

AMERICAN UNIVERSITY OF BEIRUT

MITIGATING CRYPTOCURRENCIES' CARBON
FOOTPRINT, FROM A LEGAL PERSPECTIVE - CASE OF
LEBANON

by
CHRISTELLE JOSEPH GHANEM

A thesis
submitted in partial fulfillment of the requirements
for the degree of Master of Science
to the Department of Mechanical Engineering
of the Maroun Semaan Faculty of Engineering and Architecture
at the American University of Beirut

Beirut, Lebanon
May, 2023

AMERICAN UNIVERSITY OF BEIRUT

MITIGATING CRYPTOCURRENCIES' CARBON
FOOTPRINT, FROM A LEGAL PERSPECTIVE - CASE OF
LEBANON

by
CHRISTELLE JOSEPH GHANEM

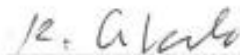
Approved by:



Signature

Dr. Nesreen Ghaddar, PhD
Department of Mechanical Engineering

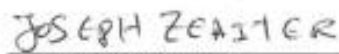
Advisor



Signature

Dr. Kamel Abou Ghali, PhD
Department of Mechanical Engineering

~~Member of Committee~~



Signature

Dr. Joseph Zeaiter, PhD
Department of Chemical Engineering

~~Member of Committee~~

Date of thesis defense: May19, 2023

AMERICAN UNIVERSITY OF BEIRUT

THESIS RELEASE FORM

Student Name: Ghanem Christelle Joseph

I authorize the American University of Beirut, to: (a) reproduce hard or electronic copies of my thesis; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes:

- As of the date of submission
- One year from the date of submission of my thesis.
- Two years from the date of submission of my thesis.
- Three years from the date of submission of my thesis.


Signature

24-05-2023

Date

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Professor Nesreen Ghaddar, for her guidance and support. Dr. Ghaddar has been generous with me in enlightening some very interesting and important elements of the topic.

I am also grateful for Professor Hassan Harajli's assistance, as he was my co-advisor before he left AUB. Dr. Harajli gave me insightful feedback and comments on my research which have been invaluable in helping me to develop my ideas and improve my writing.

I also wish to thank my family and friends for their unwavering support throughout this journey and encouragement throughout my thesis writing process.

ABSTRACT OF THE THESIS OF

Christelle Joseph Ghanem

for

Master of Science

Major: Energy Studies

Title: Mitigating Cryptocurrencies' Carbon Footprint, from a legal perspective – Case of Lebanon

Cryptocurrency is an emerging topic and bitcoin is witnessing a rising popularity throughout the world. Unfortunately, cryptocurrency presents a major downside from an environmental standpoint. Lebanon, in common to all the other countries, is also facing the recourse of a large number of its nationals to cryptocurrency, which could place it in a weak situation with respect to achieving its commitments under the Paris Agreement. The present thesis evaluates the existing evidence on the carbon footprint of cryptocurrencies in Lebanon and assesses the potential of various approaches including energy efficiency, renewable energy sources, and technological innovations to reduce their environmental impact. Through a review of existing literature, this thesis assesses the feasibility and applicability of each proposed solution from a legal stance. Finally, this thesis aims to provide policy recommendations to the Lebanese government on how best to reduce the carbon footprint of cryptocurrencies in the country, so that Lebanon could be able to offset the cryptocurrency carbon footprint and avoid worsening its situation from an environmental and climate change perspectives.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	1
ABSTRACT.....	1
INTRODUCTION.....	6
BACKGROUND	8
2.1. Overview of Cryptocurrencies	8
2.1.1. Description.....	8
2.1.2. Historical Background	9
2.1.3. Features and Characteristics.....	10
2.2. Environmental Impacts of Cryptocurrencies.....	13
2.2.1. Mining Process of Cryptocurrencies.....	13
2.2.2. Carbon Footprint of Cryptocurrencies.....	15
2.3. Rise of Cryptocurrencies in Lebanon.....	17
SOLUTIONS TO MITIGATE THE CARBON FOOTPRINT OF CRYPTOCURRENCIES.....	23
3.1. The Switch to Cryptocurrencies that are Based on Proof of Stake Mechanism instead of Proof of Work.....	23
3.2. The Use of Renewable Energy Sources for Mining Cryptocurrencies that Process on the Proof of Work Mechanism	26
3.3. The Implementation of New Green and Energy Efficient Technologies for the Mining Hardware of Cryptocurrencies that Process on the Proof of Work Mechanism	28
APPLICABILITY FROM A LEGAL PERSPECTIVE OF THE SOLUTIONS TO MITIGATE THE CARBON FOOTPRINT OF CRYPTOCURRENCIES	31

4.1. Implementing Legally the Adoption of Cryptocurrencies that Process on the Proof of Stake Mechanism.....	31
4.1.1. Risks of Cryptocurrencies.....	32
4.1.2. Necessity of a Legal Framework for Cryptocurrencies.....	33
4.1.3. The Status of Legal Framework of Cryptocurrencies in Lebanon.....	35
4.1.4. The Way Forward Regarding the Legal Framework of Cryptocurrencies in Lebanon.....	38
4.1.5. Incentivizing in the Legal Framework of Cryptocurrencies the Adoption of Proof of Stake Mechanism.....	41
4.2. Implementing Legally the Use of Renewable Energy Sources for Mining Cryptocurrencies that Process on the Proof of Work Mechanism.....	42
4.2.1. Impediments to the Installation of Renewable Energy Systems.....	43
4.2.1.1. Monopoly of Electricite Du Liban (EDL).....	43
4.2.1.2. Non-Implementation of the Electricity Regulatory Authority.....	44
4.2.1.3. Lack of Legal Framework Governing Renewables.....	45
4.2.2. Mitigation of the Impediments to the Installation of Renewable Energy Systems.....	46
4.2.2.1. Temporary Licenses for Private Sector Participation.....	46
4.2.2.2. Net-Metering EDL Board of Directors Resolution.....	47
4.2.3. The Way Forward for Reaching Definitive Solutions and Implementing Renewable Energy Projects.....	47
4.3. Implementing Legally the Use of New Green and Energy Efficient Technologies for the Mining Hardware of Cryptocurrencies that Process on the Proof of Work Mechanism.....	48
4.3.1. Imposing directly energy efficiency and green technologies.....	49
4.3.2. Imposing indirectly energy efficiency and green technologies.....	52

PRIORITY OF ALLOCATION OF AVAILABLE ELECTRICITY BETWEEN CRYPTOCURRENCY AND OTHER SECTORS IN THE COUNTRY.....56

SUMMARY OF POLICY RECOMMENDATIONS AND EVALUATION OF THEIR IMPLEMENTATION.....	60
CONCLUSION.....	64
REFERENCES	65

CHAPTER 1

INTRODUCTION

Cryptocurrency is a virtual medium of exchange existing only electronically, without having any physical material counterpart such as a coin or a bill. In recent years, cryptocurrency's value has soared. However, cryptocurrency's detractors have been always bringing to light its inefficiencies and side effects, including the lack of consumer protection, the facilitation of money laundering, tax evasion, purchase of drugs and weapons, child pornography and many other crimes. Environmentalists have always highlighted cryptocurrency's huge carbon footprint. As a matter of fact, the annual amount of energy consumed by cryptocurrencies could go up to more than what entire nations could consume. This situation leads to significant greenhouse gases emissions due to the fact that globally the dominant source of energy adopted is the burning of coal and fossil fuels. Cryptocurrency consumes an enormous amount of energy and generates a lot of carbon dioxide, but despite that, its popularity is steadily rising at a time when the whole world is desperately striving to cut carbon emissions. For instance, in Lebanon, a growing number of Lebanese have turned in the last two years to trading and mining bitcoin in an attempt to gain financial freedom and secure the much-needed remittances of fresh USD. On the other hand, Lebanon has adhered to the Paris Agreement, committing itself to cutting carbon emissions by 2030 as per the following Nationally Determined Contribution (NDC) targets: an unconditional pledge to reduce Greenhouse Gases (GHG) emissions by 20% compared to Business-As-Usual (BAU) scenario in 2030, and a conditional pledge to reduce 31% GHG emissions compared to BAU by 2030. Despite such commitments, Lebanon has witnessed a surge of the cryptocurrency which inherently stands as a threat to any

emission neutrality or even emission reduction target. The most common global solution laid down for circumventing the tremendous energy consumption of bitcoin is the adoption of green cryptocurrencies, renewable energy sources and energy efficient technologies. However, the legal and institutional background of Lebanon might be problematic for embracing such solutions, which makes today the question of whether cryptocurrency could hinder the decarbonization target of Lebanon an important topic that should be seriously addressed. This paper sheds light on the environmental impacts of cryptocurrencies, the possible solutions to mitigate them and the possibility to apply such solutions from a legal perspective.

CHAPTER 2

BACKGROUND

2.1.Overview of cryptocurrencies

2.1.1. Description

Cryptocurrency is a digital or virtual medium of exchange existing only electronically, without having any physical material counterpart such as a coin or a bill. It is created, held, and transferred electronically. It is not a physical coin or note, and it cannot be printed or minted. Cryptocurrency is a digital asset that exists only on computers and can be stored in digital wallets (Darlington, 2022).

The name cryptocurrency is a combination of “cryptography” and “currency”. In fact, cryptocurrency uses the advanced technology of cryptography for security and is a type of alternative currency, meaning that it is not a fiat currency, and it is not backed by a physical commodity such as gold or silver (Kerner, 2023).

Cryptocurrency can be used for buying and selling goods and services, investing, and transferring funds. It can also be used for speculation and trading, much like stocks, bonds, and other traditional investments. Cryptocurrency trading and speculation are highly volatile and involve high levels of risk (Frankenfield, 2022).

Cryptocurrency is different from traditional online payment gateways, like PayPal or bank transfers, in a way that there is no organization that holds the money and transfers it on behalf of its owner upon its request (Coursera, 2023). In cryptocurrency, the owner can act as his own bank by running a free software (an application on smartphone) and can connect directly with other people through their computers,

meaning that it is a peer-to-peer transaction, no middleman is required. And when a transaction is made, the money is transferred within seconds, even if the receiver is at the other side of the world.

Cryptocurrency is not issued by any central authority, rendering it theoretically immune to government interference or manipulation (Darlington, 2022).

2.1.2. Historical Background

Cryptocurrencies have been a hot topic of discussion in the news, on the internet, and in financial circles all over the world. But what many people don't know is that the history of cryptocurrencies dates all the way back to the late 1980s. In fact, the first cryptocurrency, called "Bit Gold", was developed in 1998 by cryptographer Nick Szabo (Jones, 2023).

Bit Gold was designed to be a decentralized, digital form of money that could be used by anyone, anywhere. It was meant to be a secure, anonymous, and untraceable form of money, but unfortunately the project never got off the ground (Jones, 2023).

In 2009, the world's first cryptocurrency, Bitcoin, was created by an unknown individual or group of individuals using the pseudonym Satoshi Nakamoto (Jones, 2023). Bitcoin was designed to be a peer-to-peer electronic cash system, with no central authority or banks involved. It was revolutionary in that it enabled users to send and receive money without the need for an intermediary (Frankenfield, 2022).

Since its launch, the price and market capitalization of Bitcoin have grown exponentially, making it the most popular and widely used cryptocurrency in the world.

Other notable cryptocurrencies that have been created since Bitcoin include Litecoin, Ethereum, Dash, Ripple, and Monero (Jones, 2023).

In addition to Bitcoin, other cryptocurrencies have been developed that are based on different protocols and platforms. For example, Ethereum is a decentralized platform that runs smart contracts, which are computer programs that can be used to execute digital transactions without the need for a third party (Jones, 2023).

The rise of cryptocurrencies has sparked a massive global debate about their potential impact on the world economy. Supporters of cryptocurrencies believe that they can provide a secure, fast, and low-cost way to send and receive money anywhere in the world (Jones, 2023). On the other hand, critics of cryptocurrencies argue that they can be used to facilitate illegal activities, such as money laundering, tax evasion, and terrorist financing.

Despite the controversy surrounding cryptocurrencies, the technology has revolutionized the way we think about money and the way we conduct financial transactions. Cryptocurrencies offer a new level of accessibility, security, and anonymity, and they are likely to continue to play an important role in the future of finance.

2.1.3. Features and Characteristics

Cryptocurrencies are encrypted to protect and secure transactions. As they use cryptography for security, they become difficult to counterfeit because of such security feature. The encryption technology used is typically blockchain.

Blockchain is an innovative technology that enables the secure transfer of digital assets without the need for intermediaries. It is a distributed ledger technology (DLT) that provides a secure and reliable way to store and transfer information. It records transactions between two parties in a transparent, secure, and immutable manner. It is a decentralized system that consists of a network of computers, called nodes, that validate transactions and store them in a shared ledger. This ledger is a chain of records that is continuously growing and is secured by cryptography (Dumitriu, 2020). In other terms, transactions are batched into “blocks,” which are then connected in chronological order in a long, unbroken “chain.” This is why the software is called “blockchain.”

Due to this blockchain technology, cryptocurrencies have the following features:

- The primary benefit of blockchain technology is that it is secure and reliable. Transactions are stored on a blockchain and are secured through the use of cryptographic algorithms. This ensures that no one can change the data stored on the ledger, and that all transactions are verifiable (Hayes, 2022).

In fact, to secure transactions, a cryptographic signature is embedded at the end of each block. In fact, each entry (called a block) in the database is cryptographically linked to the last entry. Each new entry must contain a sort of digital fingerprint of the last one. Since each fingerprint points back to the last one, we end up with a chain of blocks. A blockchain is immutable: if someone changes a block, he changes the fingerprint. And since that fingerprint is included in the next block, the next block is changed too. We end up with a domino effect where any change becomes evident. No one can alter any information without everyone noticing, it needs a consensus of all participants to alter it, thus prohibiting malicious tampering.

- Every transaction is recorded on the blockchain, and this blockchain is replicated on all users' computers. This ensures that no one on the network is counterfeiting the currency or double spending the same cryptocurrencies.
- Blockchains are append-only. That means that users can only add information – they cannot delete or alter information already added. So blockchain becomes a database that contains the history of whatever information it was designed to store.
- In addition to its security benefits, blockchain technology also offers transparency and trust. All transactions are stored on a public ledger, and anyone can view them. This means that all transactions are auditable and traceable. This is especially useful in cases where there is a need for transparency, such as in the financial sector (Hayes, 2022).
- Furthermore, blockchain technology is also highly efficient. Transactions are processed extremely quickly and there is no need for intermediaries, such as banks. Transactions are peer-to-peer. This makes it much more cost-effective than traditional methods of conducting financial transactions. In fact, cryptocurrencies are decentralized, meaning they are not controlled by a single entity or government. They use decentralization to create a secure and efficient system for transferring and storing funds. Decentralization is achieved by allowing users to hold and transfer funds without the need for a third-party intermediary. This makes cryptocurrencies more secure and resistant to fraud or manipulation (Hayes, 2022).

In a nutshell, cryptocurrencies are characterized by high levels of privacy and anonymity. Transactions are recorded in a public distributed ledger called a blockchain,

but the identity of the parties involved in the transactions are not revealed. This makes cryptocurrencies attractive for those looking for privacy and security for their transactions.

2.2. Environmental Impacts of Cryptocurrencies

As mentioned above, cryptocurrencies are digital assets that are powered by blockchain technology, a revolutionary form of decentralized digital ledger technology. Although the technology has the potential to revolutionize the way that people conduct financial transactions, it comes with significant environmental impacts due to its mining process.

2.2.1. Mining Process of Cryptocurrencies

Cryptocurrencies are typically created through a process called mining. Mining is the process of verifying and recording transactions to the public ledger, which is the blockchain. This is done by miners, who use powerful computers in a distributed network to solve complex mathematical puzzles. Miners then are rewarded with newly created cryptocurrencies for their work. This process is called “proof of work” (Frankenfield, 2022).

In practice, when a transaction is fielded, messages are sent to all nodes at once making it impossible to tell exactly where the message came from. In this manner the transaction is free from censorship. Then, “miners” with huge computing power will step in to try to verify that the sender and the receiver both exist, and so to validate the

transaction. The miner who first verifies the transaction and documents it on the blockchain will be rewarded with a newly minted cryptocurrency.

Cryptocurrency mining is a very competitive process, as miners must use their computational power to solve the puzzles faster than their competitors. Miners must also be aware of the current difficulty level of the puzzles, as this determines how much cryptocurrency they will receive for solving each puzzle (Hildreth, 2022).

The first step in cryptocurrency mining is to join a mining pool. This is a group of miners who are working together to solve the puzzles and share the rewards. Joining a mining pool allows miners to access more powerful hardware and use distributed computing to solve the puzzles faster (Arora, 2023).

Once the miner has joined a mining pool, they will need to install mining software on their computer. This software connects the miner to the mining pool and allows them to start solving the puzzles. The miner will also need to configure the software correctly to ensure they are maximizing their rewards (Arora, 2023).

The next step is to build a mining rig. This is a specialized computer system designed specifically for mining cryptocurrencies. The rig will contain multiple GPUs, which are needed to solve the puzzles quickly (Arora, 2023). The miner will also need to install a cooling system to keep the rig from overheating.

Once the mining rig is set up, the miner will need to choose which cryptocurrency to mine. This decision will depend on the current market value of the cryptocurrency, as well as the miner's own preferences. The miner will then need to configure the mining software to mine the chosen cryptocurrency (Hildreth, 2022).

Once the miner has configured the mining software, they will start to solve the puzzles. As the puzzles are solved, the miner will receive rewards in the form of

cryptocurrency (Arora, 2023). The miner will then need to withdraw the cryptocurrency from their wallet and exchange it for fiat currency or other cryptocurrencies (Hildreth, 2022).

In a nutshell, cryptocurrency mining is a complex process and requires a lot of technical knowledge. It is also very competitive, as miners must use powerful hardware and distributed computing to be successful. Despite these difficulties, cryptocurrency mining can be a profitable venture. By joining a mining pool, installing the right software, and configuring their rigs correctly, miners can increase their chances of success.

2.2.2. Carbon Footprint of Cryptocurrencies

The energy consumption of cryptocurrencies is considerable. The reason is the cryptocurrencies' underlying technology, blockchain, which makes cryptocurrencies truly energy intensive. The cryptocurrency mining process as described above requires a tremendous amount of energy, as miners are constantly verifying and updating digital ledgers to ensure accuracy and security. Moreover, hundreds of thousands of computers are involved in the cryptocurrencies' transactions, and cryptocurrencies miners continually increase their computing power in order to compete with other miners. This is why the process is highly energy-intensive, meaning that it requires a lot of electricity to power the computers and servers that are running the mining operations.

The exact amount of energy used and carbon dioxide produced by cryptocurrency mining is difficult to determine. This is because the process is decentralized and it is difficult to track the amount of energy used by each mining operation. However, it is estimated that cryptocurrencies' network consumes more energy than many countries

and that specifically each bitcoin transaction consumes 707 kWh (Cho, 2021). Furthermore, a University of Cambridge analysis suggests that bitcoin mining consumes 121.36 terawatt hours (TWh) a year, which makes bitcoin use more electricity annually than the entire of Argentina, or more than the consumption of Google, Apple, Facebook and Microsoft combined.

This is a huge amount of electricity, and when the carbon intensity of the electricity sources is considered, it is easy to see how the carbon footprint of cryptocurrency mining can be immense. In fact, the major worldwide source of electricity for industries, including cryptocurrencies mining, is typically sourced from traditional energy sources, i.e. generated by burning fossil fuels such as coal, natural gas, and oil. Burning these fuels has significant environmental impacts, as they release carbon dioxide and other pollutants into the atmosphere, which adds to global warming and greenhouses gases (Ritchie & Roser, 2022).

According to a report by CNBC, the produced greenhouse gases by bitcoin mining account for about 35.95 million tons of carbon dioxide emissions each year, approximately the same amount as New Zealand (Cho, 2021). Elizabeth Kolbert reported in an article published in *The New Yorker* that “according to the website *Digiconomist*, a single bitcoin transaction uses the same amount of power that the average American household consumes in a month and is responsible for roughly a million times more carbon emissions than a single Visa transaction”.

Consequently, cryptocurrencies are considered detrimental to the environment and cause considerable carbon footprint, given that they rely mainly on conventional sources of energy. In addition, the energy consumption of cryptocurrency mining operations is growing exponentially, as more and more people start to use digital

currencies, a fact that will lead to higher levels of carbon emissions contributing further to global warming.

2.3. Rise of Cryptocurrencies in Lebanon

Lebanon has seen a huge surge in the adoption of cryptocurrencies in recent years. As of January 2020, the company Blue Wallet, which allows people to store cryptocurrencies securely on blockchain, showed an increase of 1,781 percent in the number of registered portfolios in Lebanon, the highest in the world (Lautissier, 2021). Such rise of cryptocurrencies in Lebanon can be attributed to a variety of factors as follows:

- First, the proliferation of cryptocurrencies is due in no small part to the country's difficult economic situation and the lack of access to traditional banking services (Geylan, 2022). Cryptocurrencies have become increasingly popular in Lebanon as a way for citizens and businesses to protect their assets from devaluation, as the country's currency has been in free fall for years (El Chamaa & Farah, 2022) due to an economic crisis.

The economic crisis in Lebanon is an ongoing financial crisis that has been escalating over the past few years. Actually, decades ago, Lebanon was considered as a banking destination rivalling Switzerland (Tassev, 2022). Unfortunately, after the breakout of the civil war and the end of conflict in 1990, Lebanon was struggling with an unstable economic and financial situation. It is in 2019 that the country plunged into a deep unprecedented economic and banking crisis, when Lebanon defaulted on its sovereign debt in 2020 and the government failed to address a growing budget deficit and a banking sector

weighed down by bad loans and mismanagement. The country's economic woes were exacerbated by regional instability, including the civil war in neighbouring Syria and a growing influx of refugees. Also, the current crisis has been exacerbated by the coronavirus pandemic, which has caused a sharp economic contraction and widespread job losses (Wiseman, 2023).

The economic crisis has been compounded by a sharp devaluation of the Lebanese pound. The Lebanese pound has lost much of its value, leaving citizens with little faith in their government and financial system (Hills, 2022). This has led to skyrocketing inflation and a dramatic increase in the cost of living. The currency devaluation has also caused a liquidity crisis in the banking sector, with banks severely limiting withdrawals and transfers (Wiseman, 2023).

The foregoing turbulence has created a sense of fear and uncertainty among the population, who have sought out other financial solutions to protect their money. Cryptocurrencies have provided the perfect opportunity for Lebanese citizens to safeguard their wealth (El Chamaa & Farah, 2022). As a decentralized, digital asset, cryptocurrencies are seen as an attractive alternative to the traditional banking system, which is seen as unreliable and untrustworthy (Hills, 2022).

Accordingly, many Lebanese citizens have turned to cryptocurrencies as a way to protect their money from the devaluation of their national currency. Cryptocurrencies also offer a way to bypass traditional banking services, which are often seen as unreliable and inefficient due to the inability of the government to manage the banking sector (Geylan, 2022). Given that cryptocurrencies provide a way for people to access financial services without having them rely on the traditional banking system, this has made cryptocurrencies attractive to

a wide range of people, including those who may not have access to traditional banking services.

- The second factor contributing to the rise of cryptocurrencies in Lebanon is the presence of tech-savvy entrepreneurs (El Chamaa & Farah, 2022). Lebanon has long been a hub of innovation and entrepreneurship, with a thriving tech scene (Ali Ahmad, 2020). This has enabled the development of a wide range of digital products and services, including cryptocurrency exchanges, wallets and payment services (Schellen, 2018). This has made it easier for citizens to access cryptocurrencies and use them as a form of payment and investment.
- Furthermore, the government's attitude towards cryptocurrencies has also been a factor in their rapid adoption. Despite the country's economic struggles, the Lebanese government has taken a progressive stance towards the technology, recognizing its potential and even setting up a Blockchain Task Force to promote its development (Santillan, 2018).

The Blockchain Task Force in Lebanon is a government initiative to help the country's economy and its citizens benefit from the emerging technology. The Task Force is composed of members from the public and private sectors and was established to address the challenges of blockchain implementation, develop a national strategy, developing a regulatory framework to ensure the safety and security of blockchain transactions, and encouraging the adoption of blockchain technology by government entities, businesses, and citizens. The Task Force also seeks to create a conducive environment for blockchain startups and to promote the development of blockchain-based applications.

Unfortunately, such initiative was not developed further and could not lay down any tangible work or policy. Nevertheless, it cannot be argued that at the time

of its establishment in 2018, it has helped to create a more welcoming environment for cryptocurrency users and businesses and has encouraged more people to get involved.

- The rise of cryptocurrencies in Lebanon has been further fuelled by the fact that the country does not have a regulatory framework for cryptocurrencies. This has allowed for a more open market, with a wide range of different tokens and coins being traded. This has made cryptocurrencies a viable option for those looking to invest in the market, as well as those looking for a way to send and receive money without relying on traditional banking services.

The rise of cryptocurrencies in Lebanon could have a palpable effect on the country's economy. Not only have citizens found a way to protect their wealth from devaluation, but businesses can also use cryptocurrencies to facilitate payments, reduce transaction costs and expand their customer base.

Lebanon is thus not far at all from the continuous proliferation of cryptocurrencies among its nationals, and actually it is clear that cryptocurrencies have already become an integral part of the Lebanese economy and will continue to play an important role in the country's future. Therefore, given the environmental hardships caused by cryptocurrencies, Lebanon is incurring the peril of rise of the carbon dioxide emissions and the intensification of its carbon footprint. The official data of how much electricity is consumed by the cryptocurrency sector and how much carbon emissions are released therefrom in the atmosphere is not available, due in part to the economic and governance crisis in Lebanon leading State authorities to focus on more pressing economic matters and in part to the lack of regulations and decentralization of the sector leading to the inability to track all crypto mining activities.

As one study warned that Bitcoin could push global warming beyond 2°C (Cho, 2021), it is likely to say that the increased carbon emissions in Lebanon generated by the integration of cryptocurrencies in the Lebanese market and society, could have a negative repercussion on the achievement of the goals of the Paris Agreement or the commitments of Lebanon to its contributions under the Paris Agreement, mainly with respect to the reduction of greenhouse gases emission.

Notwithstanding the foregoing, another problematic issue reveals important to be treated when discussing the significant energy consumption of cryptocurrencies. In fact, the supply of electricity in Lebanon is already deficient. The current infrastructure is not well equipped to meet the basic domestic needs of the indigenous market, let alone to handle additional demands and consumption originated by the cryptocurrency energy-intensive mining process. What is happening in practice is that miners are using the limitedly provided power by the country to carry out their cryptocurrency mining activities. This is disrupting more severely the electricity grid in Lebanon and straining the power supply, which is leading to more aggravated shortages and blackouts. For instance, the power supply by the hydropower plant in Chouf region of Lebanon decreased (El Chamaa & Farah, 2022). Such fact is depriving other electricity end-users from their basic needs for power and downgrading more and more their living standards. This constitutes a controversial question involving equity in first place, how can miners use the little electricity provided in the country to generate more income to the detriment of other regular users who are then being more and more deprived of their basic needs due to these energy-intensive mining activities.

In light of the above, it can be reported that the introduction of cryptocurrencies in the Lebanese market is causing a certain turmoil in the country, whether from an environmental or equity perspectives. This thesis will look for solutions that are adopted internationally which may help to avoid the incurrence of the cryptocurrencies' hardships and will study their applicability in Lebanon from a legal perspective. The entire thesis content is based on literature review and entails extracted ideas from previous studies and other countries.

CHAPTER 3

SOLUTIONS TO MITIGATE THE CARBON FOOTPRINT OF CRYPTOCURRENCIES

After reviewing the dire hardships caused by cryptocurrencies' processing, it is imminent to look thoroughly for possible solutions in order to turn the latter into a clean processing and avoid all ensuing devastating environmental harms to the planet. Some solutions could be the following:

3.1. The Use of Renewable Energy Sources for Mining Cryptocurrencies that Process on the Proof of Work Mechanism

Proof of stake is a consensus mechanism used in cryptocurrency networks to secure the network and validate transactions. It is an alternative to the more traditional proof of work mechanism which is the consensus algorithm used by the original blockchain network, Bitcoin, and is more energy efficient and cost effective than the proof of work. Unlike proof of work mechanism, which requires miners to compete between each other in order to solve complex cryptographic puzzles to add new blocks to the blockchain and which is a mechanism that requires large amounts of energy and computing power leading to high electricity costs, proof of stake requires users to stake their coins in order to become a validator. The validators then receive rewards for verifying transactions and securing the network. The more coins a user stakes, the higher the probability that they will be selected as a validator. The validators are then rewarded for their efforts in keeping the network secure and ensuring the validity of transactions (Ruoti, 2022).

Actually, in proof of stake, in order to validate transactions, miners need to pledge coins of their own (coins associated with the blockchain). The choice between several miners of who validates a transaction is made using an algorithm that takes into account the amount of stake each miner invested and how long each miner has been validating transactions. After a miner verifies a block, it is added to the chain, and the miner receives cryptocurrency for his fee along with his original stake. If the miner does not verify the block correctly, the miner's stake or coins can be lost. Such mining process does not require huge computing powers, but only a pledge of coins. Hence, no energy consumption is needed (Ruoti, 2022).

The difference between proof of stake and proof of work is the type of investment the miner makes in order to validate a transaction: in proof of work, the miner invests money in computers, machines and electricity, whereas in proof of stake, the miner invests money in pledging coins which he risks to lose if he does not verify the transaction. The advantage of the investment in the proof of stake type of mining is that it does not cause GHG emissions (Ruoti, 2022).

Proof of stake has several advantages over proof of work:

- Proof of stake is much more energy efficient. Actually, proof of work is more resource-intensive as miners must use a significant amount of electricity and computing power to solve complex puzzles. In proof of stake, users simply have to stake their coins, which requires much less energy (Ruoti, 2022).
- Proof of stake is more cost effective, as users do not have to pay for electricity or expensive mining hardware (Dillet, 2022).

- Proof of stake allows for a more decentralized network, since anyone can participate in the network by staking their coins. This means that more people are able to take part in the network and have more control over their money.
- Proof of stake is more scalable than proof of work. As the number of transactions on a blockchain increases, the difficulty of solving the cryptographic puzzles in proof of work also increases. This can lead to slower transaction speeds and higher fees. In proof of stake, the number of validators does not increase as the number of transactions increases, so transaction speeds remain consistent and fees remain low (Dillet, 2022).

In September 2022, the famous cryptocurrency Ethereum switched to the proof of stake mechanism. Ethereum's switch from a proof of work consensus mechanism to a proof of stake consensus mechanism is a major move for the world's second largest blockchain. This transition came with many advantages and opportunities. Ethereum became more energy efficient, consuming less electricity and therefore is more environmentally friendly. Also, it became faster and less expensive, since transactions are processed more quickly and the cost of running a node is much lower (Dillet, 2022).

It is worth mentioning that since the proof of stake system is still relatively newly adopted by Ethereum, there are still a lot of unknowns and unanswered questions. It is still unclear how the system will work in practice or how it will affect the existing Ethereum ecosystem, and users might find difficulties in applying the transition from the proof of work consensus mechanism to proof of stake, as the transition requires significant changes to the underlying code and consensus mechanism (Dillet, 2022).

3.2.The Use of Renewable Energy Sources for Mining Cryptocurrencies that Process on the Proof of Work Mechanism

If cryptocurrencies proof of work's process requires electricity, reviewing the source of the needed electricity could help in mitigating the carbon emissions. Instead of using fossil fuels, renewable sources are clean sources that could provide the required electricity and thus mitigate the carbon emissions. By using renewable energy sources such as solar, wind, and hydroelectric power which produce energy without releasing greenhouse gases, cryptocurrency mining operations can reduce their carbon footprint significantly.

Additionally, renewable energy sources might be cheaper than traditional sources, which can help to reduce the cost of mining, thus increase profits for miners (Allen, 2023).

It is worth noting that some cryptocurrency mining pools have committed to using renewable energy sources to power their operations. These are known as the green mining pools. Green mining pools are designed to be much more efficient in terms of energy consumption. These pools utilize renewable energy sources such as solar and wind, which can significantly reduce the overall carbon intensity caused by the energy consumption of mining operations. This not only helps to reduce costs, but also helps to reduce the environmental hardships of mining. Therefore, by choosing to participate in a green mining pool, individuals and organizations can help reduce the overall carbon footprint of cryptocurrency mining operations.

One example of green mining pools is "Poolin" which is a bitcoin and multi-cryptocurrency mining pool that has a strong focus on sustainability, which is reflected in the fact of being powered by renewable energy sources such as hydropower. Such

green initiative is aimed at reducing the environmental impacts of cryptocurrency mining. Another example is “Terra Pool” which is a Bitcoin mining pool powered exclusively by carbon-neutral energy and renewable energy sources (Singular Research, 2022).

Also, it is worth mentioning that there are some crypto mining companies that are supporting renewable energy projects and investing in them in order to endorse the transition to a more sustainable energy future. These projects often involve installing solar panels and wind turbines in remote locations.

On another note, there exist some cryptocurrencies that are known as green cryptocurrencies. Green cryptocurrencies are digital assets that are designed to have a positive impact on the environment. Examples of green cryptocurrencies include SolarCoin, HydroCoin, CO2Bit and EcoCoin. These coins are typically used to promote renewable energy, reduce the carbon footprint, and encourage environmental sustainability.

For instance, SolarCoin is a digital asset that is designed to promote renewable energy by providing a reward to solar panel owners and operators for the solar electricity they produce and their efforts in providing clean, renewable energy to the world. SolarCoin is earned by claiming electricity production data and providing proof-of-production. Solarcoin is distributed to solar energy producers for free, as an incentive to support the development of solar energy. The belief is that “When the value and price of a SolarCoin exceed the production cost of the energy, it becomes effectively free”. Solarcoin can be redeemed for cash, or used to purchase goods and services from businesses that accept it as a payment method.

EcoCoin is a digital asset and cryptocurrency designed to promote environmental sustainability, facilitate the development of renewable energy sources, reduce the carbon footprint and enable the use of green technology. EcoCoin incentivizes people to take part in activities that reduce carbon emissions and promote environmental sustainability. EcoCoin is also used to reward individuals and companies for making green investments, such as investing in renewable energy sources or other green technologies.

3.3. The Implementation of New Green and Energy Efficient Technologies for the Mining Hardware of Cryptocurrencies that Process on the Proof of Work Mechanism

Cryptocurrency mining is becoming an increasingly popular activity with an increasing competition between miners to validate transactions. Such fact requires the installation by miners of more powerful hardware in order to process the computations necessary to verify transactions and create new coins. Thus, additional huge amounts of electricity are required for mining cryptocurrencies based on the proof of work mechanism, leading thereby to more carbon-intensive emissions and environmental damages. Therefore, it is crucial to look for new technologies to apply them on the crypto mining rigs and machines, so that environmental hardships could be reduced and more sustainable form of cryptocurrency is created.

It is worth noting that the development of green and energy efficient technologies for crypto mining hardware is deemed an important step in the development of the cryptocurrency market, not only for the reduction of their environmental impact, but also for miners to save money on their energy costs.

Some solutions based on green and energy efficient advanced technologies include the following:

- Enhancing the type of cooling system used for the machine cooling: improving the effectiveness of the system entails the need for up to 30% less power. This means that the mining server should also be energy efficient in terms of cooling, since cooling consumes between 30 to 50% of the electric power needed for the mining system. So, exerting some control on machine efficiency is important and beneficial as it helps to reduce the greenhouse gases emissions and carbon footprint.
- Replacing traditional high-energy consuming hardware with more energy-efficient hardware: this means using a specialized advanced hardware that is designed to minimize energy use while maximizing processing power. For cryptocurrency mining as with any other energy-intensive process, using more efficient equipment can significantly reduce energy consumption.

This could involve for example the use of the quantum computing. Quantum computing is a revolutionary technology that has the potential to revolutionize the way computers process data. The potential of this technology lies in its ability to process data faster than traditional computers. For example, while a traditional computer might take hours to solve a complex problem, a quantum computer can solve it in just a few seconds. This speed is made possible through the use of quantum algorithms, which allow for more efficient processing of data. This could lead to breakthroughs in several fields including cryptography. Another energy efficient technology is the Application Specific Integrated Circuits (ASICs) which are chips specifically designed to perform a single task. In the case of cryptocurrency mining hardware, ASICs are used to mine

cryptocurrency more efficiently than general purpose processors such as CPUs and GPUs, as they are designed to optimize certain parts of the mining process, such as reducing the time it takes to search for a hash, and they do not have to use as much power to perform the same task as a general purpose processor. In fact, ASIC chips for cryptocurrency mining have become increasingly efficient, with the latest generation hashing at 158 terahashes per second but only using 34.5 joules per terahash (Tardi, 2022).

The downside to quantum computing and ASICs is that they are expensive, but they are worth the cost as they offer energy efficiency.

- Using more efficient mining hardware: in a way that allows miners to reduce the amount of heat produced during the mining process, which can help reduce the environmental impact of mining.
- Making use of Waste Heat: Some mining companies are making use of the heat generated by their mining equipment to heat buildings or to generate electricity. This reduces the environmental impact of their operations.
- Use advanced technologies such as artificial intelligence or machine learning to optimize the mining operations and reduce the amount of hardware required.

After examining some solutions that have been considered or adopted internationally, it is crucial to discuss whether the legal framework in Lebanon is convenient to allow the application of such solutions. This thesis will study such matter and will further put forward some recommendations where the laws and regulations in Lebanon are “silent” or incomplete.

CHAPTER 4

APPLICABILITY FROM A LEGAL PERSPECTIVE OF THE SOLUTIONS TO MITIGATE THE CARBON FOOTPRINT OF CRYPTOCURRENCIES IN LEBANON

The present chapter aims at scrutinizing the available laws and regulations in Lebanon relevant to the solutions listed in the abovementioned chapter, in order to explore how can these solutions be implemented in Lebanon from a legal perspective and propose recommendations where the Lebanese legal framework is deemed silent or incomplete.

4.1. Implementing Legally the Adoption of Cryptocurrencies that Process on the Proof of Stake Mechanism

The Lebanese legal framework does not address the proof of stake mechanism. Hence, there is no legal impediment for adopting cryptocurrencies that are based on the proof of stake networks should any miner decide so. However, relying on the initiative of people to switch to the adoption of eco-friendly cryptocurrencies is not an efficient solution. Legalizing the matter could be a more successful action.

The integration of the proof of stake mechanism into the Lebanese legal framework would require first the establishment of a legal framework and regulatory provisions regarding the use of cryptocurrencies in general. Currently, the Lebanese government has not made any official statement regarding the regulation of cryptocurrencies and blockchain technology. However, such regulation is deemed essential given the risks of

cryptocurrencies and given that it is a milestone for the integration of the proof of stake mechanism into the Lebanese legal framework.

4.1.1. Risks of Cryptocurrencies

Cryptocurrency is a relatively new form of digital asset that has become increasingly popular in recent years. As reported in the above sections, it is decentralized, meaning it is not regulated by any central authority like a bank or government, and is based on a distributed ledger technology known as the blockchain. While cryptocurrency has many potential benefits, it also has some risks, in addition to the abovementioned environmental risks, that investors should be aware of before investing.

One of the primary risks of investing in cryptocurrency is the high volatility (CIIC markets, 2023). Cryptocurrency markets can be highly volatile, meaning prices can move significantly in both directions in a short period of time. This can have a significant impact on the value of investments. For example, if an investor buys a cryptocurrency at a high price and the market falls, they could lose a great deal of money.

Another risk is that cryptocurrency is not backed by any government or central bank (CT Gov, 2023). This means that if the value of a certain cryptocurrency decreases, there is no guarantee that it will be able to recover. Additionally, if a cryptocurrency is hacked or stolen, it is difficult to recover the lost funds.

The lack of regulation in the cryptocurrency market also means that scams are a risk (Moneysmart, 2023). Since the market is largely unregulated, it can be difficult to differentiate between legitimate crypto projects or scams and investors may be duped

into investing in projects that are not real. Also, the absence of regulatory oversight can also make it difficult for investors to seek legal recourse in case of disputes or losses.

Also, cryptocurrency transactions are irreversible (CT Gov, 2023). Once a transaction is made, it is impossible to reverse it. This means that if a user makes a mistake when sending funds or if they are the victim of fraud, they will not be able to get their money back.

Finally, cryptocurrencies can be used for money laundering (NDTV, 2021), where illicit funds obtained from criminal activities are converted into cryptocurrencies and then transferred or sold to conceal their origin. Cryptocurrencies can be used to transfer funds across borders with relative ease and anonymity, making them attractive for money laundering purposes.

Overall, cryptocurrency has many potential benefits but also carries certain risks, environmental and others, that investors should be aware of before investing. For this reason, a regulatory framework shall govern the cryptocurrency world so that no environmental hardships occur and those investors are safe from risks when investing in cryptocurrency.

4.1.2. Necessity of a Legal Framework for Cryptocurrencies

Cryptocurrency has been gaining in popularity over the past decade and is being more and more accepted by people as a legitimate form of financial payment. As more people invest in cryptocurrency, and given the risks that emanate from cryptocurrencies as mentioned above, the need for a legal framework to regulate the use of this new currency has become increasingly important. This is necessary for a number of reasons, including consumer protection, taxation, and anti-money laundering measures.

Consumer protection is a major concern when it comes to cryptocurrency (NDTV, 2021). As the currency is decentralized and largely unregulated, it can be difficult for consumers to be sure they are dealing with a legitimate service provider. Without a legal framework to provide consumer protection, users are vulnerable to fraud and scams, making it important to have rules in place that protect them from unscrupulous activity.

Taxation is another issue that needs to be addressed when it comes to cryptocurrency. Without a legal framework, it can be difficult for governments to collect taxes on cryptocurrency transactions. This means that users may be able to evade paying taxes that are due, which can be a serious problem for governments. A legal framework that includes taxation rules would make it easier for governments to collect taxes and ensure that everyone is paying their fair share.

Finally, a legal framework is necessary to prevent money laundering activities (NDTV, 2021). As cryptocurrency transactions are anonymous, criminals have been known to use this to their advantage. Establishing a legal framework with anti-money laundering measures in place would help to prevent criminals from using cryptocurrency for illegal activities.

Overall, there is a clear need for a legal framework around cryptocurrency. This framework should include provisions such as the recognition of cryptocurrencies as a form of payment, the regulation of cryptocurrency exchanges and the supervision of the activities of cryptocurrency exchanges, in addition to measures that provide consumer protection, facilitate the taxation of cryptocurrency transactions, prevent money laundering and create a system for enforcing anti-money laundering and counter-terrorist financing laws. Without such a framework in place, cryptocurrency users are

vulnerable to fraud and other illegal activities, making it important to establish rules and regulations that will protect them.

4.1.3. The Status of the Legal Framework of Cryptocurrencies in Lebanon

The current legal framework of cryptocurrencies in Lebanon is still in its infancy and is in need of further development in order to ensure proper regulation of the industry and protection of users. It is limited and does not provide sufficient protection to users or properly regulates the industry. Only article 61 of law number 81/2018 mentions that the central bank shall determine the definition of electronic and digital moneys, the methods of their issuance and use and their governing regulations.

Nevertheless, Lebanon does not have any specific regulation governing the use or trading of cryptocurrencies, and instead relies on existing legislation such as the Banking Law and the Anti-Money Laundering Law in order to regulate the sector. While these laws provide some basic protections, they do not adequately address issues such as taxation, consumer protection, or investor protection. As a result, the legal framework of cryptocurrencies in Lebanon is inadequate and does not provide sufficient protection to users.

It is worth noting that in 2013, the Central Bank of Lebanon issued a notice to the public regarding cryptocurrencies. It warned about the dangers of transactions made through unregulated networks that cannot provide any legal protection nor recourse, the risks given the irreversibility of transactions, their highly speculative and volatile nature, and their possible use for criminal activities such as money laundering and the financing of terrorism (Freemanlaw, 2022). In details, these risks are as follows:

- The platforms or networks through which these currencies are issued and traded are not subject to any legislation or regulation. Hence, in case of losses, there is no legal framework for protection that provides refund.
- This money is not issued or guaranteed by any central bank and is, therefore, subject to sharp and rapid price fluctuations, which could reach zero value.
- Operations via virtual currency facilitate their use for criminal activities, especially money laundering and terrorism financing.
- Incorrect or unapproved operations or transfers executed by such money cannot be reversed.

However, in 2018, a partial ban has been imposed by the Central Bank on financial institutions and exchanges. The ban prohibited them from exchange of electronic currencies (Ordekian, 2020).

As a result, the Lebanese regulations do not forbid the ownership, use, or trading of cryptocurrencies, **but when it comes to their adoption as a form of payment by financial institutions, regulations only accept legal tenders/fiat currencies.** Thus, the acceptance of cryptocurrencies by retailers, for example, can be governed by the provisions of barter.

The reasons behind the Lebanese Central Bank's decision to impose the aforementioned partial ban on cryptocurrency transactions remain unclear, although some have speculated that the move is an attempt to curb the use of cryptocurrencies as a way to avoid capital controls. Another factor that may have played a role in the ban is the fact that the use of cryptocurrency is largely unregulated in Lebanon, which has raised concerns about money laundering and other criminal activities.

Although the foregoing cryptocurrency ban in Lebanon has been in place for almost two years now, it is still uncertain whether it will be lifted in the near future. The Central Bank of Lebanon has not made yet any statements on the matter, and it is unclear if it is planning to lift said ban or not.

This being said, it is worth noting that in the midst of the ongoing challenging financial circumstances in Lebanon, the Lebanese central bank has been deploying all measures to help the economy survive, and it has taken a series of initiatives including those related to FinTech and Digital Payments activities. The BDL Intermediate Circular number 539 on electronic banking and financial operations issued on January 2020 is one of the steps towards digital transformation. This circular allows customers of different banks in Lebanon holding bank accounts or payment cards such as Visa Card and MasterCard to make instant financial transfers via the use of mobile devices and appropriate applications, and this was not allowed previously. Accordingly, in application of this circular, bank customers can make immediate transfers between each other at a very low cost, as the commission ceiling for these immediate transfers does not exceed 0.5% of the transfer value. Moreover, the Lebanese central bank made another amendment to Basic Circular number 69 by issuing Intermediate circular 588 that allowed the providers of electronic banking and financial services through electronic devices via the use of appropriate applications and programs to include the service of “Electronic Wallet” in these programs or applications based on certain conditions specified by BDL. This will contribute to reducing the use of banknotes as a means of payment, as it adds a safe and fast electronic payment method that meets the necessary standards (Hamdan, 2023).

Despite the above regulations which mark a development and progress in terms of accepting new forms of payment, namely electronic and digital payments, and

transitioning into a cashless economy, no further legislation targeting in specific the cryptocurrency sector has been issued yet in Lebanon.

4.1.4. The Way Forward regarding the Legal Framework of Cryptocurrencies in Lebanon

Lebanon should take a stance regarding the matter of regulating the sector of blockchain and cryptocurrencies.

The easiest position to take is to ban and restrict the use, ownership and exchange of cryptocurrencies in the aim of avoiding the risks of cryptocurrencies. Algeria for example, expressly banned the purchase, sale, possession and use of “virtual currencies” under the provisions of article 117 of the 2018 Algerian Financial Law (Ordekian, 2020). However, such approach is not safe at all, and may cause more damage than good for many reasons including the following:

- Banning cryptocurrencies could have a huge impact on Lebanon’s economy, as it is estimated that millions are held in cryptocurrency accounts within the country and that the monthly volume of transactions on bitcoin traded in the market is significant and estimated to reach 10 million USD (Lautissier, 2021). Cryptocurrency mining becomes, in the current times of banking and economic crisis in Lebanon, a new business for a lot of people to make a living therefrom and subject of numerous startups in the country; banning cryptocurrency might worsen more the economy.
- A country choosing to prohibit cryptocurrencies should work on finding efficient means to enforce these restrictions, because prohibition by imposing ordinary and classic measures will not be effective; some scholars even have

doubts on whether a state's regulation can effectively restrain the payment system on the blockchain. Users will always find a way to buy, trade and exchange cryptocurrencies due to their global and decentralized nature, meaning restrictions are easily circumvented, as cryptocurrencies can be used by simply an application on the phone, and national laws are thus undermined (Ordekian, 2020).

- The decision to ban cryptocurrency transactions in Lebanon could be seen as a step backwards in the development of the technology and stands in stark contrast to growing interest in cryptocurrencies around the world, as several countries such as France, UAE and Canada (Ordekian, 2020) are exploring the implementation of digital currencies in their own economies.

For instance, UAE issued on 11/12/2022 the Cabinet Resolution No. (111) of 2022 concerning the Regulation of Virtual Assets and their Service Providers. The aim of this resolution as per its article 2 is to protect consumers, enhance the UAE regulatory framework applicable to the virtual asset sector, regulate virtual asset activities and related service providers, and ensure that virtual asset service providers are within the scope of the UAE anti money laundering legislation. The resolution further sets out in its article 5 a number of activities which fall within its regulatory scope and would require licensing. These include (among others): (i) operating a crypto exchange; (ii) operating a crypto brokerage; and (iii) holding and controlling crypto tokens. Article 4.4 includes an express prohibition preventing any person from dealing with a Virtual Assets Service Provider that is not duly licensed by the competent UAE regulator.

Also, France introduced a specific regulation for Digital Assets Service Providers and Initial Coin Offerings in the French Monetary and Financial

Code. The French Financial Markets Authority (*Autorité des Marchés Financiers AMF*) is in charge of enforcing these regimes. Articles L. 54-10-3 and D. 54-10-2 of the French Monetary and Financial Code state that persons who provide the services of custody on behalf of third parties or access services to digital assets, purchasing or selling of digital assets against legal tender, trading digital assets for other digital asset service and operating of a digital asset trading platform must register with the AMF. The AMF issued the instruction Doc-2019-23 related to the Rules Applicable to Digital Asset Service Providers in which it listed the requirements for the grant of licence.

Accordingly, what is more recommended is that Lebanon elects to regulate the cryptocurrency sector and address all its risks rather than running away from the challenges through banning cryptocurrency transactions.

In this frame, and in order to improve the legal framework of cryptocurrencies in Lebanon, it is essential that the government develops a comprehensive regulatory framework that addresses the key issues in the industry in order to ensure a secure, transparent, and efficient market. This should include measures to protect consumers and investors, as well as taxation and anti-money laundering regulations. Additionally, it should establish guidelines for exchanges and other cryptocurrency-related services and create an official Board of Directors to oversee and enforce these regulations.

Furthermore, the government should take steps to promote public awareness of cryptocurrencies and their associated risks, as well as promote the adoption of best practices for secure storage and trading. Finally, the government should consider introducing a licensing system for exchanges and other cryptocurrency-related services

in order to ensure that all participants are properly regulated and adhere to the relevant laws and regulations.

4.1.5. Incentivizing in the Legal Framework of Cryptocurrencies the Adoption of Proof of Stake Mechanism

The Lebanese government, in the aim of encouraging people to switch to the proof of stake networks instead of the proof of work networks, shall raise awareness and educate miners on the various advantages of the proof of stake networks including their environmental sustainability and to emphasize on how the proof of work networks are not energy efficient and cause large energy consumption.

Notwithstanding the foregoing, the best way to really achieve the goal of deterring miners from using proof of work networks, is for the Lebanese legislator to integrate the proof of stake mechanism in the legal framework governing the cryptocurrencies and to further offer some regulatory incentives for those who adopt the proof of stake networks, such as:

- Offering rewards for miners who use proof of stake. Rewards could come in the form of additional tokens, discounts on fees for transactions conducted on proof of stake networks, or other forms of compensation.
- Offering a bonus for miners who switch to proof of stake networks.
- Collaborating with exchanges and other services to offer incentives for using proof of stake. For example, exchanges could offer reduced fees for deposits or withdrawals from proof of stake networks.

It is worth noting that for the purpose of monitoring the crypto transactions and crypto miners, the government in the new crypto legal framework that should be

introduced in Lebanon should strongly consider mandating that miners should get a licence and prior approval before starting activities, and that each crypto machine should be licensed also. The government can also require that the crypto mining machine has a separate meter (linked to EDL) for itself solely. So this way the government can monitor the energy consumption caused by each crypto machine. By such measures, the government, and for the purpose of granting the incentives, would be able to track all crypto miners and make sure if they are really applying the proof of stake mechanism.

4.2. Implementing Legally the Use of Renewable Energy Sources for Mining Cryptocurrencies that Process on the Proof of Work Mechanism

Lebanon to date still relies majorly on the combustion of fossil fuels in order to supply electricity to its nationals. Switching to renewable sources of energy would be a long-needed solution to cut carbon emissions and fight global environmental hazards. From a practical perspective, Lebanon does not have enough land areas for photovoltaic systems and solar panels and only limited locations for wind farms. Accordingly, other types of renewable systems are relevant, including the distributed renewable energy generation and net-metering.

The Lebanese legal framework lacks any regulation that governs the deployment of renewable energy systems. Nevertheless, several policies related to the renewable energy field have been laid down including:

- The Energy Policy Paper (2010) approved by the Council of Ministers in June 2010 outlining the objective to supply one-third of power through renewable energy systems;

- The National Energy Efficiency Action Plan (NEEAP) 2011 – 2014 for Lebanon adopted by the Council of Ministers in November 2011 setting a national action plan for renewable energy and energy efficiency to achieve the target of 12% renewable energy in the energy mix by 2020 set in the Governmental Declaration in 2010;
- The Lebanon’s Nationally Determined Contributions (NDC) approved by Parliament Law 115/2019 setting a 20% target of renewable energy in the energy mix by 2030;
- The Updated Energy Policy Paper of the Ministry of Energy and Water adopted by the Council of Ministers on the 8th of April, 2019 committing Lebanon to secure 30% of Lebanon’s total electricity consumption from renewable energy sources by 2030;

4.2.1. Impediments to the Installation of Renewable Energy Systems

4.2.1.1. Monopoly of Electricite Du Liban (EDL)

The Lebanese electricity sector is dominated by EDL, which is a public establishment that is conferred both administrative and financial autonomy. It was founded by decree number 16878 dated July 10, 1964.

EDL is the public authority in charge of solely generating, transmitting and distributing power in Lebanon, under the tutelage of the Ministry of Energy and Water. Therefore, the Lebanese electricity sector can be characterized as a monopoly managed by EDL.

EDL has the right to sell and purchase power, after achieving the required permissions from the tutelage authority, the Ministry of Energy and Water and the Ministry of finance, and after approval from the council of ministers. This is clearly indicated through Decree 7580, issued on 5/4/1974 and entitled “The Investment Law of Electricity of Lebanon”. In Article 4 (entitled “source of power”), it is stated that EDL must ensure that the required electricity power for consumption is available at all times, and in order to achieve this purpose it can undertake the following:

- Produce the necessary energy power to supply its networks through thermal or hydro power plants that it receives from the state or that it develops by itself.
- Purchase the needed energy from other institutions or from concessions that produce electricity power through hydro or thermal resources.

Article 4 of Decree 7580 indicates that EDL can purchase power from hydro and thermal resources. This raises a question whether an amendment to this law would be required to allow other types of renewables to be included, or whether Law 462 and the establishment of the Electricity Regulatory Authority (as will be elaborated below) remove this need or additional possibility.

4.2.1.2. Non-Implementation of the Electricity Regulatory Authority

Several attempts by the government of Lebanon to restructure the electricity sector and improve its performance on all levels began with the ratification of Law 462/2002. Law 462 aimed and aims to establish the Electricity Regulatory Authority (ERA), unbundle Lebanon’s power sector, and create a more competitive market for electricity with independent power producers (IPPs). The implementation of Law 462 remains, however, elusive.

The regulation of the Electricity Sector Law No.462, dated 2002, paved the way for private sector participation. This law established a new structure for the energy sector as well as a legal framework for privatization. It divides the energy sector into 3 sections: production, transmission and distribution. Only the transmission sector is to remain a 'public' function. The law mandates the creation of the "Electricity Regulatory Authority" (ERA), tasked to regulate and control the electricity sector, and endowed with independent technical, administrative and financial autonomy. ERA has the right to issue licenses (effective for fifty years) through public tenders or offerings for the purpose of producing and distributing electricity. Furthermore, ERA is tasked to promote competition in the sector, monitor and adjust non-competitive tariffs, and ensure market transparency. Article 5 of Law 462 indicates that the transmission of electrical energy remains under EDL's monopoly. It is stipulated through this Article, however, that through a Decree from the council of ministers and upon a proposal from the ministry of energy and water, contracts with the private sector for the management, operation, development, or equipment purchasing of the transmission activities can take place. The 'private sector' includes any privatized company or any company owned by the private sector. To date, Law 462 is to be implemented.

4.2.1.3. Lack of Legal Framework Governing Renewables

To date, there is no statutory provision regulating renewable energy. Any initiative in this respect would be unfortunately affected in Lebanon by a distorted decision-making process due to frequent change of government, political deadlocks, etc.

4.2.2. Mitigation of the Impediments to the Installation of Renewable Energy Systems

4.2.2.1. Temporary Licenses for Private Sector Participation

On November 11, 2006, the Lebanese Parliament ratified Law 775 which amended Article 7 of Law 462, stipulating that until the creation of the ERA, and for one year only, temporary licenses and permits to produce electricity can be granted by a decision from the council of ministers, upon a proposal from the Minister of Energy and Water. However, no power project managed to be licensed under Law 775. In 2014, the parliament ratified Law 288, likewise stating that temporarily (for a period of two years only), and until the appointment of the members of the ERA, production licenses and permits can be granted by a Decision from the council of ministers upon a combined and/or agreed upon proposal raised from the Ministry of Energy and Water and the ministry of finance. As with Law 775, no power projects were licensed under Law 288. An extension to Law 288 was ratified and the law became Law 54, dated 2014. This law extended the application of Law 288 until 30/4/2018. Although, as in Law 288, no implementing Decrees of the law were established, the Ministry of Energy and Water led the procurement process for new power projects. The new 2-year term ended and 1 set of power plants, consisting of 3 wind power projects were issued licenses through the signature of related power purchasing agreements (PPAs). Law 462, Law 775, Law 288, and Law 54 are all involved in private sector participation, where developers can sell their power to the government. Such initiatives of legislation could be the basis for implementation of renewable energy systems in Lebanon as long as the ERA is not yet established.

4.2.2.2. Net-Metering EDL Board of Directors Resolution

As mentioned above, EDL's foundation Decree 16878, dated July 10, 1964, mandates in its first article that EDL is the sole party responsible for generation, transmission, and distribution of electrical energy in Lebanon. However, through article (4) of Decree 16878, it is indicated that 'natural and legal persons are eligible to produce electricity for their own consumption and to cover their personal needs only.' Tapping into Article 4, an Administrative Curriculum (memorandum), based on a Decision of EDL's Board of Directors (No. 318-32/2011, entitled 'net metering', approved the mechanism where consumers can inject surplus renewable energy power generated on their premises (and for the primary objectives of fulfilling their own needs for power) into EDL's grid and be credited, in return, against their consumption of power from EDL. The net-metering mechanism is certified by the Ministry of Energy and Water (as the tutelage authority over EDL) and approved by the ministry of finance (since it has a financial deduction effect) on an annual basis.

It is important to highlight that due to the novelty of this scheme and in order to provide the required attention to net metering, EDL has also established a Net Metering Committee that has the role to supervise the implementation of net metering.

It is worth noting that there exists a draft law on the Lebanese Distributed Renewable Energy Generation which proposes the introduction of a net-metering concept to the Lebanese electricity sector. This draft law hasn't been passed to date.

4.2.3. The Way Forward for Reaching Definitive Solutions and Implementing Renewable Energy Projects

The following recommendations are to be taken into consideration to take the renewables sector to the next level:

- Implementation of the ERA.
- Enactment of a new law governing the renewable sources and renewable energy systems.
- Adoption of the Lebanese Distributed Renewable Energy Generation Draft Law introducing the net-metering concept.
- Adoption of EDL's Board of Directors' resolution No. 318-32/2011 by virtue of a law to have a comprehensive framework.
- On a community level, amending law number 29 of 29/05/1963 regulating the municipalities by conferring municipalities explicit authorities to deploy decentralized energy systems on a community level.

4.3. Implementing Legally the Use of New Green and Energy Efficient Technologies for the Mining Hardware of Cryptocurrencies that Process on the Proof of Work Mechanism

As stated above, there is no statutory provision regulating the cryptocurrency sector, *a fortiori* there is no legal requirement to install certain technologies in the cryptocurrency mining machines or to abide by certain standards in order to ensure energy efficiency and protect the environment. Fulfilling the foregoing could be achieved (i) directly via regulations that aim straight at imposing the use of green technologies, or (ii) indirectly via regulations that would secondarily push for the use of green technologies.

4.3.1. Imposing directly energy efficiency and green technologies

From a wide angle, it can be reported that the Lebanese legal framework encompasses some regulations pertaining to the protection of the environment, preservation of the air quality and reduction of energy consumption in the country.

For instance, in 2002, the law on the protection of the environment was enacted. This law is an important tool for preserving and protecting the natural beauty of Lebanon and its resources. It can ensure that the environment is protected for future generations if all individuals, companies, and the government comply with the law. The law provides for the protection of air, water, land, and marine life. It also outlines the responsibilities of individuals, companies, and the government in preserving the environment. The law includes provisions on the prevention, control, and abatement of pollution from industry and other sources, as well as the conservation of natural resources. It also sets out penalties for those who do not comply with the law. The law requires companies to take certain measures to protect the environment, such as reducing emissions of pollutants, disposing of waste in a responsible manner, and minimizing the use of hazardous materials. Individuals must also take certain precautions, such as avoiding polluting activities, disposing of waste properly, and avoiding activities that may cause harm to the environment. The law also requires the government to develop and implement national plans for the protection and conservation of the environment.

In particular, some provisions of said law on the protection of the environment include the following:

- Article 1 states that this law defines the general legal framework for implementing the national environmental protection policy with the aim of

preventing and curbing all forms of degradation, pollution and harm, promoting sustainable use of natural resources and ensuring a healthy and environmentally stable life framework.

- Article 24 paragraph 1 states that any person shall, in the course of exercising his activities, undertake not to emit pollutants in the air or not to exceed the maximum limit of emissions that is permitted and set in accordance with the national criteria for the quality of environment.
- Article 24 paragraph 2 states that it is prohibited to possess, use or invest machines, engines and vehicles that leak emissions or emit air pollutants or that exceed the maximum limit of emissions that is permitted and set in accordance with the national criteria for the quality of environment.

Based on the foregoing provisions, the law on the protection of the environment can be used as a basis for the issuance of implementing decrees that regulate the requirements and standards of cryptocurrency mining hardware, in the aim of reducing energy consumption, promoting energy efficiency and ultimately preserving the environment.

The government by virtue of such implementing decrees, can set a list of standards and practices that any cryptocurrency mining machine shall comply with. Such industry standards and practices could be the requirement to apply certain specific technologies that could reduce the amount of power needed and decrease thereby the greenhouse gases emissions and carbon footprint. In application thereof, the government can impose the necessity to take the prior approval of the ministry of environment on the contemplated cryptocurrency mining machine prior to its installation and launch of the cryptocurrency mining activities. This way, the government can monitor the fulfilment of the prescribed industry standards and requirements and ensure that no cryptocurrency

mining hardware which does not include the imposed green technologies or is not licensed by the ministry of environment is being used.

Another suggestion is for the government to set out thresholds for the amount of greenhouse gases that could be emitted by a certain cryptocurrency mining hardware. Such thresholds could be determined based on the size of the cryptocurrency mining machine. This way, the individual willing to immerse in cryptocurrencies mining activities, would be left with a total freedom to select the suitable technology for the individual that could meet the needs of energy efficiency and abide by the statutory thresholds of greenhouse gases emissions. This alternative presents an advantage in terms of costs, as the new advanced technologies are almost expensive. So, the individual will be granted a wider option to select the technology that allows not to exceed the maximum limit of pollutants emissions while being affordable for him. The downside of such solution is that it requires a continuous and permanent monitoring to be exercised by the government, in order to control and detect any contravention to the determined thresholds of emissions.

On a side note, article 20 of the law on the protection of the environment states that anyone who uses equipment or technologies that prevent, reduce or eliminate all forms of pollution benefits from a reduction up to 50% on the custom duties due on such equipment or technologies pursuant to a decree issued by the council of ministers. Accordingly, it is undoubtedly crucial for the government to issue such decree and grant the higher reduction possible on the custom duties, in order to encourage and facilitate financially the introduction of new green and energy efficient technologies to the cryptocurrency mining machines.

It is worth mentioning that there exists in Lebanon a draft energy conservation law that hasn't been enacted to date. Such draft law seeks to reduce energy consumption and help the country transition towards renewable energy sources. Its ultimate goal is to decrease the energy consumption by enforcing the use of energy efficiency measures in Lebanon, with a focus on the development of energy efficiency policies and their proper implementations. It requires all public and private sectors to implement energy efficient practices, such as using efficient lighting, insulation, and other energy saving technologies. Overall, the draft energy conservation law in Lebanon is a progressive step towards a more sustainable future. Its enactment would also help regulating more the cryptocurrency sector including the mining hardware, turning it into a more sustainable and energy efficient sector thus deterring its environmental risks.

4.3.2. Imposing indirectly energy efficiency and green technologies

Implementing proper fiscal policies which include a CO₂ taxation system is an effective approach that governments can take in the course of actions aiming at curbing climate change. In fact, carbon taxation has been regarded as an instrument that has correlation with low carbon emissions, thus is an eco-friendly instrument that aims at increasing energy efficiency by reducing CO₂ emissions per energy unit. Effectively, the response to increasing the price of CO₂ emissions is to simply reduce CO₂ emissions in order to escape high taxation, which entails, inter alia, the following twofold reactions: (i) a decrease in the total energy consumption, (ii) a shift away from CO₂ intensive sources towards other energy sources or newer technologies that emit less or no CO₂ (Claudia Chow, 2020).

The aforementioned policy, if adopted by the Lebanese government to the cryptocurrency sector, could push people to apply green technologies in the crypto mining machines to avoid incurring high CO₂ taxation. It is important to note that if CO₂ taxation could incentivize crypto miners to explore, shift, and invest in more eco-friendly technologies and mining hardware, carbon emission reduction could only be truly achieved provided that the measures of reducing CO₂ emissions, i.e., applying the green technologies, are less expensive than the taxation burden (Sundqvist, 2007). Hence, the government should well study the amount to be charged per each Kg of CO₂.

Another measure to be considered by the Lebanese government is the carbon offset program through green financing. Carbon offset programs are designed to reduce the net amount of greenhouse gas emissions released into the atmosphere. These programs are used by individuals and businesses to neutralize their carbon emissions, through investing in carbon offset projects as a way of compensating their carbon footprint. Implementing such program to the cryptocurrency sector would allow the crypto miners to offset the greenhouse gas emitted from their crypto mining machines by reducing emissions somewhere else. Such reduction is feasible by making crypto miners invest and finance other green and sustainable projects, like renewable energy, reforestation, water conservation, waste reduction, etc. By this way, crypto miners can reach carbon neutrality.

In practice, the Lebanese government can issue a catalogue encompassing all green and sustainable projects that are ongoing in the country, whether initiated by public or private entities. The crypto miners will have to select any of these projects and invest in them through paying an amount equivalent to their carbon emissions from the cryptocurrency activities. In other terms, the crypto miners are purchasing carbon

credits from the selected green project that allow them releasing the same amount of carbon emissions in the atmosphere. Afterwards, the crypto miners will be granted a certificate as a proof of investment in the selected green project. The calculation of the carbon credits required to be purchased by each crypto miner requires the calculation of the carbon footprint of the crypto mining machine, which is easy to be made through having a separate meter for the crypto mining machine that measures the electricity supply. By measuring the amount of electricity consumed by the crypto mining machine, the amount of emitted carbon therefrom can then be calculated in Kg. This way, can be deduced the corresponding amount of carbon credits that should be invested in the green project to reduce somewhere else the same amount of emissions generated by the crypto mining activities. Accordingly, crypto miners would offset their carbon footprint, reach carbon neutrality and ensure energy efficiency.

It is worth noting that the central bank issued in 2010 the intermediate circular number 236, by virtue of which it subsidized loans that are granted for eco-friendly and sustainability related projects. Whenever the banking sector in Lebanon is revamped, this will constitute a crucial regulation that would attract investments in such field and increases the number of green initiatives in the country, widening thereby the application of the carbon offset programs (Hamdan, 2023).

Such carbon offset programs would indirectly push crypto miners to adopt some green technologies in their crypto mining machines in order to reduce their carbon emissions and escape high amounts of investment in other green projects. Like in the CO₂ taxation scheme, the government should ensure that the carbon credits are way more expensive than the use of green technologies.

The CO2 taxation system could reveal more realistic to be applied in Lebanon than the carbon offset programs, as the latter need monitoring and are in anyway applied voluntarily by several companies under the Corporate Social Responsibility (CSR) model. However, the CO2 taxation system could present more interest to the government that is looking hard for sources of income, as this CO2 system induces more revenues which could be invested to enhance the electricity sector and address its deficiencies. In addition, the CO2 taxation policy can be welcomed today by the citizens more than before, given that already the electricity bills increased recently so there is no more taboo on the low price of electricity (Hamdan, 2023).

Whether for the CO2 taxation system or the carbon offset programs, both methods put forth further advantages on the national scale. The CO2 taxation would contribute to increasing the revenues of the government, and the carbon offset programs would help financing and funding green projects and initiatives. This being said, Lebanon should enact the proper legislation that allows the instalment of the proper framework necessary to implement the contemplated scheme.

CHAPTER 5

PRIORITY OF ALLOCATION OF AVAILABE ELECTRICITY BETWEEN CRYPTOCURRENCY AND OTHER SECTORS IN THE COUNTRY

As reported above, Lebanon suffers from an electricity sector that is a flagrant example of a failed and inefficient utility. The Lebanese electricity sector has been characterized for decades by unreliable services reflected mainly by chronic, recurrent and lengthy power cuts. Recently, Lebanon has been experiencing its worst electricity blackouts in years, leading to people often left in the dark unable to access the essential services they need.

On the other hand, Lebanon is witnessing the proliferation of the cryptocurrency sector which is very energy intensive. In this frame, it is essential to discuss whether it is legitimate to allocate the limitedly available power that Lebanon can provide its nationals with to the cryptocurrency sector, or it would be fairer to prioritize the allocation of electricity to other sectors that might be deemed more important than the cryptocurrencies', such as households, healthcare and hospitals, educational establishments, etc.

The resolution of such matter requires the conciliation between the three following factors:

- Importance of the cryptocurrency sector to the society: it is difficult to determine what the future will hold. Cryptocurrency might become a primordial widespread practice for the Lebanese people, just as whatsapp, google maps and social media became widely used, even by elderly people. It can also become inherent to the people's businesses and economy of the country. Also,²⁰ as a

mode of payment, cryptocurrency might take its place in the payment platform. Conversely, cryptocurrency might plunge, if for example the metaverse, NFTs and the virtual world won't expand and dominate in the future.

Four criteria might cause the expansion and need for cryptocurrencies in the future (Hamdan, 2023): (i) the commercial demand for cryptocurrencies which is increasing at a slow pace and their utility for financial inclusion, mainly in countries like Bahamas where crypto was a success due to the fact that most of the people are de-banked, (ii) the demand for speculation, as volatility is attractive for a lot of speculators who are interested in buying cryptocurrencies and betting on their price increase in the future, (iii) the demand for diversification away from national currencies, as on an individual level, people are diversifying in their investments mainly in countries facing economic crisis, and on a national level, there is a worldwide trend of shifting away from the USD currency and the dominance of the swift system, like for example the UAE and KSA which are looking to apply a new system of wholesale Central Bank Digital Currency (CBDC) for financial transactions between the two countries, and China and Brazil which are looking to consider the Yuan instead of the USD in cross-border transactions, and (iv) the demand for grey market as cryptocurrencies can be easily used for illegal activities.

- Electricity consumed by the cryptocurrency sector: this might vary depending on the number of transactions occurring, which can fluctuate due to the volatility of the sector leading to a variation in the number of people investing in the sector. The consumed electricity by the cryptocurrency sector could also depend on the evolution and progression made in the Research and Development

focused on new green and energy efficient technologies as well as their affordability for all crypto miners.

- The amount of available electricity in the country, whether generated from conventional sources and fossil fuels or from renewable sources: In the latter case, the estimation of power cannot be determined precisely, due to the intermittence of the renewable sources. For instance, the energy production via wind power plants depends on the wind velocities at the turbine, which even the records thereof might not be enough to make reasonable related prediction. Also, with respect to the photovoltaic energy plants, it is quasi-difficult to predict the frequency of the solar radiation incidence and its reduction by cloud before hitting solar panels.

Based on the above, it appears that each factor comprises several uncertainties and variables. Therefore, numerous scenarios could occur in the future, and no one can anticipate what scenario will happen exactly or make a reasonable estimation of the energy that will be consumed by the cryptocurrency sector.

The best solution is then for the government, mainly in the event the power shortages and blackouts remain, to make periodical assessments of the ongoing situation at the relevant time taking into account the abovementioned factors, and decide on the basis of each assessment how to allocate the available amount of electricity between cryptocurrency, households and the various other industries in the country.

For example, in case the cryptocurrency sector is causing a large consumption of power while not being a crucial need for Lebanese people or not affecting at all their

businesses or the economy of the country, then the government might take restrictive policies such as:

- Refrain from granting licences to cryptocurrency mining machines.
- Impose higher tariffs for the electricity consumed by cryptocurrency mining machines. For monitoring purpose, such policy requires that miners get a licence and prior approval before starting activities, each crypto mining machine is pre licensed and that each crypto mining machine has a separate meter for itself solely (linked to EDL) to measure the electricity consumption.
- Halt cryptocurrencies activities in case of severe scarcity of power in the country.

It is worth noting that even if Lebanon succeeds in the future in ensuring electricity based on renewable energy sources, it remains important to promote the use of green technologies for the cryptocurrency mining machines even if environmental risks won't then be an alarming concern, as such green measures, which ensure energy efficiency, are always beneficial mainly when power supply is disrupted in the country due to, inter alia, the intermittence of the renewable sources.

CHAPTER 6

SUMMARY OF POLICY RECOMMENDATIONS AND EVALUATION OF THEIR IMPLEMENTATION

The policies discussed and recommended in this thesis could be summarised as follows:

SOLUTIONS	POLICY RECOMMENDATIONS
<p>Adoption of cryptocurrencies that process on the proof of stake mechanism</p>	<ul style="list-style-type: none"> - Development of a comprehensive regulatory framework for cryptocurrencies. - Promotion of public awareness on cryptocurrencies and their associated risks. - Introducing a licensing system for exchanges and other cryptocurrency-related services and a prior approval for miners before starting crypto activities. - Introducing a prior licensing system for crypto mining machines and imposing that each crypto mining machine has a separate meter for itself solely (linked to EDL) to measure the electricity consumption. - Integration of the proof of stake mechanism in the legal framework governing the cryptocurrencies. - Offer of regulatory incentives for those who adopt the proof of stake networks.
<p>Use of renewable energy sources for mining cryptocurrencies that</p>	<ul style="list-style-type: none"> - Implementation of the ERA. - Enactment of a new law governing the renewable sources and renewable energy systems.

<p>process on the proof of work mechanism</p>	<ul style="list-style-type: none"> - Adoption of the Lebanese Distributed Renewable Energy Generation Draft Law introducing the net-metering concept. - Adoption of the Board of Directors resolution No. 318-32/2011 by virtue of a law to have a comprehensive framework. - On a community level, amendment of law number 29 of 29/05/1963 regulating the municipalities by conferring municipalities explicit authorities to deploy decentralized energy systems on a community level.
<p>Use of new green and energy efficient technologies for the mining hardware of cryptocurrencies that process on the proof of work mechanism</p>	<ul style="list-style-type: none"> - Issuance of implementing decrees, based on the law of protection of the environment, imposing a licensing system for crypto mining machines and setting a list of standards and practices that any cryptocurrency mining machine shall comply with, including the requirement to apply certain specific technologies or the requirement to not exceed prescribed thresholds for the emissions. - Reduction of the custom duties due on green and energy efficient technologies applied on the cryptocurrency mining machines. - Enactment of the proper legislation to implement a CO2 taxation scheme and/or carbon offset programs which indirectly push crypto miners to adopt green technologies in order to escape high taxation and carbon credits.

<p>Setting of a priority in allocating the available electricity between cryptocurrency and other sectors in the country</p>	<ul style="list-style-type: none"> - Assessment of the market and deciding on the basis thereof on how to allocate the available amount of electricity between cryptocurrency, households and the various other industries in the country. - Promoting energy efficiency measures even if renewable sources are adopted to power the cryptocurrency mining machines.
---	--

Lebanon has, to a large extent, a weak institutional and administrative framework coupled with political and economic deadlocks preventing it from actively and swiftly developing an all-encompassing strategy for introducing new reforms and policies.

For instance, amending or adding to the current regulatory framework, would require the involvement of the legislative, executive, as well as the administrative Board of Directors of the country. Given the current complexity of the political and administrative landscape in Lebanon, the involvement of high-level authorities may more likely lead to political deadlocks or at least a delayed decision-making process, as it is the case nowadays.

It is unlikely that the Lebanese government would put forth in the present period of time any of the abovementioned policies and reforms while the country is in quasi bankruptcy. In any way, the Lebanese government is actually facing challenges that are more urgent and imminent to be addressed than the cryptocurrencies' risks. In fact, said challenges due to the ongoing economic crisis are desperately related to basic needs of

the Lebanese population, to the point that unfortunately the issue of cryptocurrency becomes farther than a secondary matter.

CHAPTER 7

CONCLUSION

Today a new application has entered Lebanon and will continue to expand and proliferate more and more in the coming years, the cryptocurrencies, which might increase the carbon footprint even more than what is caused by other industries. In fact, the carbon footprint of cryptocurrencies has become a major issue in Lebanon due to the ever-growing need and demand for digital currencies. The findings of this thesis have revealed several potential solutions to mitigate the carbon footprint of cryptocurrencies in Lebanon. These solutions include the use of renewable energy sources, the implementation of energy efficient technologies and the switch to the proof of stake systems. It is clear that the carbon footprint of cryptocurrencies in Lebanon can be mitigated through the implementation of said effective solutions and strategies. However, their applicability requires the enactment of new laws, policies and projects or the amendment of the existing legal framework. Such requirement might be hindered in Lebanon considering the complex political and administrative decision-making process that creates deadlock scenarios and complications. Therefore, it is essential for stakeholders to work together to ensure the adoption and implementation of these strategies, in order to create a more sustainable and environmentally friendly cryptocurrency industry in Lebanon.

REFERENCES

Interview with Mr. Mazen Hamdan, executive director of the Cash Operation Department of Banque du Liban (BDL)

Text of the Lebanese Central Bank intermediate circular number 539 of January 2020. Retrieved from [file:///C:/Users/User/Downloads/int539%20\(1\).pdf](file:///C:/Users/User/Downloads/int539%20(1).pdf)

Text of the Lebanese Central Bank intermediate circular number 588 of June 2021 amending basic circular number 69 of March 2000. Retrieved from [file:///C:/Users/User/Downloads/int588\[1\].pdf](file:///C:/Users/User/Downloads/int588[1].pdf)

Text of the Lebanese Central Bank intermediate circular number 236 of November 2010. Retrieved from [file:///C:/Users/User/Downloads/int236%20\(1\).pdf](file:///C:/Users/User/Downloads/int236%20(1).pdf)

Text of the Cabinet Resolution No. (111) of 2022 concerning the Regulation of Virtual Assets and their Service Providers. Retrieved from <https://amluae.com/wp-content/uploads/2023/01/Cabinet-Resolution-No.-111-of-2022-Concerning-the-Regulation-of-Virtual-Assets-and-their-Service-Providers-1.pdf>

Text of the AMF instruction Doc-2019-23 related to the Rules Applicable to Digital Asset Service Providers. Retrieved from <https://www.amf-france.org/sites/institutionnel/files/private/2022-12/Instruction%20DOC-2019-23%20rules%20applicable%20to%20DASR.pdf>

Hayes, A. (2022, December 19). Blockchain facts: What is it, how it works, and how it can be used. Investopedia. Retrieved from <https://www.investopedia.com/terms/b/blockchain.asp>

Darlington, N., Rosic, A., Blockgeeks, & Zapotochny, A. (2022, October 19). Blockchain for beginners: What is blockchain technology? A step-by-step guide. Blockgeeks. Retrieved from <https://blockgeeks.com/guides/what-is-blockchain-technology/>

Author Zach Hildreth, Hildreth, A. Z., (2020, April 16). Cryptocurrency mining guide: Speculative mining & other strategies. Blockonomi. Retrieved from <https://blockonomi.com/cryptocurrency-mining/>

Arora, S. (2023, February 23). What is bitcoin mining? how does it work, proof of work and Facts you should know. Simplilearn.com. Retrieved from <https://www.simplilearn.com/bitcoin-mining-explained-article#:~:text=Bitcoin%20mining%20is%20the%20process,on%20the%20decentralized%20blockchain%20ledger.>

Dumitriu, P. (2020). Blockchain applications in the United Nations system: towards a state of readiness. Retrieved from https://unhabitat.org/sites/default/files/2021/10/jiu_rep_2020_7_e.pdf

Santillan, V. (2018). Lebanon Establishes a Blockchain Task Force. Retrieved from <https://www.coindesk.com/lebanon-establishes-a-blockchain-task-force/>

Schellen, T. (2018, February 16). Lebanon hops on the crypto train. Executive Magazine. Retrieved from <https://www.executive-magazine.com/cover-story/lebanon-hops-on-the-crypto-train>

Chamaa, M. E. (2022, March 7). Cryptocurrency gives rise to new 'mining' towns in Lebanon. L'Orient Today. Retrieved from <https://today.lorientlejour.com/article/1292855/cryptocurrency-gives-rise-to-new-mining-towns-in-lebanon.html>

In Lebanon, locals mine bitcoin and buy groceries with tether as the value of the dollar plummets. RSS. (2022, July 11). Retrieved from <https://www.tradealgo.com/news/in-lebanon-locals-mine-bitcoin-and-buy-groceries-with-tether-as-the-value-of-the-dollar-plummets>

Geylan, Z. (2022, September 22). Lebanese people turn to crypto, decentralization as banks close down indefinitely. CryptoSlate. Retrieved from <https://cryptoslate.com/lebanese-people-turn-to-crypto-decentralization-as-banks-close-down-indefinitely/>

Tarek Ali Ahmad, Published: 27 March, & Ahmad, T. A. (2020, May 20). Tracing Beirut's natural transformation into a tech-savvy regional hub. Al Arabiya English. Retrieved from <https://english.alarabiya.net/business/economy/2017/03/27/Tracing-Beirut-s-natural-transformation-into-a-tech-savvy-regional-hub>

A brief history of cryptocurrency - cryptovantage. (n.d.). Retrieved from <https://www.cryptovantage.com/guides/a-brief-history-of-cryptocurrency/>

Hannah Ritchie, Max Roser and Pablo Rosado (2022) - "Energy". Published online at OurWorldInData.org. Retrieved from: <https://ourworldindata.org/energy>

Chehayeb, K. (2023, March 7). Lebanon leans on U.S. dollar as Economy Tanks. PBS. Retrieved from <https://www.pbs.org/newshour/world/lebanon-leans-on-u-s-dollar-as-economy-tanks#:~:text=Lebanon's%20woes%20are%20much%20of,and%20causing%20inflation%20to%20soar.>

Kerner, S. M. (2023, January 24). What is cryptocurrency?: Definition from TechTarget. WhatIs.com. Retrieved from <https://www.techtarget.com/whatis/definition/cryptocurrency#:~:text=Cryptocurrency%20gains%20its%20name%20from,cryptographic%20algorithm%20with%20complicated%20encryption.>

What is crypto? (types, benefits, and how it works). Coursera. (n.d.). Retrieved from <https://www.coursera.org/articles/what-is-crypto>

Stephen Graves, R. S. (2022, September 15). What is 'the merge'? Ethereum's move to proof of stake. Decrypt. Retrieved from <https://decrypt.co/resources/what-merge-ethereum-move-proof-stake>

Dillet, R. (2022, September 15). Ethereum switches to proof-of-stake consensus after completing the merge. TechCrunch. Retrieved from

<https://techcrunch.com/2022/09/15/ethereum-switches-to-proof-of-stake-consensus-after-completing-the-merge/>

Stock market insights. Seeking Alpha. (n.d.). Retrieved from <https://seekingalpha.com/article/4558770-dmg-blockchain-solutions-environmentally-friendly-vertically-integrated-blockchain-company>

Allen, L. (2023, February 10). Green energy is cheaper than fossil fuels, a new study finds. Science News Explores. Retrieved from <https://www.snexplores.org/article/green-energy-cheaper-than-fossil-fuels-climate#:~:text=Data%20from%20the%20past%2020,building%20new%20fossil%20Dfueled%20plants.>

Poolin. (n.d.). Poolin.com Pool - Better BTC, BCH, LTC, ETHW, Dash, DCR Cryptocurrency Mining Pool. Poolin.com Pool - Better BTC, BCH, LTC, ETHW, DASH Cryptocurrency Mining Pool. Retrieved from <https://www.poolin.com/>

Solarcoin. SolarCoin. (n.d.). Retrieved April 21, 2023, from <https://solarcoin.org/>

The Eco Coin: A Sustainable Currency for planet earth. The ECO coin: A Sustainable currency for Planet Earth. (n.d.). Retrieved from <https://www.ecocoin.com/>

The University. What is Quantum computing. Amazon. Retrieved from <https://aws.amazon.com/what-is/quantum-computing/#:~:text=Quantum%20computing%20is%20a%20multidisciplinary,faster%20than%20on%20classical%20computers.>

Tardi, C. (2022, December 19). Application-specific integrated circuit (ASIC) miner. Investopedia. Retrieved from <https://www.investopedia.com/terms/a/asic.asp>

Text of the law on protection of the environment, retrieved from <https://www.moe.gov.lb/getattachment/8cd2fa75-a774-4ba8-9377-d876189fca57/%D9%82%D8%A7%D9%86%D9%88%D9%86-%D8%B1%D9%82%D9%85-444-%D8%AD%D9%85%D8%A7%D9%8A%D8%A9-%D8%A7%D9%84%D8%A8%D9%8A%D9%8A%D8%A9.aspx>

Energy efficiency law. LCEC. (n.d.). Retrieved from <https://lcec.org.lb/our-work/LCEC/EELaw>

Tassev, L. (2022, November 6). *Lebanese mint, keep, spend crypto amid crisis, report unveils – economics bitcoin news*. Bitcoin News. Retrieved November 18, 2022, from <https://news.bitcoin.com/lebanese-mint-keep-spend-crypto-amid-crisis-report-unveils/>

Regulating cryptocurrencies: The dilemma of reaching consensus. Official Website of the Lebanese Army. (n.d.). Retrieved November 18, 2022, from <https://www.lebarmy.gov.lb/en/content/regulating-cryptocurrencies-dilemma-reaching-consensus>

What is proof-of-stake? A computer scientist explains. World Economic Forum. (n.d.). Retrieved November 22, 2022, from <https://www.weforum.org/agenda/2022/09/proof-of-stake-computer-scientist-explains/>

Kolbert, E. (2021, April 22). Why bitcoin is bad for the environment. The New Yorker. <https://www.newyorker.com/news/daily-comment/why-bitcoin-is-bad-forthe-environment>

(n.d.). Forbes. <https://www.forbes.com/sites/joshuarhodes/2021/10/08/is-bitcoininherently-bad-for-the-environment/?sh=5bf0eec03033>

3 surprising reasons why bitcoin is bad for the environment, starting with energy consumption. (2021, May 31). Youmatter. <https://youmatter.world/en/bitcoin-badenvironment-impact/>

European Bank (2019, April 2). Introducing Distributed Sustainable Energy Regulation for the Republic of Lebanon: Background Technical Report. Update 1. Retrieved from <file:///C:/Users/User/Desktop/DES%20Project/new/The-Energy-Regulation-andMarkets-Review---9th-Edition.pdf>

Criddle, C. (2021, February 10). Bitcoin consumes 'more electricity than Argentina'. BBC News. <https://www.bbc.com/news/technology-56012952>

Bitcoin's impacts on climate and the environment. (2021, September 16). State of the Planet. <https://news.climate.columbia.edu/2021/09/20/bitcoins-impacts-on-climateand-the-environment/>

What's the environmental impact of cryptocurrency? (n.d.). Investopedia. <https://www.investopedia.com/tech/whats-environmental-impactcryptocurrency/>

How Lebanon's economic crisis highlights bitcoin's limitations. (2019, October 28). CoinDesk: Bitcoin, Ethereum, Crypto News and Price Data <https://www.coindesk.com/markets/2019/10/28/how-lebanons-economic-crisishighlights-bitcoins-limitations/>

Sundqvist, P. (2007). Do energy taxes decrease carbon dioxide emissions? <http://uu.diva-portal.org/smash/get/diva2:131515/FULLTEXT01#:~:text=Regarding%20the%20total%20effect%20on,tax%20seems%20to%20increase%20them.&text=The%20results%20show%20that%20a,taxes%20do%20decrease%20CO2%20emissions>

Chow, C. (2020, January 24). Carbon Tax: A Shared Global Responsibility For Carbon Emissions. Earth.org. <https://earth.org/carbon-tax-a-shared-global-responsibility-for-carbon-emissions/>