashrate increases), its trajectory to devour abundant, stranded and nonrival energy will become unmistakable as well as the norm. Given the opportunities that lie globally outside of China and the US, this narrative cannot be more bullish for reversing the Bitcoin energy FUD. Moreover, Bitcoin's energy usage can be powered solely on nonrival energy **today**. Based on figures from the Digiconomist and Cambridge, it is estimated that the annualized energy consumption of Bitcoin is 110 TWh/year and 142 TWh/year respectively (2020).[322,323] It seems reasonable to assume it is somewhere in between these figures. Then consider the amount of curtailed energy from methane flaring and nonrival renewables in China below.[324]

- In 2016, China curtailed 40.7 TWh worth of wind and 11.5 TWh of solar power alone, totalling **51.2TWh** of curtailment
- In 2016, Yunnan alone curtailed **31.4 TWh** worth of hydro power
- In 2016 and 2017, China curtailed **100 TWh** on average worth of hydro, solar, and wind energy, collectively
- The (very conservative estimate of) 558B CF flared/vented natural gas in the U.S., if put to use in 7 Heat Rate (7m BTU/MWh) combined-cycle plants, would have generated **76.9 TWh** in 2019

The sum curtailment figure (259.5 TWh) is clearly more than enough to run the Bitcoin network several times. Significantly, these are figures from just two sources of unrivaled energy in just

[322] Click here for more on the the University of Cambridge study on - Cambridge Bitcoin Electricity Consumption Index (CBECI)
[323] Carter, "Noahbjectivity on Bitcoin Mining."
[324] Ibid.

two countries. Should the world adopt a Bitcoin standard today, the network would not need or rely on an increase of hashrate or energy. The network is already sufficiently secure. The only reason energy consumption would spike is if the price appreciation seen (in bitcoin) with mass adoption were to incentivize new and existing miners to set up additional ASIC hashing devices. At the upper limit of 142 TWh/year Bitcoin is utilizing as much energy as Sweden or Malaysia.[325] It certainly sounds like an astounding amount for something still mysterious to most people. Ultimately, the question is how much *should* a monetary system consume to secure itself and thereby its user value?[326] Could there really be a 'right' or 'appropriate' cost here? Think about the lengths the U.S. would/did go to protect the gold at Fort Knox or to bail out the financial industry during The Great Recession. If you are of the many millions of people using bitcoin "to escape financial oppression, inflation, capital controls, then you most likely think that the energy is extremely well spent."[327] In the end, whether bitcoin is worth the energy it consumes is up to the individual and his/her conception of the environmental priority in running electricity through it.

When levying criticisms to the Bitcoin community on energy consumption, one must take into consideration, who if anyone has the privilege or right to be the arbiter on energy use or to deem the societal merit of a project. From the Bitcoin community's perspective much of the existing systems are simply gatekeeping their business moats from competition. "How often do you hear about the societal merit of game consoles, clothes dryers or Christmas lights?"[328] Take this quote from Eric Holthaus, one of the top climate journalists in the US:

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[325] "Comparisons," Cambridge Bitcoin Electricity Consumption Index, accessed May 2, 2021, https://cbeci.org/cbeci/comparisons.
[326] Nic Carter, "How Much Energy Does Bitcoin Actually Consume?," *Harvard Business Review*, May 5, 2021, accessed May 8, 2021, https://hbr.org/2021/05/how-much-energy-does-bitcoin-actually-consume.
[327] Ibid.
[328]Nic Carter, "The Frustrating, Maddening, All-Consuming Bitcoin Energy Debate," *coindesk.com*, May 5, 2021, accessed May 14, 2021, https://www.coindesk.com/frustrating-maddening-all-consuming-bitcoin-energy-debate.

> At its current consumption rates, Bitcoin could never replace the global financial system. Right now, with its high transaction fees, Bitcoin only can handle about 350,000 transactions a day. At that rate, Bitcoin would require 14x the world's total electricity just to process the 1 billion credit card transactions that take place every day. Bitcoin is not just inefficient, it's actively anti-efficient. It makes the world worse in exactly the opposite ways it's trying to help.[329]

Holthaus's comments can be broken into four components:

1. Bitcoin consumes too much energy
2. Bitcoin does not settle enough transactions for it to be useful
3. 1. and 2. together make for an outsized energy cost per transaction
4. If we accept 1., 2., and 3. Bitcoin will use more energy than exists on Earth.[330]

On the surface, Holthaus's argument on bitcoin's energy use evokes a sense of existential danger. Dig deeper and you'll see that he is misunderstanding the inner workings of the bitcoin protocol. First it is paramount to understand where most of the energy consumption is happening. Nakamoto's solution to distribute the coins in a fair manner was not to hand them out to close friends, donors, or even to have an ICO (initial coin offering; where a select audience can purchase tokens privately). He chose to have "miners surrender something valuable – energy – in exchange for the right to claim them."[331] In this manner, Nakamoto was able to "fairly, and in a decentralized manner, issue units of digital value to the world."[332] This is the PoW mining covered earlier and is also where the majority of energy is consumed. It is important to note that miners do not gain any substantial advantage by having the capabilities to mine. The business margins are razor thin and miners often sell their coins to cover the cost of mining. It may be

[329] Carter, "The Frustrating, Maddening, All-Consuming Bitcoin Energy Debate."
[330] Ibid.
[331] Ibid.
[332] Ibid.

easier to understand the value of bitcoin if you compare it to gold. Gold is valuable because it is difficult to mine, process, transport and protect. Similarly, "bitcoin mining is a synthetic approximation of gold mining…[but]...instead of sifting rock, you're sifting through a mathematical space."[333] The transactions on the bitcoin network have negligible energy expenditure. It is the mining that is energy intensive. As covered above, the energy intensive PoW currently is and can be done with existing non-rival energy. Now you can see how Holthaus's statements is misguided from the start: mining ≠ transactions. He is confusing the energy consumption from mining and extrapolating it to the energy consumed by transactions. Additionally, we know that bitcoin's coin issuance is halving every 4 years and is on a deflationary trend. It is true, that as the price of bitcoin reaches new all time highs, there will be an influx of new miners. The number of miners finding their operation to be successful with each successive jump in price will be low given the increased competition, hardware obsolescence, and a 50% reduction in coin issuance with each halving event.

Furthermore, his assertions on the amount of transactions being processed is erroneous as well. He misunderstands what 'one transaction' means. One transaction ≠ one payment. Bitcoin, unlike Visa (for example), offers *final* settlement. Visa offers non-final settlements that depend on the interoperability of many other systems working in tandem ("Visa relies on ACH, Fedwire, SWIFT, the global correspondent banking system, the Federal Reserve and, of course, the military and diplomatic strength of the U.S. government to ensure all of the above are working smoothly.").[334] There is a huge fundamental difference in each network's settlement assurance. Visa transactions can be reversed (we are all too familiar with the chargeback window) whereas on the blockchain they are final.[335] One is decentralized and is structured on a bottom up network

[333] Ibid.
[334] Ibid.
[335] Nic Carter, "What Bloomberg Gets Wrong About Bitcoin's Climate Footprint," *coindesk.com*, February 15, 2021, accessed May 14, 2021, https://www.coindesk.com/what-bloomberg-gets-wrong-about-bitcoins-climate-footprint.

while the other is a highly centralized, top-down dependent system composed of derivative networks.

To directly address the transactions critique, bitcoins base layer settlement (where one transaction ≠ one payment) can include a batch of inputs all approved in one transaction. Take the example of Strike in El Salvador. Strike is a second layer solution which enables bitcoin to scale its transaction volumes. All activity on Strike (from a few hundred to few million) can be batched as a single transaction amongst the many transactions in a block which is then settled at the base layer. Moreover, layer 2 solutions such as Strike or the Lightning network enable the bitcoin base layer to settle multibillion dollar transactions with finality and without incident.[336] It should also be noted that these layer 2 solutions are not needed for multi-billion or million dollar settlements, it only makes them more frequent as transactions are batched together. What the layer 2 solutions do offer though, is the increased data space necessary to aggregate transactions. Bitcoin cannot push through massive amounts of inputs on its base layer given the protocol mandated blockspace data maximum (refer to Blocksize war in chapter four footnote). A maximum is necessary for the network to be distributed and decentralized. Too much data throughput would hamper the distribution and thereby the decentralization of the blockchain validating nodes as those with large data centers would be the only entities capable of such high density data management. Ultimately, a larger block size would defeat the entire purpose of Nakamoto's 'peer-to-peer decentralized' creation.

In the end, there is no denying bitcoin consumes a recognizable amount of energy, but as detailed above Holdthau's critique items 1. and 2. derail his entire argument. What is most important is to understand the nuance of why and at what juncture the protocol consumes the most energy. Furthermore, a lack of understanding of the bitcoin protocol is one of the largest

[336] Carter, "The Frustrating, Maddening, All-Consuming Bitcoin Energy Debate."

obstacles for society to have meaningful debates on its environmental/energy FUD, let alone the real world utility Bitcoin is showcasing in El Zonte, supply chain management, energy microgrids, curtailment of excess negative externalities and more.

Finally, compared to fiat or traditional banking systems and gold, bitcoin consumes much less energy (albeit at a much smaller market cap and network effect for now). According to Ark Invest (Fig. 25), annualized energy consumption for legacy banking systems stands at 2.34 billing gigajoules (GJ) and gold mining at 500 million GJ.[337] Bitcoin only consumes 184 million GJ/year, less than 10% and 40% of the aforementioned respectively.[338] In the future, it will be up to the user to interpret the use and justification of energy for any given device/system/network. For example, gold and diamonds are rare because of the intense amount of energy needed to form them.[339] Similarly, for Bitcoin, one could say that the amount of energy to create, secure, and transact is a testament to the value Bitcoin can provide. In the end, I would have to agree that, "the cost for having no central authority is the cost of that energy" and that in itself, is worthy of expenditure.[340]

[337] Elmandjra, "Debunking Common Bitcoin Myths."
[338] Ibid.
[339] Tapscott, *Blockchain Revolution*, 632.
[340] Ibid.

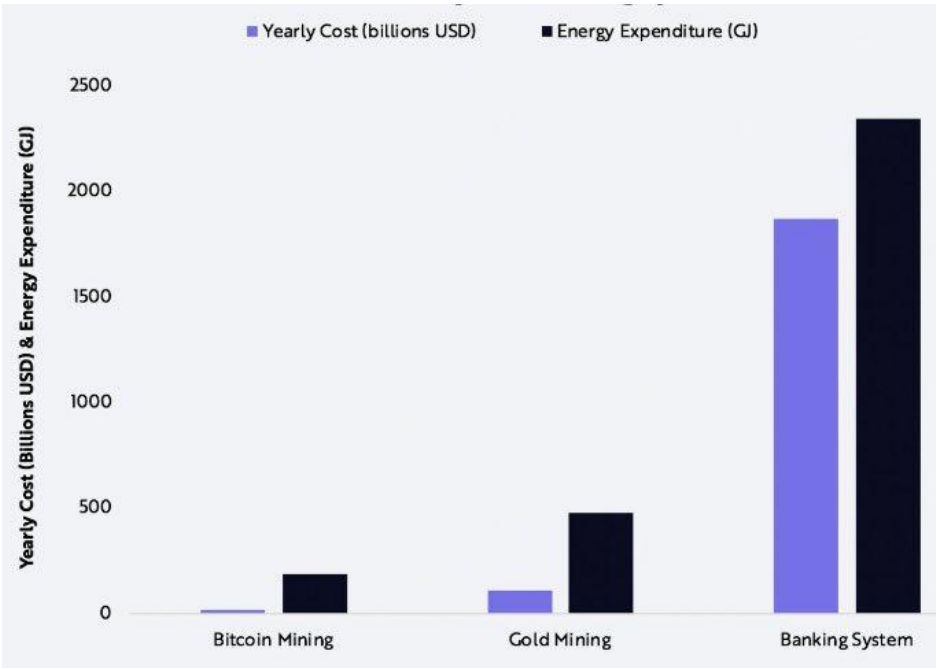

Fig. 25 Energy Expenditure Across Bitcoin, Gold and Banking. (Yassine Elmandjra, "Debunking Common Bitcoin Myths," *ARKINVEST.com*, June 26, 2020, accessed April 9, 2021, https://ark-invest.com/analyst-research/bitcoin-myths/.)

	Yearly Cost	Energy Used (GJ)
Gold Mining	$105B	475M
Gold Recycling	$40B	25M
Paper Currency and Minting	$28B	39M
Banking System	$1,870B	2,340M
Governments	$27,600B	5,861M
Bitcoin Mining	$4.5B	183M

Fig 26. Annualized Costs & Energy of Bitcoin, Banking and Gold. (Dan Held, "PoW is Efficient," *medium.com*, September 14, 2018, accessed March 13, 2021, https://danhedl.medium.com/pow-is-efficient-aa3d442754d3.)

Blockchain Implementation. ECOcoin (ECOs) and Bitgreen are two examples of a comprehensive implementation of blockchain integrating many aspects discussed throughout this paper. They are first and foremost environmentally focused blockchain initiatives, providing positively reinforcing incentives and direction for participants. Both protocols run a Proof of Stake protocol (PoS). A PoS system allows for much less energy consumption to reach network consensus and security as it allocates mining privileges to those who have 'staked' the most tokens. While PoS still uses a cryptographic mechanism the objective of the protocol is different as there is no mining reward and the stake is rewarded by a transaction fee. Those who have put up the most native tokens have the highest chance of being selected by the algorithm to approve transactions and essentially earn 'interest' through the transaction fees. While the mechanisms between PoW and PoS each have their merits and demerits, PoS does win the energy consumption battle. Bitgreen has successfully harnessed the PoS infrastructure to run their project on just 0.6% of Bitcoin's energy consumption.[341] At their core either project aims to reinforce environmentally sustainable and positive activities. ECOcoin, for example, rewards actions such as eating meat-free meals, commuting by bike, or using renewable energy in ECOs.[342] What makes ECOcoin special is that every minted ECO is backed by planting a tree, making it a living digital asset.[343] Furthermore, the intrinsic value of the ECO is three fold when you consider the environmentally friendly action it took to 1.) produce an ECO, 2.) the tree that is subsequently planted, and 3.) the positive externalities that trees provide to the ecosystem. Actions are verified by independent 'ECO Inspectors' who, like bitcoin miners, earn ECOs for their work. In fact, much like anything in our ecosystem, the ECOs are born, live, and decay over

[341] "The BitGreen Ecosystem," *bitg.org*. Accessed Feb 7, 2021, https://bitg.org/whitepaper/.
[342] *The ECOcoin: A Cryptocurrency Backed by Sustainable Assets*. PDF files. Accessed February 2, 2021. https://uploads-ssl.webflow.com/5c1b58255c613376879c2558/5c4970105b4d237571564f43_ECOcoin_white_paper_v1.0.pdf. 4.
[343] *The ECOcoin: A Cryptocurrency Backed by Sustainable Assets*. 8.

time.[344] In order to keep accurate track of the tree to which the ECO is linked, when the tree dies, so does the ECO. ECOcoin uses the average tree lifespan (ATL) to determine a particular ECO's ultimate decay.[345] Should the tree still be alive at the end of the ATL, the coin will not die by default, but live on. In this way, the supply of the ECO is not only backed by physical value, but its inflationary or deflationary factors are backed by positive environmental actions.

Both ECOcoin and Bitgreen provide useful roadmaps for how to harness blockchain technology into positive environmental impact through tokenization of their network ethos (where their ethos is to be eco-friendly). Both share a clearly intended purpose: solely that of spreading their ethos. The same cannot be said for a majority of digital assets aka currency. While all start with a vision and utility proposal (some truly genuine, most of them somewhat ambiguous) many attract users by big jumps in price action and not their intended utility proposal. Consider Dogecoin, which was originally created as a joke or 'meme coin'.[346] It has been on an absolute tear the last six months for a 17,804% gain, out performing Bitcoin, Ethereum, and Binance-coin combined (the top three assets currently by market cap).[347] For every serious project such as ECOcoin and Bitgreen that clearly aim to advocate for planetary health, there are another ten 'meme coins' that join the cryptoverse. One may attribute multiple reasons to the sudden and incredible gain in Doge. First, the ease and accessibility to crypto currency trading has increased thanks to apps such as Robinhood, Coinbase, and Binance. Secondly, the likely traders of Doge are of the younger generation who understand and feed into the 'meme' culture of assets 'going to the moon!'. Lastly, the Gamestop saga in early 2021 has cast a spotlight on the idea of 'getting rich fast' with unprecedented historically outsized market

[344] *The ECOcoin: A Cryptocurrency Backed by Sustainable Assets*. 3.
[345] *The ECOcoin: A Cryptocurrency Backed by Sustainable Assets*. 9.
[346] Justina Lee, Joanna Ossinger, "The Dogecoin Joke Is Turning Serious in Latest Crypto Binge," *bloombergquint.com*, May 6, 2021, accessed May 7, 2021, https://www.bloombergquint.com/markets/the-dogecoin-joke-is-turning-serious-in-latest-crypto-binge.
[347] "Crypto Tracker," *coinstats.app*, accessed May 7, 2021, https://coinstats.app/.

moves. Above all, I contend that at the very base, Metcalfe's Law is to blame and simultaneously be praised for both Doge & Gamestops' surge and ECOcoin and Bitgreens' failure to 'take off' thus far. Metcalfe's Law states that a network's value is proportional to the square of the number of users (Fig. 27).[348] In order to have 'network effect' there would need to be an explosion or a steady rise in users. Facebook captured this phenomena well, so did Google, Apple and so on.

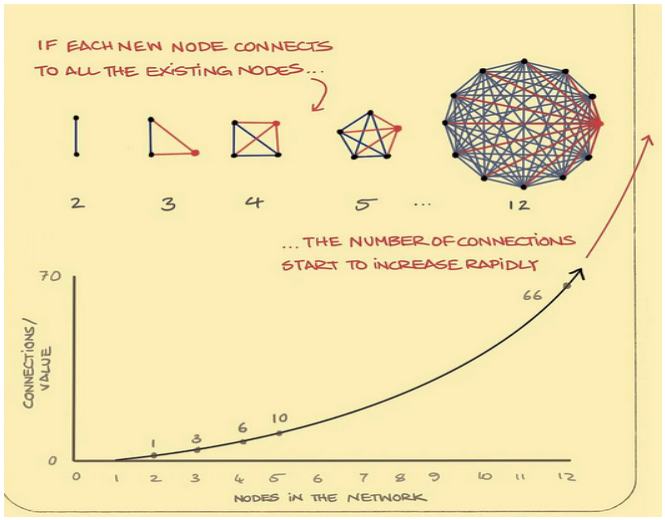

Fig. 27: Metcalfe's Law ("Metcalfe's Law," *sketchplanations.com*, accessed May 6, 2021, https://sketchplanations.com/metcalfes-law.)

Similarly, for environmentally focused blockchain projects to take off, I propose that there needs to be a momentous push deriving from Metcalfe's Law. That is, while independent companies such as ECOcoin, Crusoe, BMG, etc. can succeed, a truly planet wide shift to environmental consciousness via blockchain adoption calls for a monumental project - an effort befitting the importance and respect deserved by our ecosystems. Though blockchains are not a social network like Facebook, it most certainly is a *social network* in kind that has the capacity and potential to touch all of humanity. The aforementioned companies encourage others to pursue environmentally sound aims through various projects as there is a wide variety of adoption possible at all levels of economies and industries, such as supply chain logistics, data harvesting

[348]"Metcalfe's Law," *sketchplanations.com*, accessed May 6, 2021, https://sketchplanations.com/metcalfes-law.

and analyzing, and policy/regulation accountability. Independent projects at the local level still have the advantage of capitalizing on multiple touch points where mass adoption has yet to reach. I advocate that given the low network effect of these projects, the Bitcoin standard which undeniably has the best network effect performance so far, is the most viable foundation to build an environmentally sound global operating system. Eventually, the local and global can merge through the spreading of the blockchain mycelium across nations, industries, businesses, and individuals to create the largest network ever known.

The proposal to advance the earth's health by utilizing blockchain technology will have three layers outlined below.

1. Bitcoin for the individual to recapture the utility of sound money and thereby aligning oneself with low time preference values and incentives society ought to strive for. The first layer of a new environmental standard will be to adopt a sound money standard. As outlined in chapter four, the fiat legacy does not qualify. It distorts every single human being's time preferences by distorting energy/money value in the markets. I argue that this is one of the main culprits responsible for the present inability to accurately assess an ecosystem's value, much less perceive the need to protect and preserve it. Bitcoin is sound money, but even more, it has integrity. It allows for " honest accounting of costs and benefits of actions, as well as the economic responsibility necessary for any organization, individual, or living being to succeed in life: consumption must come after production."[349] This in effect would curtail and change the consumerist mindset unsound money has promoted and abate the consumption of pollutant heavy products/services. Though a sound money standard need not be a digital asset, the world has been on a digitizing trend. It would be counter productive to not embrace the technological trend

[349] Saifedean. *The Bitcoin Standard*, 323.

society is clearly adapting. China has already released a Central Bank Digital Currency (CBDC) (though it is not 'sound money' as it is merely a representation of the Yuan fiat) and other nations cannot afford to be laggards in the further digitization of money. Given money is not widely perceived in the manner presented in this paper, the case remains that money is a battery for our life's work and energy exerted. Once you can understand the correlation between energy and money, and the effects on living standards, it is easy to see how money influences what and how we focus and expend our energy . For the majority of us today, our focus is compromised due to manipulated fiat systems. With the knowledge from Bitcoin we can restore our focus and sharpen it to start engaging in low time preference projects for the environment.

2. Blockchain IPOs for eco-friendly/CEJ focused businesses to capture starting capital and momentum to achieve network effect. There are many proposals to make for the business sector of the world. To those who are not concerned about or disengaged from ESG initiatives these recommendations can provide a starting point. Perhaps first a director/coordinator to oversee company operations and guidelines. Then a committee, unit, a product/service and so on. Most companies that do concern themselves with environmental/social justice movements are of two types. Either they are large enough to allocate capital and personnel or their business model hinges on it. An example might be McDonald's and Luke's Lobster, both in the QSR (quick service restaurant) industry, yet distinct in their approaches to environmental and social justice issues. McDonald's started from a place of pressure. In the 1990's the CHEJ's (The Center for Health, Environment & Justice) McToxic's campaign targeted McDonald's rampant use of styrofoam in sandwich packaging.[350] McDonald's later that year did stop using styrofoam for sandwich packaging, but continued to pour coffee into millions of styrofoam cups. Furthermore,

[350] Trey Granger, "McDonald's to Stop Using Foam Packaging by End of Year," *earth911.com*, January 12, 2019, accessed May 8, 2021, https://earth911.com/business-policy/mcdonalds-foam/.

they did not credit the McToxic campaign which was largely fueled by young students and instead credited the Environmental Defense Fund (EDF).[351] Decades later, in 2012 McDonald's finally stopped styrofoam use for their beverage containers after being pressured by As You Sow, a non-profit environmental advocate.[352] Time and time again, we see social pressure being the trigger for action decades apart. In comparison, a smaller family owned business such as Luke's has led the way in environmental stewardship head on. From their inception in 2009, Luke's has made it their mission to serve the best possible product. That is, to only source their lobster from MSC (The Marine Stewardship Council) certified waters and from fishermen who abide by the industry/Luke's standards of sustainable and responsible fishing. Luke's is also a certified B-Corporation, a designation of the highest verified social and environmental performance by a company awarded by fulfilling three criterias: performance, legal accountability and public transparency.[353] "P over P" (People over Profit) is Luke's motto and it is exemplified through their varying initiatives with coastal communities, companies, and industry leadership.[354] Importantly, Luke's develops direct personal relationships with the fishermen and their co-ops to ensure they get the fishermans' best quality catch before any other buyer. While both businesses rely on ecosystems to produce their products, one inherently has gone out of their way to obtain B-corp status and the other has been a laggard, only incentivized by negative pressure. Some critics may argue that McDonald's does not have the same relationship and reliance on a particular ecosystem service as Luke's does. However, they miss the point of being environmentally conscious regardless of a business's proximity and reliance on a particular ecosystem. I contrast the diverging models to show that both, whether willingly or through social pressure, surely ought to invest in blockchain technology to further capture the value of their

[351] Ibid.
[352] Ibid.
[353] "About B Corps," Bcorporation.net, accessed May 9,2021, https://bcorporation.net/about-b-corps.
[354] "Purpose," *lukeslobster.com*, accessed May 9, 2021, https://www.lukeslobster.com/purpose/.

ESG work. For example, Lukes's and McDonald's make claims about their supply chain initiatives and list figures on how much trash they have eliminated or mitigated.[355,356] Unfortunately, there is no way to verify these claims easily and in a transparent manner. By partnering with companies such as Provenance they can not only show the work and effort that is put in behind the scenes, but they can also then market and draw better talent, grow larger customer bases, and find mutually beneficial partnerships with other businesses.

Furthermore, for environmentally focused entrepreneurial or startup businesses a blockchain IPO is recommended. In the crypto/digital assets space, an IPO is typically called the Initial Coin Offering or ICO. Through an IPO/ICO, a business not yet flush with capital can sell their native token to accrue base capital. The rest of the tokens can then be bought or sold on a public market should they make their platform public and permissionless. There are some advantages to this recommendation, for such an offering of tokens does not equate to diluting shareholder positions in the company. Given that shareholder equity is not diluted, the company's vision is uncompromised internally, though external pressure may still apply. To achieve transparency and make things abundantly clear, these events should be accompanied or preceded with publication of a whitepaper (a company prospectus). The whitepaper can further outline the goal and scope of the project, what the IPO/ICO funds will go towards, the purpose of the tokens and so on. Furthermore, from an investor's point of view, the tokens are bought in the belief that the project is of value and in time would pay the investors back in increased token value similar to stock price appreciation. Do not fail to consider that the initial investment can be made so that the investors are also the beneficiaries of said project - perhaps a solar energy project in a remote area where a microgrid would benefit the local community. As they invest in,

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[355] "Purpose." *lukeslobster.com*.
[356] "Sustainable Agriculture & Beef," *corporate.mcdonalds.com*, accessed May 9, 2021, https://corporate.mcdonalds.com/corpmcd/our-purpose-and-impact/our-planet/sustainable-agriculture.html.

say the ‘Suncoin’ project, those funds would be utilized to support and build out the initial grid they will come to use. In this way, and in a true decentralized manner, angel investors need not be the only source for capital. By expanding the threshold for smaller but impassioned and actual *stakeholders* a blockchain IPO can capture serious momentum and credibility for future expansion. Additionally, the IPO can specifically target those who may not otherwise have had the opportunity to invest in anything without blockchain technology. Capital funding can be crowd sourced from environmentally endangered areas or places of economic impoverishment where individuals spare what cash they can so that any accrued growth can then be put back into their communities to form a positive feedback loop. Given blockchain technologies' capability to verify and communicate data, a smart contract could be drawn up where money does not need to be invested to receive tokens from the IPO. Instead, their labor can be paid in the token and released by the blockchain once the contract is fulfilled. Ultimately, these IPO/ICOs of token sales can be seen as functioning more as an incentive structure for eco-friendly behavior. While in the beginning the token may not have much economic value, it still inherently maintains the *purpose* and signifies the incentivized green behavior. Ultimately, should some projects fail for whatever reason, this can be attributed to a faulty iteration or interpretation of how to digitize and scale ecologically responsible behavior/products/services. In the end, instead of negatively reinforcing people to do less (ie. carbon emission trading) blockchain IPOs can be the driving force in incentivizing people to do more good. As ECOcoin points out, “If you can make money from cutting down a tree why can’t you make money planting one?”[357]

3. Smart contract blockchain operations for governance, facilitated by oracle systems such as Chainlink. For a governance proposal, an IPO/ICO can still be suitable, but a more likely

[357] *The ECOcoin: A Cryptocurrency Backed by Sustainable Assets*

and wider use case would be to create a protocol designed for MRV data. Carbon emission trading markets can and should be utilizing blockchain to facilitate market activity. The transparency, real time update, verification of trades and ability for immutable contracts to be drawn up would be highly beneficial for accuracy and cost reduction. For reporting and accountability purposes, bodies such as the UN should use a permissioned blockchain. For example, countries participating in the Paris Agreement are invited onto the private chain and interact with the protocol such that their commitments, claims and MRV reporting can be validated by participating nodes (the privilege to validate and update blocks can be structured to only the central UN authority or to certain countries, or even all participants depending on prior agreement). Mechanisms to further verify inputs can be outsourced to trusted intermediaries or programs coded into the protocol to detect anomalous entries. The CCC (Climate Chain Coalition) is one such company that can take the cost and stress off governing entities to implement a blockchain solution. For other governance models, blockchain can also be used as a medium to vote on environmental proposals, policies, and regulatory issues. This would be applicable at the community level as well as addressing congressional or shareholder level initiatives. Utilizing a native token on the voting blockchain, each voter would be sent a token in order to cast their vote. The token would be sent by the voter to a 'wallet' or 'address' representing a particular project or initiative.[358] The chain would then approve each transaction leaving a transparent chain of votes for everyone to witness. What's more, the voters can remain anonymous should they want to remain so. This can also be done for general elections outside of the environmental realm. Voting on a blockchain medium can enhance voter engagement and also better represent the interests and desires of the voting population. Since a vote can be cast through a smart device, people do not need to travel to a voting site, saving them time, money

[358] Tapscott, *Blockchain Revolution*, 547.

and energy and offering a superior voting experience. Participation would increase and voting records would be public for everyone to see and scrutinize. The 'bottom up' nature of blockchain is a game changer in many countries that have biased, corruptible and fallible governments and politicians.[359] Given that the net exporters of raw materials and precious metals in the world are in areas with poor physical and governmental structures a "decentralized yet trusted technological tool" can provide them with the voice and freedom they deserve, most importantly including our ecosystems.[360]

Challenges & Recommendations. As with most technological change, humans adapt rather slowly and only embrace change once it has reached a level of entrenchment in their lives where it is obvious to do so. In fact, this is not an adaptation to change, but rather adapting to the new norm. This stems from a multitude of factors ranging from cost of implementation, user knowledge and education, hesitancy to disrupt legacy systems, and the uncertainty of the ROI. Early adoption will be made by those in the specific industries who have the best understanding of the technology. In this way "the future is [already] here; its infrastructure is just unevenly distributed."[361] The examples throughout this paper indicate that there are a multitude of companies harnessing and capitalizing on the power of blockchain and Bitcoin. To be fair, the old school cypherpunks are the earliest users of blockchain and Bitcoin. However, some of the aforementioned businesses are truly industry pioneers. It is still early in the grand scheme of things and the challenges that await are multifaceted. Bitcoin and other digital assets have become increasingly accessible to the layman especially as of 2020-21. On the other hand, the concepts of blockchain or decentralized distributed systems are still foreign.

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[359] Fuessler, De León, Mok, et al. *Navigating Blockchain and Climate Action,* 87.
[360] Ibid.
[361] Tapscott, *Blockchain Revolution*, 615.

Most people who have heard of Bitcoin do not investigate its inner workings or controversial history and move onto the hottest coin on the market (thank you, Doge). Yet, thanks to the internet, education has also become widely accessible, and is available to the individuals with an appetite to learn. This is where a behavioral change would be an obstacle. As the existentialist Sartre is famous for saying, "Man is condemned to be free" and therefore responsible for everything he/she does. Whether you are of Sartian persuasion or not, with blockchain and Bitcoin comes ultimate personal freedom *and* never before seen responsibility and accountability as well. Many people still rely on banks, credit card companies, or equity firms to act as custodians for their assets and to deal with the nitty gritty of the financial world. Blockchain effectively eliminates banks and other intermediaries through obsolescence. This does not have to be a death sentence if they can pivot to be a part of the revolution as the overseers of digital wallet addresses and the respective keys. With no middleman to mediate participants on a blockchain network, they are solely responsible for their actions. Whether that be accountability and living up to promises of less carbon emissions or to hold their own private keys (passwords) to their digital wallets (bank accounts). Indeed, the finality of transactions can be a tough transition for people who will inevitably make mistakes. Such mistakes on a public chain could be devastating and the regulations surrounding such instances must be well thought out without compromising the security or integrity of the network/protocol. Greater autonomy requires greater discipline and responsibility. A lack of legal recourse is also of concern for parties engaging in smart contracts or erroneous transactions. Given the automatic nature of transaction verification and smart contract execution, once a decision is made, it will very likely be final. The mathematical certainty at which blockchains and smart contracts execute, leave

little margin for error.[362] Without careful consideration on building the protocol, blockchains could very well not leave any "...room for human beings."[363]

Another challenge, and perhaps the most consequential, has to do with legal and regulatory frameworks that will be introduced by governing entities. As with many things governing bodies deal with they must govern the unforeseeable.[364] Too much regulation and innovation suffers; too little and civil liberties could be abused by both criminals and governments. A stable approach to minimize regulatory uncertainty allowing innovation to flourish will be key.[365]

The principal/agent problem is a foreseeable issue. This arises when those who cannot afford the newest technological investments and must rely on those who can. What makes this a complex problem is that in a relationship of representative (agent) and dependents (principals), the former does not inherently act nor is incentivized to act in the expressed interest of the latter.[366] A typical example is the relationship between a government and its citizens. For all intended purposes governments are of the people, by the people and for the people. Incentives and actions often do not align. If blockchain technology is to bring true accountability to those holding political office/power perhaps the incumbents will be less than eager to introduce such mechanisms. Any reason that may bring public, immutable and undeniable failure or reveal negligence may threaten their political standing and future candidacy. Currently, it is easy for politicians to muddy the waters of discourse and present close to little substance on a varying array of issues.

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[362] Tapscott, *Blockchain Revolution*, 623.
[363] Ibid.
[364] Tapscott, *Blockchain Revolution*, 640.
[365] Ibid.
[366] Kuriyama and Managi, *Environmental Economics, 205.*

In conclusion, I present an overview of actionable items that can usher in a new, healthier, much needed relationship between humans and their surrounding environments. First, make an active choice to get involved in reshaping your relationship with the Earth. Then inform and inspire one another. Next, help by taking action to implement the philosophies of environmentally positive externalities, follow sound money principles, lower your time preference, and embrace technological innovation. Early innovators always seem a bit bizarre. Start with sustainability initiatives that are feasible and within the scope of home, community,or business. Get the ball rolling, meet others in your neighborhood or industry and cultivate those relationships. Join a community board of eco-friendly cohorts or even start your own! Leading the way to integrate a smart-city/locality is a momentous step forward in realizing the capability of existing and upcoming advancements. However, without an existing infrastructure, the intake or absorption of said innovation cannot set its roots. Thus, it is paramount to explore and urge your community leaders to have an appetite for systematic change and technological adoption. Once the components of community engagement, technological integration, and performance based goals are in operation, the positive feedback loop will be ready to go. If rebuilding existing relationships with our environments can be accomplished by local and business cooperation, government representatives will be compelled to work with regulators and other policy making entities to further environmental goals demanded by their constituents. In short, follow the steps below:

1. *Inform and Inspire the Public*
2. *Build an Environmentally Smart Community*
3. *Support and Participate in a Green Innovation Economy*

While the past decades have raised awareness and sought solutions, fundamentally little progress has been made. On the other hand, basic problems within existing systems have been exposed (Financial, Climate and Social Justice Crisis). The doomsday clock updated each year by The Bulletin of the Atomic Scientists visually represents (by estimation of The Bulletin considering the three main threats of climate change, nuclear disasters, and disruptive technologies) how close human civilization is to existential catastrophe. The closer the hands are to midnight, the sooner humanity reaches its demise. As of 2020, we are 100 seconds away from midnight. This is the closest we have been to midnight since its inception in 1947.[367]

In stark terms, the environmental health of the planet is in crisis and the effectiveness of current strategies and systems are inadequate. There are revolutionary tools available **now** to apply to the problems that have hampered past progress. To begin, we must as a species take stock of how and what we most value in our environments. Then we can assess how Bitcoin and blockchain align with and propagate the biotic *good* of the planet. A crucial component to success will be our willingness to take action. For this reason, the paper outlines the corrupt incentive structure of the fiat versus the sound money standard of Bitcoin. To quote billionaire investor Charlie Munger's famous words, "Show me the incentive and I will show you the outcomes." In the end, working towards eliminating negative environmental externalities will hinge not upon mandates or sole reliance on emerging technologies to save the day, but the persistent desire to do so from a moral and economical foundation. Bitcoin and blockchain technology are viable and can continue paving the way. Achieving true harmony in the proposed digital paradigm that bridges the gaps of ecology and humanity will require the greatest efforts of every individual and will undoubtedly test the strength of our commitment. Are you ready?

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[367] "This is your COVID wake-up call: It is 100 seconds to midnight," *Bulletin of the Atomic Scientists*, accessed May 8, 2021, https://thebulletin.org/doomsday-clock/.

It's more Yoda than God. But this new protocol, if not divine, does enable trusted collaboration to occur in a world that needs it, and that's a lot. Excited, we are.[368]

[368] Tapscott, *Blockchain Revolution*, 161.

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