The 6th International Conference on Economic Management and Green Development (ICEMGD 2022)
DOI: 10.54254/2754-1169/4/2022929

Research of the development of Green Central Bank Digital Currency, CBDC[1]

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Abstract: The idea of a green central bank digital currency (CBDC) has been mentioned by some institutions such as the Congress of the United States and private companies, but it has not been explained. It is intuitive that this concept refers to a way of issuing or using CBDCs by taking the environment into consideration. In this research, it is explored a way that this could work by limiting the CBDC issuance to the total renewable energy production. The paper shows a list of the 40 countries that produce the most renewable energy and compares it with a well-established economic standard, the Total Reserves of Central Banks. For 2018, it was found a correlation among the percentage of the total energy that is produced with green sources and the percentage that could be backed by international reserves if it were the same thing. This correlation is presented as a patron that can be use by Central Banks in order to take environment in to consideration and to calculate how much of a CBDC can be issued by central banks as a standard

Keywords: Green Finances, Standardization, Environmental Commitments.

1. Introduction

In June 2021 the Committee on Financial Services of the United States Congress mention a "green CBDC as a potential design requirement worth testing for" [1] without explaining exactly what "Green CBDC" means or how does this design requirement might be worked? Also in 2021, Alessandro Tentori published for the AXA Investment Managers SA, which is a global investment management firm, a financial report in which states that: "A green CBDC would establish a strong direct link between green finance and the central bank's balance sheet" an idea that he links to green bonds to be available to non-banks [2].

Nonetheless Central Bank Digital Currencies are not bonds, according with the Bank of France CBDCs are:

[1] We kindly appreciate the suggestions made by the members of the International Telecommunication Union and the Bank of International Settlements for this article.

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DOI: 10.54254/2754-1169/4/2022929

"a digital asset that only the central bank may issue or destroy, that is traded at par against bank-notes and reserves, that is available 24/7, that may be used in peer-to-peer transactions and that circulates on digital media that are at least partially different from existing media." p.2 [3],

And also, there is a more widely used definition from the BIS, namely: "a form of digital money, denominated in the national unit of account, that is a direct liability of the central bank" [4].

There are two types of CBDCs: those intended for the general public, which are called Retail CBDCs, and they must specify the forms of security, the types of transfers and the gadgets used. And those envisioned for the use of central banks and operations between then, and with public and private commercial banks, as well, which are called Whosale CBDCs. This research it is about the second one.

2. Central Bank Digital Currency issuance

The Central Bank Digital Currencies, CBDC are the issuance of digital money made by a central bank as its name indicates and unlike other digital currencies such as Bitcoin or Ethereum, it is not backed by cryptography but by what the Central Bank or the government indicates.

Until June 20, 2022, there are at least four CBDCs in force: the Bahamas Sand dollar, the E-RMB from China, the Jam-Dex from Jamaica, and DCash from Eastern Caribbean Central Bank [5]. By February of 2022, around 100 countries were developing or interested in developing Central Bank Digital Currencies [6].

The main economies of the world are studying the implementation of their own digital currency. For example, Japan is studying the Digital Yen, the European Central Bank is studying the Digital Euro, and different entities of the Federal Reserve of the United States of America are studying a Digital Dollar. There are also independent projects from the United Kingdom, Sweden, and Israel.

2.1. The environmental commitments in finances

The Stockholm Conference of 1972, held within the framework of the United Nations Organization, in its 7th proclamation urges that: "Individuals in all walks of life as well as organizations in many fields, by their values and the sum of their actions, will shape the world environment of the future" [7], as well as that it "will require extensive cooperation among nations and action by international organizations in the common interest" that is, this treaty, calls on all people, institutions and States, at their different levels of government, to collaborate in the preservation of the environment.

Also, Paris Agreement of 2015 seeks to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, and to this end stablished in its article 2.1.C: "Making finance flows consistent with a pathway towards low green-house gas emissions and climate-resilient development." [8].

The European Central Bank have declared their objectives toward a green transition (9) [9]. Also, they are efforts made by the Bank of International Settlements, BIS and Central Banks around the world for a sustainable economy with research groups like the BIS Innovation Hub's with develop-ments as the Genesis Project that look for a vision for technology-driven green finance, and involves financial researchers from places like Israel and Hong Kong [10].

Standardization and security on CBDC. There exists a need for standardization for the wide-spread adoption on Central Bank Digital Currency to facilitate the interoperability among the banks that enable payment systems to exchange information. This would include characteristics from infra-structure to common legal and regulatory frameworks to facilitate cross-border and cross-currency payments that usually are more complex than domestic ones [11].

A standard must accomplish not only interoperability among banks and countries but also to offers security for possible problems as quantum computing. There are different opinions of when quantum

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computer would be available but big tech companies as Alphabet, IBM, Microsoft, Ali Baba and others are investing billions in research and development of their quantum computing; also, governments, for example, China invested USD 10 billion in a national quantum computing laboratory, the U.S. government USD 1 billion, and the EU more than EUR 1 billion [12]. With so many major players involved sooner than later quantum computing would be available what would be a big problem for CBDCs.

A major part of our security systems, including banks security and CBDC prospects are base in cryptography, and the conventional methods of cryptography when they face quantum will become unreliable [13]. If any system cannot afford to fail that one is the future of our money.

There are alternatives in order to create a virtually unbreakable system, for example a long blockchain as Bitcoin it would be much harder to break and will be secure from quantum computing attacks for many years [14]. What means that a multinational long blockchain network of banks and central banks interconnected might offer security and interoperability, but at the same time the Bitcoin a mining system has an enormous electricity consumption, that today's reach an estimated 150 of terawatt-hours of electricity annually, that is more than the entire country of Argentina, population 45 million [15].

It would be beneficial if, in addition to security, if a CBDC system had a backup, which would allow to restored information on existing money to be retrieved or reissued in a verifiable manner and at the same time would not contaminate or consume so many resources.

3. The system of digital money issuance of renewable energy

A fast energy transition will be key to achieving the climate goals. Transformation of the global energy system to meet the objective of the Paris Agreement to limit the rise in average global temperatures to well below 2°C would require investment of nearly USD 22.5 trillion in new renewable installed [16].

These previously presented challenges could help solve each other if a CBDCs is issued (or limited) to the capacity to produce renewable electrical energy estimated in Megawatts or Gigawatts hour per year of countries; which would offer a global solution since all countries need to switch to renewable energies, and the creation of money would be the right stimulus, which at the same time would offer a standard for CBDCs as well as a system that could be easily verifiable against the problems.

A green CBDC might follow the following principles or reasonings:

1. A coin must be limited access so that not everyone can have access to mint money. Even when people can produce their own energy it will only be a few watts or at best kilowatts, but for now it is almost impossible for a single average individual (excluding the richest people on the planet) to produce 1 Giga watt hour per year with renewable energy, which only countries can do.
2. Money must be issued according to something durable and verifiable. Power generation plants such as dams with proper maintenance can last for centuries and energy production can be easily verified.
3. The issuing of money must be able to adapt to the situation, whether it is necessary to issue more money in an emergency, or whether a new technology is developed that generates much more electricity than the existing ones.
4. The issuing of money by itself should be beneficial to humanity. In this way this proposal overcome gold standard and Bitcoin. The production of CBDCs would stimulate the creation of renewable electric power plants, which would be beneficial both for the environment and for the economy by reducing the cost of electricity, but it would also it would increase the investment in renewables research.

DOI: 10.54254/2754-1169/4/2022929

5. To avoid inflation and populism, the money generated by the production of renewable energy must be introduced into the economy in intervals of five years or every five years, which coincides with the duration of most presidential terms around the world. In this way, people would not associate their well-being with the figure of a person.

6. The construction of power plants must respect human rights, as well as avoid negative environmental impact.

In compliance with the reasoning, it is proposed that the new currency be backed by the country's ability to produce non-harmful energy. For this currency, only renewable energy that comes from: 1. Hydroelectricity, 2. Wind energy, 3. Solar energy, 4. Geothermal energy and 5. New sources that do not negatively affect our environment would be taken into consideration, for example the generation of electricity by using captured CO2, or fusion energy.

The formula might work as follows: When a country would be capable of producing 1 Gigawatt hour per year (GW hr/year) with renewable energy (RwE), it would be authorized to have the amount of one million dollars in digital money. (1 $M). Each monetary value issued in this way will have the same value, regardless of the country where it is issued, which will be equal to 1 US$.

$$1\text{US\$ Million} = \frac{(\text{X})\ \text{GW} \cdot \text{hr/year of RwE}}{1}$$

Where X is the amount of electricity produced by a given country or company, and the value the 1 of the dividers may vary according to the development of technologies or the situation, but this variability must be recorded in a network that might be a blockchain.

Here is comparation of a unit of green energy with a currency unit. This proportion is set according with a curious correlation found it among the green energy production and the total reserves of central banks. This would be determine following a common formula and this amount of money would work apart from cash but interchangeable with it.

The authorization would be given by the central bank to the government of the country that uses this system which would have a common book of accounts with other central banks partners, the common book would be in Blockchain technology or any other similar to facilitate its monitoring and make it difficult to modify. Normally, there is an electricity market where users buy electricity from producers, but here is influencing the money supply (which is normally influenced by the central bank in line with their monetary policy mandates).

3.1. A curious correlation

The creation of a green CBDC, beyond its usefulness in security and standardized, as well as being able to help mitigate climate change, also presents a curious correlation with a well-established economic standard: The total reserves of Central Banks, that "comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities." [17]. This correlation might be used to prevent future inflation by removing money from international reserves and replacing them with green CBDCs reserves.

The values would consider the following:

1. Total production of green energy (without biomass). (Gwh.h/year) in 2018.

2.The percentage of the total energy produce by a country that it's produced with green energy.

3. Total reserves of each country in 2018.

4. The percentage of total reserves that could be backed by renewable energy in Gwh.h/year if this were equivalent to million dollars.

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Table 1: Top 10 countries ordered by production of renewable energy.

Countries with the biggest production of renewable energy: 1 - 10	Total production of green energy (without biomass). (Gwh) [2]	Percentage of the total energy produce with green energy:	Total reserves in 2018, including gold[3]	Percentage of total reserves that could be backed by renewable energy
China	1,772,207	25%	3.170.000	54%
USA	694,000	17.5%	449.000	141%
Brazil	440,371	74.5%	374.000	117%
Canada	385,971	75%	80.016	357%
India	256,744	19.1%	399.170	64%
Russia	193,426	17%	468.650	41%
Norway	143,385	98%	68.110	210%
Germany	179.735	30%	162.346	111%
Japan	161.021	12%	1.270.000	12,6%
France	110.442	28%	166,480	43%

For the table number 1; by taking the percentage of the total energy produce with green energy of China (25%), Brazil (74.5%), Russia (17%), Norway (98%) and France (28%) if these values were multiplied by 2, they would be almost the same than the Percentage of total reserves that could be backed by renewable energy of the same countries: China (54%), Brazil (117%), Russia (41%) and France (43%). In order to reach a similar number of total reserves with renewable energy the formula would be:

$$1\text{US\$ Million} = \frac{(\text{X})\ \text{GW} \cdot \text{hr/year of RwE}}{2}$$

This means that at least for 5 of the 10 major producers of renewable energy there is a common formula that can be associate with how much they would have to increase their energy production if they want to achieve their actual amount of total reserves. In the case of Japan the value is 1 = 1, it means that percentage of the total energy produce with green energy is equal to percentage of total reserves that could be backed by renewable energy.

Table 2: Countries ordered by renewable energy production, from 11 to 20.

Countries with the biggest production of renewable energy: 11- 20	Total production of green energy (without biomass). (Gwh) [4]	Percentage of the total energy produce with green energy:	Total reserves in 2018, including gold[5]	Percentage of total reserves that could be backed by renewable energy
Spain	100,347	33.2%	70,630	142%
Italy	96,978	31%	152,360	64%

[2]Data source: International Energy Agency, IEA, (2022)
[3] Word Bank (2022)
[4]Data source: International Energy Agency, IEA, (2022)
[5] Word Bank (2022)

DOI: 10.54254/2754-1169/4/2022929

Table 2: (continued).

Türkiye	95,118	42,3%	100,700[6]	95%
Vietnam	83,487	38%	64.000[7]	129%
Sweden	79,296	52%	61.417[8]	129%
United Kingdom	77,593	23%	163.820[9]	48%
Colombia	59.932	62%	47.543[10]	126%
Paraguay	59.211	100%	8.000[11]	740%
Venezuela	58,156	67,6%	8.320[12]	698%
Mexico	52.141	21%	176.533[13]	33%

In the second group of countries, for countries with the biggest production of renewable energy, from position number 11 to 20 (table 2), it can be found the same correlation by taking the percentage of the total energy produce with green energy Italy (31%), Türkiye (42.3%), Sweden (52%), United Kingdom (23%), and Colombia (62%) with the percentage of total reserves that could be backed by renewable energy: Italy (64%), Türkiye (95%), Sweden (129%), United Kingdom (48%) and Colombia (126%). Which means that in order to reach almost exactly the same amount of total reserves with green energy the formula would continue without changes.

Table 3: Countries ordered by renewable energy production, from 21 to 30.

Countries with the biggest production of renewable energy: 21- 30	Total production of green energy (without biomass). (Gwh) [14]	Percentage of the total energy produce with green energy	Total reserves in 2018, including gold[15]	Percenge of international reserves that could be backed by renewable energy
Austria	48,704	67.7%	23,190	210%
Australia	41,114	22.7%	65,650	62,7%
Switzerland	39,747	57%	787,020	5,05%
New Zealand	36,333	80.8%	17,662	210%
Indonesia	35,845	12.1%	130,220	27%
Argentina	34,088	21.1%	66,200	51,4%
Peru	32,974	49.1%	60,335	54,68%
Chile	32,073	35.8%	39,860	80%
Pakistan	31,129	33%	11,840	262%
Portugal	27.245	48.4%	24.920	109%

[6] Türkiye Cumhuriyet Merkez Bankası (2018)
[7] Vietnamplus (2018)
[8] Sveriges Riksbank (2018)
[9] Bank of England (2018)
[10] Banco de la República Colombia (2018) "Saldo de las reservas internacionales. Mensual desde 1960"
[11] Banco Central de Paraguay (2018) "Anexo Estadístico del Informe económico - 21 de septiembre de 2018, cuadro 53-b"
[12] Banco Central de Venezuela (2018) "Reservas internacionales – 14/09/2018"
[13] Banco de Mexico "(CF 169) – Information on Banco de Mexico´s International Assets – agosto 2018"
[14]Data source: International Energy Agency, IEA, (2022)
[15] Word Bank (2022)

DOI: 10.54254/2754-1169/4/2022929

In a third group of countries, for countries with the biggest production of renewable energy, from position number 21 to 30 (table 3), it can be found a similar correlation previously pointed, this time with: Argentina (21.1%), New Zealand (80.8%), Indonesia (12.1%), Chile (35.8%), Australia (22.7%), and Portugal (48.4%) in which the percentage of total reserves that could be backed by renewable energy it would be: Argentina (51.4%), New Zealand (210%) Indonesia (27%) Chile (80%), Australia (62,7%) and Portugal (109%).

Table 4: Countries ordered by renewable energy production, from 31 to 40.

Countries with the biggest production of renewable energy: :31 - 40	Total production of green energy (without biomass). (Gwh)[16]	Percentage of the total energy produce with green energy:	3.Total reserves in 2018, including gold[17]	Percenge of international reserves that could be backed by renewable energy
Romania	26,190	40.6%	34,507	75%
Lao	22.328	53.1%	980	2,278%
Philippines	22,221	23.4%	79,200	28%
Ecuador	20,678	58%	2,940	703%
Iceland	19,824	100%	6,320	313%
South Korea	19,428	1.8%	403,080	4.82%
Tajikistan	18,394	97.5%	1,280	1437%
Egypt	17,664	8,5%	41,840	42.25%
Iran	16,283	5.7%	122,500[18]	13.29%
Greece	15,851	29%	6083	171%

In the last analyzed group of countries analyzed in this brief study, countries with the biggest production of renewable energy, from position number 31 to 40 (table 4)19, it can be found the same correlation previously pointed in the following countries: Romania (40.6%), South Korea (1.8%), and Iran (5.7%), in which the percentage of total reserves that could be backed by renewable energy it would be: Romania (75%), South Korea (4.82%), and Iran (13.29%), what offers a total of 19 over 40 countries that might use the same formula.

Limitations to the application of a Green CBDC. Despite the fact that every country needs to produce renewable energy and this would produce great benefits for the environment and the economy, there are some issues that would have to be considered in order to apply a green CBDC. These include:

[16]Data source: International Energy Agency, IEA, (2022)
[17] Word Bank (2022)
[18] International Monetary Fund (2021)
[19] See the annex

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1. Infrastructure of the country: In addition to the country's existing renewable energy capacity, which will be a factor that would facilitate the adoption of this currency by policymakers, telecommunications infrastructure should be considered, as these are essential for any digital transaction.

2. Digital literacy and use of digital payments: The culture of payments, as well as the digital culture of a country, must be considered in order to be able to assess how much a Green CBDC could encompass in the population of a country. This challenge can be mitigated by consulting the population and disseminating information, as well as the gradual incorporation of the currency.

3. Legal and Political limitations: To incorporate a CBDC there are political and legal limitations that must be taken into account in each country, for example the adoption of laws changes from country to country, and although monetary policy is controlled by central banks, it must also be consistent to the economic and political needs of the countries that could see the limitation of renewable energy as an obstacle.

4. The shift of a paradigm: Even when limit the money issuance to the renewable energy production would force to governments to invest in renewable energy what would help to mitigate climate change, since the gold standard was abandoned in the 1970s, there is no limit to the amount of money that countries can issue, monetary policies respond to their economic and political needs. Creating a new standard, the renewable energy standard, could not work in the entire monetary mass, it must allow countries flexibility to acting when is necessary, which would probably make that a green CBDC have a limited direct influence on their effects against climate change, but nevertheless it would help to facilitate the trillion dollars investment for the avoidance of climate change [18].

4. Conclusion

Central banks are issuing or exploring how to issue digital currencies, while private companies are launching their own versions of digital tokens. In this rapidly evolving landscape, it is important to consider the role that renewable energy can play in powering the digital economy. The total amount of renewable energy to mint digital currencies can have several benefits, for example:

1. It would standardize and secure the global financial system by providing a common platform for all central banks to issue their own digital currencies.

2. Promote the use of renewable energy more broadly.

3. Using the amount of renewable energy to mint digital currencies can help to raise awareness about the importance of transitioning to a low-carbon economy.

4. The adoption of a Green CBDC system would allow the accomplishment of the Paris Agreement of 2015 by directing finance flows to a climate-resilient development, that at the same time stimulates CO2 decreasing, which in conjunction with CO2 sequestration measures, and respect for human rights, including the rights of nature, could create an alternative that is worth further study.

5. Give access to the issuance of a robust decentralize currency to developing countries, that would strength their national incomes and help to reduce inequalities worldwide.

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Considering the existing correlation among the percentage of the total energy produce with green energy, and the percentage of total reserves that could be backed by renewable energy in: China, Brazil, Russia, Norway, France, Italy, Türkiye, Sweden, United Kingdom, Colombia, Argentina, New Zealand, Indonesia, Chile, Australia, Portugal, Romania, South Korea, and Iran… until now, it can be said that it is a global correlation that can be used to establish an economic standard that takes into account the environment and stimulates the production of renewable energy.

The fact that the correlation found, was observed in almost the entire world, with countries in Europe, Africa, North America, South America, Oceania, and Asia, might facilitate the standardization of CBDCs and opens the door to further research.

References

[1] *U.S. House of Representatives, Digitizing the dollar: investigating the technological infrastructure, privacy, and financial inclusion implications of central bank digital currencies, https://www.govinfo.gov/content/pkg/CHRG-117hhrg45254/html/CHRG-117hhrg45254.htm, last accessed 2022/12/02*

[2] *AXA, IM, Central bank digital currencies: policy and design, https://www.axa-im.com/news-and-experts-insights/investment-institute/macroeconomics/macroeconomic-research/central-bank-digital-currencies-policy-and-design, last accessed 2022/12/03*

[3] *Banque de France, Central Bank Digital Currency: https://publications.banque-france.fr/en/central-bank-digital-currency, last accessed 2022/12/03*

[4] *Bank for International Settlements, Central bank digital currencies: foundational principles and core features. https://www.bis.org/publ/othp33.htm, last accessed 2022/12/03*

[5] *Auer R, Cornelli G, Frost J. Rise of the central bank digital currencies: drivers, approaches and technologies. In: BIS Basel; pp. 1 - 41 (2022)*

[6] *International Monetary Fund, The Future of Money: Gearing up for Central Bank Digital Currency: https://www.imf.org/en/News/Articles/2022/02/09/sp020922-the-future-of-money-gearing-up-for-central-bank-digital-currency, last accessed 2022/12/03*

[7] *United Nations, Report of the United Nations Conference on the Human Environment; United Nations Publication; Stockholm (1972).*

[8] *United Nations, Paris Agreement. In United Nations Framework Convention on Climate Change; United Nations, Paris (2015)*

[9] *European Central Bank, Speech by Christine Lagarde, President of the ECB, at the International Climate Change Conference in Venice, https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210711~ffe35034d0.en.html, last accessed 2022/12/03*

[10] *Bank of International Settlements, Project Genesis 1.0: Prototype digital platforms for green bond tokenization, https://www.bis.org/about/bisih/topics/green_finance/green_bonds.htm, last accessed 2022/12/03*

[11] *Bank of International Settlements, Central banks face key decisions on interoperability and cross-border usage if CBDCs are to fulfil their potential - joint report, https://www.bis.org/press/p220711.htm, last accessed 2022/12/03*

[12] *Rietsche R, Dremel C, Bosch S, Steinacker L, Meckel M, Leimeister JM. Quantum computing. Electronic Markets. pp. 1-12. Springer, Berlin (2022)*

[13] *Vaishnavi A, Pillai S. Cybersecurity in the Quantum Era-A Study of Perceived Risks in Conventional Cryptography and Discussion on Post Quantum Methods. Journal of Physics: Conference Series, 1964 pp. 1-12. (2021)*

[14] *Webber M, Elfving V, Weidt S, Hensinger WK. The impact of hardware specifications on reaching quantum advantage in the fault tolerant regime. AVS Quantum Science, vol 4 pp. 1-16 (2022)*

[15] *Columbia Climate School, Cryptocurrency's Dirty Secret: Energy Consumption, ttps://news.climate.columbia.edu/2022/05/04/cryptocurrency-energy/#:~:text=How%20much%20energy%3F,of%20Argentina%2C%20population%2045%20million., last accessed 2022/12/03*

[16] *International Renewable Energy Agency, Investment, https://www.irena.org/Energy-Transition/Finance-and-investment/Investment#needs, last accessed 2022/12/03*

[17] *World Bank Group, Metadata Glossary, https://databank.worldbank.org/metadataglossary/international-debt-statistics/series/page/5, last accessed 2022/12/03*

DOI: 10.54254/2754-1169/4/2022929

[18] United Nations, The trillion dollar climate finance challenge (and opportunity), https://news.un.org/en/story/2021/06/1094762, last accessed 2022/12/03