Virtual Currencies Innovation applied for Climate Change Mitigation by the People

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Summary

Climate change mitigation and adaptation are part of the environmental dimension of Sustainable Development. Based on the interconnections required at all levels it is necessary to facilitate direct people's participation on climate change mitigation activities and the goals of 2030 Agenda. A decentralized and distributed efforts among people could be implemented through a very innovative mechanism of value creation taken from the financial and monetary fields: virtual currencies backed by CO_2 emissions reductions. The most popular virtual currency known is the *bitcoin*. It is not generated by any central bank or national government, but from people who offer its hardware capabilities for the functioning of this virtual monetary system. *Bitcoin* is being currently used as any fiduciary currency (dollars, euros, pounds, yuans, etc.) for buying or selling goods and services worldwide. It is based on cryptographic algorithms that guarantee the creation of a fixed amount of *bitcoins* in the future, in a quite similar way to the establishment of a limited *world carbon budget*. Some virtual currencies similar to *bitcoins* have been designed to achieve positive impacts to environment, a class of them that are named *e-cryptos* throughout this research. This study propose the implementation of an alternative virtual currency for a "shared value creation" by people and for people, through an international system based on the Paris Agreement and, at the same time, the concepts of *Blockchain* and the *Internet Of Things*. This opens an opportunity to giving the people an effective way to contribute with small CO_2 mitigation actions locally and, at the same time, to take advantage of financial micro-incentives in the fight against climate change.

Keywords: cryptocurrencies, blockchain, bitcoin, climate chance, energy, IoT.

Introduction

The Paris Agreement adopted in 2015 set out a new international agenda for the decarbonization of the world economy, with the aim of eliminating the high dependence on fossil fuels, emitters of greenhouse gases that cause climate change. This goal is directly linked to the Sustainable Development Objectives (ODS), specifically #7 (Affordable and Clean Energy), #8 (Decent Work and Economic Growth), #11 (Sustainable Cities and Communities) and #13 (Climate Action), and indirectly with objectives #9 (Industry, Innovation and Infrastructure) and #12 (Responsible Consumption and Production).

The Kyoto Protocol, predecessor to the Paris Agreement, although not the ultimate response to climate change, was a highly relevant experience in clarifying the motivations and incentives of nations to increase their ambition to mitigate climate change and explore some effective delivery mechanisms. In fact, the new Paris Agreement is partly the result of this previous protocol that served - among other things - to give birth to the global carbon market. However, in this regulated market, the underlying asset of which is the reduction of greenhouse gas (GHG) emissions, was largely supported by national governments, supranational organizations, and corporations of key sectors of national economies, all focused on climate benefits that industries modernization and technological advances could report. This global carbon market did not offer significant opportunities to the reach and direct influence of the population base. In a way, it could be said that it was reserved for institutional "investors"; perhaps this explains the emergence of voluntary carbon markets, whose operation is in parallel with the former.

The methodologies for calculating GHG emission reductions, which guarantee with high certainty the effective reduction of GHG emissions, are still very oriented to technological projects only, in a kind of bet that

the effective fight against climate change is only possible through technological progress. Subsequently, with the introduction of Nationally Appropriate Mitigation Actions or NAMAs, attempts were made to capitalize, in some cases, the diffuse efforts of some mitigation projects that were not always technological; In any case, it can be affirmed that there are no official methodologies that consider the rational and conscious human decision factor as a contributing element in the reduction of GHG emissions.

This study presents a conceptual proposal for a mechanism that leads to the direct participation of the population in the mitigation of climate change through local mitigation actions that contribute to the achievement of the objectives of the Paris Agreement as well as to the objectives of Sustainable Development mentioned above. In addition, other benefits could be leveraged - to a greater or lesser extent - relative to the other ODS, especially due to the increase of individual, family or community monetary income implied by this proposal, and its consequent impacts on poverty reduction (ODS # 1) and reduction of inequalities (# 10).

The proposed mechanism is based on the adoption of a virtual global monetary unit, not dependent on any government or central bank, that acquires its value thanks to the support derived from the reduction of GHG emissions achieved by people through local actions for mitigation of climate change, from conscious and voluntary energy savings (individually or collectively) or autonomous production of renewable energy to the satisfaction of their own needs or those of their neighbors. It is a mechanism in which all can be creators or issuer of virtual money, unique, cryptographically authenticated, tradable, predictable and backed by the real effort invested in voluntary energy savings or energy production from renewable sources, actions that ultimately translate into reductions in CO_2 emissions. Already earlier, other authors have put forward strategies for implementing systems or mechanisms that consider these emission reductions of CO_2 as the backing asset for the adoption of a global fiduciary currency (Levi, 1991; Stua, 2017).

For the elaboration of the proposal an exploratory study was done over some virtual currencies or cryptocurrencies existing at the present time, that were created with the intention of obtaining some specific environmental benefit. Generally speaking, the term cryptocurrency refers to the use of computational cryptographic techniques to guarantee the authenticity and inviolability of the virtual currencies that are supposed to be unique. This concept seeks, on the one hand, to avoid fraudulent "double spending" of the same currency and, on the other, to eliminate the intervention of intermediary institutions (such as banks) that increase transaction costs and, therefore, operating fees of the system. *Bitcoin* is the first cryptocurrency created in 2009 by Satoshi Nakamoto (2009), and from it were created several cryptocurrencies with multiple variations in their operating characteristics. Currently, eight years after the creation of *bitcoin*, there are more than 700 cryptocurrencies whose general concept has meant a great innovation in the financial world, especially facing economic paradigms related to monetary policy, since, as was said, the creation of cryptocurrencies does not depend on the coinage of physical currencies or the printing of bills by central banks or governments, but depend on the people themselves, their users, the hardware and software put online in order to collaborate for the operation of the system.

Bitcoin introduced an operating algorithm for the validation and protection of purchases or sales transactions made with this currency, which consists of a kind of public accounting book, transparent and auditable, in which all the transactions made are recorded to date since its inception in 2009. This “book” is known as the *blockchain*. In itself, blockchain technology and its various applications have been, according to many authors, the greatest innovation of recent times, even more relevant than the own cryptocurrencies, since this book or accounting register is shared among all the participants (or nodes) as a mean of verification of authenticity (of assets, decisions, policies, contracts, etc.) on a decentralized and distributed basis at a global level, at lower operating costs and increasing trust and transparency among participants, without relying on an institution, company or intermediary authority.

Problem statement

Perhaps the reader already has a concern about the *blockchain* technology, in relation to its energy consumption, which presumably is very intensive due to the conception of the computer system that supports it, since it is decentralized and distributed among nodes and users, it implies -a priori- a simultaneous and aggregate energy consumption of significant magnitudes (Malmo, 2015). Due to this high energy consumption, it is necessary to investigate the net environmental benefit of the adoption of cryptocurrencies, especially those promoted as "environment friendly", and contribute to the global debate on the energy efficiency of algorithms and computational infrastructures that support cryptocurrencies and the blockchain technology in general. In this sense, it can be added that blockchain development has been incorporating new features that make it more energy efficient, such as for example the adoption of Proof-of-Stake (PoS), replacing the bitcoin former Proof-of-Work (PoW). These "tests" or "evidences" are required by the blockchain as one of the elements that contribute in the process of validation of the transactions. In the case of bitcoin, the PoW is required to demonstrate to the system that the node (known as a “miner”) has performed the work required to be rewarded for offering its hardware capability for proper system operation. PoS works in a different way, since it is a combination between the “age” of the cryptocurrencies that the node possesses and the number of them, alluding that it will be a stronger “evidence” or stake -at the moment of the validation- that provided by the nodes with greater quantity of cryptocurrencies (for example the one known as Ether), and kept in their “virtual wallets" for a longer time.

For the objectives of this study, cryptocurrencies that were created for the purpose of achieving certain environmental benefits were referred to as "environmental cryptocurrencies" (hereinafter referred to as "e-cryptos"). More specifically, e-cryptos are oriented to adding wills to their own virtual "monetary system” in order to promote and support activities and behaviors that benefit the environment, or as instruments of investment and fund raising for projects, for example those that seek to reduce greenhouse gases (PV solar cell residential installations, carbon offsetting, among others). All of the above would be based on the interest and/or environmental sensitivity raised by the promoters and users of e-cryptos since its public launch on the internet. These "green" environmental "intentions" can also be seen in other real-world financial instruments, such as Voluntary Emission Reductions (VERs) or Green Bonds, whose issuers use money collected from buyers to finance environmentally friendly projects or activities (Berensmann et al, 2016).

To what degree are e-cryptos integral to the environment, in the sense that their net environmental benefits are actually favorable or positive?

Is it possible that any of the e-crypts will have a negative environmental impact greater than the environmental benefits it seeks to achieve, particularly with respect to energy consumption?

Finally, are the current e-crypts coherent, conceptually speaking, considering their objectives, premises and operating algorithms?

Justification

Beyond the cryptocurrencies as a highly disruptive financial innovation for the typical monetary systems known, with the emergence of cryptocurrencies was revealed to the world its operation technology -the blockchain- almost as a serendipity, and it has brought important contributions to the problems of verification, auditability, inviolability and transparency of asset protection systems, in their broader conception.

The inviolability of the system and the authenticity of each bitcoin monetary units (or other cryptocurrencies) that have been created and protected according to the blockchain technology, reminds us the importance of the "environmental integrity" required for climate change mitigation measures. For example, it is well known that within the framework of the flexibility mechanisms of the Kyoto Protocol, the methodologies for calculating the CO_2 emissions of the projects are highly demanding, as well as the Monitoring, Reporting and Verification (MRV) of their results. Of equal importance is the integrity of the mechanisms

for the allocation, registry and cancellation of Certified Emissions Reductions (CER) and Assigned Amount Units (AAU) by the United Nations Framework Convention on Climate Change (UNFCCC) to countries which belonged to Annex I of its Kyoto Protocol. Over the next few years, these issues will undoubtedly regain focus because of the application of the MRV approach (transparency, auditability, etc.) to the achievements and results of the Nationally Determined Contributions (NDCs) of the Paris Agreement.

Some global scandals occurred regarding the environmental integrity of certain mitigation measures under the Kyoto Protocol. In 2009, for example, under the Clean Development Mechanism (CDM), there was a proliferation of companies producing a refrigerant gas known as HCFC22, while it was found that in reality the main incentive for many of these new companies were the destruction of a residue gas derived from this industrial process and identified as HFC23, which is a gas with high impact to the climate change, as it has a global warming potential (GWP) equivalent to 11,700 times the GWP of CO_2 (EIA, 2010). Through the immediate controlled and certified destruction of this residue gas or by-product, CERs were subsequently claimed, representing large amounts of tradable securities in the carbon market. The UNFCCC and particularly the European Union authorities set their position regarding the proliferation of these types of companies that violated the *environmental integrity* desired for the proper functioning of the CDM and prohibited these fictitious and incoherent increase of CDM projects of gas destruction residue HFC23.

Another example that was also a scandal in the carbon market was the resale of lots of reduced CO_2 emissions certificates that had already been "used" for the purposes of the European Market Emissions or EU-ETS (Euractiv, 2010). Double expense?

Other drawbacks, not from the point of view of vulnerability of the environmental integrity of the Kyoto protocol's mechanisms, but of technological vulnerability or fraud to which the carbon market participants could be exposed, was reported in the New York Times as follow:

> "One particularly damaging case involved a 'phishing' scam in which criminals established fake websites designed to mimic the online registries of E.U. member governments participating in the ETS. They then sent e-mails to carbon traders asking them to update their information in the fake systems. That information was used to hack into EUA accounts and steal millions of dollars' worth of credits." (Gronewold, 2011).

As can be seen, there are several demands on the carbon market regarding the transparency of its operation, the authenticity of its operations, the environmental integrity of its achievements, among other things, which would result in the construction of a more solid global carbon market, reliable and secure (Interpol, 2013), as well as lower transaction costs. In this respect, the adaptation of blockchain technology to the carbon market would appear to be a great opportunity. More particularly, the possibility of adopting a cryptocurrency promoted by the United Nations system, the World Bank or renowned governmental and financial Institutions in the world for their efforts in the fight against climate change, justifies the in-depth investigation of the subject, and specially if it is promoted for people -and not only corporations- to actively participate through local financially rewarded mitigation actions, which would also be contributing in the same direction to several of the Sustainable Development Goals 2030.

Research Objectives

- To study the diversity of environmental cryptocurrencies (e-cryptos) from the point of view of their conception, aims, functioning and results.
- Elaborate a proposal of concept of an e-crypto that promotes, at first, the conscious and voluntary energy savings and whose backed asset is the corresponding reduced CO_2 emissions, and that also promotes the production of renewable energy.

Methodological steps

Part I

1. Definition of eligibility criteria for cryptocurrencies which seek positive environmental results.

2. Selection of a credible online cryptocurrency Directory.
3. Elaboration of a list of key words to make an initial quick search of e-cryptos in the Directory.
4. Identification, selection and analysis of e-cryptos relevant to the study.
5. Presentation and discussion of results.

Part II

1. Elaboration of the proposal of concept for the new e-crypto.

Results

Eligibility criteria

1. The cryptocurrency launch concept explicitly states that environmental benefits of any kind are being sought (climate, water, biodiversity, etc.).
2. It is indicated that its operating algorithm seeks to be more energy efficient.

Refers to table No. 1 in order to the cryptocurrencies identified according to this criteria. Regarding the "more energy efficient algorithms", only those cryptocurrencies that express this as a main feature were selected.

Directory or database for the study

The cryptocurrencies Directory that was chosen to carry out the study was the so famous CoinMarketCap (www.coinmarketcap.com), which, by the end of April 2017, already had more than 700 cryptocurrencies in its general list.

Keywords for the initial quick search

The following list of words was used to conduct an initial e-cryptos quick search in the Directory: Energy, Efficiency, Renewables, Solar, Wind, Geothermal, Thermo, Biomass, Atomic, Climate, Forest, Forestry, Forestation, Reforestation, Kyoto, Green, Electricity, Ecology, Live, Earth and Carbon. It was tried to search the spanish translations of these words but did not produce any results, so only the keywords in english language were considered.

e-cryptos identified

The following table shows cryptocurrencies identified as e-cryptos. In total they are ten, which represents about 1% of the total cryptocurrencies listed in the Directory.

Table 1 shows the symbol with which it is identified in the Directory, as well as in the various virtual currency exchange markets in which they are traded (exchanges). Table 1 also indicates the purpose or mission of each e-crypto.

No.	Cryptocurrency name	Symbol	Purpose or Mission
1	EarthCoin	EAC	Support enviromental projects through donations
2	LeafCoin	LEAF	Sponsorship to re-forrestation activities
3	TeslaCoin	TES	Support renewable and free energy projects
4	SolarCoin	SLR	Reward solar energy production
5	EnergyCoin	ENRG	Facilitate the transition from fossil fuels towards renewable local
6	GreenCoin	GREV2	Reward renewable energy producers
7	CarbonCoin	CARBON	Energy efficient digital currency that plants trees for climate change
8	EverGreenCoin	EGC	Support diverse environmental projects
9	SolarFlare	SFC	Support renewable energy projects
10	BioBar	BIOB	Support diverse environmental and aid projects

Table No. 1 e-cryptos identified

The launch date of the first e-crypto on the list was December 2013, then from No. 2 to No. 7 were launched in 2014 (five of them during the first semester), in 2016 EverGreenCoin was launched, and finally in 2017 the last two of the list were launched.

Table No. 2 shows the same listing in Table No. 1 but incorporating the maximum market capitalization reached by each of the e-cryptos at a specific date and time in its history. Also, the maximum historical price or quote reached is indicated, in US dollars (USD), being understood that, for example, 1 EarthCoin reached the value of 0,006372 USD (that is to say almost a cent of dollar); the correct notation would be EACUSD = 0,006372 or what is the same USDEAC = 156,94. The darker green color denotes the higher values.

Note: for this section of the study the point (".") is used as thousands separator, and the comma (",") as decimal separator.

No.	Cryptocurrency name	Max MarketCap (USD)	Max Price (USD)
1	EarthCoin	5.928.866,00	0,006372
2	LeafCoin	2.051.361,00	0,000252
3	TeslaCoin	7.674.657,00	0,115184
4	SolarCoin	8.426.804,00	0,245471
5	EnergyCoin	2.993.030,00	0,024768
6	GreenCoin	323.203,00	0,000372
7	CarbonCoin	914.347,00	0,000059
8	EverGreenCoin	5.495.065,00	0,420512
9	SolarFlare	74.041,00	0,008077
10	BioBar	22.499,00	0,039186

Table No. 2 Maximum market capitalization and historical maximum price or quotes of e-cryptos

No.	Cryptocurrency name	Current supply (units of coins)	Max Supply (units of coins)
1	EarthCoin	9.346.468.332	13.500.000.000
2	LeafCoin	15.322.977.853	21.000.000.000
3	TeslaCoin	70.685.014	75.000.000
4	SolarCoin	34.995.363	98.034.155.630
5	EnergyCoin	120.857.413	110.000.000
6	GreenCoin	2.969.156.641	*unknown*
7	CarbonCoin	15.391.912.869	16.000.000.000
8	EverGreenCoin	13.301.434	13.000.000
9	SolarFlare	9.167.000	20.000.000
10	BioBar	885.756	985.756

Table No. 3 Number of units currently issued by the e-crypto and maximum amount for them

An interesting feature of the cryptocurrencies is the expected amount to be emitted of them. For example, the bitcoin algorithm plans to emit up to 21 million bitcoins. The promoters of each criptocurrency design this characteristic in a particular way according to their own criteria and intentions. Table No. 3 shows the number of currency units that have already been issued (current supply) for each e-crypto, and the maximum amount (max supply) that will be issued (if maximum is not reached yet).

It should be noted that in the case of the GreenCoin e-crypto, it was not possible to know the maximum number of GREV2 units that would be emitted. This may be due to the fact that some cryptocurrencies, certainly, do not consider creating a maximum limit of units, but, on the contrary, the possibility of creation of currency is open indefinitely. A different discussion would correspond to the mechanisms to increase the value of the cryptocurrencies, particularly those that do not have a maximum limit for them.

Finally, Table No. 4 shows some characteristics of the e-cryptos with respect to the algorithm of its *blockchain*, among others.

No.	Cryptocurrency name	Features
1	EarthCoin	PoW
2	LeafCoin	PoW
3	TeslaCoin	PoW+PoS. Most of the time marketcap is below 90000 USD
4	SolarCoin	PoW+PoG
5	EnergyCoin	PoW+PoS; Initial supply of 110M ENRG
6	GreenCoin	PoG+PoS
7	CarbonCoin	PoW
8	EverGreenCoin	PoW+PoS
9	SolarFlare	PoW+PoS
10	BioBar	PoW+PoS

Table No. 4 Other features

Discussion of results

The identified e-cryptos represent a very small proportion of the cryptocurrencies universe listed in the coinmarketcap.com directory, only about 1%. Many of the cryptocurrencies that have been invented are a mere replicas (hard forks) of the bitcoin algorithm, with some modifications. In the case of e-cryptos, some of these incorporate the “future fulfillment” of environmental purposes or goals if the evolution and favorable valuation of the e-crypto allow it.

As for the energy efficiency per se of the identified e-cryptos, almost all of them (9 of 10) use the PoW algorithm, which is energetically intensive. However, some argue that they use it only in an *initial stage* since the launch of the cryptocurrency, in order to achieve the first generation or emission of these (pre-mined) through the PoW algorithm, then continue the operation of the cryptocurrency using the Proof of Stake (PoS) algorithm, which is less energetically intensive. Some e-cryptos, in fact, are promoted as "energetically efficient" just by using the PoS algorithm or other particular cryptographic algorithms.

A pair of e-cryptos indicate using an algorithm called the Proof of Generation (PoG), mainly associated with the generation of solar energy. For example, it is the particular case of SolarCoin (SLR), which specifies that for each 1 MWh of solar energy produced by a photovoltaic (PV) module, the owner of the installation will receive the reward of one (1) SLR. By contrast, the rest of the e-cryptos that also refer to solar energy (TeslaCoin, EnergyCoin, GreenCoin, and SolarFlare, "promise" to promote solar energy through project financing in this area, depending on the success of each cryptocurrency, as a function of a favorable increase of its market value.

The launches of the identified e-cryptos show that since 2013, around two e-cryptos have been created per year (considering only those listed in the CoinMarketCap.com Directory). During days, weeks or even months, the launch phase closely resembles the public offerings of any publicly traded company, or *crowdfunding* campaign with supposedly environmental benefits. In the slang of the cryptocurrencies, these OPAs are known as ICO: Initial Coin Offer.

With regard to the maximum supply or emission of cryptocurrencies, this practically is at the discretion of the creators of each one. It was not known with certainty the reasons why TeslaCoin, for example, establishes that its maximum emission of currencies will be of 75 million units, whereas for the case of SolarCoin the maximum emission will be of approximately 98,000 million units (98 billion), which will be released (granted to solar producers) to form part of the solarcoins in circulation (in each producer's virtual wallets). In particular, the creators of SolarCoin state that "growth in the supply of coins over the next 40 years imitates the growth of solar electric power generation around the world" (Bitcointalk.org, 2014). From previos statement, it would be deduced -a priori- that at least 34,995,363 MWh of solar energy have been generated since 2014 (according to Table No. 3); however, the developers clarify that an initial lot of 100 Million SLR (approx. 0.1%) is reserved for a pre-mined phase using PoW algorithms; and the more part of those 34 million coins issued to date are a combination of those obtained by PoW and others by PoS.

It is important to note that the current issue of the EnergyCoin and EverGreenCoin e-cryptos exceeded the maximum number of coins that were supposed to be issued. It is presumed that this situation refers to the initial launch of coins to be mined through the PoW algorithm that corresponds to the maximum amount shown in Table No. 3, but once it is reached, the PoS algorithm is adopted as a mean for new coins to be created. Must be noted that PoW requires continuos hardware improvement in order to be rewarded with new coins because PoW requests more and more computational power (hashing power) for solving the computational test implied in the Proof of Work concept. By the other hand, Proof of Stake does not request bigger computational power because the parameters considered to be reward are different: age of coins kept, quantity of them, online presence, etc.

The market capitalization corresponds to the result of multiplying the quantity of coins issued at a certain date, by the price or quote of the cryptocurrency on that same date. In Table 1 it can be seen that the SolarCoin is the one that has reached a higher market capitalization than the others (8.4 million US dollars); followed by TeslaCoin ($ 7.6 million) in order of magnitude (also a coin related to renewable and free energy production projects); and third, the EarthCoin and EverGreenCoin currencies, each related to the support of environmental projects and with a capitalization of 5.9 and 5.4 million dollars, respectively. Note that the dates on which these maximum market capitalizations were reached are not the same for each currency, i.e. the information shown in Table No. 2 does not correspond to an equal cut-off date for all e-cryptos . This is neither the case for the quotations shown in the "Max Price

(USD)" column of the table. Regarding these it is possible to observe that the one that has obtained a higher price in the cryptocurrencies market is the EverGreenCoin, with 0,420512 dollars by each EGC. It is followed by SolarCoin at USD 0.245471/SLR, and finally TeslaCoin at USD 0.115184/TES. It is noteworthy that the maximum value reached by CarbonCoin was 0.000059 USD/CARBON, a remarkably low value. For reference, Figure 1 shows the price of the five most heavily capitalized coins in the cryptocurrency market, at the beginning of May 2017.

#	Name	Symbol	Market Cap	Price
1	Bitcoin	BTC	$25,641,788,866	$1571.89
2	Ethereum	ETH	$8,895,975,441	$97.38
3	Ripple	XRP	$3,788,581,687	$0.099816
4	Litecoin	LTC	$1,363,784,260	$26.76
5	Dash	DASH	$721,460,828	$99.12

Figure No. 1 Top-5 cryptocurrencies with higher market capitalizations in the world

Conclusions

Cryptocurrencies for environmental purposes are at an early stage of development. There is a high potential in the implementation of the cryptocurrencies blockchain technology in general, but especially as a framework for the operation of environmental-oriented ones, because of the challenge of obtaining positive net environmental benefits from this revolutionary technology that was born being very energy intensive.

Blockchain technology can be used to keep global accounting for CO_2 emissions reduction, especially if these efforts are increasingly being deconcentrated from large corporations and national and supranational levels, and adopting new forms such as NAMAs, which actioned climate efforts at levels closer to the common people but not enough yet.

The concept of e-cryptos comes in addition to that of Voluntary Carbon Markets, but even surpasses it, since rather than seeing CO_2 emissions reductions as simple *emissions offsets*[1], the e-cryptos will allow the appropriation of a financial instrument (virtual money) that can gain value over the time and globally adoption.

The proportion of e-cryptos over the cryptocurrencies universe in general is quite low (about 1%), as well as being very far from being in the top-5 of the higher market capitalization cryptocurrencies. However, in order to climb positions in such world ranking, the clarity, specificity and transparency of the environmental objectives of each e-crypto statement is very necessary, that is, it may not be recommended to promote environmental e-cryptos with only promises for the future, as this adds uncertainty and therefore would not expect significant growth in the market value of the currency.

The transcription, into computational cryptographic algorithms languages, of the many international accepted methodologies of greenhouse gas emissions and reductions estimations (e.g. IPCC and Clean Development Mechanism methodologies respectively), could be an ideal field for the development of blockchain technology applied to the mitigation of climate change. Since such methodologies require precise and very accurate real physical data (also in accordance with MRV approach), it would be advisable to visualize nexuses between the development of e-cryptos and their functioning algorithms, in connection with the Internet-based data acquisition and transmission new kind of devices under the so called *Internet of Things* (IoT) and blockchain, as a technological platform for trust that provide real -non fake- data and therefore credibility to e-cryptos impact.

Environmental cryptocurrencies are conceived to achieve laudable and even very pertinent environmental objectives in the world of today, particularly those that seek to make positive contributions in the fight against climate change. Additionally, the possibility of being rewarded with cryptocurrencies thanks to the autonomous production of solar energy, for

[1] emissions reductions through a globally net zero emissions approach.

example, could have a positive impact on the promotion of this renewable energy source and its impacts on the mitigation of climate change. Likewise, the promotion of the reduction of energy consumption through voluntary and energy-conscious savings (based on an *energy education* perspective) could be seen as a field of opportunity for the development of a new cryptocurrency with a place in the carbon market. Institutional support for such a project would greatly contribute to its wide dissemination and adoption by individuals worldwide, both in developed and developing countries.

The development of environmental cryptocurrencies, particularly those associated with climate change, would have an impact on ODS #7 (Affordable and Clean Energy), #3 (Climate Action) and #12 (Responsible Consumption and Production), due to the promotion of the renewable energies that can be addressed and the energy efficiency by the conscious savings and rational use of energy resources especially at the level of common people. The ODS #8 (Decent Work and Economic Growth) and #9 (Industry, Innovation and Infrastructure) would be positively impacted because the development of e-cryptos would contribute so much to the provision of personal, family or community additional incomes through the rewards provided by e-cryptos (and its increased market value), and also due to the connection with the mass-manufacturing industry of IoT devices designed to work with the “e-cryptos enable” scheme, especially those devices from the energy field. The ODS #11 (Sustainable Cities and Communities) could get positive impacted due to the environmental objectives that are pursued by e-cryptos, even more with the existing potentialities into the cities.

Recommendations

- To carry out a deeper research of the cryptocurrencies considered in this study through discussion’s forums like bitcointalk.org, the website preferred by cryptocurrencies enthusiasts around the world as a launching platform (with detailed info, technical specifications and clarifications). This analysis could better clarify the process of creation of each e-crypto, which can be useful in order to know the best practices regarding its conceptualization and operation.

- To conduct a process of direct contact or personal interviews with the promoters of the e-cryptos projects, in order to know more about their experiences and causes that determined their successes or failures.

- To study the possibility of unification of energy and CO_2 emissions reductions e-cryptos and preview the impacts of this measure and its potentialities in regards of the consolidation of a unified and trusted environmental cryptocurrency with support of international organizations. A dedicated website for the monitoring and focus on e-cryptos only could be a good starting point, even an “Exchange" website, in terms of market traded operations among e-cryptos, could be an interesting middle step.

- To deeper the study of different algorithms used by cryptocurrencies (PoW, PoS, PoG, etc.), in order to determine in a more accurate and precisely way its computational efficiency and energy consumption, and perform a better assessment of net environmental benefits.

References

Berensmann K., Dafe, F., Lindenberg, N. & Kauts, M. (2016). **Green Bonds: Taking Off the Rose-Coloured Glasses**. German Development Institute.

Bitcointalk.org (2014). “SolarCoin (SLR)”. Disponible en https://bitcointalk.org/index.php?topic=785257.0

Evironmental Investigation Agency, EIA (2010). “Compensación del gas HFC-23 en el contexto del Régimen de Comercio de Derechos de Emisión en la UE”. Disponible en: http://carbonmarketwatch.org/wp-content/uploads/2010/07/HFC-23_Policy-Briefing_ES2.pdf

Euractiv (2010). “Hungary’s sale of ‘used’ CO_2 credits worries carbon traders”. Disponible en http://www.euractiv.com/section/climate-environment/news/hungary-s-sale-of-used-co2-credits-worries-carbon-traders/

Gronewold (2011). “Europe's Carbon Emissions Trading -- Growing Pains or Wholesale Theft?”. New York Times. Disponible en http://www.nytimes.com/cwire/2011/01/31/31climatewire-europes-carbon-emissions-trading-growing-pai-74999.html?pagewanted=all

Levi, M. D. (1991). **Bretton Woods: Blueprint for a greenhouse gas agreement**. Ecological Economics, 4, 253-267.

Malmo, Christopher (2015). “Bitcoin is Unsustainable”. Motherboard. Disponible en: https://motherboard.vice.com/en_us/article/bitcoin-is-unsustainable

Nakamoto, Satoshi (2009). Bitcoin: un sistema de dinero en efectivo electrónico peer-to-peer. Disponible en: https://bitcoin.org/bitcoin.pdf

Stua, Michele (2017). **From de Paris Agreement to a Low-Carbon Bretton Woods**. Springer International Publishing.

Annex 1.-

Proposal of concept for a new e-crypto:

The Project and its innovation aspects

Create a world cryptocurrency backed by CO_2 emissions reductions through energy savings and renewable energy production.

Put the carbon market micro-financial incentives for climate change mitigation at the level of common people and not only reserved for corporations, governments and institutions.

EdEnCoin: The first virtual currency proposed to be backed by CO_2 emissions reductions through energy savings. Each time people save energy then they get rewarded.

EdEnCoin is intended to be the global cryptocurrency that could adopt the United Nations Framework Convention on Climate Change, in order to value the decarbonation pathways proposed by the Paris Agreement.

EdEnCoin is an energy saving ecosystem based on the Internet of Things concept

All electronic appliances and devices in houses, buildings and even in transport vehicles will be monitored and network connected through the Internet of Things (IoT) philosophy, following several energy saving protocols specially designed to measure and report kilowatt-hours of energy saved by rational use, consciousness and Energy Education from the common people and its correspondent CO_2 emissions reductions.

The more people involved the more value EdEnCoins will have, in a quite similar way of the famous cryptocurrency known as *bitcoin*.

Environmental Impacts

Several organizations around the world has calculated that the human being need to avoid the emission of billions of tonnes of CO_2eq into the atmosphere in order to prevent an arise of global temperature of about 2°C by 2100. This is called the World Carbon Budget; in monetary terms it is like the gold reserves that -in the past- backed the issuing of money by central banks in some countries, but now here EdEnCoin is presented as the very innovative cryptocurrency with the World Carbon Budget as its backup asset, limiting by this way the fixed quantity of EdEnCoins that could be issued.

The world potencial in energy savings through rational use of energy and Energy Education is huge, and the more ambition in issuing of EdEnCoins the more impacts on CO_2 emissions reductions.

According to UNEP and IEA, no more than 19 GtCO2e must be emitted by 2050 in order to avoid a maximum of 2ºC increase of global temperature, i.e. about 61 GtCO2e (61,000 million tonnes) must be reduced according to

BAU[2] scenario. “Personal” category shown in figure No. 2, represents the potential of emissions reductions at the reach of people.

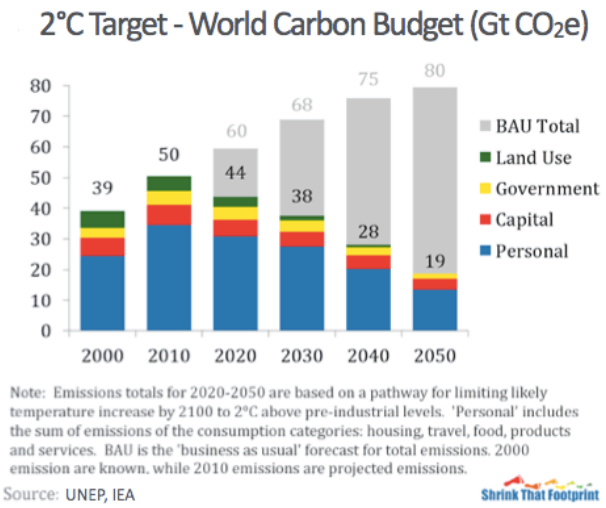


Figura No. 2 World Carbon Budget

Market & client’s eagerness

Carbon markets will not be only for corporations but for common people too. However, corporations and electronics devices and gadgets manufacturers will be natural allies.

In the same way as bitcoin “miners” wish more powerful hardware equipment to gain more rewards (bitcoins), with EdEnCoin the common people will demand for a more diverse and energy savings potential IoT devices to be designed, developed and put into markets in order to be connected to the ecosystem and start gaining EdEnCoins.

Why people will want to be part of EdEnCoin?

1) Because it is an opportunity to be financially rewarded by just saving energy.
2) Because saving energy is cheaper than produce it, so the IoT devices diversity will be bigger and at the hands of common people worldwide. However, EdEnCoin will be also designed to incorporate renewable energy production to its ecosystem of CO_2 emission reductions.
3) Because to be energy consumption aware is the right thing to do.

Initial product developments

EdEnCoin enabled RFID[3] wall light switch

EdEnCoin enabled wall outlet

EdEnCoin enabled Smart energy meters

EdEnCoin enabled Wifi Routers with storage

Temperature and illumination sensor over IoT

Transcription of CDM methodologies for emission reduction through lighting projects, renewable energy small scale production.

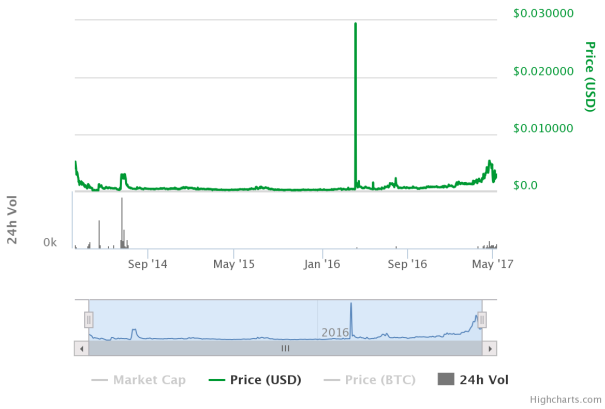
Annex 2.- Examples of cryptocurrencies market quotes

Solar Coin (SLR)

TeslaCoin (TES)

[2] Business As Usual

[3] Radio Frequency Identification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$0.020000
$0.010000
$0.0
Price (USD)
24h Vol
0k
Sep '14
May '15
Jan '16
Sep '16
May '17
2016
Market Cap
Price (USD)
Price (BTC)
24h Vol
Highcharts.com