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The Economic and Environmental Impact of Bitcoin

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ABSTRACT The controversies surrounding Bitcoin, one of the most frequently used and advertised cryptocurrency, are focused on identifying its qualities, the advantages and disadvantages of using it and, last but not least, its ability to survive over time and become a viable alternative to the traditional currency, taking into account the effects on the environment of the technology used to extract and trade it. Based on such considerations, this article aims to provide an overview of this cryptocurrency, from the perspective of conducting a systematic review of the literature dedicated to the economic and environmental impact of Bitcoin. Using peer-reviewed articles collected from academic databases, we aimed at synthesizing and critically evaluating the points of view in the scientific literature regarding the doctrinal source of the emergence of Bitcoin, the identity of this cryptocurrency from an economic point of view, following its implications on the economic and social environment. Subsequently, this research offers the opportunity of evaluating the level of knowledge considering the impact of Bitcoin mining process on the environment from the perspective of the energy consumption and CO_2 emissions, in order to finally analyze Bitcoin regulation and identify possible solutions to reduce the negative impact on the environment and beyond. The findings suggest that, despite high energy consumption and adverse environmental impact, Bitcoin continues to be an instrument used in the economic environment for a variety of purposes. Moreover, the trend of regulating it in various countries shows that the use of Bitcoin is beginning to gain some legitimacy, despite criticism against this cryptocurrency.

INDEX TERMS Bitcoin, cryptocurrency, environment, energy consumption.

I. INTRODUCTION

The last decade has been marked by the evolution of cryptocurrencies, which have captured the interest of the public through the offered opportunities and the feeling of freedom, resulting from decentralization and lack of authority to oversee how cryptocurrency transactions are conducted. The most popular cryptocurrency so far, Bitcoin, was put into circulation in the early 2009 by an anonymous entity, working under the pseudonym "Satoshi Nakamoto", after in 2008 the same entity presented the concept in a paper, stating that "a purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution." Reference [1] Bitcoin uses a database, making use of nodes, working "all at once with little coordination" in a peer-to-peer network for the purpose of inventorying transactions [1]. The purpose of using cryptography in the process of using Bitcoin is to provide the basic security features - Bitcoin can only be spent by the owner and this can be done only once [1]. Precisely because the existence and circulation of such a coin are closely linked to the existence and proper functioning of a network and of special devices, the issue of its impact on the environment has also recently arisen, especially in the context of discussions about sustainable development and the application of its specific objectives. Nowadays, sustainable development and climate change are among the major challenges that humanity is facing. Information and communication technology is a key factor in addressing these challenges, giving rise through its products to very serious controversies in both academia and business. While, on the one hand, technology can help reduce energy and resource consumption, on the other hand, its increasing use induces an increase in the demand for energy and resources, generating

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TABLE 1. Number of articles containing the terms "Bitcoin" plus "environmental impact", "economic impact" and "regulation" in the Scopus and Web of Science databases in the period 2016-2020.

	Bitcoin	Bitcoin environmental impact	Bitcoin economic impact	Bitcoin regulation
Scopus	4219	12	70	171
Web of Science	3098	12	57	152

Source: authors' processing by using the data provided by scopus.com and webofknowledge.com

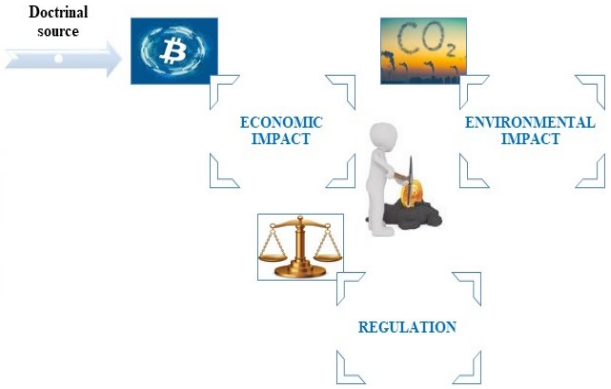

FIGURE 1. The impact of Bitcoin Source: author's processing.

all kinds of emissions into the atmosphere, in the context of the energy transition to a low-carbon society is on the agenda of decision-makers in the European Union [2] and beyond.

In this context, the growing interest in various cryptocurrencies has generated controversy in academia from debating what cryptocurrency actually is to issues related to the sustainability of the technology used to mine various cryptocurrencies. Articles written on this topic were dedicated to establishing the economic identity of Bitcoin [3]–[5], analyzing the factors that influence its volatility [6], the efficiency of Bitcoin [7], establishing the identity of its doctrinal affiliation and its advantages [8], [9] etc.

At present, the number of issues that can be discussed regarding Bitcoin is significant - from the issue of the parallel use of the official currency and the cryptocurrency, to the sustainability of the banking system compared to that of the cryptocurrency. The increase in the number of articles published on cryptocurrencies is visible. However, the number of articles dedicated to the economic and environmental impact of cryptocurrency and implicitly of Bitcoin is not impressive, as can be seen in table no. 1.

Based on such considerations, this article aims to provide an overview of the literature dedicated to Bitcoin's economic and environmental impact, as well as its regulation, which is very important for Bitcoin's present and future use. The need for this kind of research arise from the scarceness of existing studies that explore in a multidisciplinary way the issue of Bitcoin, starting from its doctrinal framework, highlighting the economic identity, presenting the impact on the environment and analyzing its legal implications, as one may notice in Figure 1.

In order to conduct this research we have systematically reviewed articles in the growing academic literature on a popular cryptocurrency - Bitcoin, and summarized the findings in three parallel lines of inquiry for scholars: economics, environment, and law. We used a two-step approach to identify the articles to be analyzed in order to answer the research question: What is the economic and environmental impact of Bitcoin?

In the first stage, the appropriate search terms were chosen to identify relevant online articles, book chapters and reports from international organizations. In the second stage, we used specific criteria to determine the inclusion in the analysis of articles, book chapters and reports. The selection of keywords was based on a preliminary review of the available literature. We initially did a Google Scholar search for the words ''economic and environmental impact of Bitcoin'', and the first 20 studies were briefly revised to identify other terms. Based on the review, it was established the need for separate searches for the ''Bitcoin economic impact'', the ''Bitcoin environmental impact'', as also the ''Bitcoin regulation''. To organize relevant research, we limited our search to those documents that were classified as articles from peer-reviewed journals, book chapters from prestigious publishing houses. There were also used reports and official documents from competent international bodies. We also applied an inclusion criterion for the language of publication and took into account only those documents published in English.

Section 2 provides a synthesis and critical evaluation of the points of view in the scientific literature on the doctrinal source of the emergence of Bitcoin and the establishment of the economic identity of this cryptocurrency, following the implications it has on the economic and social environment. Section 3 presents the impact on the environment of Bitcoin mining, targeting specific aspects of sustainability, as well as the implications that the use of Blockchain technology has on the business environment. In Section 4 the Bitcoin regulation is analyzed, in order to identify the geographical area in which Bitcoin can be legally used, but also to identify potential legal solutions to reduce its impact on the environment and beyond. The last section is dedicated to the conclusions.

II. THE ECONOMIC IMPACT OF BITCOIN

Since ancient times, philosophers such as Xenophon, Plato and Aristotle have tried to discern essential aspects of the value, form, functions and way in which money circulates in the market [8]. Studies have advanced with the times. No matter how much the dimensions or the terms of economic exchanges modify, the appearance and evolution of money reveal elements characteristic of the stages of human development. Thus, the issue of private money is brought back into public debate. Some schools of economic thought addressed the problem of private money, especially since the second half of the nineteenth century. Controversies related

to money and currency clearly reflect the need, opportunity, but also the possibility of monetary competition, which would ensure, from the perspective of entrepreneurs, the production of the most suitable money according to the expectations of the preferences of economic agents. Historically, it has been shown that humans have the ability to discover ways in which they can ''avoid'' prohibitions of various kinds, being able, including in the case of currency, to find alternatives to what the state offers (examples: TEM, Sano, M-PESA, QQ etc.)[8]. History shows us that human ingenuity has been decisive in providing an alternative and drawing competition between the official and private currencies, regardless of the level of education of individuals.

At the academic level, the problem of using private money has been raised since the nineteenth century, when Carl Menger showed that the origin of private money can be found in the behavior of the individual guided in economic actions of his own interest. Carl Menger pointed out that the exercise of monopoly over the management and issuance of currency was based on the alleged historical priority of the state, but also on legal-official confusion, as the exercise of money functions brought together economic, psychological and administrative interests [9].

Following the footsteps of the Austrian school of economic thought, we identify Friedrich August von Hayek, who in „Denationalization of Money: The Argument Refined'' introduced the controversial idea that free competition between private currency producers is the best way to obtain a healthy currency [10].

Moreover, F.A. von Hayek pointed out that the existence of a private currency can bring with it a number of advantages, which over time have been ignored, such as: ''(a) a money generally expected to preserve its purchasing power approximately constant would be in continuous demand so long as the people were free to use it, (b) with such a continuing demand depending on success in keeping the value of the currency constant one could trust the issuing hanks to make every effort to achieve this better than would any monopolist who runs no risk by depreciating his money, (c) the issuing institution could achieve this result by regulating the quantity of its issue, (d) such a regulation of the quantity of each currency would constitute the best of all practicable methods of regulating the quantity of media of exchange for all possible purposes'' [10].

Hayek's conviction has generated and still gives rise to serious criticism in academia.

Practically, in the history of economic thought of the last three centuries, there have been three recognized directions in approaching the problem of private money: the first seeks its origin in the behavior of the individual who is guided in his economic actions of his own interest (Carl Menger, Friedrich August von Hayek and other representatives of the Austrian school of economic thought), the second associates private money with the extension of the individual freedom of initiative (Milton Friedman), while the third establish private money as a privilege of a private bank (George Selgin) [9]. The last century has brought a new element - that of cryptocurrency, whose status can still not be underlined with certainty to fall into the category of private money, scientists still debating what it is from a doctrinal and economical point of view.

Fernandez-Villaverde started from contradicting Hayek and shows that private monetary agreements will not be, except in some special cases, socially optimal and cannot address any issue cheaper and better than in the case of use of money issued by the government. The preference for a private or public monetary arrangement will depend on the comparison of two relative evils: an inefficient market mechanism over an incompetent government [11]. Rahman also states that a purely private arrangement of digital currencies will not provide a socially efficient allocation [12].

There is a large debate in the literature about the nature of cryptocurrencies and their functions. If in ancient times, the coin was made of precious metals, and people trusted its intrinsic value, nowadays most countries use fiat money, which is backed by government guarantees. In contrast, in the case of cryptocurrencies, where the value is established by algorithms and verified by electronic data transfer, all transactions players are anonymous and the guarantee is not offered by any authority. In the case of fiat currency, everything around it is subjected to regulation and even if there is a security breach, the parties involved will be held liable and fiat currency users will receive compensation [13]. On the other hand, in the case of cryptocurrency, security is mainly of IT nature, the cryptocurrency market being a very dynamic one and subjected to the influences of several types of factors.

In 2018, there were over 1800 different types of cryptocurrencies in circulation [14]. According to the site coinmarketcap.com, on August 13, 2020 there were 6442 cryptocurrencies in circulation [15]. Some of the new cryptocurrencies manage to survive, others disappear after only a few days. The different characteristics of each cryptocurrency influence their prices and stability, as well as the relationships between them. Factors, such as market uncertainty, investor expectations can lead to significant fluctuations.

From an economic point of view, there are a number of controversies about what Bitcoin really is and what its functions are. Thus, some authors treat Bitcoin as a medium of exchange, others as a speculative investment. Corbet *et al.* start from the identification of cryptocurrencies as a financial asset [16]. Frisby emphasized that Bitcoin seems to possess the characteristics of money and even works better than the traditional currency [17]. Thus, durability, divisibility, portability, high liquidity and lower transaction costs make it attractive. Dyhrberg shows that we can treat Bitcoin from the perspective of gold, which can even be seen as a hybrid between a currency and a commodity [18]. If we want to look at Bitcoin as a currency, then we need to start with the generally accepted functions for money. The history of economic thought shows us that, even in this sense, over time, economists have not agreed on the number of functions that money performs. Jevons in his 1875 book ''Money and the

Mechanism of Exchange'' identifies four fundamental functions for money: exchange environment, common measure of value, standard of value, store of value [19]. Currently, economic theory is adapted to the evolution of modern times, therefore the functions of money have been updated. Kubát indicates, in addition to the classical functions, the informational function, the investment function, etc. [3]. Graham (1940) recognizes only two main functions of money: the unit of accounting and the bearer of options, showing that all other functions come from these primary function [20]. Based on these considerations, Kubát concludes that Bitcoin does not qualify to be considered money [3].

However, history shows that over time the most diverse elements have been used as money. In some religious communities in Catalonia, Valencia and the Balearic Islands (Spain), tokens called ''pellofes'' circulated between the fourteenth and nineteenth centuries as a means of payment. During the 19th century, in the United Kingdom, many communities far from major financial centers did not have enough gold coins or banknotes from the Bank of England [11]. A common response was the distribution of copper tokens with almost zero value, which circulated as money, even when His Majesty's government did not accept them for the payment of taxes. Later, during the Great Depression, so many local currencies emerged in the United States and Germany that they aroused great interest in famous economists such as Irving Fisher [11]. Similar to such tokens, cryptocurrencies can be seen as intrinsically worthless tokens, adopted by social convention, used as a memory of transactions. In fact, they are even more worthless than private banknotes, because a cryptocurrency is an electronic collection of digits like zero and one, not even having the residual value of the paper on which the banknotes are printed [11].

The European Central Bank considers Bitcoin to be a digital representation of value, which is not issued by a central bank, but can serve as a substitute for banknotes, coins, demand deposits and electronic money [21].

Some authors even claim that Bitcoin has the ability to become a universal currency [22]. On the other hand, the possibility of a new type of dual currency is introduced by Hong *et al.* [23], which mentions the coexistence of a digital currency without any intrinsic value and a fiat currency issued by the government. Dual currency regimes are often observed in emerging economies, where a foreign currency is officially used as a substitute for the internal one and it is often not easy to stimulate market participants to hold the national currency [23]. Lutz [24] discuss the pressure on central banks due to the existence of cryptocurrency, especially in times when central banks suffer from an image deficit, postulating that one currency cannot exist without the other and therefore cryptocurrencies and fiat currency will be uniform [24]. Seetharaman *et al.* [25] argue that Bitcoin will not be a coexisting currency in the long run due to regulatory hurdles, even if it has the ability to positively influence the world's currencies. Van Alstyne argues that in order to have value, Bitcoin must be supported by the government [26].

Selgin suggested that a digital currency can be created using an algorithm that replicates all the monetary rules specific to the economic literature [27]. However, Ammous demonstrated that a cryptocurrency cannot play the role of conventional money, although it can be successfully used as a means of exchange, but cannot be used as a unit of account due to the lack of a central authority to manage it, a fluctuating demand and an inflexible supply [22].

Yermack starts by showing that Bitcoin is not a currency since all cryptocurrencies have no intrinsic value [28]. Instead, Woo *et al.* show that Bitcoin can be considered as having the specific value of money thanks to its function as a mediator of exchange and keeper of value [29]. Ammous shows that a cryptocurrency can only gain credibility if it has the ability to prove to its users that supply will not grow surprisingly fast and will lead to the devaluation of the cryptocurrency [22].

It seems that so far Bitcoin has been the only such cryptocurrency capable of demonstrating low growth rates of the supply and controlling potential inflation [22]. Regarding Bitcoin, it is well known that it can be extracted in limited quantities, the extraction not following a logistical distribution, but a logarithmic increase [30].

According to specialized sites, in the second quarter of 2020, there were 18.42 million Bitcoins circulating, as one may notice in Figure 2. However, one must take into account the fact that not all of those 18.42 million of Bitcoins were really used, as in some cases, as related in the press (see, for examples articles from The New York Times, Wall Street Journal etc.), some of the users lost their private keys to the digital wallet.

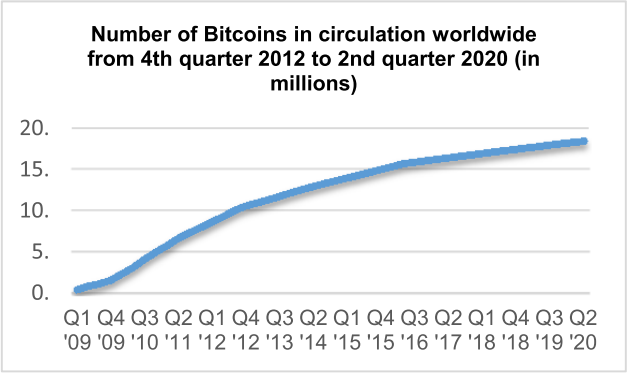

FIGURE 2. The amount of extracted Bitcoins Source: blockchain.info.

Vlasov sees Bitcoin as the next stage in the process of money evolution - an electronic currency in no way connected to the objects of the material world [31]. Others argue that Bitcoin has been turned into an element of speculation rather than functioning as money [32]. Bal shows that Bitcoin does not currently fulfill the specific functions of money in the classical economic sense, but that it has the potential to turn into money in the future [5]. Dyhrberg argues that Bitcoin is somewhere between a currency and a commodity, due to its decentralized nature and limited market size, which

does not mean that Bitcoin is less useful than current market assets [18]. As one may notice, the controversies are surrounding the economic nature of this cryptocurrency. In the academic world and even in the legal one, this subject still needs clarifications. For instance, there is another way to look at Bitcoin. Because it has an economic value, it can be considered a ''digital asset'' in which the computing power is the one that determines the rarity and market value [33].

Selgin showed that the acceptance rate of Bitcoin has been constantly increasing, due to the involvement of traders, who have accepted the payment of products or services in cryptocurrency. As early as 2014, more than 75,000 U.S. merchants, including the largest, accepted Bitcoin, which also proved to be a preferred medium for remittances from workers abroad [27]. Selgin underlined the fact that in 2012, ''the number of Bitcoin accepting merchants then had reached about one thousand, and that it was likely to reach ten thousand in another year.'' [27] He tried to emphasize the rhythm of the growing number of the merchants accepting this cryptocurrency. Nowadays, according to specialized sites, as 99bitcoins.com, one may observe the fact that 36% of small and medium businesses in the United States of America accepted payments with Bitcoin in 2020. The same site (www. 99bitcoins.com) enumerates among those accepting Bitcoin some very well-known major companies such as: Microsoft, Burger-King, AT&T, Wikipedia, KFC, PizzaHut, Overstock etc., emphasizing that ''today it's possible to buy almost anything with Bitcoin through the use of Bitcoin debit cards'', which are issued by Visa or Mastercard. There are some cases in which Bitcoin payments are accepted directly and others in which are indirectly accepted.

The list may be completed by adding Wordpress.com, Reddit, Dell, Target, Expedia, Bloomberg, PayPal, and Tesla Motors. Dell accepts direct Bitcoin payments, but Amazon instead offers digital gift cards, which can be purchased with Bitcoin and then used to purchase goods from their website [34]. Moreover, in Cyprus, Canada, Romania, etc. ATMs have been installed, through which real currency can be converted into Bitcoin [8]. A research conducted in 2018 indicated the existence of a number of 2098 Bitcoin ATMs and altcoins in 62 countries [35]. Compared to the total number of ATMs existing on the Globe (according to The World Bank – more than 3.5 million in 2020), 2098 does not represent a significant amount, but it shows that even in this segment the existence and use of cryptocurrencies is starting to be visible. Almost 60% of these ATMs were located in the USA, while 96% of all ATMs are in North America and Europe [35]. The number of ATMs in Asia is only 2.4% [36].

Kristoufek shows that, despite the general opinion that the Bitcoin market is chaotic and irrational, the Bitcoin system behaves like a standard market in which market forces are normally manifested [37].

A series of research aimed at establishing the possibility of Bitcoin to survive in the long run, start from identifying

TABLE 2. Swot analysis of bitcoin using in economy.

ADVANTAGES OF USING BITCOIN	DISADVANTAGES OF USING BITCOIN
✓ Bitcoin saves the time and physical space of those involved in transactions, using the virtual environment ✓ It is not controlled by any authority, being able to circulate freely, directly between people, without intermediaries imposing transaction costs similar to commissions charged by banks. However, there are charged some miners fees. ✓ It does not involve the payment of commissions that banks usually charge ✓ The price of Bitcoin results from the confrontation of demand with supply ✓ It does not involve bureaucracy in any of the stages of obtaining or using ✓ Because it exists in limited quantities, it does not generate inflation ✓ It meets the requirements of the "IT generation". ✓ Bitcoin illustrates the free market model that spontaneously self-orders ✓ It maintains the anonymity of economic operators that carry out transactions and are interested in this issue. ✓ It is compatible with the globalization of financial markets ✓ The number of traders accepting Bitcoin is growing ✓ It creates the impression of freedom, not implying the existence of a central authority	- Increased volatility in all markets - Representatives of several banks around the world believe that investing in Bitcoin is risky - High environmental costs, generated by electricity consumption and CO_2 emissions - Increased vulnerability generated by the use of the online environment, in which security breaches can also occur - Lack of an institution/central bank to protect users in case of speculative attacks - Accessibility conditioned by a level of training compatible with new communication technologies - Limited trust, due to use in illegal activities - cryptocurrency in general can encourage gambling, tax evasion, terrorism, transactions with goods prohibited by law (drugs, weapons), money laundering, etc. - Lack of intrinsic value for correlation with the price of traded goods and services - Prohibition of the use of Bitcoin in certain countries
OPPORTUNITIES	**THREATS**
▪ The use of Bitcoin-based technology can lead to unsuspected performance in the virtual environment, associated with different areas of activity ▪ It stimulates older generations to adapt to new technologies ▪ It is not related to issues of a patriotic nature, anthem or state, without thus arousing disputes of a nationalist nature ▪ The number of those who accept BTC is increasing all over the world - restaurants, cafes, shops, universities, etc. ▪ Unlike traditional currency, Bitcoin has no material basis, therefore it does not require a	▪ Authorities publicly expressed concern about the possibility of using cryptocurrencies for money laundering and other illegal activities ▪ Losses suffered by states due to non-taxation of transactions / use in illegal activities with Bitcoin may lead in time to a ban on its use ▪ High costs for purchasing the technology needed to obtain Bitcoin ▪ The attraction to using Bitcoin is a sufficient cause for concern for traditional, conservative and rigid markets. ▪ The pressure exerted by the followers of the classical monetary canons, especially

TABLE 2. *(Continued.)* **Swot analysis of bitcoin using in economy.**

very elaborate process for issuing money ▪ Being still unregulated in many countries, it leaves the impression of a real freedom	in the direction of Bitcoin recognition through a political act of the state ▪ Lack of intrinsic value for correlation with the price of traded goods and services ▪ Human errors, like losing the password, losing the memory etc. ▪ Cyber risks

Source: authors' processing after [8] and [9]

the advantages and disadvantages of Bitcoin [8] or from conducting a SWOT analysis [9]. If we look closely at the table below, we will see that both the advantages and disadvantages deserve further study.

Demir *et al.* [38] examine the relationship between Bitcoin and the uncertainty index of economic policy and conclude that it can be used as a tool to protect against uncertainty. At the same time, some papers point out that speculative bubbles and the low intrinsic value of cryptocurrencies bring uncertainty and reduce price stability. Glaser *et al.* consider that media reports also play an important role in influencing the volatility of cryptocurrency prices [39]. Regarding stability, it seems that there are authors who claim that the lack of a central bank to manage the supply of cryptocurrency is a real disadvantage, depriving cryptocurrency of stability [22]. Bitcoin exchange rate volatility is a challenge, along with lack of liquidity, functioning in an informal market with high security risks, lack of market regulations and government control [27].

As one may notice in Figure 3, the evolution of the Bitcoin – USD exchange rate shows us that it is a very fluctuating one. If on March 15, 2020 one Bitcoin was worth 5355 USD, on April 15, 2020 it was quoted at 6887 USD, on July 15 9260 USD, and on August 15 it was 11752 USD [40].

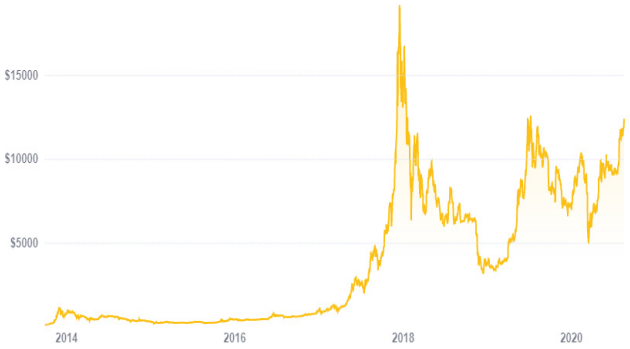

FIGURE 3. **The evolution of the Bitcoin - USD exchange rate Source: coindesk.com.**

When Malone and O'Dwyer address the issue of Bitcoin, they start by examining its profitability and come to the conclusion that while the Bitcoin exchange rate is decided by those who use it, it is also related to the price of electricity and how it is used [41]. It counts the competition in the system, which targets not only the visible part of transactions, but also the problem of developing more energy-efficient hardware to be financially viable [41].

Corbet *et al.* examine the relationship between three popular cryptocurrencies (Bitcoin, Ripple and Litecoin) and other traditional financial assets (gold, bonds and others), showing that the three cryptocurrencies are relatively isolated of other financial assets and therefore they can be used to diversify investor risks [16]. Yi *et al.* studied the mechanism of transmission of volatility fluctuations among a number of eight cryptocurrencies and showed that it is almost invisible, being closely related to market imperfections or investor behaviors and feelings [42].

Darlington formulated an interesting hypothesis, namely that Bitcoin offers an advantage to people living in underdeveloped economies and facing problems, because it solves the problems resulting from hyperinflation, exchange and counterfeiting [43].

At the same time, the fact that Bitcoin ensures an almost perfect anonymity of transactions, has placed it over time in the area of facilitators of illegal transactions, with drugs or other goods and services prohibited by law [44]. Therefore, some experts fear that virtual currencies could gradually become criminal currencies [45] and for this reason, a special place should be allocated to the issue of cryptocurrency regulation. Moreover, the problem of regulation also arises in the case of potential attacks on the network itself. Barber *et al.* [46] show that the theft of Bitcoins can occur in the network. Moore and Christin analyze the attacks on Bitcoin exchanges [47]. Kroll *et al.* highlight a network attack scenario, by controlling over 50% of mining power [48]. This particular issue will be widely discussed in the penultimate section of this paper.

Beyond determining whether or not the cryptocurrency falls into the category of private money that may or may not survive the market test in the medium and long term, there is a pragmatic problem related to the increased interest shown by individuals in the process of obtaining and using cryptocurrency - is this sustainable or not?

III. THE ENVIRONMENTAL IMPACT OF BITCOIN

Considering the fact that cryptocurrencies are defined as „a peer-to-peer version of electronic cash, which allow online payments to be sent directly from one party to another without going through a financial institution''[49], it can be easily noticed that in obtaining and using any cryptocurrency, and implicitly Bitcoin, there are used resources that require electricity consumption. Given the concerted efforts to reduce global greenhouse gas emissions under the Paris Agreement, the information and communications industry (ICT) has received little attention as a significant contributor to the deterioration of environmental conditions [50]. Under the Paris Agreement, which took place in December 2015, 196 countries approved a global plan to reduce climate change in the coming years, proposing to limit global warming to below 2 degrees C [50].

Lately, the concerns about the energy consumption required for Bitcoin mining have begun to grow. Concerns about CO_2 and natural gas emissions due to the exploitation of Bitcoin cannot be overlooked. PoW and PoW / PoS hybrid schemes are currently used for Bitcoin mining [51]. All calculations of the hybrid PoW and PoW / PoS schemes, including Bitcoin process of mining and system maintenance, are complemented by energy-intensive electronic devices. The high computing power required by the Bitcoin network initially involved the use of CPU and GPU (2009-2011), FPGA (2011-2013) and later they reached ASICs (since 2013) [52].

There are currently developed two tools for estimating electricity consumption by the Bitcoin network:

- Cambridge Bitcoin Electricity Consumption Index (CBECI), developed recently by the University of Cambridge
- Bitcoin Energy Consumption Index (BECI) realized by Digiconomist.

On September 30, 2019, according to the two indexes, the network annually consumed between 73.1 [53] and 78.3 terawatt-hours (TWh) [54] of electricity [55]. However, de Vries pointed out that based on an analysis of Bitcoin miners' sales, it can be estimated that, in fact, the Bitcoin network consumed 87.1 TWh annually on September 30, 2019, exceeding estimates made based on the two indexes and approaching energy consumption of a country like Belgium [55]. We cannot say that currently there were discovered exact means by which energy consumption can be concretely measured, but there are some instruments that can be used to approximate it [56].

However, it should be borne in mind that estimates vary considerably depending on several factors, including hardware efficiency and electricity prices used in the process [57]. For the years 2016, 2017 and 2018, Krause and Tolaymat reported estimates of 283 MW, 948 MW and 3441 MW [57]. For 2017, the study conducted by Dilek and Furuncu shows that except for a few countries on the African continent compared to which Bitcoin uses more energy, Bitcoin's energy consumption accounted for about 13% of Turkey's electricity consumption [35].

Some studies conducted in 2018 showed a total electricity consumption of the grid that equaled that of some developed countries and areas, such as Ireland, Hong Kong and even Austria [58]. Küfeoğlu and Özkuran show that in the first half of 2018, the estimated minimum energy demand for the Bitcoin mining process was between 1.34 and 2.80 GW, while the maximum demand was between 5.14 and 13.82 GW [59]. In June 2018, the annual energy consumption was between 15.47 (minimum) and 50.24 TWh (maximum) [59].

Such estimates have attracted the attention not only in the case of scientists, but also of international bodies, such as the European Commission, which has stated that it will monitor energy consumption without using its own tool in this regard [55]. Moreover, there is research, such as that conducted by Citigroup, which claims that if all the amount of electricity needed for the network and transactions with Bitcoin continues to grow, it is possible that the Bitcoin system will collapse [35]. However, we must keep in mind that de Vries shows that miners are more concerned with the size of the profits that can be obtained than energy efficiency. He predicts that as more people interested in profits enter this industry, energy use will increase considerably [55].

At the same time, there have been a number of speculations about the source of fuel used by Bitcoin network, and some of them lead us to Chinese coal, Icelandic geothermal energy and Venezuelan subsidies [60]. The Bitcoin industry is facing a fierce competition. For example, the Swedish company KnCminer has positioned its Bitcoin mining centers at the Arctic Circle to benefit from the local hydropower and cold air at extremely low costs; however, it went bankrupt in the mid-2016 [61]. A study conducted by Cambridge University showed that 58% of Bitcoin mining is done in China, followed by the USA with 16% [35]. Mining is done in China, because here electricity is cheaper; Bitcoin centers in China continue to depend mostly on coal for the consumed energy [62]. The largest such center is situated in Inner Mongolia, an autonomous area of China, with cheap electricity [35].

Kamiya (2019) estimates that China is the country where 60% to 70% of the total of Bitcoins is mined, but mining centers are located in remote areas of China, with resources that are rich in hydropower or wind energy, thus being cheaper [63]. Therefore, we note that in order to maximize their profits, miners prefer geographical areas where electricity is cheaper. We can therefore consider that the exploitation of cryptocurrencies is related for economic reasons to the geographical position of the mining site.

The figures accompanying Bitcoin transactions are worrying not only from the perspective of electricity consumption, but also from the perspective of greenhouse gas emissions. There are rumors that all cryptocurrencies would ''pose a serious threat to the global commitment to mitigate greenhouse gas emissions under the Paris Agreement''[64], especially in the context of gloomy forecasts stating that ''Bitcoin emissions alone could push global warming above 2°C'' [65]. However, Masanet *et al.* [66] show that the analysis made by Mora *et al.* [65], which predicts that Bitcoin mining may lead to an increase in global warming by more than 2°C in the next 11-22 years, is not entirely plausible. The effects of Bitcoin processes, however, are visible. Stoll *et al.* emphasized that the carbon footprint generated by Bitcoin mining ''sits between the levels produced by the nations of Jordan and Sri Lanka, which is comparable to the level of Kansas City''[67].

Li *et al.* show that beyond Bitcoin mining, carbon emissions also result from the activity of obtaining other cryptocurrencies, such as Monero, for which they estimated a consumption of 645.62 GWh of electricity in 2018. Li *et al.* showed that if a mining activity of 4.7% takes place in China, the consumption is at least 30.34 GWh, contributing to a carbon emission of 19.12-19.42 thousand tons [56].

Moreover, Loviscach proposed two fundamental aspects that must be taken into account in assessing the impact of Bitcoin on the environment: (a) computer power consumption (expressed in kWh) for computing, networking and cooling; (b) disposal of electronic waste produced [68]. Starting from the fact that the mining equipment used to obtain Bitcoin becomes obsolete in about 1.5 years, leaving only those that prove to be economically viable remaining viable, we should also consider how they turn into electronic waste [69], the amount of which is comparable to the total electronic waste generated by a country such as Luxembourg (12 kt) [70].

Let us not forget at the same time that air pollution harms the environment, generates costs to the economy, but also leads to the loss of human lives. It is estimated that air pollution leads to around 3 million deaths worldwide each year. In 2016, it generated 7.6% of the total deaths [71].

There are studies that follow the gain generated by Bitcoin in close connection with the issue of sustainability. Thus, Hayes assumed that Bitcoin mining would stop in the specific economic situation in which the marginal cost of Bitcoin mining would exceed the price of Bitcoin [72]. Stephen shows that Bitcoin will turn into a disaster due to the cost of the extraction process that consumes daily electricity worthing over 150,000 USD [73]. The empirical results obtained by Das and Dutta indicate the energy costs as the Achilles heel for Bitcoin miners' incomes when their incomes are low and volatile [74]. Goodkind *et al.* estimated that in the case of the year 2018 ''each 1USD of Bitcoin value created was responsible for 0.49USD in health and climate damages in the US and 0.37USD in China'' [75].

Malfuzi *et al.* highlights the declining trend of marginal costs for renewable energy production compared to marginal costs of fossil fuel energy production, which may cause miners to move to renewable energy [76]. Krause and Tolaymat estimated for the period January 1, 2016 - June 30, 2018, that Bitcoin, Ethereum, Litecoin and Monero mining consumed on average 17, 7, 7 and 14 MJ to generate one USD, while conventional aluminum extraction, copper, gold, platinum and rare oxides consumed 122, 4, 5, 7 and 9 MJ to generate one USD, which draws our attention to the cost-benefit analysis [57]. The same study shows that mining for all 4 cryptocurrencies was responsible for an amount of 3-15 million tons of CO_2 emissions [57].

A more important element is that by 2028, 98.44% of the total of Bitcoins will be extracted, which means that the discussion about the energy consumption generated by the process of Bitcoin mining will be valid until then [59].

Despite the environmental costs outlined above, Bitcoin appears to remain an economically viable alternative to the official currency, according to McCook, who estimated the environmental costs of Bitcoin mining to be lower than the costs of issuing paper money, gold mining and banking systems, as can be seen in the table no. 3 [77]. McCook's study considered only energy consumption compared to other systems, excluding gold mining, warehousing and transportation, and the construction of about 600,000 bank branches worldwide that employ about 7 million people, including only operational energy used [77].

TABLE 3. Cost comparison.

Gold mining & recycling	gross yearly cost: USD$105 billion+USD$40 billion
	energy used (GJ): 475 million + 25 million
	tonnes CO_2 produced: 54 million + 4 million
Paper currency & minting	gross yearly cost: USD$28 billion
	energy used (GJ): 39.6 million
	tonnes CO_2 produced: 6.7 million
Banking system	gross yearly cost: USD$63.8 billion (for electricity use); USD$1870 billion (all expenses)
	energy used (GJ): 2340 million
	tonnes co_2 produced: 390 million
Bitcoin mining	gross yearly cost: USD$0.375 billion
	energy used (GJ): 3.97 million
	tonnes CO_2 produced: 0.66 million

Source: authors' adaptation after [77]

However, when comparing the system using Bitcoin with the banking system, one must take into account the fact that the offered services are not identical and the fact that unlike fiat money, Bitcoin needs special conditions to be used, meaning that its existence is conditioned by the using of technology. One cannot use Bitcoin if one do not have an Internet connection and a special device, such as a smartphone, a laptop etc.

In the same spirit, Cocco *et al.* [78] emphasizes that the social and economic impact of cryptocurrencies is much smaller than that of traditional financial systems. Their study starts from the premise that periodically in order to guarantee quality standards for banknotes in circulation, used banknotes are crushed, so that, to all operating costs specific to the banking system, are added the production costs of coins and banknotes, but also their destruction. Instead, systems based on Blockchain technology only need to connect to the network, without having to bear additional costs such as those generated by ATMs, large numbers of employees or waste produced, for example by using paper and toner for printers [79]. At the same time, a research conducted by the CoolClimate Network from the University of California, Berkeley and cited by Cocco *et al.* estimated the impact of the banking sector and showed that it is worth 383.1 million tonnes of CO_2 / year for bank branches and 3.2 million tonnes

of CO_2 / year for ATMs. In addition, energy consumption is 2.3 billion GJ for bank branches and 18.9 million GJ for ATMs [78]. Therefore, the Bitcoin system is less harmful to the environment, if we were to compare the 0.75 million tons of CO_2 produced per year by Bitcoin with the approx. 387 million tons of CO_2 produced by the banking sector. Therefore, Blockchain technology could be adopted in the banking system [78].

There are also studies that compare the environmental impact of Bitcoin with that of the VISA system. However, Imran considers it inappropriate to compare the energy consumption of VISA per transaction with that of Bitcoin, because while VISA uses this energy specifically for the mentioned transactions, the energy consumption of Bitcoin is used to protect all transactions with dates from 2010 [80].

Baur and Oll show that there is a viable technical solution to avoid Bitcoin's negative impact on the environment. They start from the premise that Bitcoin miners could use more and more renewable energy sources, such as hydrogen or solar energy, which could turn the Bitcoin network into a more sustainable one [81].

In principle, we can discuss several ways in which Bitcoin can be transformed into something that meets the principles of sustainability both from the perspective of environmental implications and from an economic perspective. Derks *et al.* shows, however, that none of the possibilities seem realistic [82]. Truby proposes a regulatory-oriented approach, especially by imposing fiscal measures to limit the energy consumption of the Blockchain and thus its environmental implications [64]. Ziolo *et al.* show that environmental taxes have proven over time to be an effective tool for mitigating greenhouse gas emissions, especially in the case of developed countries [83]. The issue of Bitcoin regulation in the sense of reducing its impact on the environment will be addressed in section 4 of this paper.

Beyond all the disadvantages that the process of obtaining and using cryptocurrencies generates for the environment, Blockchain technology can be a support solution in the fight to maintain an unpolluted environment. Blockchain technology is considered a promising solution to address the challenges of the modern electricity distribution system, providing a reliable environment for participants with faster and more transparent operations [84]. This technology, which was first used in 2008 in the case of Bitcoin [1] has developed and has been used over time for financial services, real estate, healthcare and business [85].

Car manufacturers, their component suppliers, technology manufacturers, battery suppliers, other equipment manufacturers can find in Blockchain technology a lasting support for their problems, as it can be used in various fields successfully, even in the sense of environmental protection. It all depends on the people who implement it. Thus, in the summer of 2017, the Massachusetts Institute of Technology awarded, in addition to diplomas in standard format, a group of 111 graduates' electronic diplomas to certify their authenticity for employers using Blockchain [86]. As the issue of falsification of diplomas is not negligible and many countries face it, the major universities in China and India are considering introducing similar approaches. In Sweden and Brazil, land rights are registered based on Blockchain technology [86]. Blockchain technology can contribute to building smart cities by developing common economic services [87]. Blockchain can be used in healthcare to store large medical documents of people that can be accessed by doctors and patients from anywhere in the world, which could save time and save many lives in medical emergencies [88].

Adjeleian *et al.* highlighted that the application of the Blockchain could provide more people with access to renewable energy and lead to the resizing of the renewable energy market [89]. However, the spread of Blockchain technology is difficult to be applied in countries with a population with a low level of education and poor infrastructure [90]. Morice *et al.* concluded that in the context of zero CO_2 emissions by 2070 the implementation of Blockchain technology can help keep global warming in the range of $+0.3 - 0.5°C$ ($4 - 8°F$) above pre-industrial temperature [91]. Implementing this technology in the next decade (by 2030) may reduce global warming to 0.3°C (4°F) by 2050. A reduction of $0.1 - 0.2°C$ could result from the elimination of paper use in the financial world [92].

The study conducted by Taskinsoy starts from the premise that if paper money could be removed from global circulation, being replaced with cryptocurrencies, approximately one billion trees could be saved from deforestation and these trees would be allowed to continue absorbing CO_2 through photosynthesis [92].

However, Blockchain technology, which can be successfully used sustainably in various areas of activity, cannot guarantee the success of Bitcoin mining so that the environment will suffer less. Let's not forget that, beyond all the effects already mentioned in the case of obtaining Bitcoin, there are voices in the literature that indicate other dangers. Thus, mining has been found to have a major impact on local communities due to the high energy consumption of mining and illegal mining operations in some residential neighborhoods [93].

It is already well known that miners have settled in areas known for cheap energy. As crypto-mining operations began to consume a large amount of energy in a district, energy surplus exports declined, significantly increasing the price of electricity [93]. Moreover, a 2018 study shows that the high demand for electricity resulting from Bitcoin mining has overwhelmed the capacity of public utility districts, threatening the capacity of the district's electricity grid infrastructure and causing a number of safety issues [94]. Mining operations endanger both the building in which the miners are located and the neighboring buildings, as there is a risk of fire generated by overloading the electricity network, which was sized for domestic consumption, not to support multiple high-performance servers [94].

Another issue that needs to be discussed is the use of renewable energy. Bitcoin defenders raise the issue of its

exclusive use so that the impact on the environment to be as insignificant as possible. However, the literature shows that there are several visions in this regard. Thus, some argue that if miners start using exclusively renewable energy, mining could help subsidize the introduction of renewable energy resources, as nowadays there is an estimated that 77.6% of crypto-mining facilities are using electricity from renewable sources, while the rest use fossil fuels and nuclear energy [95]. However, we have to think that it is very difficult to verify these figures due to the anonymous nature of the mining process. The second view starts from an old economic problem, that of the self-interest, and shows miners are not interested in altruistic behavior - they will use the cheapest energy available regardless of the impact on the environment [93].

De Vries has an international vision of the energy consumption of the Bitcoin network and its ecological implications and concludes that these problems will not be solved only by applying renewable energy and that the only way forward is to change the PoW algorithm with ''Proof of Stake'' [70].

Therefore, we note that the environmental problems generated by crypto-mining operations are not to be neglected. That is why this issue should be given more attention from all members of society, starting with those who have decision-making and regulatory power and reaching the average citizen, who should be concerned about sustainability issues.

IV. BITCOIN REGULATION

The problem of the legal classification of Bitcoin has been and still is a challenge, but beyond that, some states have realized that they can benefit from the popularity of Bitcoin, completing their budget by taxing transactions with Bitcoin (e.g. Germany, Brazil, Canada, Bulgaria etc.). Currently, on the regulation of cryptocurrencies, there are several proposals - liberal, conservative or repressive and waiting models [96]. Within the liberal and conservative regulatory models, the law establish the taxation of transactions made with cryptocurrency, which aims to increase state budget revenues and try to avoid financial flows in the world of cybercrime.

Starting from the difficulty of accurately classifying Bitcoin in the category of money, financial assets, etc., there is also an increased difficulty when it comes to regulating it. European experience with legislation shows that at EU level, unitary regulation has not been addressed so far. Different countries, however, have decided to approach the issue from their own perspective. Thus, German law does not recognize Bitcoin as a legal means of payment or foreign currency, but considers that it meets only the criteria of ''accounting unit''[97]. Germany charges a 25% tax on capital gains in the case of Bitcoin, but this is only required if the income was obtained within one year from the receiving of Bitcoin [98].

In Bulgaria, the National Revenue Management Agency has decided that revenues from the sale of digital currencies, such as Bitcoin, should be treated as revenues from the sale of financial assets and taxed at a rate of 10% [97].

The Czech government has introduced a law requiring the identification of customers' identities when virtual currency exchanges are taking place, proposing the application of a value added tax (VAT) to virtual currencies [97].

In Denmark, the Financial Supervisory Authority has announced that companies' transactions with Bitcoin will be taxed normally and individuals will not be subject to taxation. Slovenia established in 2013 that Bitcoin is neither a financial asset nor a currency and should be taxed according to the circumstances in which it is used - for trading or mining profits [97].

In Romania, Law no. 30/2019 introduced a tax, expressly defined, on the sale of virtual currencies, such as Bitcoin and Ethereum, by amending the Fiscal Code. Thus, earnings from cryptocurrency transfers are considered income from other sources, which, if they exceed a certain annual limit, are taxed [98].

In the case of the United States, Bitcoin is recognized as one of the types of payment in e-commerce. Bitcoin is accepted for payment in many restaurants, hotels and stores in many states. There are US states where the environment is conducive to the heavy use of Bitcoin, such as: Texas, Kansas, Tennessee, South Carolina and Montana, while New York, New Hampshire, Connecticut, Hawaii, Georgia, North Carolina, Washington and New Mexico have more restrictive regulations [99]. For example, in New York, in August 2015, the Department of Financial Services introduced the need to obtain Bitlicense to enter the cryptocurrency business. In April 2017, Japan legalized cryptocurrency as a form of payment, which is why interest in Bitcoin continued to grow steadily in the country [99]. At the end of 2013, the People's Bank of China banned financial institutions from transacting with Bitcoin, but individuals are free to use cryptocurrency. Bitcoin is considered illegal in: Russia, Vietnam, Bolivia, Ecuador, Colombia, Saudi Arabia and Northern Africa [100].

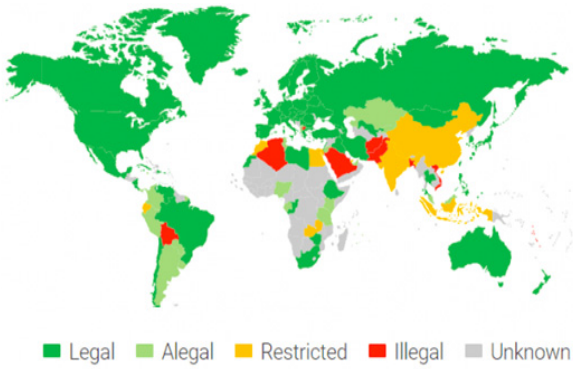

FIGURE 4. Legality of Bitcoin Source: [101].

Some believe that regulation will bring a more stable exchange rate and will increase the level of trust in Bitcoin [102]. Lim argues that regulation should not be anti-industry; its role is to reduce the uncertainty specific to

Bitcoin and to increase the legitimacy of its use [103]. It shows that there is a problem with the principle of territoriality; since the transactions are carried out in the virtual environment, the law of which state will apply when the trading parties come from different states? [103]

Moreover, the Bitcoin market behaves like any other market, in which the tendency to increase the degree of concentration exists. Regardless of the decentralized nature of the Bitcoin blockchain, the four largest Chinese pools offer about 50% of the total hash rate, and Bitmain operates three of these four pools [67]. In addition, PoW, the first Blockchain public consensus mechanism, becomes vulnerable if a participant has at least 51% of the computing power of the Blockchain network [104] because it can solve the puzzle faster than others, and thus monopolizing the rights to validate the new data blocks. This is where the problem of finding legal means to operate in such a way as to ensure fair competition in this market arises.

Attempts to use cryptocurrency to trade illegal goods and services have already been found [105], requiring the intervention of competent bodies. Beyond such issues, there is the issue of regulation from the perspective of the impact that the mining process has on the environment. We must keep in mind that there are currently several thousand cryptocurrencies, whose mining process requires electricity. Studies have focused mainly on electricity consumption and CO_2 emissions in the case of Bitcoin, but we must not forget that in addition to this, there are other cryptocurrencies that, although not as popular, have an impact on the environment. Currently, there is no clearly enacted legislation that specifically provides for this issue. The size of carbon emissions, combined with the risk of collusion and concerns about control over the monetary system, could justify regulation [67].

One of the proposed solutions for determining those involved to find new ways to pollute less the environment could be to apply the ''polluter pays'' principle. Within the EU, this principle is enshrined in Article 191 (2) of the Treaty on the Functioning of the European Union, while the Organization for Economic Co-operation and Development has long been a supporter of this principle [106]. In ''Choices on the Road to Clean Energy Future'', Cash shows that economic performance can be achieved in accordance with the environment only where smart government regulation provides clarity, certainty and well-applied rules [107]. Thus, carbon credits could be used [84]. Carbon emitters must measure their carbon emissions and purchase equivalent credits from emission reduction projects using smart contracts. Nasdaq was the first global stock exchange to examine the application of Blockchain technologies to carbon trading [108]. In addition, these carbon emitters also send money to finance global emission reduction projects, also using Blockchain technology [84]. In addition, the governments of the world's countries should encourage the use of environmentally friendly technology through various means.

V. CONCLUSION

Our research highlights the implications and challenges that Bitcoin faces in the economic environment and beyond. In general, this research serves as a basic study, as it provides the opportunity to assess the level of knowledge about the impact that Bitcoin has on the environment, sounding the alarm on the negative aspects that accompany the mining process, reason for which we advocate for finding green solutions.

In addition, we want also to emphasize the limitations of our research, which are related to the thorough investigation of the externalities generated and the various methods by which they can be internalized. More extensive studies can be conducted in the future to look at such issues, as well as the issue of the perception of certain categories of individuals on the use of Bitcoin as a potential monetary alternative to the traditional currency. Another limitation of this paper refers to the analyzed articles, as only articles written in English were used in the research. The analysis of other articles written in other languages may be of interest to complete the conclusions of this study. In addition, the systematic approach used to conduct this study and the selection of articles were subjective.

We know that Bitcoin is the result of spontaneous and voluntary action of individuals, not being generated by a decision of a legal authority [9]. What is certain is the fact that Bitcoin has created unique challenges for both academia and practitioners. At its inception, Bitcoin seemed to promise a lot, to be seen by some economists as a kind of Holy Grail, to ensure full freedom of transactions. Although Bitcoin has opened up a whole new world, the uncertainty accompanying it and its disadvantages seem to erode Bitcoin's success.

From an economic point of view, a common denominator has not yet been reached regarding its identity, as it has not yet been concretely classified as a currency through legislation, despite the fact that it is accepted by various economic agents as a means of payment. But, we should not forget all the functions of a currency! The fact that over time currencies which are similar to Bitcoin have appeared in a physical or virtual environment and have circulated in parallel with the traditional currency supported by the state, shows that individuals have expressed a desire to escape from the ''magnifying glass'' of authority or benefit from freedom. Often, the competition between the currencies that Hayek wrote about was the one that led to their disappearance, the market maintaining only that particular currency in which individuals had the greatest confidence. In some cases, it was the law that banned the circulation of a parallel currency.

However, Bitcoin advocates should pay attention to sustainability issues and the environmental impact of the mining process. The carbon footprint that cryptocurrencies generate should raise the issue of externalities for governments. Although no perfect solution has been discovered so far, we are aware of the fact that there are certainly options for internalizing such negative externalities.

The sustainability of Bitcoin depends, as seen, on a number of environmental, economic, social and ideological factors. What is certain is that, despite the impact that Bitcoin through the consumption of energy used has on the environment, it still circulates and is still used, indicating the appetite of a certain category of individuals for an instrument involving the lack of state intervention. A question arises: when Bitcoin will be regulated in the states of the world, will there be the same preference of libertarians to use it and identify it as a Holy Grail that saves economies, being interpreted as a result of the spontaneous action of individuals? Will it still be attractive for this category of economists?

Of course, there have also been economists who have remained skeptical about this cryptocurrency [13]. Numerous arguments can be found in the case of those who are pro-Bitcoin, but also in the case of those who want it banned. From a sustainability perspective, the impact that the mining process has on the environment is obvious. Moreover, this cryptocurrency, like many other economically exploited elements for potential gains, tends to be seen beyond the environmental aspects in which future generations will develop. But one thing remains certain, that technological advancement cannot be neglected in the area of means of payment. That is why it is up to all of us to find the optimal solution not only in terms of economic efficiency, but also in terms of ensuring the necessary premises for a normal development of future generations.

REFERENCES

[1] S. Nakamoto. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. Accessed: Aug. 17, 2020. [Online]. Available: https://nakamotoinstitute.org/bitcoin/

[2] *Commission Proposes New Rules for Consumer Centred Clean Energy Transition*. Accessed: Aug. 17, 2020. [Online]. Available: https://ec.europa.eu/energy/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition_en

[3] M. Kubát, "Virtual currency Bitcoin in the scope of money definition and store of value," *Procedia Econ. Finance*, vol. 30, pp. 409–416, 2015, doi: 10.1016/S2212-5671(15)01308-8.

[4] D. Yermack, "Is bitcoin a real currency? An economic appraisal," Nat. Bureau Econ. Res., Working Paper 19747. Accesed: Aug. 13, 2020. [Online]. Available: http://www.nber.org/papers/w19747

[5] A. Bal, "How to tax Bitcoin?" in *Handbook of Digital Currency*, D. L. K. Chuen, Ed. San Diego, CA, USA: Academic, 2015, ch. 1, pp. 267–282.

[6] P. Katsiampa, "Volatility estimation for Bitcoin: A comparison of GARCH models," *Econ. Lett.*, vol. 158, pp. 3–6, Sep. 2017, doi: 10.1016/j.econlet.2017.06.023.

[7] A. Urquhart, "The inefficiency of Bitcoin," *Econ. Lett.*, vol. 148, pp. 80–82, Nov. 2016, doi: 10.1016/j.econlet.2016.09.019.

[8] A. Rogojanu and L. Badea, "The issue of competing currencies. Case study—Bitcoin," *Theor. Appl. Econ.*, vol. 21, no. 1, pp. 103–114, 2014. [Online]. Available: http://www.ectap.ro/the-issue-of-competing-currenciescase-study-bitcoin-angela-rogojanu_liana-badea/a946/

[9] A. Rogojanu and L. Badea, "The issue of 'true' money in front of the Bitcoin's offensive," *Theor. Appl. Econ.*, vol. 22, no. 2, pp. 77–90, 2015. [Online]. Available: http://www.ectap.ro/the-issue-of-true-money-in-front-of-the-bitcoins-offensive-angela-rogojanu_liana-badea/a1084/

[10] F. A. von Hayek, *Denationalisation of Money: The Argument Refined* (An Analysis of the Theory and Practice of Concurrent Currencies), 3rd ed. London, U.K.: The Institute of Economic Affairs, 1990.

[11] J. Fernández-Villaverde, "Cryptocurrencies: A crash course in digital monetary economics," *Austral. Econ. Rev.*, vol. 51, no. 4, pp. 514–526, Dec. 2018, doi: 10.1111/1467-8462.12306.

[12] A. J. Rahman, "Deflationary policy under digital and fiat currency competition," *Res. Econ.*, vol. 72, no. 2, pp. 171–180, Jun. 2018, doi: 10.1016/j.rie.2018.04.004.

[13] L. Badea, "Cryptocurrency—A new trend in the business world?" in *Proc. BASIQ*, vol. 1, 2017, pp. 62–70. [Online]. Available: https://basiq.ro/papers/2017/Badea.pdf.

[14] S. Kethineni and Y. Cao, "The rise in popularity of cryptocurrency and associated criminal activity," *Int. Criminal Justice Rev.*, vol. 30, no. 3, pp. 325–344, Sep. 2020, doi: 10.1177/1057567719827051.

[15] *Cryptocurrency Prices, Charts and Market Capitalizations*. Accessed: Aug. 25, 2020. [Online]. Available: https://coinmarketcap.com/

[16] S. Corbet, B. Lucey, A. Urquhart, and L. Yarovaya, "Cryptocurrencies as a financial asset: A systematic analysis," *Int. Rev. Financial Anal.*, vol. 62, no. C, pp. 182–199, 2019, doi: 10.1016/j.irfa.2018.09.003.

[17] D. Frisby, *Bitcoin: The Future of Money?* 1st ed. London, U.K.: Unbound, 2015.

[18] A. H. Dyhrberg, "Bitcoin, gold and the dollar–a GARCH volatility analysis," *Finance Res. Lett.*, vol. 16, pp. 85–92, Feb. 2016, doi: 10.1016/j.frl.2015.10.008.

[19] W. S. Jevons, *Money and the Mechanism of Exchange*, no. 2. Indianopoli, IN, USA: Liberty Fund, 2011.

[20] F. D. Graham, "The primary functions of money and their consummation in monetary policy," *Amer. Econ. Rev.*, vol. 30, pp. 1–16, Mar. 1940.

[21] *European Central Bank Virtual Currency Schemes: A Further Analysis*, Eur. Central Bank, Frankfurt, Germany, 2015.

[22] S. Ammous, "Can cryptocurrencies fulfil the functions of money?" *Quart. Rev. Econ. Finance*, vol. 70, pp. 38–51, Nov. 2018, doi: 10.1016/j.qref.2018.05.010.

[23] K. Hong, K. Park, and J. Yu, "Crowding out in a dual currency regime? Digital versus fiat currency," *Emerg. Markets Finance Trade*, vol. 54, no. 11, pp. 2495–2515, Sep. 2018, doi: 10.1080/1540496X.2018.1452732.

[24] J. K. T. Lutz, "Coexistence of cryptocurrencies and central bank issued fiat currencies—A systematic literature review," FiDL Working Paper 2, Dec. 2018. Accessed: Aug. 26, 2020. [Online]. Available: https://ssrn.com/abstract=3303252

[25] A. Seetharaman, A. S. Saravanan, N. Patwa, and J. Mehta, "Impact of Bitcoin as a world currency," *Accounting Finance Res.*, vol. 6, no. 2, p. 230, May 2017, doi: 10.5430/afr.v6n2p230.

[26] M. V. Alstyne. *Why Bitcoin Has Value*. Accessed: Aug. 25, 2020. [Online]. Available: https://cacm.acm.org/magazines/2014/5/174354-why-bitcoin-has-value/fulltext

[27] G. Selgin, "Bitcoin: Problems and prospects," Hillsdale Univ. 2014 Free Market Forum, Indianapolis, IN, USA, Oct. 2014. Accessed: Aug. 26, 2020. [Online]. Available: https://www.hillsdale.edu/wp-content/uploads/2016/02/FMF-2014-Bitcoin-Problems-and-Prospects.pdf

[28] D. Yermack, "Is Bitcoin a real currency? An economic appraisal," in *Handbook of Digital Currency*, D. L. K. Chuen, Ed. San Diego, CA, USA: Academic, 2015, ch. 2, pp. 31–43.

[29] D. Woo, I. Gordon, and V. Iaralov. (2013). *Bitcoin: A First Assessment*. FX and Rates. Cause and Effect. [Online]. Available: http://web.elastic.org/~fche/mirrors/www.cryptome.org/2013/12/boa-bitcoin.pdf

[30] P. Giungato, R. Rana, A. Tarabella, and C. Tricase, "Current trends in sustainability of Bitcoins and related blockchain technology," *Sustainability*, vol. 9, no. 12, p. 2214, Nov. 2017, doi: 10.3390/su9122214.

[31] A. V. Vlasov, "The evolution of e-money," *Eur. Res. Stud.*, vol. 20, no. 1, pp. 215–224, 2017. [Online]. Available: https://www.um.edu.mt/library/oar/handle/123456789/28785

[32] E.-T. Cheah and J. Fry, "Speculative bubbles in Bitcoin markets? An empirical investigation into the fundamental value of Bitcoin," *Econ. Lett.*, vol. 130, pp. 32–36, May 2015, doi: 10.1016/j.econlet.2015.02.029.

[33] D. Quah, *Digital Goods and the New Economy*. Rochester, NY, USA: Social Science Research Network, 2003.

[34] G. Pieters and S. Vivanco, "Financial regulations and price inconsistencies across Bitcoin markets," *Inf. Econ. Policy*, vol. 39, pp. 1–14, Jun. 2017, doi: 10.1016/j.infoecopol.2017.02.002.

[35] Ş. DiLek and Y. Furuncu, "Bitcoin mining and its environmental effects," Ataturk Univ., 2019. [Online]. Available: https://dergipark.org.tr/en/download/article-file/641972

[36] *Bitcoin ATM Map—Find Bitcoin ATM*. Accessed: Aug. 25, 2020. [Online]. Available: https://coinatmradar.com/

[37] L. Kristoufek, "Bitcoin and its mining on the equilibrium path," *Energy Econ.*, vol. 85, Jan. 2020, Art. no. 104588, doi: 10.1016/j.eneco.2019.104588.

[38] E. Demir, G. Gozgor, C. K. M. Lau, and S. A. Vigne, "Does economic policy uncertainty predict the Bitcoin returns? An empirical investigation," *Finance Res. Lett.*, vol. 26, pp. 145–149, Sep. 2018, doi: 10.1016/j.frl.2018.01.005.

[39] F. Glaser, K. Zimmermann, M. Haferkorn, M. C. Weber, and M. Siering, "Bitcoin—Asset or currency? Revealing users' hidden intentions," ECIS, Tel Aviv, Israel, 2014. Accessed: Aug. 13, 2020. [Online]. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2425247

[40] *Bitcoin Price Index—CoinDesk*. Accessed: Aug. 25, 2020. [Online]. Available: https://www.coindesk.com/price/bitcoin

[41] K. J. O'Dwyer and D. Malone, "Bitcoin mining and its energy footprint," in *Proc. 25th IET Irish Signals Syst. Conf. China-Ireland Int. Conf. Inf. Commun. Technol. (ISSC/CIICT)*, 2014, pp. 280–285, doi: 10.1049/cp.2014.0699.

[42] S. Yi, Z. Xu, and G.-J. Wang, "Volatility connectedness in the cryptocurrency market: Is Bitcoin a dominant cryptocurrency?" *Int. Rev. Financial Anal.*, vol. 60, pp. 98–114, Nov. 2018, doi: 10.1016/j.irfa.2018.08.012.

[43] J. K. Darlington, "The future of bitcoin: Mapping the global adoption of world's largest cryptocurrency through benefit analysis," Honors Thesis Projects, Univ. Tennessee, Knoxville, TN, USA, 2014. [Online]. Available: https://trace.tennessee.edu/utk_chanhonoproj/1770

[44] J. Bucko, D. Palova, and M. Vejacka, "Security and trust in cryptocurrencies," in *Proc. Central Eur. Conf. Finance Econ.*, 2015, pp. 14–24. [Online]. Available: https://www.researchgate.net/publication/317955860_Security_and_Trust_in_Cryptocurrencies/citations

[45] J. Baron, A. O'Mahony, D. Manheim. C. Dion-Schwarz, *National Security Implications of Virtual Currency: Examining the Potential for Non-state Actor Deployment*. Santa Monica, CA, USA: RAND Corporation, 2015.

[46] S. Barber, X. Boyen, E. Shi, and E. Uzun, "Bitter to better—How to make Bitcoin a better currency," in *Financial Cryptography and Data Security*, A. D. Keromytis, Ed. Berlin, Germany: Springer, 2012, pp. 399–414.

[47] T. Moore and N. Christin, "Beware the middleman: Empirical analysis of Bitcoin-exchange risk," in *Financial Cryptography and Data Security* (Lecture Notes in Computer Science), vol. 7859, A.-R. Sadeghi, Ed. Berlin, Germany: Springer, 2013, pp. 25–33.

[48] J. A. Kroll, I. C. Davey, and E. Felten, "The economics of bitcoin mining, or bitcoin in the presence of adversaries," in *Proc. 25th Workshop Econ. Inf. Secur. (WEIS)*, Washington, DC, USA, Jun. 2013.

[49] L. P. Nian and D. L. K. Chuen, "Introduction to Bitcoin," in *Handbook of Digital Currency*, D. L. K. Chuen, Ed. San Diego, CA, USA: Academic, 2015, ch. 1, pp. 5–30.

[50] L. Belkhir and A. Elmeligi, "Assessing ICT global emissions footprint: Trends to 2040 & recommendations," *J. Cleaner Prod.*, vol. 177, pp. 448–463, Mar. 2018, doi: 10.1016/j.jclepro.2017.12.239.

[51] *What are Cryptocurrencies? | Introduction to the World of Cryptocurrencies*. Accessed: Aug. 13, 2020. [Online]. Available: https://coinmarketcap.com/intro-to-crypto/go-forth-into-the-world-of-cryptocurrency/

[52] M. B. Taylor, "The evolution of Bitcoin hardware," *Computer*, vol. 50, no. 9, pp. 58–66, 2017, doi: 10.1109/MC.2017.3571056.

[53] *Bitcoin Energy Consumption Index*. Accessed: Aug. 13, 2020. [Online]. Available: https://digiconomist.net/bitcoin-energy-consumption/

[54] *Cambridge Bitcoin Electricity Consumption Index (CBECI)*. Accessed: Aug. 13, 2020. [Online]. Available: https://www.cbeci.org/

[55] A. D. Vries, "Bitcoin's energy consumption is underestimated: A market dynamics approach," *Energy Res. Social Sci.*, vol. 70, Dec. 2020, Art. no. 101721, doi: 10.1016/j.erss.2020.101721.

[56] J. Li, N. Li, J. Peng, H. Cui, and Z. Wu, "Energy consumption of cryptocurrency mining: A study of electricity consumption in mining cryptocurrencies," *Energy*, vol. 168, pp. 160–168, Feb. 2019, doi: 10.1016/j.energy.2018.11.046.

[57] M. J. Krause and T. Tolaymat, "Quantification of energy and carbon costs for mining cryptocurrencies," *Nature Sustainability*, vol. 1, no. 11, pp. 711–718, Nov. 2018, doi: 10.1038/s41893-018-0152-7.

[58] A. D. Vries, "Bitcoin's growing energy problem," *Joule*, vol. 2, no. 5, pp. 801–805, May 2018, doi: 10.1016/j.joule.2018.04.016.

[59] S. Küfeoglu and M. Özkuran, "Bitcoin mining: A global review of energy and power demand," *Energy Res. Social Sci.*, vol. 58, Dec. 2019, Art. no. 101273, doi: 10.1016/j.erss.2019.101273.

[60] (2018). *The Economist, Why are Venezuelans Mining so Much Bitcoin?* [Online]. Available: https://www.economist.com/the-economist-explains/2018/04/03/why-are-venezuelans-mining-so-much-bitcoin

[61] H. Vranken, "Sustainability of Bitcoin and blockchains," *Current Opinion Environ. Sustainability*, vol. 28, pp. 1–9, Oct. 2017, doi: 10.1016/j.cosust.2017.04.011.

[62] *Coal is Fueling Bitcoin's Meteoric Rise—Bloomberg*. Accessed: Aug. 17, 2020. [Online]. Available: https://www.bloomberg.com/news/articles/2017-12-15/turning-coal-into-bitcoin-dirty-secret-of-2017-s-hottest-market

[63] *Bitcoin Energy Use—Mined the Gap—Analysis*. Accessed: Aug. 14, 2020. [Online]. Available: https://www.iea.org/commentaries/bitcoin-energy-use-mined-the-gap

[64] J. Truby, "Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of blockchain technologies and digital currencies," *Energy Res. Social Sci.*, vol. 44, pp. 399–410, Oct. 2018, doi: 10.1016/j.erss.2018.06.009.

[65] C. Mora, R. L. Rollins, K. Taladay, M. B. Kantar, M. K. Chock, M. Shimada, and E. C. Franklin, "Bitcoin emissions alone could push global warming above 2°C," *Nature Climate Change*, vol. 8, no. 11, pp. 931–933, Nov. 2018, doi: 10.1038/s41558-018-0321-8.

[66] E. Masanet, A. Shehabi, N. Lei, H. Vranken, J. Koomey, and J. Malmodin, "Implausible projections overestimate near-term Bitcoin CO_2 emissions," *Nature Climate Change*, vol. 9, no. 9, pp. 653–654, Sep. 2019, doi: 10.1038/s41558-019-0535-4.

[67] C. Stoll, L. Klaaßen, and U. Gallersdörfer, "The carbon footprint of Bitcoin," *Joule*, vol. 3, no. 7, pp. 1647–1661, Jul. 2019, doi: 10.1016/j.joule.2019.05.012.

[68] J. Loviscach. (2012). *The Environmental Cost of Bitcoin*. Accessed: Aug. 14, 2020. [Online]. Available: https://j3l7h.de/talks/2012-09-20_Environmental_Cost_of_Bitcoin.pdf

[69] J. Koomey, S. Berard, M. Sanchez, and H. Wong, "Implications of historical trends in the electrical efficiency of computing," *IEEE Ann. Hist. Comput.*, vol. 33, no. 3, pp. 46–54, Mar. 2011, doi: 10.1109/MAHC.2010.28.

[70] A. D. Vries, "Renewable energy will not solve Bitcoin's sustainability problem," *Joule*, vol. 3, no. 4, pp. 893–898, Apr. 2019, doi: 10.1016/j.joule.2019.02.007.

[71] *WHO | Mortality and Burden of Disease From Ambient Air Pollution*,. Accessed: Aug. 14, 2020. [Online]. Available: http://www.who.int/gho/phe/outdoor_air_pollution/burden/en/

[72] A. S. Hayes, "Cryptocurrency value formation: An empirical study leading to a cost of production model for valuing Bitcoin," *Telematics Inform.*, vol. 34, pp. 1308–1321, Nov. 2017, doi: 10.1016/j.tele.2016.05.005.

[73] *Bitcoin is a High-Tech Dinosaur Soon to be Extinct—Bloomberg*. Accessed: Aug. 17, 2020. [Online]. Available: https://www.bloomberg.com/opinion/articles/2013-12-31/bitcoin-is-a-high-tech-dinosaur-soon-to-be-extinct

[74] D. Das and A. Dutta, "Bitcoin's energy consumption: Is it the Achilles heel to miner's revenue?" *Econ. Lett.*, vol. 186, Jan. 2020, Art. no. 108530, doi: 10.1016/j.econlet.2019.108530.

[75] A. L. Goodkind, B. A. Jones, and R. P. Berrens, "Cryptodamages: Monetary value estimates of the air pollution and human health impacts of cryptocurrency mining," *Energy Res. Social Sci.*, vol. 59, Jan. 2020, Art. no. 101281, doi: 10.1016/j.erss.2019.101281.

[76] A. Malfuzi, A. S. Mehr, M. A. Rosen, M. Alharthi, and A. A. Kurilova, "Economic viability of Bitcoin mining using a renewable-based SOFC power system to supply the electrical power demand," *Energy*, vol. 203, Jul. 2020, Art. no. 117843, doi: 10.1016/j.energy.2020.117843.

[77] H. McCook, "An order-of-magnitude estimate of the relative sustainability of the bitcoin network," 2nd ed., Working Paper, Jul. 2014. Accessed: Aug. 13, 2020. [Online]. Available: https://bitcoin.fr/public/divers/docs/Estimation_de_la_durabilite_et_du_cout_du_reseau_Bitcoin.pdf

[78] L. Cocco, R. Tonelli, and M. Marchesi, "An agent based model to analyze the Bitcoin mining activity and a comparison with the gold mining industry," *Future Internet*, vol. 11, no. 1, p. 8, Jan. 2019, doi: 10.3390/fi11010008.

[79] L. Cocco, A. Pinna, and M. Marchesi, "Banking on blockchain: Costs savings thanks to the blockchain technology," *Future Internet*, vol. 9, no. 3, p. 25, Jun. 2017, doi: 10.3390/fi9030025.

[80] S. Imran. *Bitcoin & Energy*. Accessed: Aug. 13, 2020. [Online]. Available: https://medium.com/nodeblockchain/bitcoin-energy-b230a9d7dd5d

[81] D. G. Baur and J. Oll, "The (un-)sustainability of bitcoin investments," Social Sci. Res. Netw., Rochester, NY, USA, 2019. Accessed: Aug. 14, 2020, doi: 10.2139/ssrn.3365820.

[82] J. Derks, J. Gordijn, and A. Siegmann, "From chaining blocks to breaking even: A study on the profitability of Bitcoin mining from 2012 to 2016," *Electron. Markets*, vol. 28, no. 3, pp. 321–338, Aug. 2018, doi: 10.1007/s12525-018-0308-3.
[83] M. Ziolo, K. Kluza, and A. Spoz, "Impact of sustainable financial and economic development on greenhouse gas emission in the developed and converging economies," *Energies*, vol. 12, no. 23, p. 4514, Nov. 2019, doi: 10.3390/en12234514.
[84] A. Adeyemi, M. Yan, M. Shahidehpour, C. Botero, A. V. Guerra, N. Gurung, L. Zhang, and A. Paaso, "Blockchain technology applications in power distribution systems," *Electr. J.*, vol. 33, no. 8, Oct. 2020, Art. no. 106817, doi: 10.1016/j.tej.2020.106817.
[85] B. A. Tama, B. J. Kweka, Y. Park, and K.-H. Rhee, "A critical review of blockchain and its current applications," in *Proc. Int. Conf. Electr. Eng. Comput. Sci. (ICECOS)*, Aug. 2017, pp. 109–113.
[86] V. Denisova, A. Mikhaylov, and E. Lopatin, "Blockchain infrastructure and growth of global power consumption," *Int. J. Energy Econ. Policy*, vol. 9, no. 4, pp. 22–29, Jul. 2019.
[87] J. Sun, J. Yan, and K. Z. K. Zhang, "Blockchain-based sharing services: What blockchain technology can contribute to smart cities," *Financial Innov.*, vol. 2, no. 1, pp. 1–9, Dec. 2016, doi: 10.1186/s40854-016-0040-y.
[88] A. Ekblaw, A. Azaria, J. D. Halamka, and A. Lippman. *A Case Study for Blockchain in Healthcare: 'MedRec' Prototype for Electronic Health Records and Medical Research Data*. Accessed: Aug. 14, 2020. [Online]. Available: https:///paper/A-Case-Study-for-Blockchain-in-Healthcare-%3A-%E2%80%9C-%E2%80%9D-for-Ekblaw-Azaria/56e65b469cad2f3ebd560b3a10e7346780f4ab0a
[89] A. Adjeleian, O. Jurjica, and H. M. Kim, "Breaking the stagnant spell: How blockchain is disrupting the solar energy industry," Social Sci. Res. Netw., Rochester, NY, USA, 2018. Accessed: Aug. 14, 2020, doi: 10.2139/ssrn.3207104.
[90] R. Zambrano, R. K. Seward, and P. Sayo, "Unpacking the disruptive potential of blockchain technology for human development," IDRC-CRDI, Ottawa, ON, Canada, 2017.
[91] C. P. Morice, J. J. Kennedy, N. A. Rayner, and P. D. Jones, "Quantifying uncertainties in global and regional temperature change using an ensemble of observational estimates: The HadCRUT4 data set," *J. Geophys. Res., Atmos.*, vol. 117, no. 8, pp. 1–22, Apr. 2012, doi: 10.1029/2011JD017187.
[92] J. Taskinsoy, "Global cooling through blockchain to avoid catastrophic climate changes by 2050," Social Sci. Res. Netw., Rochester, NY, USA, 2019. Accessed: Aug. 25, 2020, doi: 10.2139/ssrn.3495674.
[93] H. Samford and L.-F. Domingo, "The political geography and environmental impacts of cryptocurrency mining," Henry M. Jackson School Int. Stud., Univ. Washington, Washington, DC, USA, Tech. Rep., 2019. Accessed: Feb. 2, 2021. [Online]. Available: https://jsis.washington.edu/news/the-political-geography-and-environmental-impacts-of-cryptocurrency-mining/
[94] K. Craig. (Mar. 19, 2018). *PUD Chelan County. PUD Commissioners Halt Work on Applications from Bitcoin & Similar Data Operations*. Accessed: Feb. 2, 2021. [Online]. Available: http://www.chelanpud.org/about-us/newsroom/news/2018/03/20/pud-commissioners-halt-work-on-applications-from-bitcoin-similiar-data-operations
[95] C. Bendiksen, S. Gibbons, E. Lim. (Nov. 26, 2018). *The Bitcoin Mining Network; CoinShares Research*. Accessed: Dec. 28, 2020. [Online]. Available: https://coinshares.co.uk/wp-content/uploads/2018/11/Mining-Whitepaper-Final.pdf
[96] S. Volosovych and Y. Baraniuk, "Tax control of cryptocurrency transactions in Ukraine," *Banks Bank Syst.*, vol. 13, no. 2, pp. 89–106, 2018, doi: 10.21511/bbs.13(2).2018.08.
[97] *World of Cryptocurrencies—List of Nations*. Accessed: Aug. 17, 2020. [Online]. Available: https://blogs.thomsonreuters.com/answerson/world-cryptocurrencies-country/
[98] *Parlamentul României, Legea nr. 30/2019 din 10 Ianuarie 2019 Pentru Aprobarea Ordonanţei de Urgenţa Guvernului nr. 25/2018 Privind Modificarea Si Completarea Unor Acte Normative, Precum Si Pentru Aprobarea Unor Măsuri Fiscal-Bugetare*, Monitorul Oficial, Bucharest, Romania, 2019.
[99] M. Inshyn, L. Mohilevskyi, and O. Drozd, "The issue of cryptocurrency legal regulation in ukraine and all over the world: A comparative analysis," *Baltic J. Econ. Stud.*, vol. 4, no. 1, pp. 169–174, 2018, doi: 10.30525/2256-0742/2018-4-1-169-174.
[100] M. Rogic. (2018). *Countries that Legally Accept Bitcoin (BTC)*. Accessed: Aug. 17, 2020. [Online]. Available: https://theoofy.com/22223/countries-that-legally-accept-bitcoin-btc/
[101] J. Joshi. *Crypto Regulations Around the World: 2020*. Accessed: Aug. 25, 2020. [Online]. Available: https://medium.com/@jigneshjoshi_13831/crypto-regulations-around-the-world-2020-133b78ca8aa1
[102] A. Cruysheer, "Bitcoin: A look at the past and the future," in *Handbook of Digital Currency*, D. L. K. Chuen, Ed. San Diego, CA, USA: Academic, 2015, ch. 2, pp. 519–526.
[103] J. W. Lim, "A facilitative model for cryptocurrency regulation in Singapore," in *Handbook of Digital Currency*, D. L. K. Chuen, Ed. San Diego, CA, USA: Academic, 2015, ch. 1, pp. 361–381.
[104] M. B. Mollah, J. Zhao, D. Niyato, K.-Y. Lam, X. Zhang, A. M. Y. M. Ghias, L. H. Koh, and L. Yang, "Blockchain for future smart grid: A comprehensive survey," *IEEE Internet Things J.*, vol. 8, no. 1, pp. 18–43, Jan. 2021, doi: 10.1109/JIOT.2020.2993601.
[105] J. Aldridge and D. Décary-Hétu, "Not an 'ebay for drugs': The cryptomarket 'silk road' as a paradigm shifting criminal innovation," Social Sci. Res. Netw., Rochester, NY, USA, 2014. Accessed: Aug. 20, 2020. [Online]. Available: https://ssrn.com/abstract=2436643
[106] *Behavioural Insights and Public Policy: Lessons From Around the World| OECD*. Accessed: Aug. 12, 2020. [Online]. Available: https://www.oecd.org/gov/regulatory-policy/behavioural-insights-and-public-policy-9789264270480-en.htm
[107] D. W. Cash, "Choices on the road to the clean energy future," *Energy Res. Social Sci.*, vol. 35, pp. 224–226, Jan. 2018, doi: 10.1016/j.erss.2017.10.035.
[108] M. Andoni, V. Robu, D. Flynn, S. Abram, D. Geach, D. Jenkins, P. McCallum, and A. Peacock, "Blockchain technology in the energy sector: A systematic review of challenges and opportunities," *Renew. Sustain. Energy Rev.*, vol. 100, pp. 143–174, Feb. 2019, doi: 10.1016/j.rser.2018.10.014.

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