UNIVERSITY OF PIRAEUS
DEPARTMENT OF INTERNATIONAL AND EUROPEAN STUDIES

MASTER PROGRAM

"ENERGY: STRATEGY, LAW & ECONOMICS"

DIGITALIZATION OF ENERGY SECTOR

The Potentials of Blockchain Technology, Cryptocurrencies & Artificial Intelligence

Prosmitrellis Konstantinos

Master Thesis submitted to the Department of International and European Studies of the University of Piraeus in partial fulfillment of the requirements for the degree of Master of Science "Energy: Strategy, Law and Economics"

Piraeus, January 2019

Thesis Advisor: Dr. Dagoumas Athanasios

Solemn Declaration

_____

On my own responsibility and being fully aware of the penalties stipulated under article 22 par. 6 of Greek Law 1599/1986, I hereby declare that:

"The intellectual work fulfilled and submitted based on the delivered master thesis is exclusive property of mine personally. Appropriate credit has been given in this diploma thesis regarding any information and material included in it that have been derived from other sources. I am also fully aware that any misrepresentation in connection with this declaration may at any time result in immediate revocation of the degree title."

_____

ABSTRACT

The purpose of this Master Thesis is to decode and describe the most fundamental potentials of Blockchain, Cryptoassets/Cryptocurrencies and Artificial Intelligence while determining the usefulness of all those technological achievements in the Energy sector. The digitalization of energy market will be at the core of political debates in the near future as the sustainability of the aforementioned industry will be achieved through constant reformations of energy generation, transmission and trading stages. The research executed for this paper was based on case study soliciting and on research of multiple academic papers and books written by modern technology experts. Developments in modern technology are so rapid that every year we have to assess the obsolescence of an application and what can be further done in order to help its users. This paper aims at presenting what kind of technological inventions can be useful and how we can integrate the components of modern technologies to ameliorate our level of life in 2019.

Frequently, the majority of people confuse the terms “Blockchain” and “Bitcoin”. Probably the best way to clarify what Blockchain is actually for ordinary people, could be the explanation through empirical examples that are more conceivable for non-knowledgeable individuals. In a few words, Blockchain is a platform which provides its users with a more secure and more transparent environment for transactions. Many companies claim that Blockchain is the future of everything so they hire experienced staff in order to make this set of technology more popular. The integration of Blockchain technology in any sector could revolutionize the way an industry operates until today and that is why hundreds of companies are investing respectable amounts of capital in modern technologies.

A sector in need of innovative applications of technology to reduce prices and simplify certain operations is that of Energy. Energy stock exchanges, new ways of energy generation and distribution, faster payment by final consumers, greater contribution of renewable sources and more liberated surveillance of governments to all three stages of energy management (upstream, midstream, downstream) are just some of the procedures that can be facilitated by Blockchain technology. Since automation is becoming more and more necessary in order for the Energy sector to meet the demand of its customers, Blockchain grants us several applications which could make transactions faster and competition greater. What we can figure is that Blockchain technology, even though it is considered a threat for many reasons, its potentials cannot be contested in the Energy sector. Energy firms are willing to minimize costs and consumers need it to eliminate the paperwork and reduce fees.

Thus, when consumers' satisfaction is combined with energy firms' cost reduction, the result is a successful formula which is oriented towards innovation and progress.

On the other hand, Bitcoin is a digital currency mainly used as a means of transaction or hoarding. Fiat currencies sometimes experience sharp appreciation or depreciation with devastating consequences in most cases. Limitations on imports and exports or cuts of pensions and benefits are some of the measures taken to deal with such challenges. Even so digital currencies cannot guarantee that can solve this kind of problems, they can facilitate the way Blockchain users transact with each other. The immutability of the blocks in the chain offers secure exchange of assets (Bitcoins for a product or a service). Nevertheless, cryptocurrencies can be used either as a means of transaction or as tokens. The origin of each type is principally the same but the manner one person can use them is totally different.

Last but never least, Artificial Intelligence is on the rise in the last decade because it can offer its services in many scientific fields managing statistical data and a vast amount of information. Machine Learning and Data Mining are some terms that will be heard a lot in the near future as a few conglomerates of Energy and Software Development sector. Machines reacting with people and automated responses according to our behavior or data set will radicalize customer service departments of thousands of companies worldwide. Data science was emerging for a long time and now scientists hold a tool that can multiply their capacity in trying to explore those uncharted waters.

Table of Contents

USEFUL TERMS

BLOCKCHAIN TERMINOLOGY GLOSSARY

Node (Full Node): A computer connected to the Blockchain network. Most nodes are not full nodes and full nodes can be difficult to run due to their bulky size. A full node is a program which can fully validate transactions and blocks bolstering the Peer-to-Peer network.

Peer-to-Peer (P2P): Refers to the decentralized interactions that happen between at least two parties in a highly interconnected network. P2P participants deal directly with each other through a single mediation point.

Blockchain: A type of distributed ledger, comprised of unchangeable, digitally recorded data in packages called blocks. Each block is then 'chained' to the next block, using a cryptographic signature. This allows block chains to be used like a ledger, which can be shared and accessed by anyone with the appropriate permissions.

Protocol: A set of rules that dictate how data is exchanged and transmitted. This pertains to cryptocurrency in Blockchain when referring to the formal rules that outline how these actions are performed across a specific network.

Scalability: A change in the size or scale to handle the network's demands. This word is used to refer to a Blockchain project's ability to handle network traffic, future growth and capacity in its intended application.

Cryptography: A method for securing communication using code. The main example of cryptography in cryptocurrency is the symmetric-key cryptography used in the Bitcoin network. Bitcoin addresses generated for the wallet have matching private keys that allow for the spending of the cryptocurrency. The corresponding public key coupled with the private key allows funds to be unlocked.

Hash: A function that takes an input and outputs an alphanumeric string known as the "hash value" or "digital fingerprint". The hash is used to confirm coin transactions on the Blockchain. Each block in the Blockchain contains the hash value that validated the transaction before it and its own hash value.

Proof-of-Work (PoW): A system that ties mining capability to computational power. Blocks must be hashed, which is in itself an easy computational process, but an additional

variable is added to the hashing process to make it more difficult. When a block is successfully hashed, the hashing must have taken some time and computational effort.

Proof-of-Stake (PoS): An alternative to the Proof-of-Work system, in which your existing stake in a cryptocurrency (the amount of currency that you hold) is used to calculate the amount of that currency that you can mine.

Fork: Creates an alternative version of a Blockchain. The two chains run simultaneously on different parts of the network. They can be either accidental or intentional.

Digital Commodity/Cryptoasset: A digital commodity which is scarce, electronically transferrable and intangible, with a market value.

Distributed Ledger: Distributed ledgers are a type of database that are spread across multiple sites, countries or institutions. Records are stored one after the other in a continuous ledger. Distributed ledger data can be either "permissioned" or "private" to control who can view it.

Decentralized Autonomous Organization (DAO): A form of investor-directed venture capital fund that seeks to provide an enterprise with new decentralized business models. Built on the Ethereum Blockchain, the DAO's code is open source.

Decentralized Application (dApp): An open source and trustless software application running on a decentralized Peer-to-Peer network rather than a centralized server.

Whitepaper: An authoritative report or proposal that is used in the web 3.0 community as an integral marketing tool to attract investors, educate the public about the project, and present to venture capital firms. Almost every ICO or ITO has a whitepaper on their website that is essentially an informative sales pitch.

CRYPTOCURRENCY TERMINOLOGY GLOSSARY

Fiat Currency: A currency that a government has declared to be legal tender, but it is not backed by a physical commodity. The value of fiat money is derived from the relationship between supply and demand rather than the value of the material from which the money is made.

Cryptocurrency: A form of digital currency based on mathematics, where encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds. Furthermore, cryptocurrencies operate independently of a central bank.

Token: A Token represents an asset built on an existing Blockchain (different from a coin).

Bitcoin (BTC): The most well-known cryptocurrency, based on the Proof-of-Work Blockchain.

Ethereum: An open software platform where developers build and run decentralized apps that contribute to the value of ETH cryptocurrency ecosystem. Ethereum is a public blockchain network.

Ether (ETH): The native currency of the Ethereum Blockchain network. It functions as gas of the Ethereum ecosystem and acts as a medium of incentive or form of payment for the network participants to execute their requested operations on the network.

Gas: A way to measure computational steps necessary for a transaction on the Ethereum network that then equates to a fee for network users. More intensive actions require more gas.

Mining: The process by which transactions are verified and added to a Blockchain. This process of solving cryptographic problems using computing hardware also triggers the release of cryptocurrencies.

Wallet: A designated storage location for digital assets (cryptocurrency) that has an address used for sending and receiving funds to and from the wallet. The wallet can be online, offline, or on a physical device.

Smart Contract: A contract whose terms are recorded in a computer language instead of legal language. Smart contracts can be automatically executed by a computing system, such as a suitable distributed ledger system.

Initial Coin Offering (ICO): An event in which a new cryptocurrency sells advance tokens from its overall coinbase, in exchange for upfront capital. ICOs are frequently used for developers of a new cryptocurrency to raise capital.

Initial Token Offering (ITO): Similar to ICO, but different in that not every Blockchain project that is tokenized has developed a new coin. A project built on the Ethereum network that is tokenized using ETH would be considered an ITO, the project isn't launching a new coin, just a new application on an established coin platform. [1]

[1] All Blockchain and Cryptocurrency-related terms were retrieved by www.blockchaintechnologies.com. Available at: https://www.blockchaintechnologies.com/glossary/

ARTIFICIAL INTELLIGENCE TERMINOLOGY GLOSSARY

Artificial Intelligence (AI): A specific field of computer science that focuses on creating systems capable of gathering data, making decisions and solving problems.

Data: Any collection of information converted into a digital form.

Data Mining: The process by which patterns are discovered within large sets of data with the goal of extracting useful information from it.

Machine Learning: A subset of AI in which computer programs and algorithms can be designed to "learn" how to complete a specified task, with increasing efficiency and effectiveness as it develops. Such programs can use past performance data to predict and improve future performance.

Supervised Learning: A type of Machine Learning in which human input and supervision are integral parts of machine learning process on an ongoing basis, like a teacher supervising a student.

Unsupervised Learning: A type of Machine Learning algorithm used to draw inferences from datasets consisting of input data without labeled responses.

Deep Learning: A subset of AI and Machine Learning in which neural networks are "layered", combined with plenty of computing power, and given a large measure of training data to create extremely powerful learning models capable of processing data in new ways in a number of areas.[2]

[2] All Artificial Intelligence-related terms were retrieved by www.medium.com Available at: https://medium.com/machine-learning-world/artificial-intelligence-terminologies-260f1d6d299f

INTRODUCTION

To compose this Master Thesis, we conducted a research including the most fundamental and the most recent books published in the sectors of Blockchain, Cryptocurrencies and Artificial Intelligence. In addition to them, we proceeded by meticulously reading scientific journals composed by university professors and top specialists working in private enterprises. Those journals contained both theoretical knowledge which operates as a base and the technical knowledge that renders a new application unique and different than other companies' innovations. Nevertheless, papers and books do not include the more practical side of modern technologies and their implementation in everyday life while surveys performed by major institutions can raise certain influential statistics about what respondents believe about decentralized platforms and smart devices. In order to come to a conclusion concerning the application of Blockchain in Energy sector, a traditionally state-controlled industry, one should include official reports from international organizations such as the United Nations and the European Union. This will aid the reader to understand the rationale behind governments' decisions and policy-making procedures and priorities.

United Nations have already declared that there are 17 goals to achieve in the next decades. Some of them are "Affordable and Clean Energy", "Industry, Innovation and Infrastructure" and "Sustainable Cities and Communities". The application of state-of-the-art technologies such as Blockchain and Artificial Intelligence can undoubtedly assist in order to ensure sustainability and innovation in our communities. Nevertheless, most of global organizations evaluate Blockchain not bearing into consideration the potential it has for our everyday life but the value it can offer to powerful conglomerates. Maybe this is one of the reasons why Blockchain has not yet proved its necessity as many policy-makers stress the financial aspect of it on the detriments of the decentralized characteristics that can provide. That is because banks and governments do not wish to lose control over both the financial and the technological advancements as other private sector organizations could use modern technologies as leverage against public interest.

Certain steps have been made towards regulating those new technologies in a manner that will not undermine their innovative components. The level of importance that European bureaucracy demonstrates towards Blockchain and cryptocurrencies is relatively high than other individual countries of the world. More specifically, European Parliament adopted a text which aims at drawing the attention of Member States on some areas of Distributed Ledger Technologies (DLTs). Its most notable points are: The usage of Blockchain for the empowerment of citizens in a wide variety of areas such as Energy, Healthcare system, Supply Chains and Infrastructure. The benefits of Blockchain include the decision by the citizens themselves about what kind of personal data are willing to share with other users, the transparency of transactions within users despite their anonymity and the familiarization

of citizens with modern technologies as a tool to tackle digital illiteracy. The elimination of intermediaries will create a loss of jobs but at the same time will reduce the prices of certain products by rendering them competitive than those originating from Asian of American markets. The gap created by the job loss will be covered through the augmentation of demand of developers and programmers who will run complicated systems like those of Artificial Intelligence and Blockchain.

Likewise, in the Energy sector, the European Parliament is proposing the wider use of renewable energy sources like solar or wind power in order to facilitate the energy trading among private users. Such an example of this new type of decentralized energy platform is “smart grid”, which eliminates the dominant position of power utility companies and enforces cooperation of consumers within small communities or towns. In this way, EU deputies believe that electric vehicles will be more attractive than before as cheap energy will render them cost-efficient in the long-term. Nevertheless, European Parliament has raised everyone’s attention over the damaging effects of “Proof-of-Work” algorithm as it consumes a great amount of electricity while other mechanisms can have the same result while being energy-efficient. Even though governments are considered as abolitionists of decentralization, European Union has already founded the Blockchain Technology Observatory & Forum which operates as a knowledge hub on Blockchain and brings together stakeholders from multiple sectors of the economy. Tackling tax evasion and money laundering through cryptocurrencies is crucial for European governments as billions of euros could be saved providing a less turbulent environment for banks and other financial institutions. Finally, small and medium enterprises (SMEs) will have the opportunity to participate on equal terms in the European Single Market by developing more competitive products and services as decentralization will eliminate unnecessary third parties and will facilitate the communication among enterprises and customers.

As for Artificial Intelligence (AI), European Union is trying to use robot-like computers as a means of economic development. The real challenge is AI’s ethical and legal impact because the debates have not matured yet in a way that one could be optimistic of a proper regulatory approach and a widely accepted legal framework. Under the Horizon 2020 Program, European Union increased investments of AI by 70% in order to proceed to determined policies which will be applied on certain strategic sectors. It is vital for EU citizens to understand the potentials Artificial Intelligence bears and try to train themselves in order to better integrate it in their workplaces. On the ethical side of the issue, the GDPR Regulation created a legal path which offers a new trust-building base on which AI can be elaborated. For that reason, the anthropocentric spirit included in the EU’s Treaties should never be undermined by the Artificial Intelligence’s ambiguous ethical approach. The same kind of debate exists within the United Nations too where developing countries are blaming developed economies for enlarging the gap between them.

The term “Blockchain” has been presented lately due to the emergence of hundreds of cryptocurrencies the potential of which is promising. However, the first time academics and researchers introduced several characteristics of Blockchain into the academic community without uttering the relevant term was back in the 1990’s decade. The immutability of documents standing on the Internet (most commonly known as Time-stamping) was crucial 25 years ago because certifications of data alteration would be essential so as to guarantee that no user would tamper with the dates or the content of a document. Terms such as “digital signature” and “time-stamping” were later used by Satoshi Nakamoto in order to realize the vision of some innovators who foresaw the capacity of Blockchain technology. In 2008, Nakamoto displayed the Blockchain as we know it nowadays. A chain of blocks which demands computing resources to add new blocks to the chain by using cryptography and by earning a reward (Bitcoin) for every mathematical algorithm solved by a user is in a few words what Satoshi proposed as a means of dependency level reduction of people with governments and banks and strengthen the transacting power of consumers. The point of time was the beginning of “Blockchain 1.0 Era”.

The potentials of Bitcoin’s Blockchain were not satisfactory for many specialists of the sector and thus they proposed a new version of Blockchain which is not too energy-demanding as Bitcoin’s and which treated the tokens not merely as alternative currencies. Ethereum’s Blockchain was created by Vitalik Buterin and succeeded Bitcoin in order to boost the capacity of distributed ledger technology. “Blockchain 2.0 Era” commenced with the introduction of smart contracts which permitted programmers and developers to create applications favoring the decentralization of currently centralized structures. Apart from the decentralized applications (dApps), Ethereum offered a new platform in order for anyone interested to fundraise capitals using Ethereum’s Blockchain. This process is called Initial Coin Offering and works by offering tokens in exchange for fiat money. In 2018, the “Blockchain 3.0 Era” delivers “cloud computing”, which is the granting of computer services such as storage, databases and software analytics. This practice will reduce the amount of work an IT department is currently offering by rationalizing its manner of operating. Higher speed, lower costs, more productivity and higher security standards are some of cloud computing’s benefits. Blockchain is considered to change with the introduction of such technologies as it will assist in the decentralization process. The revolution Blockchain promises will be realized by defining ownership status from the beginning.

A report published in June 2018 by International Monetary Fund through Finance & Development magazine is quite remarkable as it raises attention over modern technological achievements and their impact on our economies. Cryptocurrencies’ regulation is recognized as a major debate among economists as many of them claim that more regulation will degenerate the true goal of Bitcoin and its competitors. Another point of reference is the tendency of many countries to render cash obsolete and boost more digital policies. The advertising of cryptocurrencies is creating high expectations and that is the reason why

people should be informed about their real capacity in order to await for feasible outcomes. The emergence of cybercrime is alerting the relevant authorities however it is difficult to track down illegal use while cryptocurrencies are unregulated in the majority of countries and mainly because of the decentralized nature of cryptocurrencies. Last but never least, the role of robots within workplaces and their impact on other workers is under deliberation primarily in technologically advanced economies (Japan, South Korea, Germany and Sweden). Robots come to assist by replacement or as a supplementary tool to accelerate time-consuming procedures.

The 3 Ds (Digitalisation, Decentralisation and Decarbonisation) are three different goals to be achieved by governments in order to render the energy production sustainable and eco-friendly. Digitalization is the number one goal of our times as it will automate certain procedures that are both costly and time-consuming. Automation will result in faster decision-making systems which will reduce a company's cost of operation. Decentralization materializes itself as a result of the digitalization of operations. Once a procedure becomes automated it is rational to become decentralized too because Blockchain provides more secure communication and transaction conditions for its users. Finally, Decarbonization will reduce the effects of climate change and will stabilize the meteorological and atmospherical conditions on Earth. This will happen because of the intermediaries' elimination as fewer resources are used to achieve a goal and less energy is spent too.

In 2018 survey over Blockchain, Deloitte published some really meaningful figures deriving from the responses of 1,053 executives of the Blockchain sector from 7 countries (Canada, China, France, Germany, Mexico, the United Kingdom and the United States). More specifically, even though 74% of respondents claimed that Blockchain technology is compelling, only 34% stated that they have already applied some kind of Blockchain technology in their enterprise and the reason for another 40% of respondents waiting for the best timing to enter the Blockchain environment is the fact that they lack a compelling application to justify its implementation. Also, 59% of them support they are sure about Blockchain's revolutionizing impact on a variety of sectors and 78% claim that if they will not implement Blockchain in their company they will become less competitive. However, they stress the fact that Blockchain industry is all the more uncertain and no plan can be drawn on a stable basis.

In May 2017, HSBC, a UK-based bank, published a survey which aimed at demonstrating how many people know the existence of Blockchain technology and whether they acknowledge its contribution in our societies. The survey took place in 11 countries (Canada, China, France, Germany, Hong Kong, India, Mexico, Singapore, the United Arab Emirates, the United Kingdom and the United States) and 12,000 individuals were asked to answer simple questions concerning Blockchain. The numbers were merciless. 59% of people asked in the survey claimed that they have never heard about Blockchain, not even as a term. 33%

percent claimed that they have heard about Blockchain but they cannot explain what it is and how it works. The remaining 8% knows what Blockchain technology is and some of them are up-to-date with it. The results show that there is a challenge to deal with as technological changes happen every year and Blockchain could cause the Fourth Industrial Revolution. People should be more familiarized with terms like “Internet of Things”, “Digital Identity” or “FinTech” because if people fear the change due to the lack of digital education or the lack of familiarization with modern technology in general, then the criticism applied on Blockchain could work as a self-fulfilling prophecy on the detriment of progress and change.

Since one person is reading this Master Thesis, he probably belongs to the 59% and he is willing to be a part of the 33% trying to widen his academic horizons. Either way we should all handle this document as a guide for those who do not know what Blockchain technology is and what are its potentials or as an updated academic paper for the familiarized ones. Every chapter is connected with the previous and the next in order to prove the interdimensional character of modern technologies that concern from IT professionals and financial consultants to engineers and every professional dealing with computers in general. That is why this paper can be read by anyone regardless of the professional status and academic background of the reader.

The main questions this Master Thesis is trying to answer are the following:

1. How can energy consumers and producers benefit from modern technologies?
2. What are the weakest points of modern technologies?
3. What will be the future of modern technologies in the Energy sector?

UNIT 1

CHAPTER 1: Basic Aspects of Blockchain Technology

1.1 What Is Blockchain And What Purpose Does It Serve?

It is really difficult to give a proper definition of Blockchain that could stand by its own and be understandable enough. Every definition is always accompanied by an extensive and dense paragraph which gives all the necessary components. There are multiple definitions of Blockchain circulating the Internet but the following one tries to explain what it is and which is its "raison d'etre" by oversimplifying procedures, terms and causes. Thus, it can be defined as "a decentralized database shared among nodes, which uses cryptography to record transactions of value or data". It looks simple, it sounds generic and vague and it feels like it is something that serves only Information Technology professionals. This chapter will focus on what Blockchain is by shedding light on every aspect of this technology.

It is more convenient to use examples from everyday life to have a solid idea of how Blockchain works. Imagine how general ledger works in accounting, where we have a book in which we keep a record of every single transaction we have made. Distributed Ledgers (Blockchain is one of them too) works in the same way but in a digital manner. All information is uploaded in a huge network of computers (nodes from now on) recognizing no borders and spreading to all corners of the world. The way those transactions are verified by nodes will be analyzed later on this chapter.

The next term we need to explain is "decentralized". In simple words, each node uses and shares voluntarily its computing resources (disk storage, network bandwidth or processing power) with other participants of the network. In Peer-to-Peer (P2P) case, there is no need for permission from a central server. All nodes in the network are equal in terms of rights and duties and no node can intervene to fix, change or develop anything in the network by its own. This works as a safety valve as the lack of a central server could alert many people who could question the integrity of a P2P network. Even if a malicious node tries to hack another node in order to change some data, the network remains intact because if a single node remains unhacked then the network can operate again without any problem. This is not a rule that works all the time because nothing is simple in the world of computers. A classic example of malfunction can happen in the 51% Attack case which will be analyzed in the next chapters. What we should keep in mind at this point is that it is quite difficult to hack the network unless a great amount of computing resources is used.

An important difference between a central server and a distributed network is that the first can be congested and thus slowed down by the huge number of nodes while in a P2P network the bigger the number of nodes participating, the faster will run and compute

transactions. Imagine Internet of the last years where one website could be brought down and every information and file in it could be lost forever. By using P2P network files and data live forever in the heart of every single node within the network.

How can we make sure that we can continue to own our data in such a network? The notion of “ownership” is fundamental in Blockchain technology and the reason is obvious. In the current form of Internet, social networking works with the help of social media companies like Facebook, Twitter, YouTube, etc. Those companies have become the owners of our data (personal or not) as users agree with the terms of the platform that give a free pass to those companies to use our data at will. This phenomenon changes with decentralized networks as every node can be the owner of a certain amount of data but at the same time everything is crystal clear and transparent in the network and everyone can see almost everything in it. P2P is offering a new communication channel through which a node can send a message to another node directly without the involvement of other third parties. However, the ownership of the data is never and under any circumstances contested by anyone. But if someone tries to question the ownership of one’s data then the history of the network will make the majority of the nodes to “vote” in favor of the real owner.

The next question in our minds is why do others have to verify what data we own? In Blockchain platforms what matters the most is collaboration in order to maintain such a complicated structure. For that reason, users assist one another in the verification process in order to be assisted in case of emergency. It may sound unnecessary but it serves a solid purpose. The key word here is “cryptography”. Most of us know cryptography from the war movies where messages are transmitted in the form of Cesar’s Shift in 50 B.C. or Enigma machine during World War II. Cryptography works in exactly the same way nowadays on Blockchain. All the data we insert are time-stamped by a cryptographic hash. It is a “stamp” which gives our data a “certificate of authenticity”. If someone tries to change even a single coma, the hash changes completely alerting all other nodes about this change. Then multiple data from several nodes are collected and put in a single block which includes the hash values of every transaction and becomes the next block of the chain only after 51% of the nodes vote in favor of that block. It sounds complicated but in the next pages we will meticulously focus on every single step of Blockchain procedure.

What about trust? How can we ensure that other nodes are not willing to falsify our data even though it costs a lot for them? Trust is the result of high security level concerning Blockchain. As we mentioned before, it is much difficult to intervene and change anything in the chain as it would demand a huge amount of computing resources (a very fast computer and a lot of electrical power). Since a malicious node cannot achieve its purpose we assume that all nodes respect the rules of the network. This is not always the case as there have

been a lot of incidents where China and Russia build large infrastructure with supercomputers in order to create forks[3] in the Blockchain.

1.1.2 How Blockchain Works?

The basic role of Blockchain is to gather and settle data in order, because stocking thousands of files and information in less time is what Blockchain technology was created for. This chaos of information, arriving in the network at the same time, is placed in array by automatic time-stamping. Then, data are put in blocks and are ready to be verified by the majority of the nodes. We have to imagine each block of the chain as a box which includes three different components: the data we want to insert in the Blockchain, the cryptographic hash of our data and finally the hash of the previous block in order to prove the link with the previous block. We will assess every one of them to understand the nature of both the input and the output of this procedure.

Data that are inserted into the network could be a simple message, a single document, a file with several documents, a picture, a video, a contract or a transaction sheet (which will be in the center of our paper) and can exist in three different forms: unencrypted, encrypted and hashed. Unencrypted data can be read by everyone in the network without any use of cryptography. Encrypted data are divided into two major categories: symmetrically encrypted data and asymmetrically encrypted data. Finally, hashed data are the ones which have undergone a digital processing by replacing a file, picture, contract or currency with alphanumeric digits. This is a very generic picture about what data are inserted in the Blockchain and how those data are treated.

Cryptographic hash of our data is so vital because it is the component that secures the whole Blockchain procedure and traces any change happening to a block. An algorithm receives information and converts them into a string of numbers and letters of fixed length that changes completely if anything is altered. Now a vital question should be answered. What is the difference between hashing and encrypting? The main difference is that hashed data cannot be un-hashed by using any key just like encryption where one who possesses a key (public or private) can decrypt the data.

In order to become more familiar with the relevant terminology, the data we insert into the Blockchain are called “input”, the algorithm which converts data into hash is called “hash function” and the output of that procedure is called “hash value”. If we need to find out

[3] A fork in Blockchain is when there are two blocks for the same transactions and nodes have to vote which of the two will be the next in the chain. We have to keep in mind that there is only one chain that constitutes the Blockchain, so while voting for the next block, some nodes will vote for block A and some for block B. At the same time, nodes will add new blocks to both block A and block B according to what they have voted for. It sounds unimportant but due to network latency approximately 5-6 blocks that have been created after the controversial blocks may eventually disappear.

whether all nodes possess the same chain, we have to match the hashes to see if they look identical. As we said before, two inputs cannot result with the same hash value. This is the signal that the chain is tamper-proof and all nodes are on the same ground. The difference between symmetric and asymmetric encryption is based on what kind of key is used to encrypt and decrypt our data. In the case of symmetric encryption, the same key is used to both encrypt and decrypt our data while in the asymmetric encryption a public key is used to encrypt the data and a private is used to decrypt them. The asymmetric cryptography is also commonly known as public key cryptography for the above mentioned reason.

Last but not least, the hash of the previous block is very important In order to achieve the continuity of the whole chain. It works like puzzle pieces that match uniquely and create a stable basis for the next blocks of the network. Remember that two identical hash values cannot exist at the same time. Hashing data ensures the immutability of a block in the chain and that is the reason why nodes pay attention to hashed data. Even the last block of the chain can lead a node to the very first block also known as “Genesis Block”, which has been created by the founder of the certain Blockchain protocol. A protocol contains all the necessary information about how communication and transmission of data will take place between nodes. It is like programming a robot before it can be fully functioning. “Consensus protocol” is the set of rules which ensures that every node will receive that same information from the network. It is a self-auditing mechanism that keeps the Blockchain in a balance.

To proceed, we should use an example to make the procedure more understandable. Let’s imagine that Alice wants to buy a book from Benjamin. Benjamin has put a price of 2 units of a certain cryptocurrency (for the sake of the example we assume they use Bitcoins even though 1 Bitcoin equals more than 3,800 dollars at this time). A document will be created including the buyer, the seller, the amount of money needed, the sender’s digital signature and finally the exact time of the transaction. Digital signature of the sender is vital in order for the recipient to know that it was indeed Alice the person who sent the relevant document and it is vital for Alice too because this signature can release Bitcoins from her own wallet. When this document is put in the block, the block is ready for the verification process in order to be added to the chain. A node verifies it after 10 minutes (this is the average time it takes for a block to be added to the Blockchain of Bitcoin) and now this block is part of the chain. Usually, in order for the seller to be sure that the transaction is 100% valid, he has to wait approximately 1 hour (the amount of time it takes in order to add 6 blocks in the chain) because after 6 blocks it is computationally impossible to falsify the block in which our document is included. After 1 hour the seller is sure that the 2 Bitcoins were added to his digital wallet and this is how a transaction is realized within Bitcoin’s Blockchain. Blockchains may differ and this is why we choose to use a specific example at this level.

The Blockchain is an effective solution of the centuries-old consensus problem. Using cryptography (hashes and digital signatures) and a system which rewards participants, the winner reaps the rewards while, at the same time, ensures the validity of the entire ledger. Additionally, the Blockchain is not a universal solution to any problem concerning transaction verification and security. Its implementation must be adopted only after careful examination of the requirements of the application. The impact of the Blockchain in modern society is disruptive and the consequences of its widespread adoption are still unknown.[4]

1.1.3 Blockchain Technology Benefits

Disintermediation

Probably the greatest advantage of Blockchain technology is the lack of intermediaries, which means that participants in the network do not need a trusted third party anymore to guarantee that the procedure will be secured. Until today, if one person is willing to buy a service or an item from the other side of the world he would have to pay a certain amount of money through his bank and give it to the bank of the seller. This procedure includes two transactions. First, the buyer gives a certain amount of money from his bank account to the seller's bank and finally the seller's bank gives that amount to the seller. Blockchain offers the ability of every participant to communicate and transact directly with the other party even though there is no trust among them. The reason why trust is not needed is because once a piece of information is added to the network it is impossible to change it for either noble or malicious reasons.

Lower Costs

The elimination of intermediaries leads to fewer institutions involved in the whole procedure. Imagine that a buyer should not only pay the cost of a service or an item but also a transaction fee because different banks from different countries participate in the transaction. We should not forget that trust is paid and is not for free in the financial system. Banks are rewarded for clearing payments all over the world as thousands of payments take place every day. This is why many multinationals or start-ups are very interested in Blockchain technology which could lead to greater dividends or faster depreciation of an investment. The price of mainstream computers, memory, disk space, and networking equipment has fallen dramatically during the past 20 years. Since distributed systems consist of many computers, the initial costs of distributed systems are higher than the initial costs of individual computers. However, the cost of creating, maintaining, and operating a super-computer is still much higher than the costs of creating, maintaining, and operating a

[4] Puthal, D., Malik, N., Mohanty, S. P., Kougianos, E., Yang, C. (2018). The Blockchain as a Decentralized Security Framework. [pdf] Future Directions, page 3. Available at: https://www.researchgate.net/publication/323491592_The_Blockchain_as_a_Decentralized_Security_Framework_Future_Directions [Accessed 9 March 2018].

distributed system. This is particularly true since replacing individual computers of a distributed system can be done with no significant overall system impact.[5]

Decentralization

The lack of a single central authority in Blockchain network has democratized information because every user can directly send data to other nodes without waiting for permission from a server or filtering of information. The only authorization will be the one from other nodes trying to verify our transaction. In addition to that, the fact that there is no central server means that the transaction will be delivered faster because until today banks need 2-3 days to clear a transaction while it takes just a few minutes within Blockchain network. Being fast and direct is vital for enterprises like service providers in general from banking to cargo management.

Part of the reason for this explosion in data is the Internet of Things (IoT), sometimes known as the Internet of Everything (IoE). The IoT refers to devices that collect and transmit data via the Internet, and covers everything from your smartphone, smartwatch, Fitbit band, even your TV and refrigerator. The IoT has seen enormous growth in recent years, and it is only just getting started. Today, there are about 13 billion devices that connect to the Internet. By 2020, that number is predicted to rise to over 50 billion. Smartphone users alone are predicted to number over 6 billion by 2020. Smart devices are transforming our world, our cars, our homes and our businesses. By 2020, a quarter of a billion cars will be connected to the Internet, allowing scope for a whole host of in-vehicle services including automated driving. […]Connected devices can not only connect to the Internet, they can also connect and share information with each other. In fact, machine-to-machine connections will grow to 27 billion by 2024. So, in the near future, it's not unreasonable to imagine your refrigerator knowing when your milk is out of date and automatically telling your smartphone to order more in the next online shop. In other words, the amount of data we're generating is not going to slow down anytime soon. On the contrary, businesses which learn to harness this data are the ones which will survive and thrive in future.[6]

The Internet of Things (IoT) is increasingly becoming popular technology in both the consumer and the enterprise space. A vast majority of IoT platforms are based on a centralized model in which as broker or hub controls the interaction between devices. However, this approach has become impractical for many scenarios in which devices need to exchange data between themselves autonomously. This specific requirement has led to efforts towards decentralized IoT platforms. The Blockchain technology facilitates the

[5] Drescher, D. (2017). Blockchain Basics - A Non-Technical Introduction in 25 Steps. Frankfurt: Apress, page 12.

[6] Marr, B., (2017). Beyond the Big Data Buzz – How Data is Disrupting Business in Every Industry in the World. KoganPage, page 4.

implementation of decentralized IoT platforms such as secured and trusted data exchange as well as record keeping. In such an architecture, the Blockchain serves as the general ledger, keeping a trusted record of all the messages exchanged between smart devices in a decentralized IoT topology.[7]

Security - Transparency

Every node is the indisputable owner of data as private keys within Blockchain permit a node to encrypt information and select who and how can decrypt them. This eliminates the danger of hackers obtaining our digital information, but if however one node is hacked the network stays intact because a copy of the Blockchain network as a whole exists in each and every node of the network. Even though everyone can see a transaction made, the immutable nature of Blockchain data reassures the user about the integrity of information provided by other nodes. Last but not least, since everything is automated in Blockchain, the possibility of a human mistake happening is eliminated as decentralized ledger systems have as a principle that human involvement will be reduced if not abolished. This has provoked a huge debate as many researchers claim that human surveillance could prevent a system failure while others claim that decentralized automated systems are self-regulated.

At the heart of Blockchain security three main concepts are included, identification, authentication and authorization. “Identification” works like an identity card for nodes. A node can claim to be someone and this may be true but sometimes may be false. Identification is not a safe criterion by itself in order to prove that a node is actually who he claims to be and for that reason authentication is needed. “Authentication” is achieved by cryptographic proof which is needed by institutions such as banks, utility companies or insurance companies in order to prove the true digital identity of a specific node. When a node will be entering Blockchain for the first time, it will be asked to submit certain personal data such as name, address, insurance number, fingerprint or other biometric information. The aim of most Blockchain-related companies is to prove the necessity for digital identities both for security reasons and for practical reasons too. Finally, “authorization” is the last step for granting access to some of the network’s resources. For example, it works like VIP pass for someone or like fidelity card for the most loyal customers. The more data we offer to Blockchain the more services we can apply for.

Increased Capacity

One of the main advantages of Blockchain is that the network as a whole is upgraded every time a new node is connected to the system, which means that from this time on, a computer’s resources and power contribute to the system and help transactions be verified faster. Imagine if a hundred supercomputers could join the network what potentials could

[7] Crosby, M., Nachiappan., Pattanayak, P., Verma, S., Kalyanaraman V. (2015). BlockChain Technology - Beyond Bitcoin. California: Sutardja Center for Entrepreneurship & Technology, page 17.

offer to Blockchain technology. It could work as a multiplier of all the above mentioned benefits minimizing the risks at the same time. The computing power of a distributed system is the result of the aggregated computing power of its constituents. One can increase the computing power of the whole system by connecting additional computers with the system. As a result, the computing power of the whole system can be increased incrementally on a fine-grained scale. This supports the way in which the demand for computing power increases in many organizations. The incremental growth of distributed systems is in contrast to the growth of the computing power of individual computers. Individual computers provide identical power until they are replaced by a more powerful computer. This results in a discontinuous growth of computing power, which is only rarely appreciated by the consumers of computing services.[8]

1.1.4 Blockchain Technology Drawbacks

Scalability

The problem of Blockchain scalability can be best described through the "Tragedy of the commons" theory. The Tragedy of the Commons is the situation where a lake contains a certain number of fish which is multiplied in a certain rhythm. The lake faces no problem if a fisherman catches less fish than those born each day. If fisherman catches more fish than those born each day, then at some point the lake will bear no fish at all. The potential of the lake is specific and the rule is strict and clear. If one follows the rule the lake will continue to carry fish and the fisherman will benefit from the number of fish he catches. Now we should bring this example close to Blockchain reality. Imagine that the lake is the Blockchain network and fisherman is a miner. As it is commonly known, Bitcoin's Blockchain is not infinite. The purpose is to stop producing Bitcoins when 21 million Bitcoins have been created. Many critics claim that now exist 17.5 million Bitcoins and it is difficult to continue mining because it demands a lot of investments in computing resources and only the best and the fastest computers can obtain the reward. We can assume what will be the situation in the next years when we will have more miners to compete for less Bitcoins, the reward will remain the same while the resources and the power spent will be greater. To sum up with the Tragedy of the Commons theory, Bitcoin is condemned to be abandoned at some point because the vast majority of Bitcoins will be mined and the incentive to mine more will be outweighed by the cost to maintain a computer with great potential.

Back in 1980, computer scientists began to examine reliability of computers. It was determined that a reliable computing system must be able to cope with the failure of one or more of its components. A failed component may exhibit a type of behavior that is overlooked and problematic, namely, sending conflicting information to different parts of

[8] Drescher, D. (2017). Blockchain Basics - A Non-Technical Introduction in 25 Steps. Frankfurt: Apress, page 13.

the system. The problem of coping with this type of failure is expressed abstractly as the Byzantine Generals Problem. This abstract problem and the solutions thereof are used in developing highly reliable and trusted Blockchain implementations.[…] The Byzantine Generals Problem is built around a similar story line: the commanding general who makes a decision to attack or retreat, and must communicate the decision to his lieutenant generals. A given number of these actors are traitors (possibly including the general). Traitors cannot be relied upon to properly communicate orders; worse yet, they may actively alter messages in an attempt to subvert the process. In the analogy, the generals are collectively known as processes, the general who initiates the order is the source process, and the orders sent to the other processes are messages. Traitorous generals and lieutenant generals are faulty processes, and loyal generals and lieutenant generals are correct processes. The order to retreat or attack is a message with a single bit of information: a one or a zero. A solution to an agreement problem must pass three tests: termination, agreement, and validity. The best way we know to implement a reliable trustworthy computer system (e.g., Blockchain) is to use many different processors to compute the same result, and then to perform a majority-vote on their outputs to obtain a single value.[9]

General Costs

A lot of criticism exists concerning high cost of maintaining Blockchain and whether an alternative could solve this problem. The answer is both YES and NO and the rationale behind it sounds logic. Blockchain uses Proof-of-Work (PoW) that was first used to deter companies from sending spam e-mails to consumers. With PoW the sender should consume a lot of energy making it expensive for him to send arbitrarily e-mails to millions of consumers. PoW is an answer to a challenge set by the block which needs to be added to the chain. It is difficult and costly to create it but once created it is easily applied in order to solve the “puzzle” that is necessary to be us the ones to add the block to the chain and gain a reward for that. However, other academics claim that PoW is too costly especially for miners who live in countries with expensive electric power.

Poor Regulation

The absence of a central server means that there is no central authority ruling the network. Transactional Law varies from country to country and for that reason it is difficult to locate a malicious node that tried to violate the rules of transactions in a decentralized network. How is supposed to protect himself a participant who has been the victim of a fraud in Blockchain? There is a need for an exclusive governing law covering a wide spectrum of system violations and it should not be considered a means of State’s involvement in Blockchain as it is the participants who will benefit from such a development. There have

[9] Bambara, J. J. and Allen R. P. (2018). A practical Guide to Developing Business, Law and Technology Solutions. McGraw-Hill Education, page 9.

been incidents concerning intellectual property and cryptocurrency exchanges frauds where people have lost assets and money due to the lack of decisive regulation.

Recentralization Trend

There is a stereotypical perception about the role of the State in Blockchain. It is considered as a threat and nodes try to keep it away at all costs even though governments are not always fighting decentralization techniques. However, there have been complaints that some nodes act in recentralizing manner rather than a decentralizing one. They form mining pools (a group of multiple nodes) which bring together computing resources of many nodes in order to get the reward and making mining an expensive occupation for a few rich and technology savvy users. Nodes from Russia and China use mining pools widely in order to exploit the lack of regulation and legal instruments as a means to proceed to money laundering and tax evasion.

Without the principle of a distributed trust protocol, the applications of virtual machines are limited; data controlled by centralized, trusted third parties who monopolize the analytics through secret algorithms, is inherently limited. Not only is the data inaccessible to the wider community unless fees are paid, but mistrust of the monopoly can lead data providers to withhold information. A "global brain" can't really come into existence in an economy dominated by the centralized trust model. Blockchain-based network designs probably won't get the same attention in homeware magazines as smart doorknobs and self-driving cars, but they will be a fundamental backbone of the network computing capacity of an Internet of Things economy in which tens of billions of devices like doorknobs and cars are autonomously "talking" to and trading with each other.[10]

Except from Proof-of-Work, according to which the higher the hash rate is the better chances we have to mine the next Bitcoin, there are other types of Proof to secure Blockchain transactions:

Proof-of-Stake

In this case, Blockchain platform selects different users each time to mint or forge the next block. This happens because the user does not have to spend computing resources in order to mine the next block. The criteria can be either the combination of the lowest hash rate and the size of the stake of every user. The stake a user has to offer is a certain number of cryptocurrencies the amount of which is set by the user himself according to his spending capacity. Usually, the criteria of choosing the next forger are random in order to maintain a balance between all users so as to avoid the centralization trend of Proof-of-Work. However,

[10] Casey, M. J., Vigna, P. (2018). The Truth Machine – The Blockchain and the Future of Everything. St. Martin's Press, page 122.

in most of the cases, the users with the more Bitcoins are winning in order to reward the ones who are participating or using the platform more frequently.

Proof-of-Stake (PoS) is a category of consensus algorithms for public Blockchains that depends on a validator's economic stake in the network. In proof-of-Work (PoW) based public Blockchains, the algorithm rewards participants who solve cryptographic puzzles in order to validate transactions and create new blocks (mining). In PoS-based public Blockchains, a set of validators take turns proposing and voting on the next block, and the weight of each validator's vote depends on the size of its deposit (stake). Significant advantages of PoS include security, reduced risk of centralization, and energy efficiency. In general, a PoS algorithm keeps track of a set of validators, and anyone who holds the Blockchain's base cryptocurrency (in Ethereum's case, Ether) can become a validator by sending a special type of transaction that locks up their ether into a deposit. The process of creating and agreeing to new blocks is then done through a consensus algorithm that all current validators can participate in.[11]

Proof-of-Time

In this case not only the sheer existence of an entry in the Blockchain is important but also the time when the entry was added. The Blockchain can serve that need since the blocks of the Blockchain-data-structure store the time when the process of adding them was started. Applications that benefit from the time-stamping capabilities of the Blockchain are those that track the occurrence of events in time such as delivery or notification tracking, tracking of payments, tracking of orderly opening and closing of public bidding procedures, and management of predictions.

Proof-of-Order

This pattern of usage utilizes the ordering capability of the Blockchain. Applications which benefit from that property of the Blockchain are those that track the relative ordering of events regardless of their absolute time, for example, tracking of application processes, auditing public bidding procedures, and escrow services. Proving that some event was the first or the last of its kind is a specific example of Proof-of-Order. This kind of proof can be important when resources are allocated in the same order in which certain claims or documents are submitted such as college or university applications, patent applications, or copyright claims.[12]

Blockchain as a network uses a lot of electricity and the reason is simple. Every time a new node participates in the network it has to communicate with each and every node of

[11] GitHub.com. (2018). What is Proof of Stake. Available at: https://github.com/ethereum/wiki/wiki/Proof-of-Stake-FAQs#what-is-proof-of-stake

[12] Drescher, D. (2017). Blockchain Basics A Non-Technical Introduction in 25 Steps. Frankfurt: Apress, page 225.

the system because whatever happens to the system (new nodes, a transaction, a message or a system reform) should be shown to every node. Approximately, 5 transactions on average happen every second on Bitcoin Blockchain network so it is impressive to think how fast a computer should work to proceed to 5 updates per second. Blockchain works on the principle that its network is real-time and no one has different or older version of the network. This constant update procedure demands a lot of electrical power. One last point is forks of the chain. Computing resources and electricity are spent when nodes have to decide which of the two blocks should be the next in the chain.

Proof-of-Identity

Proof-of-Identity can be considered a specific case of Proof-of-Existence because it proves that a certain identity already exists. The Blockchain serves that use case since it not only stores data that can be used to identify a user but also provides basic security concepts for identification and authentication. Concrete applications of this use pattern are digital identity documents for people, animals, or goods. Governments could utilize such Blockchains as part of their e-government/ digital administration strategy for managing personal documents, drivers' licenses, or passports.

Proof-of-Authorship

This use pattern focuses on proving that a specific person or institution added certain data to the Blockchain. The Blockchain can serve that purpose because it does not only store data that can be identified by its cryptographic fingerprint but also offers basic security concepts such as identification, authentication, and authorization. Identification and authentication are necessary to identify authors and verify their identity. Authorization is necessary in this use case in order to prevent someone from adding data to the Blockchain without having the right to do so. Applications that utilize this use pattern are, for example, electronic publishing, tracking of content changes in documents, content delivery, collaborative editing, and protecting copyrights.[13]

Decentralization isn't the be-all-and-end-all for every problem. It's not an end in itself, but rather a means of achieving certain goals: equal opportunity, wider inclusion, greater shared prosperity and collaboration, etc. Where those goals can be better served by decentralization, that approach should be promoted. But in many cases, especially where the intermediating institution is trusted and reliable, a centralized structure will be an inherently more efficient way of processing information.[14]

[13] Ibid. page 226

[14] Casey, M. J., Vigna, P. (2018). The Truth Machine – The Blockchain and the Future of Everything. St. Martin's Press, page 246.

1.2 Cryptocurrencies and Tokens

1.2.1 Cryptocurrencies' What, Who, How and Why?

In order to clearly understand the rationale behind Bitcoin one should read the White Paper of Satoshi Nakamoto, the creator of this innovative cryptocurrency. Till today, it is unclear who Satoshi Nakamoto truly is and if he is one person or it is a façade for a group of coding geeks. Satoshi's White Paper called "Bitcoin: A Peer-to-Peer Electronic Cash System" included some current payment system's malfunctions that prevent it from reaching its full potential. His aim was not to abolish the existing payment system but to show its gaps and bring them to the light. The reason why Nakamoto published his White Paper in 2008 was relevant to the economic crisis in that period which made people all over the world lose faith in banking institutions if not losing their deposits after all.

This new system is not keeping financial institutions out of the debate as more and more financial institutions are very interested in the way Bitcoin can create units of value. To be more specific, banks are not interested only for the Bitcoin as a new type of currency but for Blockchain that is the spirit of every cryptocurrency. Some banks that use Blockchain technology in their payment system are: Bank of China, Barclays' Investment Bank, Credit Suisse, Development Bank of Singapore, J.P.Morgan, Morgan Stanley, Royal Bank of Scotland and Switzerland's UBS. One could claim that Blockchain technology cannot be a bubble if those banking titans are investing millions in it. Or can it be? The answer is difficult to find as Blockchain technology has not reached its full potential yet. The truth is that no matter if cryptocurrencies become mainstream, banks will have to adopt them and use them too. For that reason, it lays on the hands of people to make cryptocurrencies mainstream by investing in it either as a customer or as a business owners. If buyers demand Bitcoin ATMs or if sellers demand payment only in Bitcoin then a new era of transactions will begin.

Bitcoin uses Blockchain and for that reason it is used in a decentralized way. Instead of having a central point of control now we can have a system which permits everyone to be equally responsible for the maintenance of the financial system. Decentralization will be achieved with the use of a P2P system that facilitates communication between nodes without using a central server. On the one hand, one good aspect of P2P system is that the more users participate, the better will be its functionality. P2P systems demand a lot of computing resources (electricity, hardware, software, etc.) and every computer that joins the system contributes with its capacity. On the other hand, one controversial aspect is whether multiple individuals can manage properly the functionality of the system or there will be again one group of extremely talented IT professionals who will control the whole Blockchain system using sophisticated resources.

One important characteristic of Bitcoin is that even though it is susceptible to price fluctuations it cannot cause inflation because Bitcoin's Blockchain will stop generating new

units when 21 million Bitcoins have been produced. This is estimated to happen at 2140. What economists are afraid of is that since the monetary base (Bitcoin units) will remain stable at 21 million Bitcoins and since a certain amount of those will disappear due to acts of fraud or because of cold storing where people save Bitcoins on a piece of paper and after a while they forget their password to enter Bitcoin system again. This will result in a lot of lost Bitcoins that will compress the monetary base even more. A rational economic human being would store his Bitcoins under those circumstances because the supply of Bitcoins is dropping and this will cause lack of demand of goods and services. Lack of demand will cause price reduction while production prices remain the same. This phenomenon deters investors from spending money too so the impact of Bitcoin in its own market is important. In order to fix that, one should increase Bitcoin supply but this is not possible as there is no Central Bank to produce new units or decrease interest rates.

Due to their Blockchain background, cryptocurrencies offer security and transparency to their users. Security, because it is much more difficult to create counterfeit bills or to hack a central server where transactions are saved. Transparency, because everyone can see a transaction happening but cannot relate the addresses with real persons and this "transparent anonymity" leads to further security. In addition to that, we should imagine how many people remain unbanked in 2019. Bitcoin Blockchain gives them the opportunity to gain access to a globalized financial system of payments. Until now, one should have a bank account to move capitals around the world. With Blockchain technology he needs just a computer or a smartphone and he can be part of remittance market. In the past, we moved from a system based on cash which was based on gold reserves to a system of plastic money in the form of credit and debit cards. Now, the next step is starting to emerge. We are moving from plastic cards to digital money transfers.

1.2.2 How Cryptocurrencies Work?

A person who is willing to be part of Bitcoin market can choose between two main ways to use it: to download the whole open ledger of Bitcoin transactions from Day 1 until now or just create a Bitcoin account and transact with other users by using "digital signature" to prove that he possesses an active Bitcoin account. This digital signature is created by a private key which along with a message (in our case simple transaction data) are hashed. The result is a digital signature that accompanies our transactions and messages sent by us. The immutability of hashed data is known for its security properties and for that reason we will not elaborate here the reason why hashed data cannot be decrypted.

Furthermore, "double-spending" is rare to happen in our case as each and every transaction is placed in the chain in chronological order and every ring of the chain is meticulously examined to prove which transaction happened first. The second one will be rejected by the other users who will notice that our wallet is empty. Theoretically, double-

spending could happen if a fork appears in the Blockchain and there are no adequate verifications of the block in which our transaction exists. As the hash solving process is becoming more and more difficult, the confirmation process is delayed accordingly. The key-number of six confirmations is becoming difficult and for that reason double-spending is appearing again as a potential problem.

How Bitcoins are created is a major question that needs to be analyzed. The process through which a user can generate Bitcoins is called “mining” that demands the solution of really complicated mathematical algorithms by using computing software and hardware. However, the creation of Bitcoins is not uncontrollable as the aim of the system is to generate new Bitcoins every 10 minutes following the “difficulty rating”. This kind of rating is setting a bar at a certain point that makes it sometimes easy or sometimes difficult for a node to solve the mathematical equation. As long as the number of nodes participating in the system is rising, the difficulty rating is setting the bar high in order to make it difficult for the nodes to solve the equation and maintain the Bitcoin creation rhythm at 10 minutes.

One could reasonably wonder why is it so important to generate Bitcoins every 10 minutes? The answer is simple and not technical at all. By keeping the pace of 10 minutes per block in the Blockchain, we let more Bitcoin transactions to be put in a single block before it is verified. We have to exploit every capability of the system in order to make it operate beneficially for us. But it is not that easy to invest in Bitcoin mining and earn money due to the high costs of computer hardware and software on the one hand and the price of electricity that varies from country to country on the other hand. For that reason, the new trend in Bitcoin is “cloud mining”. With this new trend the abovementioned problem of equipment amortization is solved because now all we have to do is to rent computing resources from other nodes and use them by paying a certain amount of fee. Usually, those resources belong to companies that gather together multiple high-tech computers and work as a “mining pool”. If the mining pool manages to verify one block the reward is divided by the number of nodes that actually participated in the verification process. If you had rented the resources but at that time you were offline then you cannot receive any reward.

There is another way of distributing new units of cryptocurrency by their own creators in the form of “Initial Public Offerings” (IPOs) and Initial Coin Offerings (ICOs). We will use an example in order to clarify their characteristics and their goals. Assuming we have a cryptocurrency company and we are willing to release the “CryptoCoin” as a Bitcoin competitor. Our company, in the case of “Initial Public Offerings” will publicly ask for capital in fiat money most of the times without excluding the possibility of requesting a more stable cryptocurrency even though this would be a lot risky because of constant price fluctuation. In return, our company will provide investors with shares of our company promising them interest in the form of dividends.

In the case of "Initial Coin Offerings" our company already possesses a certain amount of CryptoCoin units and offers them to users willing to participate in our endeavor before the mining process begins officially. Those users will pay our company in the same way as in the IPOs case (either in fiat currencies or other cryptocurrencies). In this way, our company's shares experience a surge and our goal is to stabilize the price of our CryptoCoin to start gaining a share in the cryptocurrency market. Among the investors one can find both cryptocurrency fans and speculators. The good thing about IPOs and ICOs is that we create excitement about something new in the market but at the same time, the bad thing about them is that we create high expectations that if not met, the result could be catastrophic for both our cryptocurrency and our benevolent investors.

1.2.3 Do All Cryptocurrencies Serve As Fiat Currencies?

In order to facilitate the analysis of cryptocurrencies and provide understandable examples, we will place them in the same category under Bitcoin. To use the Bitcoin system, an agent downloads a Bitcoin wallet. A Bitcoin wallet is a software that allows the receiving, storing, and sending of (fractions of) Bitcoin units. The next step is to exchange fiat currencies, such as the U.S. dollar, for Bitcoin units. The most common way is to open an account at one of the many Bitcoin exchanges and to transfer fiat currency to it. The account holder can then use these funds to buy Bitcoin units or one of the many other cryptoassets on the exchange. Due to the widespread adoption of Bitcoin, the pricing on large exchanges is very competitive with relatively small bid-ask spreads. Most exchanges provide order books and many other financial tools that make the trading process transparent.[15]

There are some cryptocurrencies which bear different characteristics than Bitcoin which was the first digital currency but in the next years after its creation other substitutes appeared to be more promising. One component that is vital in order to create a new cryptocurrency is a Blockchain base platform which will work as an open ledger for the new "cryptocurrency". For that reason, every time a group of entrepreneurs declares its will to invest in a new cryptocurrency, a fork is created in the Bitcoin's Blockchain if they do not develop a new Blockchain from the scratch. However, this process concerns only altcoins (other cryptocurrencies that imitate Bitcoin and function as currencies). The process followed in order to create a token is different as the vital component in that case is smart contracts.

Platforms like Ethereum operate on Blockchain and are used by programmers mostly to run applications. In order to participate in that platform or proceed to transactions the user has to pay an "Ether fee" (ether is Ethereum's digital token). This fee is estimated based on how much energy resources are required to run an application or transact with other users.

[15] Berentsen, A. & Schär, F., (2018). A Short Introduction to the World of Cryptocurrencies. Federal Reserve Bank of St. Louis Review. Page 5.

The amount of resource energy needed in Blockchain platforms is called “gas” in programmers’ dialect as it is the fuel which makes the Blockchain machine move. For that reason, Ethereum does not have any plafond like Bitcoin in 21 million BTCs. It has to produce tokens in order to attract more and more developers to invest in an application or incentivize them to create a new application.

Smart contracts can be used as accounts that require multiple signatures in order to proceed to a transaction as in this case transactions are more controlled and speculation is reduced. Even though smart contracts can function like a mutual agreement upon certain terms or conditions, they may concern a transfer of value for example or information storage for an application. The potentials of that technology are more than evident because a smart contract can provoke the creation of multiple smart contracts just like derivatives in financial institutions. For example, if Alice has a smart contract with Bob then maybe David can bet by using a different smart contract that Alice’s contract will fail in the next 10 days. To run any contract we need “gas” the amount of which depends on the complexity of the contract in terms of computing power.

Crypto-tokens can have many different forms. For instance, if it originates from a high-tech start-up, it may take the form of use rights over a computer or if it is created by a tourist agent it can be a free city tour. With crypto-tokens one can buy anything from working hours of a person to computer storing capacity in Japan. That is the reason why Blockchain technology and crypto-assets are so popular. The capacity of this technology could revolutionize the way people or enterprises transact with each other. Ethereum has its own Blockchain platform so that people interested in that will not have to use Bitcoin’s platform like altcoins do. The fact that a developer does not have to spend time to create a new Blockchain platform from scratch is very important as it can save time from many innovative ideas.

The whole process of smart contracts is shaped as follows. The first stage of the process is the “token creation” where the issuer sets the terms, the value and the amount of tokens he will issue. Once the transaction begins, platform’s verification miners will monitor the compatibility with the terms of the contract. The second stage is “token acquisition” where a user asks the platform for a token (which may vary from a city tour to a cup of tea) and if a token of our taste exists then after the user offers a certain amount of ethers he receives the token and the platform begins to update itself in order to inform users about the availability of every type of token. Last but not least, the third stage is “token transaction” where a user can transfer a token to another user through a personal user’s wallet following the rules of the platform just like someone could transfer money from his to another user’s account.

Crypto-tokens can take many forms but only one can fit the needs of the new energy trading model. The most common category is “utility tokens”, which include tokens used as

if they were real currency. A typical example is casinos where one can give $100 and get 10 tokens of $10 in order to gamble, drink or eat. In the case of casinos we can change money with tokens inside the casino but in the case of crypto-tokens we can find them through an Initial Coin Offering (ICO), where we offer money in exchange for a certain amount of crypto-tokens. Or else, one can create an account in a cryptocurrency exchange and change fiat money with crypto-tokens.

1.2.4 Cryptocurrency Benefits

Freedom from Surveillance

There are multiple cases of banking institutions which set certain limits to their customers in order to guarantee their solvency. Imagine that we live in a country where banks are controlled by the State and the government can see how and where we are spending our money. How would we feel if we could buy a gadget from another country with our credit card and police would come to our house to check why we bought it? In many developed countries, banks provide police with information that a person would not like to share. Another recent example of bank intervention in people's accounts was in Greece in 2015 when banks, due to GREXIT rumors which made people withdraw their money from banks, preceded to capital controls. This is a limitation that could never happen within the cryptocurrency ecosystem due to its decentralized nature. Even when Bitcoin lost 60% of its value in fiat currency (a drop from $19,666 to almost $7,000 per BTC) people still kept using it for their transactions in order to conserve that venture of an intervention-free transaction system.

Capital Storage Facilitation

Cold storage is the solution to many problems connected to banks as Bitcoin system gives us the opportunity to hoard digital currency in a USB, other types of hardware or even on a piece of paper. Even though it sounds strange enough, it is true. In this way, we can have a copy of our Bitcoin wallet in the form of a QR code on a piece of paper or as a link in our USB. It gives us the opportunity to withdraw our money from the system without causing any problem to it as Bitcoin does not offer loans to third parties like financial institutions do. A bank needs liquidity to survive while Bitcoin just needs its users' trust.

Transactions' Transparency

Transparency in the case of cryptocurrencies is a double-edged sword because no one wants to see his transaction data posted online. However, Bitcoin's Blockchain does not link our transactions directly to our true identity. To give an example, if Bob (whose Bitcoin address is Re37s4S4t5P84y2TVJ75b3Km88) gives Lisa (whose address is Gx2rP66St6W8hBlNg3Co7) 1 BTC, then only just the two of them know who the other person is. Every Bitcoin user relies heavily on the good will of the others who want to continue using Bitcoins and do not want to undermine the whole venture. For that reason, it

seems so difficult to hack a Bitcoin transaction as it would need a huge amount of computing resources. Every move on the Blockchain would be online for everyone to see and many users are experienced enough to discern when someone is trying to hack the system.

In the Bitcoin system, a payment order can be communicated to any number of network nodes. The network nodes are linked together in a loose network and forward the message until all nodes have been informed about the transaction. The decentralization of the system has many advantages. In particular, it makes the system extremely robust. There is neither a central point of failure that can be attacked nor any system relevant nodes that could cause the system to collapse. Therefore, the system functions even when some network nodes are unreachable, and it can always establish new connections and communication channels.[16]

However, transparency is not beneficial for all those who are using Bitcoins for money laundering and illegal transactions. It is logical that no one would like to draw every user's attention to transactions including 20 BTC for example. This amount to Bitcoins equals to 133,000 US dollars and it is an amount that could make any user the perfect target for mining pools or hackers in general. Another side of transparency is payment tracking. If we receive BTCs from someone then we can see from which wallet address that user took his money. An example will make this more understandable. Taking for granted that we are very suspicious Bitcoin users and we claim in advance that every other user is a potential hacker, we would appreciate to prove his innocence by looking how much money he has now and from where he got his money. In this way we can prove if he is double-spending his money or if he is a loyal part of Bitcoin community.

Lower Participation Fees

Concerning the fees' policy, banks keep charging a lot both the buyers and the sellers. They demand the interchange fee, which is the fee paid to the bank that issued the credit card and the assessment fee, which is the fee paid to the credit card company like Visa or MasterCard. These two fees constitute the base fee charged to everyone using credit card either to give or to send money and is close to 1.5%. Bitcoin charges fees too but it varies from 0.5-5% according to how fast we want to get our transaction verified. But the advantage of Bitcoin transactions is not just the lower fees. Bitcoin transactions are faster too as one can give money to another user in another continent and wait for confirmation from 10 minutes to 1 hours maximum. For banks, it usually takes days to confirm the transaction and this is way e-commerce is moving towards decentralized methods of payment.

[16] Berentsen, A. & Schär, F., (2018). A Short Introduction to the World of Cryptocurrencies. Federal Reserve Bank of St. Louis Review. Page 10.

1.2.5 Cryptocurrency Drawbacks

System Scalability

System scalability is a major problem of Bitcoin's Blockchain as the 10-minute limit to add a new block to the chain is causing transaction verification delays. Many sellers feel exposed to digital threats such as hacking or double-spending and they have to wait one hour (that equals to 6 new blocks added after the one which includes his transaction with a buyer). Many developers claim that if block capacity was bigger (from 1 MB now to 1.5 MB) more transactions could fit inside shortening 10-minute limit to 7.5 minutes. A huge debate has started claiming that certain technical difficulties cannot fulfill that wish. We will not focus on technical issues here but the core of this debate will monopolize our attention in the near future.

Different Approaches by Governments

There is a huge economic gap between developed and developing countries and this gap keeps widening due to legislation that makes central government control every aspect of economic life within the country. We observe that developing countries conceive modern technology as a threat which will undermine their supremacy. In this way, they exclude a large number of unbanked individuals from participating to economic system. There are examples of countries which exploit Blockchain technology and cryptocurrencies in order to attract investments and capitals from all over the world like Malta. Legal issues of Bitcoin still exist mainly because there is a general feeling of ordinary people that cryptocurrencies are used for money laundering and that they are controlled by a few malicious hackers. Legislation is moving very slowly in this field of modern technologies and the reason is that governments do not know whether they have to deal with Bitcoin as an asset or as a currency. The steps to be followed must be careful in order to make this venture sustainable and profitable for both the users and governments.

Price Volatility

One of the most evident problems of cryptocurrencies is their constant price volatility which makes them surge and plummet even within a day. Many critics claim that in this way true investors are repelled and speculators are the only ones willing to bear the risk. Funds which are searching for quick and easy profits buy and sell Bitcoins in cryptocurrency exchanges. However, this might be a good fact if we consider the difficulty of ordinary people to find Bitcoins. Instead of becoming a miner one can buy Bitcoins directly from an exchange which collects thousands of Bitcoins from the speculators. If we would provide an example we could claim that if someone needs apples he does not need to become a farmer but he can buy them from the supermarket by staying out of the farming market (in our case farming market is mining market).

Bitcoin appears to the news bulletins only when the exchange rate drops sharply giving it a bad name in the market but this is not the publicity it merits even though many people consider it either a new bubble or a threat. This phenomenon is not always erosive for Bitcoin as it helps it, when it plummets, to soar again and offer a kind of stability. In other words, the hype built around cryptocurrencies which presents them as a tool for revolution against capitalism or quick profits for everyone should be reduced in order to offer price stability and make Bitcoin a true competitor of other fiat currencies. This happens mostly because most of the people do not really know or appreciate the whole concept behind cryptocurrencies and this vague image does not help the imposition of Bitcoin as a dominant currency in the digital world.

Fraudulent Incidents

The "Silk Road" case is still fresh in our memory when a group of cryptography science fans created a website through which one could sell and buy drugs in any form using exclusively Bitcoins. This use of decentralized networks combined with the ignorance of the majority of academic and scientific community, leads Blockchain and its derivatives to a very slow, ineffective and indifferent use of them in everyday life. Many people feel that the moment they will try to enter the world of cryptocurrencies and P2P networks will lose either money or their personal data will be compromised due to hacking attacks like those happened from 2014 to 2016. The challenge is for both governments and enterprises to be persuaded that modern technology will follow certain rules and that no one will try to undermine the well-tempered way of living, transacting, legislating, voting, deciding, etc. The most significant examples of fraud in Bitcoin history are the following which shaped and influenced people who want to participate in cryptocurrency market:

Mt.Gox is the most famous case as it involved more than 850,000 BTCs lost at once due to a system breach in 2014. It was totally unexpected because Mt.Gox was the dominant enterprise for Bitcoin exchange services as it controlled approximately 75% of Bitcoin trading volume. Due to its domination, Mt.Gox became a prominent target for hackers and for that reason it dealt with multiple hacking incidents that resulted in many lost BTCs. It also suffered a lot of internal technical issues such as bugs which led to uncontrollable transaction ID alteration. In February 2014, Mt.Gox announced the suspension of withdrawals due to the loss of 6% of the BTCs in circulation back then which made it lose 20% of its market value or in fiat currency terms it lost over $450 million. Several other companies which cooperated with Mt.Gox proceeded with legal measures against it and the rumors spread quickly that Bitcoin is a new bubble.

In 2015, another incident happened in Europe when some operational wallets were compromised and more than $5 million were stolen from the Bitcoin system so Bitstamp Company had to suspend its operation in order to deal with the attack. The impact was great as Bitstamp was the leading Bitcoin exchange company in Europe, a region where many

countries, even though they do not have a solid and mature cryptocurrency legislation, trade digital currencies and assets. However, 2016 was a year-milestone for cryptocurrencies as United States started legislating in a way to recognize Bitcoin and other relevant platforms as legal auction places where one can receive and provide a new currency by avoiding the traps of the past. Money laundering and drug dealing through Deep Web belong to the past and now e-commerce is trying to adopt Blockchain and digital currencies to facilitate transaction and payments.

In 2016, a hacking attack happened due to security holes in the Bitcoin exchange system. The case of Bitfinex led to deep insecurity of investors and users who could not guarantee that they can keep their money safe anymore. The case of Bitfinex, a Hong Kong based company, was as shocking as Mt.Gox because 120,000 BTCs ($66 million in that time) were stolen due to a hacking attempt. Luckily this loss did not led to bankruptcy and Bitfinex still operates trading Bitcoins. The opposite happened to Mt.Gox which declared bankrupt due to insolvency issues.

To sum up, cryptocurrencies are promising major changes in the way Blockchain users transact with each other. The decentralized nature of cryptocurrencies are not controlled by banking or other financial institutions and for that reason a respectful percentage of people claim that the overdependence of consumers on banks has to change immediately. However, some drawbacks of cryptocurrencies such as price volatility and Bitcoin's dark history are challenging their success. Both centralized and decentralized structures of capital management bear different advantages and disadvantages but they are trying to respond to the same issues of money hoarding and security of transactions.

1.3 Fundamental Information about Artificial Intelligence

1.3.1 Machine Learning vs Deep Learning

We have all experienced, one way or another, the application of Artificial Intelligence in our everyday life. One recent example is Amazon Echo Alexa which is a Conversational Artificial Intelligence machine enabling us to interact with it and obtaining useful information such as the weather or traffic in the road or even we can entertain ourselves by asking Alexa to play music or read out loud a book using a Voice User Interface (VUI). The fascinating aspect of Alexa and other similar machines is that can interact with humans by converting voice to commands and commands back to voice messages using our language. However, communication is the least it can offer as it can learn from the data we feed it by finding patterns in them. To give an example, if we ask Alexa to tell us the weather in Georgia (the country) and it gives us the weather in Georgia (the US state), we can ask her once to tell us the correct location and it will adapt accordingly the next time we ask it.

One real life problem of data patterns is that machines sometimes fail to be 100% accurate about the categorization of output. For a computing machine real life data look significantly difficult to decipher because real life can sometimes diverge from normality. It is very important to teach machines a way to accept this kind of information and exploit their capacity to retrieve useful output from a large pool of data. At this stage of evolution, perfection is not what scientists are working for. Artificial Intelligence is useful basically because it can discern patterns where humans just see digits. In other words, it is not only the output that is mostly needed but the pattern and the process of it which matters a lot. The data a machine receives though should be statistically random because in other case the bias of the output data will be significantly high and the result will not be reliable and patterns that are wrong. The same applies for the amount of data we insert as few data will offer us misleading output.

The challenge was to create a machine which could learn from its own mistakes in order to give better and more accurate results later. The integration of machines which can accomplish certain tasks that require human intelligence in our life is the fact which makes some academics and scientists claim that Artificial Intelligence will begin the next industrial/technological revolution. The tools of Artificial Intelligence to achieve that is “machine learning”, the subset which is responsible for machine upgrade providing them with new and better data. However, it is crucial to make a distinction between Machine Learning and Deep Learning that is commonly used to refer to the same process.

1.3.1.1 Machine Learning

Machine Learning belongs to the wide field of Artificial Intelligence that utilizes statistical methods and task-specific algorithms in order to teach computers by inserting data and offering the machine freedom to learn by itself via repetitive learning. The production of divergent or incorrect outputs is punished and the correct answers are rewarded. The innovative aspect of Machine Learning is that as time progresses, programming of the machine is not needed because it can correct itself. So, it is becoming independent in a beneficiary for the scientific community manner.

The disciplines of statistics, data mining, and machine learning all have a role in understanding data, describing the characteristics of a data set and finding relationships and patterns in that data to build a model. There is a great deal of overlap in how the techniques and tools of these disciplines are applied to solving business problems. Many of the widely used data mining and machine learning algorithms are rooted in classical statistical analysis. Data scientists combine technology backgrounds with expertise in statistics, data mining and machine learning to use all disciplines in collaboration. Regardless of the combination of capabilities and technology used to predict outcomes, having an understanding of the business problem, business goals, and subject matter expertise is essential. You can’t expect

to get good results by focusing on the statistics alone without considering the business side.[17]

In the case of Machine Learning, machines work based on functions that realize certain operations. These functions, as the time passes, ameliorate the process of output retrieval due to repetitive learning. An example is YouTube where videos are set in a certain way that the majority of users have chosen to watch. If 100 millions of users have watched a video of Donald Trump's speech then this video becomes a viral trend and is put on the top of others. In a way, users vote with their clicks which videos will go viral all over the world. YouTube also has a unique way to offer us what videos we should watch next. Like in global surveys, users that watch Donald Trump usually watch after Hillary Clinton so we will be advised to watch Hillary Clinton next. This is how Artificial Intelligence can be applied in everyday life and satisfy the needs of millions by improving the way it offers outputs and this is the way patterns work in Machine Learning.

Machine Learning is divided into two main categories, Supervised Machine Learning (SML) and Unsupervised Machine Learning (UML). SML is widely used mainly because we can insert labeled data that when processed by a machine will give us an already known output. For example, we insert 1000 different answer sheets of a questionnaire concerning which way of entertainment is better: cinema or theater? Once we already have analyzed the data manually we know that 65% chose cinema, 30% chose theater and 5% voted for none of the two. The aim is to see if the machine will result in the same percentages every time if we run the test 100 times. One would ask at this point, what is the reason to run a test whose output is already known? The answer is that this is the first stage of Machine Learning (also known as test training stage) because scientists want to see if the machine was well organized because in the next step the scientists will insert thousands of answer sheets that would cost us a lot of money and time to assess them manually.

In SML the machine can identify what is the input (numbers, images or papers) because a programmer wrote the code of the machine and he tries to make the algorithm come to certain conclusions we want. If we do not put limitations to that machine then if we insert 1000 essays written in Spanish but concern different subjects it may categorize all of them in one category, that of Spanish written essays. This is not what the machine was meant to offer us. A machine with these potential can compute and analyze a huge amount of data in a second. When algorithm ameliorates in order to explain better the information we insert into the machine, we have an almost ready prediction function (also known as "hypothesis"). And this is where a second question rises. So what is the fact which makes

[17] Hurwitz, J. & Kirsch, D. (2018). Machine Learning for Dummies. New Jersey: IBM Limited Edition, page 11.

SML different from Excel or even Internet itself? The answer to this question will need further explanation about how Machine Learning works.

SML aims at two main points, classification and regression. Classification is used when we need to match certain inputs with certain outputs (categorizing outputs) while regression is used when we want to observe whether our inputs correspond to our single output. Usually classification systems answer at YES or NO questions such as “Does this output fit our needs?” while regression systems answer at quantity question such as “How much is enough?”. No matter which method we choose in order to achieve our goal, we should always bear in mind that what we are looking for is any relation between data and the already known correct answers because the results a machine can offer are relevant to the code that a programmer (human) has inserted to it. The machine should point out which is the best way to analyze data and which data structure will explain better a certain trend that humans cannot see. In other words, real life situations differ from the controlled conditions of computers and machines.

In UML machines receive data that are not labelled and try to find patterns that can associate inputs into different categories. By using the word “unlabeled” we mean that we have not trained the machine to identify input like in the SML case. We insert information and we want to see how the machine will come to a conclusion. Output of UML is even more arbitrary than supervised learning as the machine creates categories based on similar features reminding us that its thinking method is like that of a human being but the result and the pattern finding are computing processes. No programmer sets the rules to the machine and no output is wrong in advance. The way a machine works under UML is by clustering certain objects in the same group which bear similar features. It is a very common tool for the science of statistics and data management and this is why Machine Learning proves its necessity in modern world.

The way Unsupervised Learning is approached is similar to the experiment of a mouse that is put in a labyrinth and tries to find the cheese at the end of it. We do not know how the mouse is thinking but we are curious to see if it can find the way out. However, even if it does not find the way out we can observe the patterns that it makes subconsciously like if it chooses always right or left at crossroads. In UML we do not know the result in advance and this is why it is the best source to find other features to cluster data rather than optical likeness. It is a way to explain information in a primitive manner without thinking like a scientist, taking into consideration natural factors in order to predict certain phenomena or describe a trend.

From all the above we can be sure that UML can be extremely useful in exploratory data analysis that is used in questionnaires and polls from which a scientist can collect specific answers that when grouped and analyzed they can present a hidden reality.

Nevertheless, Unsupervised Learning methods are not necessary only for scientific purposes; it can be used in customer services too. Customers fall under certain group according to their taste in a product or a service and then are treated in a similar way like in the YouTube example. It may be too complicated for small and medium enterprises but it can solve problems that a human eye cannot even discern.

The machines are trained in a different way because the manner they come to a conclusion is different. In the case of Supervised Machine Learning, a scientist feeds the machine with multiple controlled and labeled input tests and shapes in advance the result for the machine. In the case of Unsupervised Machine Learning, a scientist feeds the machine with multiple unlabeled input data and waits for the result and the patterns of the machine to draw conclusions on a test. The process of finding information by processing different input material by a machine is called “data mining” just like miners look for gold based on information. Machines are looking for patterns included in the massive input data using multiple scientific fields (machine learning, database systems and statistics). Generally speaking, data mining belongs to the wider field of computer science aiming at discerning information and processing it in order to make it useful for further study by scientists.

1.3.1.2 Deep Learning

Deep Learning is more practical and more technologically sensitive as it covers the fields of neuroscience, informatics and network development. Its capacity goes one step further than Machine Learning because machines in Deep Learning are taught not only to identify inserted data but also to find possible categories they could belong in a way that a human cannot find, at least quickly enough. One should simply bear in mind that Deep Learning is a part of Machine Learning and Machine Learning is a tool to achieve Artificial Intelligence, which means that what happens in Deep Learning influences Machine Learning too. This tool is crucial for scientists who are working on data extraction from a huge information pool.

The tool that Deep Learning uses to manage the information is Artificial Neural Network (ANN) which can identify inserted data and can categorize them in groups of similar features. Deep Learning’s output is not set in advance by scientists because the goal is to assess patterns and not the accuracy of information. The relationship of Deep Learning with Neuroscience is close and that is the reason why machines compute and process information in the same way humans draw conclusions. ANN works in a layered composition of algorithms that filters data and makes distinctions based on them. Machines of Deep Learning make better and more accurate decisions as training tests continue.

The Artificial Neural Network is inspired after the function of animal brain which learns after teaching, observing or suffering a bad experience before. This is exactly how ANNs work as they need only little information that can train them in order to identify the nature

of the input. However, the fact that ANNs are based of animal brain is not limiting the potential of this technology as it has surpassed the capacity of human brain and tries to find data where humans cannot easily reach. Generally, those networks are not algorithms but instead they constitute a framework capable enough to offer multidimensional output of the same data. It is like a platform which supports any type of application. Like any neural system, ANNs contain some connected neurons (in our case we call them nodes). Each node receives data as an input and delivers an output in the form of a signal that is transmitted to the next node until it reaches the final node which will offer the final output. It contains several layers of nodes in order to find several patterns or other information that could help us with our research.

Each of the connections between the nodes has a weight associated with it that is adjusted during learning. On the input side we might have all the pixel values of an image with output values that stand for a category like “cat” or “house.” If the output determined by the passing of values through these links is not the same as the output value set by the category, each node failing to match sends a signal back indicating that there was an error and the weights on the relevant links must change. Over time, these tiny changes steer the network toward the set of weights that enables the network to correctly assess that a new input is in the appropriate category. The activations sent from one side of the network result in the right values at the other end.[18]

1.3.2 Machine Learning and Deep Learning at a Glance

Machine Learning Features

1. The machine needs a relatively small and controlled amount of training data. The scientist inserts a few but very concise training test information and from that time on the machine learns by its own.

2. A machine cannot identify the nature of input. For that reason a programmer teaches the machine what the input truly is and codes the way the machine should treat the input.

3. The testing process lasts long enough in order to teach properly the machine with training tests and in order for the machine to learn from its mistakes.

4. Its potentials can thrive on a simple laptop as it is not extremely demanding in computing resources. For that reason, it is mostly used by medium enterprises too.

[18] Hammond, K., (2015). Practical Artificial Intelligence for Dummies. New Jersey: Narrative Science Edition, page 28.

5. A machine in Machine Learning divides a problem into pieces and deals with each one at a time. It is easier to come up with some conclusions and then gather together several conclusions than coping with a huge pool of information.

6. The rules set by the programmer are rigid and the machine obeys only to them. Even if it learns how to change a manner of coping with data, it cannot reach the point of regulating itself. Those rules can justify the tools and the result of a test as the machine is not totally independent to change.

7. Finally, the machine learns from previous tests and data. If a scientist inserts information which is controversial, the machine will acknowledge the pattern and will learn to group similar data together.

Deep Learning Features

1. In the Deep Learning case, machines need fewer training data as it should offer us a pattern rather than an accurate result in first place.

2. Machines do not focus on visually similar characteristics. They focus on features that a human eye cannot discern at first glance. For that reason, programming is not necessary for machines working on Deep Learning because it is programmed to categorize information in its own way.

3. Deep Learning machines work independently in many ways. This is why testing and training does not require a lot of time.

4. One of Deep Learning's drawbacks is that it is a resource demanding technology as it needs a high-technology equipment to support the computing procedure and that is why medium enterprises cannot afford using it.

5. Machines learn to solve problems and cope with a huge amount of data without dividing the process into small pieces. It deals with it as a single challenge and at the end the result is probably what scientists need.

6. Since machines use their own logic, it is difficult to interpret the results in a way that human beings could understand. The way a machine finds patterns is not an issue that concerns data scientists at this stage of research. In other words, the reasoning is simply unknown.

7. Finally, Machines learn through Artificial Neural Networks. ANN is a set of multiple layers which transfer information form neuron to neuron in order to offer us an output that explains the similarity of certain objects.

1.3.3 Artificial Intelligence Benefits

Trustworthiness

The first characteristic of AI is its trustworthy nature which derives from the hundreds of training tests that renders a machine capable of taking decisions with a lower percentage of erroneous conclusions. In the case of a situation of high risk a machine of that technology could analyze a series of data and offer a proposal within a small period of time. For instance, a company which tries to explore scientifically uncharted regions could take into consideration the data output of the machine in order to decide whether to proceed or abort a specific endeavor.

Practicality

Another component is Artificial Intelligence's practicality. Due to its trustworthy nature, a machine can identify the optimal solution for a particular problem and this factor facilitates multiple scientific procedures which assess different scenarios, percentages, algorithms and other time-consuming tasks.

24/7 Working Capacity

One of the most important cases of AI is the uninterrupted working capacity of such a machine. One super-computer can operate 24 hours per day and seven days per week without experiencing latency in any form. A human brain cannot work efficiently for too many hours and for that reason errors are more common in the latter situation. A computer can perform solid and reliable data without being suspicious about its output. Furthermore, machines cost a specific amount of money and can replace the analyzing capacity of a group of scientists. In other words, a company can utilize scientists in specific tasks and super-computers in other cases.

Best Tool So Far

The potential of such machines is already known and for the time being it is the furthest it has ever gone. For that cause, it is characterized as the most valuable tool an analyst can have in his kit. Our era is dominated by "Big Data" and an ocean of meaningless details for the average human. Those details and data are in the center of both science and companies as they can provide useful information about ostensibly unsuitable input material.

Life Quality Amelioration

Many supporters of Artificial Intelligence claim that the quality of life will ameliorate because of its potentials. For example, multiple aspects of our everyday life will aid industries, manufacturing, medicine and new technologies in general. Apart from the innovative momentum that every advanced economy will face, there are other social advantages such as job creation as the constant integration of super-computers in our lives will demand more and more technicians, developers, programmers and data analysts who are in shortage even now. Job creation will reduce unemployment and the new available positions will be more creative than monotonous tasks which will be carried through by machines from now on. The best solution is to introduce machines into the workplaces in order to accompany workers and offer a better result. However, AI will not only influence industries and workplaces as "green houses" will be multiplied and their environmental ramifications will sharply decline. If we manage to use AI in a productive manner, we could solve today's major problems and aim at tackling other challenges of the future as we did in the last centuries with the rapid evolution of technology.

Cost Reduction

One major advantage for companies will be a reduction in operational costs brought by automation which is offered by Artificial Intelligence. By automating complex and heavy tasks companies could save millions because it will reduce dramatically the overall time needed to complete a task. A machine which works 24 hours per day is not being paid hundreds of euros per month and the Return for Investment is known in advance. In other words, it is an excellent type of investment in order to achieve economies of scale within a company.

1.3.4 Artificial Intelligence Drawbacks

95% Precision

As for the drawbacks of Artificial Intelligence, it is true that AI machines do not offer correct information all the time. They offer solid information which means that they include certain patterns. Whether those patterns satisfy our research is worth discussing but we cannot be confident that every time the computer has the optimal solution for our problem. This is evident if we consider that even though programmers force computers to think in any way, Deep Learning output data cannot be justified by the machine due to its complexity of the decision making (Artificial Neural Networks). This is the main point of criticism as Deep Learning

constitutes an area which is not totally controllable by scientists and programmers. It is a real challenge that pattern identification and analysis has not evolved with the same speed as technology does and there is a fear that Artificial Intelligence could expand its own potentials and cause problems to our research. A simple example which explains better this argument is a case when a super-computer discovers by its own, after thousands of trials, a new, better and faster pattern identification procedure which may slightly differ from the programmed procedure. Will the data be correct in that case? This is a question to be answered in the near future.

Time-Demanding Training

Another disadvantage of Artificial Intelligence is its time-consuming processes. To elaborate more, those super-computers are extremely data demanding and it takes a respectable amount of time to train them properly. A scientist needs hundreds if not thousands of training tests which will be inserted in the machine through programming procedures and it will identify, assess and categorize information according to either already installed criteria (supervised learning) or according to unknown criteria (unsupervised learning). Furthermore, because Artificial Intelligence in its latest form is a new tool with which data scientists do not feel familiarized yet, they will need time to become a daily routine for them.

High Costs

One of the greatest drawbacks of AI is its high cost in every aspect. It is much expensive to buy Artificial Intelligence machines due to their complex computing systems and the top quality materials it needs to operate perfectly. However, it is cost-ineffective in electricity consumption as it needs huge amount of power. This is the reason why abolitionists of AI accuse it for being environmentally unfriendly as a technology. Last but now least, such a machine needs spare parts which are overpriced and increase the total cost of maintenance. Its costs increase together with its capabilities. A simple voice recognition machine can be cheap but if we need a super-computer in order to assess millions of data from a satellite the cost becomes unbearable. In other words, innovation will be expensive and Artificial Intelligence is an expensive tool to achieve it. Whether there can be other tools to innovate remain to be seen in the future.

Unemployment

The most ethical argument against Artificial Intelligence is based on the fact that it could sideline millions of jobs in the next decade if AI continues to expand with the

same pace. Unemployment is already high in many countries which have not healed their wounds from the financial crisis of 2008. Even regions within advanced countries deal with poverty of local populations and immigration issues. There is a fear that huge multinational conglomerates will choose super-computers instead of job protection for people if needed. The right balance lies where decision makers will integrate machines in a workplace in order to help workers instead of trying to replace them.

Artificial Intelligence or Just a Fast Computer?

A negative argument that is not widely known but is constantly set in an AI debate is the fact that right now we do not possess truly Artificial Intelligence machines as they are extremely complex and our means cannot create such a machine. We have just created super-computers which are based on Artificial Intelligence capacities in order to solve specific problem. A significant example is the humanoid robot (Sophia), constructed by Hanson Robotics, which is basically an interaction robot with which one can communicate. Sophia does not identify complex patterns however it can identify behavioral and sentimental patterns from facial and vocal recognition.

UNIT 2

CHAPTER 2: Modern Technologies' Capacities

2.1 Blockchain Potentials in Energy Sector

The rationale behind Blockchain technology in Energy sector is to eliminate third-party entities which increase the final price for end consumers. Third-party entities are considered to be intermediaries or even governments. With this type of technology suppliers can have a more direct relation with their customers through applications of exchanging data and customer service. The domination of natural monopolies, which are state-owned power companies, is about to end because Blockchain technology promises, "cheaper", "cleaner" and "direct" energy transactions. Those three words need further explanation to prove their beneficial contribution to the energy market. Blockchain permits the prosecution of transactions by recording them in the public ledger and using the Peer-to-Peer network in order to offer a more immediate way. The parties involved (the buyer and the seller) use smart contracts and set the rules according to which the transaction will be processed. In that form, all energy flows are instantly controlled to create a balance between energy supply and demand. The amount of energy delivered is calculated with high accuracy and the terms of contract keep the transaction safe from alterations and misjudgment.

Energy transactions through Blockchain-based grids will be "cheaper" mainly because a producer of energy using solar panels can trade his excess of power setting a price himself, always lower than the price a utility company offers. If a solar panel system produces on average 12kWh per day but we only need 10kWh, we can sell our 2kWh excess to a neighbor using a smart contract in an attractive price. This, in the long-run, will force all utility companies to reduce their prices as competitiveness will increase. Every household that can host a wind turbine or a solar panel system can threat the primacy of big companies. In the past, power generation, transmission, distribution and supply were all parts of natural monopolies. One state-owned company offered all four services and no other private company had the potential to offer lower prices in a totally new market mainly because of poor legislation on energy market deregulation.

Energy transactions will be "cleaner" due to the increase of renewable energy sources' contribution. In this way, households are motivated to install renewable

energy equipment in order to generate energy and distribute it if needed. Research and development in the renewable's sector has led to better performance of solar panels, which is the most preferred type of installation a household can host. The decentralization of energy distribution and trading system has lowered the prices and this method has permitted people choose eco-friendly options which differentiates a country's energy mix. In addition to that, generation occurs in the same place of consumption which means that no added transmission and distribution charges exist. This constitutes a great advantage of decentralized energy systems because it eliminates interdependence of multiple organizations in order to deliver power to consumers.

Energy transactions will be "direct" because of the grid's nature. Blockchain gives consumers the ability to trade power themselves in a price formed after an auction clearing between micro-producers and consumers. Before that, an algorithm has already taken into consideration how many token the buyer is willing to pay and how many tokens the seller is willing to receive in order to come to a conclusion and settle down the agreement under a smart contract. Peer-to-Peer systems enable users to exchange data, energy and money in a secure and transparent manner. In the case of the previous example of a house willing to sell its 2kWh excess to a neighbor, the producer publishes a smart contract including all necessary information such as price of a single kWh, the total amount of kWhs, the date of smart contract's publication and the date of smart contract's expiration. All smart contracts are based on the principles of "if-this-then-that", which means that every contract contains certain steps to be followed. If one step is either breached or overpassed then the contract is cancelled. The reason why one person should trust a smart contract is its distributed and immutable essence. Once a smart contract is published, it is automatically distributed to every single user of Blockchain and their verification is needed to integrate it into the chain. Its immutable characteristic derives from the fact that once a smart contract is integrated into the Blockchain, it cannot be altered in any way as it would challenge the main core principle of Blockchain technology which is the high security of transactions. In this way, the buyer is totally protected from frauds by the system itself.

A significant case study is SUNCONTRACT, a company willing to deliver energy to people through Blockchain platform. By using smart contracts, people will be able to buy and sell energy directly from each other without paying intermediaries for facilitation of the whole process. The aim is to create a single energy pool in which

every micro-producer will deposit his excess of energy. If anyone needs a certain amount of energy, he can arrange a smart contract with the relevant energy depositor and transact freely according to the rules of the contract which have been written and coded in advance. In order to create a smart contract one needs a certain amount of tokens which are bought from SUNCONTRACT through an ICO where other cryptocurrencies and strong fiat currencies are exchanged with Sun Coins. This token is valuable only for SUNCONTRACT use as we cannot buy a car with them for instance.

Self-sufficient communities could rationalize energy consumption and promote more efficiently the integration of renewable sources of energy. Company's key of success lies in the marriage of the 5 Ts (Trust, Transparency, Traceability, Time Stamp and Transaction) with the 5 Ds (Digitalization, Decarbonization, Deregulation, Decentralization and Democratization). Users should trust the Blockchain because it can offer secure and faster transactions. Without trust, Blockchain is fragile and users will lose faith upon it very quickly. Public ledger of Blockchain provides us transparency as every single change on the Blockchain would alert every user in order to prevent any fraudulent actions. Furthermore, once something is added to the chain it can be traced down no matter how far in the past this transaction took place. Time stamping every block in the chain is crucial in order to check when the block was added to the platform in a case of misunderstanding or in the case of a fork in the chain. Finally transactions on the Blockchain are including all four principles from above and this is a proof of a robust system.

As for the Ds, digitalization of energy trading has rendered it fast, clean and transparent and for that reason energy sector should follow the evolution of technology in order to be efficient. Decarbonization is achieved basically because renewable energy sources gain much more space in the energy mix proposed by SUNCONTRACT. While technology is leading the way, governments should proceed with the relevant deregulation as current structure of energy markets foster monopolies instead of innovation start-ups. Legislation is incapable of offering sustainability to decentralized energy systems. Decentralization of energy trading and grid management constitutes the core philosophy on which everything written above is based. It is a really innovative idea that could revolutionize the way people trade energy until now. Last but not least, it is not an exaggerating comment to claim that Blockchain technology democratizes energy as it lowers the prices, reduces the

environmental footprint of a city, promotes true competition among energy producers and rationalizes the manner energy prices are shaped.

A concerted global effort is underway to decrease greenhouse gas (GHG) emissions. Each technology and policy pathway to decarbonization will rely on methods for accurately measuring and recording carbon emissions with limited transparency, disconnected standards, uneven regulatory regimes, and issues of trust. A prominent mechanism for managing carbon emissions reductions is an emissions trading system (ETS), which establishes a mandatory cap on emissions and allocates tradeable permits to participating entities. An ETS is designed to internalize the invisible costs of emissions and allow a sustainable marketplace to emerge. A successful ETS requires substantial resources, meticulous design, and a commitment to best practices in monitoring, reporting, and verification (MRV). Globally, the total cost to administer current ETS systems has been estimated at $980 million. Blockchain's core capabilities directly align with the many challenges around developing, deploying, and managing emissions tracking and trading systems. As a trusted repository of transaction data, Blockchain streamlines trades, strengthens the verification process, and eliminates the need for costly centralized management. Blockchain could help harmonize design criteria across numerous ETS through a uniform set of rules, maintaining a consistent framework for interoperability between linked systems. MRV design criteria created by market participants can be embedded in the Blockchain to establish consistent markets, while assuring best practices are maintained.[19]

Energy Premier Company operates aiming at facilitating energy trading among individuals. It is a Blockchain-based electricity trading platform that enables users to trade electricity in a faster, safer, and cheaper way, with the help of Blockchain technology. It is the first platform which enables suppliers to directly access the retail energy market by eliminating multiple intermediaries and taking out distance as a limiting factor to trade, which then results in lower prices for the consumers. The way someone can sell or buy electrical power is carried through by first signing in the platform with an official account either as a seller or as a buyer. The first move belongs to the buyer as he creates a bid in order to notify producers that he needs energy. The request can be single or a joint one in order to achieve a better price per kWh. After the request becomes public, the suppliers ask permission to participate in

[19] Kizer, A., Hezir, J,. Kenderdine, M., & Savitz. S, (2018). Can Blockchain Enable Faster, Cheaper, and More Secure Energy Services?. The ICER Chronicle, Edition 9, page 28.

the auction by an administrator who has been appointed by the supplier. The energy producers then have a certain amount of time, which has been set by the buyer, to offer a bid. The buyer is notified by the administrator for the minimum and the maximum the producer is willing to sell his asset. After the time limit has expired, a report is published including the requests and the offers of both sides and the buyer can identify at which price he managed to buy the relevant amount of energy. The identity of both sellers and buyers remain unknown in order to maintain a platform of competitive prices and transparent practices. The last step in order to finish the auction procedure is the sending of all necessary documentation by the supplier who won the auction in order to be signed by the buyer.[20]

Every producer of renewable energy can trade amounts of energy excess with other consumers forming multiple energy cells which shape when connected a microgrid within a town or a neighborhood. This method bears a lot of benefits for its participants like the reduction of blackouts as decentralization of power grids remains intact from a damage of the central production unit and work as backup solutions. Nevertheless, this does not mean that a new grid is constructed next to the utility company's one. The existing power grid is used to transfer energy from producers to consumers. A microgrid connects all assets that are capable of producing and storing energy in order to receive and deliver energy in a more efficient and sustainable manner. These microgrids allow trading in electricity within a specified area by offering energy trading services usually through an application using Blockchain technology. One of the most popular ways to consume energy from microgrids is Electrical Vehicles which demand a lot of power to be charged. Due to its high demand for energy, microgrid's energy is really attractive due to its lower cost compared to utility company. The right balance is the main challenge of every power grid, however, microgrids have successfully overpass this problem by using smart meters which can alter power flow in order to meet the demand or adjust power consumption according to the price of electricity at a certain point of time. Companies like LO3 Energy with projects in Germany, USA and Australia are applying innovative methods in cities to prove Blockchain's capacity.

Smart meters are electronic devices which collect information about the grid as a whole and deliver a feedback to the company operating the network. The amount of information collected can be sent to the consumer on a 30-minute, daily or

[20] Energy Premier. (2018). How it Works. [online] Energy Premier. Available at: https://energypremier.com/en [Accessed 19 November 2018].

monthly basis in order to be informed about his consumption habits. They can keep a record about how much energy we consume and how much it costs. Rationalization of energy consumption is the first and most important aspect of smart meters followed by total control of energy allocation within a building and accuracy in the estimation of power flowing in the house. Using smart meters in a microgrid energy system transforms data into digitally valuable assets which can reduce final prices of energy and diffuse the mentality of eco-friendly behavior.

2.2 White Papers as a Tool for Attracting Potential Investors

Every start-up wishing to be involved in the cryptocurrency world should first of all publish a "white paper". The purpose of a white paper, as it is already commonly known, is to inform potential customers about the aim of the start-up as it resembles the way people are attracted to NGOs. Interested parties read the white paper which calls for investment through an Initial Coin Offering (ICO) or an Initial Public Offering (IPO). As white papers in general have an informative and operative nature, those concerning Blockchain must include certain information which will render the whole venture competitive. In simple words, the start-up asks for capitals in exchange for tokens or cryptocurrencies (it depends according to what every start-up is selling). Trust is the main ingredient in order to succeed in this endeavor because if no one trusts the purpose of a start-up then its moving space will be tighter. A white paper also contains technical information which extends from the code used to support the platform to how tokens are used and what benefits the platform can offer. Its scope is to convince even the most doubtful investors because almost no one is spending his money without taking into consideration the risks of his investment. There have been cases of start-ups which were created in order to abduct money from ambitious and progressive investors but right now it is much more difficult to deceive people because the cryptocurrency hype is settling down and more serious entrepreneurs are involved proving that this new environment is no more perilous for investors.

Usually, white papers hold the same structure: Introduction, which includes the purpose of the start-up. Second comes the definition of the problem our company is trying to solve. If the problem is evident and addresses a major concern then our company is more probable to convince investors. Third comes the project's technical solution which includes the means in order to achieve the aforementioned goal by explaining all the technical parts of our application. Feasibility of our application is of paramount importance in order to prove our platform's necessity. Fourth comes the

application of the project which includes the ways our application will deal with the problem. This stage is also full of technical details which support the project's goal and most of the times are focused more on the ICO process and less to the application itself.

2.3 Decentralized Applications

Smart contracts which are pieces of code that live on the Blockchain constitute the base of Decentralized Applications (dApps) the structure of which is decided by their own programmers who determine the reputation model, means of communication, transacting methods and users' identity. In simple words, Ethereum is providing its users with the capacity to run their programming code of a DApp by using Ethereum Blockchain. Instead of having to create a whole new Blockchain platform in order to run an application, one should participate in the Ethereum Blockchain. In order to participate, one should possess an application token. In our case "Ether" is the gas/fuel of Ethereum's Blockchain-based platform. Transaction fees or other types of services are offered when using Ether as a token. In order for a smart contract to be added to the Ethereum's Blockchain, a user should pay a certain amount of "fuel" in order for miners to include the smart contract in the next block of the chain.

It is crucial at this point to elaborate more on what decentralized applications really are. dApps function like websites on the Internet and smart contracts grants access to a user in order to be connected to the Blockchain. The features of a dApp are the same even though the use of decentralized applications might differ according to the needs of the programmer. First of all, all dApps are open source software applications and each and every alteration should be agreed upon the users who vote. In this way, Ethereum ensures that changes will happen either on a mutually agreed basis or they cannot happen at all. Supporting the first feature, decentralized nature of those applications is of predominant importance as it guarantees the continuity of the platform no matter how challenging the situation is. Furthermore, a decentralized application should have an incentive. With the word incentive we mean a crypto-token that will function just like fuels work for an engine. This is crucial in order for an application to be considered "decentralized". Last but not least, the protocol plays a major role in the well-tempered operation of Ethereum as it is the matrix in which tokens are mined. Right now Proof-of-Work protocol is used but it is under negotiation to become a hybrid protocol of semi-Proof-of-Work and semi-Proof-of-Stake in order to avoid the huge electricity

consumptions and thus mining pools that undermine the decentralization principle of Blockchain.

The benefits of Ethereum's platform are multiple and are presented below. The immutability of information added to the Blockchain by a third person is really difficult and almost impossible as we have mentioned in Chapter 1 due to the need for 51% control of the nodes. Second advantage of Ethereum is the lack of censorship as no user can tamper with our information because once anything is written on the Blockchain it cannot change without every user is notified. Applications' security is granted basically due to the decentralized nature of dApps as there is no central failure point. The Blockchain of Ethereum remains in the computer of every user and this is why Blockchain is a democratization tool in the modern technology sector. In addition to that benefit, an application cannot be switched off by anyone and cannot fail as it does not rely on a central server. There are drawbacks too in Ethereum, however everyone agrees that if exist any, most of the times it will be a human's fault. Smart contracts are actually programming codes. If the programmer does a simple mistake during the coding process, it could be dangerous for the security of the application because it could work like a Trojan horse for potential hackers. After an attack, if the programmer tries to change the code in order to fix the problem then he would have violated the immutability principle of Blockchain. For that reason, it is crucial to be really careful so as to avoid such an incident. In order to start a dApp one should first publish a white paper after he has already created a programming code and then set up an ICO to attract investors. The process of ICO has meticulously been analyzed in Chapter 1.

Some examples of decentralized applications will demystify the great image of Blockchain-based applications that could support resource-intensive sectors like the energy industry:

Golem is made on Ethereum's Blockchain so anyone can use it anywhere. Golem's "supercomputer" system gets its power from both small personal laptops and giant data centers spread around the world. As a user of this platform, one can run a website, do energy-intensive scientific calculations, run a long code, or do CGI rendering. One can also run mining units using this computing resource and mine cryptocurrencies too. Golem makes computing decentralized by changing the very nature of how computer-intensive tasks are carried out in a distributed manner. With this, a new global economy can be created which shares unused computing power. And at the same time, anyone can earn money by 'renting' out his unused

space. Energy companies could either offer or ask for computing power according to the needs of every situation. Data mining requires a lot of electricity and for that reason, energy multinationals, Regulatory Authorities or even the Ministries of Energy should exploit that potential that is relatively cost-effective taking into consideration the fact that organizations buy equipment which costs thousands if not millions.

Requestors are asking for computing power and as long as they pay a certain amount of GNTs (Golem Network Token) they grant permission to utilize hardware from other users and software from Golem platform (usually applications). Providers are offering computing resources to the requestors in exchange for GNTs. Finally software developers are developing applications for multiple uses and they are also paid in GNTs for their services. GNT (Golem Network Tokens) are Ethereum-based tokens used to fuel the Golem platform. To simplify it a bit more, Golem supercomputers will run when the user pays GNT tokens. GNT's coin supply is fixed, which means as the project becomes more popular, the price of GNT will likely increase.[21]

Another useful application is Factom with its "Factoids" as a token. Based on the Bitcoin's Blockchain, Factom offers the ability to store records of information on the Blockchain after hashing them. In simple words, Factom permits companies to create an additional layer on top of the Bitcoin's Blockchain so as to exploit the Bitcoin's immutability, efficiency, data integrity and data recording. This acts like a trustable record against which any copy can be verified and original records are kept safe. Factom Inc. is a Blockchain technology company that is on a mission to provide Blockchain data provenance for complex industries. Factom specializes in building scalable Blockchain technology to handle complex enterprise data and volume. Factoids (FCTs) are the native cryptocurrency token for the Factom platform which remain on Factom's Blockchain and are traded like any other cryptocurrency in the market. The FCT acts as fuel to enable its users to access their data on the Factom's platform. These tokens are used to secure information by linking them to Bitcoin's Blockchain.

Factom works on "hash technology". A hash is a cryptographic one-way function which transforms any digital artifact into a fixed alphanumeric string. This string is like a digital fingerprint print of that artifact. It is impossible to arrive at the original

[21] CoinSutra. (2018). Golem – A Decentralized Sharing Economy Of Computing Resources. Available at: https://coinsutra.com/golem-decentralized-sharing-economy-computing-resources/

artifact by reverse engineering the digital fingerprint. These hashes are collated and again transformed into a single hash. This single hash is then anchored to Bitcoin's Blockchain which acts as a time stamping machine that can't be rolled back. Data entries on Factom's blockchain are paid to prevent spam of data. For this, Factom uses other software tokens known as Entry Credits (EC). EC tokens are non-transferable tokens which can be purchased in exchange of Factoids (FCT).[22] Storing capacity is an ever-growing challenge for great multinational companies whose data production per day can reach many gigabytes. For that reason, applications like Factom can offer a solution to enterprises willing to get involved into digital technologies like electricity providers who are using smart grids, cryptocurrency bill payments methods and smart metering practices. All those information can be digitally sent to enterprises through smart contracts and then through hashing procedures companies can store those information reassuring customers for the immutability of their records (bills, MWhs used per day, number of rooms, number of heating appliances, etc.).

Augur application is used in order to predict multiple future events, from political elections to the success of a new gadget. To elaborate more, a user can turn political knowledge into predictive power by trading on the outcome of upcoming elections, potential policy decisions, and other political events, hedge against catastrophic events like natural disasters, market crashes, and geopolitical upheaval by betting that the event will occur or harness the power of crowds to create a more accurate weather prediction tool for events like hurricane landfalls, heat waves, and daily temperature averages. Companies from their side can use Augur to guide decision making by forecasting vital information such as total product sales and project completion times.

The process of participating actively in Augur is as follows: In the first step the user has to choose an event to predict. There are no limits to the nature of the question posed to other users. It can be economic, commercial, meteorological or even gossip rumors. In the next step, the user has to set the market which someone would like to predict like who will succeed the CEO of a famous conglomerate. One important aspect is that the user should bear in mind that a bet might exist already in Augur so he has to check before he sets a prediction procedure. Then, the users can trade on the outcome of any event by buying and selling shares in its market. By

[22] CoinSutra. (2018). A Comprehensive Beginner's Guide to Factom Cryptocurrency. Available at: https://coinsutra.com/factom-cryptocurrency-fct/

buying shares the user goes long on an outcome, or sells shares to short it. The last step includes the reporting of the event's outcome but we should be careful because other users can dispute our report if they don't agree. Users who hold shares of the winning outcomes are paid out from the market contract when the market is resolved.[23]

By empowering prediction platforms we have one beneficiary and one damaging element. First of all, companies willing to gain a share of a certain market (in our case the energy market), can benefit from the boost of predictions by augmenting the price of its shares in the stock market. At the same time, it can deal with negative reputation driven by prediction for a failure especially for electricity providers. It is considered to be a double-edged sword because the risk level is so high that it can be fatal for a new start-up. Many critics claim that it will magnify the impact of market speculation tactics that will result in a new Lehman Brothers' crisis and customers will lose faith in robust companies.

2.4 Decentralized Autonomous Organizations

This type of organizations differs a lot from the traditionally known concept of a typical organization. Until now, an organization of any type should have a head (either one person or a group of individuals) which follows the relevant legal framework in order to administrate inferior members of the organization. The radical proposal of Blockchain is that now there is no need for a single head as everyone participating in the same Blockchain platform can vote for the head they wish following the rules set and agreed by the users themselves. The role of the law is played by the protocol and the role of the mission statement is played by the code. This does not mean that Blockchain is violating the legal framework but it exploits the lack of strict regulation concerning Blockchain and cryptocurrencies and that it does not need in certain points the protection a law can offer to it. For that reason it can have more space to interact freely even though it is really risky to act so.

DAOs are operating on smart contracts just like decentralized applications do but this fact does not guarantee that an organization will operate normally because if voting is needed in order to take any decision then the organization becomes dysfunctional and loses flexibility in an industry where changes occur within seconds. The programmer can predict all possible outcomes of multiple situations but only one is needed to be missing in order to cause a major problem. As we mentioned

[23] Augur. (2018). The Future of Forecasting. Available at: https://www.augur.net/

above, smart contracts are equally effective and useful as their own programmer because the code offers us whatever we choose to obtain from it. The role of the programmer is crucial because if he neglects to bear into account certain cases then the users will have to vote by majority how they will proceed in order to surpass the issue and this can prove the platform's inefficiency as the majority of the users will claim that the immutability principle is violated. However, if the code is written in such a way that every decision making procedure is already agreed upon once before the smart contract runs on the Blockchain then its automated operation facilitates the decision making process and rationalizes the modus operandi of the whole organization.

Code manipulation or tampering is almost impossible because of the immutability principle of Blockchain. Third party permission is not needed and for that reason only users relevant to the smart contract can participate in the process by providing a certain amount of tokens in the same way shareholders offer a certain capital in order to gain the equal percentage of control over the organization. Decentralized Autonomous Organizations are created in order to transact and manage valuable assets like contracts, currencies or whatever value system the organization is based on. In order to vote or propose a change for the DAO, a user has to pay a specific amount of tokens so as to avoid spamming proposals. DAOs could be used especially in the cases of smart grids and generally in every type of decentralized system of energy circulation as big energy multinationals are facing decentralized structures with doubt. Trust is the basic element of smart grid because one person relies heavily on the energy of his neighbor. Smart contracts, which are necessary in order for a DAO to operate, need trust too. It could be a great opportunity for smart grid operators to prove that decentralized systems are not a new bubble of our times.

Nevertheless, there has been an incident of a DAO hacking in 2016. The DAO project was very famous as it constitutes until today the greatest crowdfunding on the Blockchain ever. It managed to pool over $150 million through the ICO process where a user could exchange 1 Ether with 100 DAO tokens. This virtual venture capital organization collects capitals from relevant investors who deposit their money in that organization. If another investor has a proposal for a new project he has to collect the votes of those users who possess all together the 20% of DAO tokens. If he manages to achieve that goal then a certain capital is transferred to his smart contract where his proposal is written and then when he reaps the benefits of

his investment, he should deposit his earnings back in the pool in order for the DAO to grow bigger and operate as an investment bank. The problem began when the creators of DAO project wanted to help minority users who may disagree with a voted and passed proposal. The decision was to create split of the procedure which transfers the tokens of all users who voted in favor of a proposal to a child-DAO created by the user who won the voting procedure. During this split, which lasts 48 days, no user can usurp and control tokens 100%. A hacker managed to find a loophole in the split process (recursive call exploit) as he could exploit the fact that the user who wins the voting calls for token transfer and then he updates the balance of the DAO. In simple words, the hacker could have the ultimate control of the DAO balance at that very step of the procedure. The main problem of the hacking attack was that those tokens, according to the code, they were never stolen but transferred and the attacker would have 27 days before he could use them at will.

The dilemma was evident at that point. Either DAO project users let this hacking attack happen and proceed with a soft fork on Ethereum Blockchain or they proceed with a hard fork in the Blockchain but all transaction after the hacking will be recalled. One can claim that the hiatus between those two groups was growing bigger and bigger every day. The first group claims that by hard forking the Blockchain users violate the immutability principle of the platform and it would eliminate the trust between the users and the DAO. It resembles the debate of nuclear weapons where there are those who are in favor of their use in extreme cases and others who believe that once they are used then no one can claim for sure that it will not happen again. The hardest part is to begin using them, after that barrier everyone possessing them is most likely to use them. The second group supported the that they should not let a hacker steal their tokens because of a loophole in the system as it would disappoint a great amount of potential investors willing to involve themselves in a DAO. The solution followed was a hard fork and from that time on Ethereum Blockchain is that fork while the other branch is called Ethereum Classic now. This hacking attack was a typical example of how a human mistake can be exploited by attackers and cause severe economic damage to the Blockchain community. For that reason, it is vital to create a legal framework protecting digital transactions in general but the question is, will the law respect the code or will the code obey the traditional centralized structure of businesses and lose its radical characteristics?

CHAPTER 3: Cryptocurrencies in Energy Sector

3.1 Different Types of Tokens

It is common in our times that companies and start-ups which create new Blockchain-based cryptocurrencies, actually use them as a means to transact with other users of the platform. Either as a digital currency or as a token, cryptocurrencies are used in order to substitute fiat currencies like dollar or euro. In the next pages we will try to outline certain applications of digital currencies and tokens in the real world and how companies are using them so as to attract investors and customers. The fact that digital currencies are used just like fiat currencies offers us a limited explanatory space, so this chapter is mainly devoted to tokens the use of which differs a lot according to the company's perspective.

Tokens can serve the same purpose as Bitcoin, however it can be a very different asset at the same time. Although a company can be paid for its products or services in its own token, a user of the platform can use it to achieve benefits and bargains too. The different categories of tokens are elaborated below:

3.1.1 Intrinsic/Built-In Tokens

Those tokens are created based on a Blockchain platform like Bitcoin is based on Bitcoin's Blockchain or Ether is based on Ethereum Blockchain. The tokens which fall under this category are necessary in order to transact with other users in platforms like Ethereum which is also commonly known as Ethereum Virtual Machine (EVM) that is a program running by all the computers participating in the Ethereum platform. EVM is the base on which Ethereum is thriving at the moment as it constitutes a welcoming environment for decentralized applications and protects the chain from both hacking attacks by empowering the firewalls of the platform and from users who are trying to double-spend their capitals. Blockchain is used as a base for this type of technology and holds great potential for the future.

However, built-in tokens' most important contribution in Blockchain community is the use of cryptotokens as a medium of exchange and store value. Those two types of media are interconnected as its exchanging capacity fuels the interest to store it at the same time. Supply and demand of this cryptocurrency plays the major role which forms the final exchange rate. To be more specific, Satoshi Nakamoto claimed in 2008 that Bitcoin is a Peer-to-Peer electronic cash system which eliminates intermediaries and permits transactions between users directly using

Bitcoin's Blockchain. A currency allows us to denominate cash flows and is a means of storing or purchasing power. However, cryptocurrencies have no cash flows and cannot be valued. Their value comes after being priced against other currencies. In the long term, currencies which can hold their purchasing power better will also see their prices rise, in comparison to those currencies which will not. However, in the short term, regulatory bodies such as governments work towards manipulating the exchange rate of a currency.[24]

One major detail to remember is that in Ethereum's case there are multiple layers which offer a stable base and freedom for programming and separate built-in tokens from application tokens. More specifically, the first layer is the Ethereum's Blockchain which includes all those data which should be agreed upon in order for the platform to run in a stable pace. Ethereum's Blockchain permits the creation of smart contracts on top of the whole Ethereum world and this is the main difference when comparing it to Bitcoin's Blockchain. In the case of centralized servers, there is one central point that decides the future of the platform without asking for permission from the users. Ethereum should ask for this permission because of its decentralized nature and because Blockchain in general promises decentralized consensus. If users are divided into those who want total anonymity and those who want total transparency, now it is the right moment to either negotiate a common road and proceed or disagree and follow different paths. The second layer includes all storage and content delivery services such as Cloud-like providers which authorize users to save a huge amount of data in order to avoid the enlargement of Ethereum's Blockchain as new users will have to download a file of many terabytes. The nature of this layer remains decentralized and in order to avoid this enlargement, a user should store his data on this platform and then hash those data in order to save the relevant hash into the block of the chain. Cloud-like services can save a lot of time and space.

3.1.2 Asset-Backed Tokens

A commodity derives its value from its use as raw material to meet a fundamental need, such as energy, food or shelter. While that value can be assigned depending on the demand for and supply of the commodity, developing commodities is typically a long process which makes it valuation process much more difficult than for an asset. A commodity is also a good used in commerce that is

[24] Gupta, R., (2017). Future of Bitcoins – A Study. Delhi, India: Journal of Internet Banking and Commerce, page 6.

interchangeable with other commodities of the same type; commodities are most often used as inputs in the production of other goods or services. The quality of a given commodity may slightly differ, but it is essentially uniform across producers. When they are traded on an exchange, commodities must also meet specified minimum standards, also known as a basis grade.[25]

This type of tokens was created in order to facilitate the transit of non-fungible assets like any kind of property, pieces of land, right of use, spare capacity or even kilowatts. In other words, real life "assets" are represented by tokens in the digital world in order to eradicate any barrier deterring asset management and liquidation. Tokenization is taking the whole digital economy several steps further and sidelines a fair amount of intermediaries in all interim stages. In this way, the final price is reduced in favor of both the participants and the market itself. The main challenge is what will happen if trust is lost within the users of the platform and equally important is how Blockchain can guarantee that if hacked, a user can retrieve his tokens like in the DAO project case. An asset-backed token is actually an IOU that is circulating among platform users. A house is represented as a single token with a value equal to the value of the house and this token is offered to the potential buyer of the house. The buyer now possesses an asset which promises that the seller will sell him a house of the same price. In this way, a house owner can hold his property's digital record on the Blockchain such as geographic location, ownership status or its acreage.

One of the main advantages of asset-backed tokens is that it increases the liquidity levels in a relevant market. This mainly happens because a user can liquefy intangible or non-fungible assets in less time than before. Liquidity in a market can enhance the value of an asset as it eliminates the risk included in assets that are difficult to dispose of timely. In addition to that, digitalized assets can be traded on daily basis, even during holidays and this fact can provide investors with further opportunities that concern not only their national markets but also worldwide. For example, when United States' stock exchange opens in Japan it is late night and vice versa and this reduces the trading hours between the two markets. After that change, markets will be open 24 hours per day and they will be available at anyone interested to invest. Furthermore, trademark or patent exclusivity rights can be tokenized and traded through Blockchain in order to make the process of rights'

[25] Gupta, R., (2017). Future of Bitcoins – A Study. Delhi, India: Journal of Internet Banking and Commerce, page 8.

insurance more transparent and more indisputable. While this is the case, intangible assets like those have lower chances of entering a secondary marketplace where investing opportunities thrive. However, a user can reassure that no one will claim his patent and be confident that his rights can be traded freely. In simple words, every commodity traded through exchange markets can become a tradable asset-backed token like bonds, stocks, precious metals or oil and gas. An investor can already buy and sell those commodities digitally but only cooperating with other intermediaries. In the case of Blockchain traded asset-based tokens, intermediaries are not involved in the process and investors gain both time and money. Through asset-backed tokens a company can turn an asset into collateral in order to receive a loan from a bank. For instance, a natural gas company can turn one of its LNG carriers into guarantee avoiding a lot of bureaucratic effort and constituting the whole process more transparent. This will permit energy companies expand into relevant markets including electricity, natural, oil and renewable sources.

3.1.3 Utility Tokens

Most of utility tokens are delivered through ICOs to customers. In simple words, utility tokens function like tokens in a funfair where we pay a token to enter each activity. The value incorporated in each token is either predefined or is fluctuating according to other linked cryptotokens. With those tokens a customer guarantees access to a future product or service of the company issuing the utility token. Concerning the financial aspect of utility tokens, they are not considered as investment or securities under national investment legal framework. It is not that rare to see customers purchasing utility tokens early enough even before tokens are generated by the company. The hype hovering over modern technologies and cryptocurrencies has led investors proceed with high risk in cryptocurrencies financial markets. In this way, the relevant company can gather a significant amount of capitals so as to realize token generation.

Token demand plays a major role in the relevant market as high demand can create great expectations and provoke a surge of a start-up's shares. On the other hand, low demand for a utility token can devastate a company's business plan once and for all. A useful hint in order to prove a utility token is the purpose it serves and its real-life use case. Most of the times, a utility token, the proposal of which is vague, makes investors really suspicious because precision and applicability of a technology is what matters the most. Usually, the trap is hidden in the fee's reduction which is attractive for potential investors.

3.1.4 Security Tokens vs Equity Tokens

A new trend has begun to emerge in the Blockchain tokens' environment. Until now we knew about the utility tokens which can substitute fiat currencies or permit access to applications just like arcade coins. In simple words, utility tokens were mostly used as a means of payment or value hoarding. The purpose of the new types of tokens is to facilitate enterprises in the process of attracting new investors. Their necessity in the investment arena is crucial as it will offer greater opportunities to low-budget investors (up to 10,000 euros). Furthermore, a financial market which runs on the Blockchain is more accessible as it remains open 24/7 worldwide by everyone using the Blockchain. As long as the issuer of a Security Token Offering (STO), which is the process through which a company is willing to attract new investors, becomes more and more digitalized and mainstream, the cost of organizing an STO will be reduced eventually. It is worth mentioning that STOs resemble the procedure of Initial Coin Offerings (ICOs) even though they have fundamentally different purpose. In the case of a traditional share trading in a stock exchange, the whole procedure is considered time consuming and cost ineffective due to the variety of intermediaries (brokers) meddling between the seller and the buyer of stocks. The cost reduction will prompt small and weak investors to devote themselves in a totally new and decentralized market. Last but not least, security tokens permits potential investors to embrace fractional ownership which means that an asset could be fragmented into several pieces and each piece could be traded as a single security token providing a fraction of the total wealth created by the relevant asset. One of the main advantages of security tokens is that it augments the liquidity of digital financial markets as tokens can be traded after their first sale to an investor. Selling such derivatives will multiply the amount of capitals that are spent in stocks and shares. However, first, we should analyze more what security and equity tokens are because it is very common mistake to confuse those two terms and use them interchangeably as if they were the same.

Security tokens function like a traditional security asset that contains a certain amount of wealth that is created by a third party (a company usually). The holder of the security asset (token) has a stake in the wealth created by the relevant collateral asset which could be a real estate property, a bond or even a piece of art. The value of the security token is formed according to the success or failure of the company's manager. Regularly, the acquisition of a security token is accompanied by the equivalent amount of voting rights in the administrative council. On the contrary, equity tokens serve as traditional stocks which contain a relation of ownership of the

token holder with the company itself or its assets. According to the law, equity tokens are considered as “securities”. The main difference between the two is that security tokens do not address rights of ownership to the token holder while equity tokens work like shares in the traditional financial markets. The whole procedure of both tokens is based on smart contracts which can digitalize any asset in order to add it to the Blockchain.

It is very common in the last years for companies to invest in utility tokens so as to avoid the regulatory restrictions of a certain legal system. Searching deeper into the details one company could bypass the confining boundaries of the law as security and equity tokens are considered to be securities and this phenomenon sharply increases the difficulty to trade such tokens. In simple terms, the legal framework concerning the security tokens is too immature to support the innovative ideas of some technology-oriented entrepreneurs. In addition to that, paperwork and a huge amount of working hours are necessary for a start-up in order to proceed with a successful STO. A manager should be extremely careful with the offering process as he has to bear into consideration the possibility of a malfunction in the smart contract and the interested parties to consider it as a scam and spread the rumor. The most significant disadvantage of security token market is that its emergence happened very recently and its sustainability has to be proven in practice. The risk remains considerably high for investors who are looking forward at facilitating their trading procedures and appears that speculators will exploit its high return rate.

3.2 Energy Companies Using Cryptocurrencies and Tokens

SolarCoin Foundation has created a cryptocurrency in order to reward its customers for producing solar energy by providing them with 1 SolarCoin per 1 MWh produced from solar panels. The goal is to quit using fossil-based fuels step by step and turn towards solar energy solutions which have a lower environmental footprint. SolarCoins can be spent just like every other cryptocurrency so as to buy products and services or change them with fiat currencies in an exchange market. Its Proof-of-Stake-based algorithm makes computers consume much less energy than Proof-of-Work algorithms. Every solar panel owner of more than 20kW capacity can benefit from SolarCoin. In order to subscribe himself into SolarCoin, the user has to file a claim for SolarCoins to the Foundation by registering their installation through a Foundation’s affiliate solar panel company. Certificates which prove ownership, compliance and personal data documentation are necessary so as to proceed with

the registration. With a network of 63 countries and multiple affiliates per country, SolarCoin sends the equivalent amount of coins to the producer every six months which the user can cold-store on a paper wallet for his own protection. The identification of energy generation will be monitored by smart meters which will record the amount of electricity produced and will remunerate the producer accordingly. SolarCoin is global, decentralized, and independent of any government. The distribution part of the program is designed to last 40 years. SolarCoin is spendable and tradeable like a cryptocurrency, but focuses on incentivizing real-world economic and environmental activity: verifiably produced solar energy.[26]

4NEW Company has created KWATT/FRNCoin which is actually an asset-backed token embodying within it 1kW of electrical power. The electricity produced derives from a waste processing plant which consumes approximately 50-100 thousand tons of waste per year. The power generated is transmitted to an onsite crypto-mining farm in order to feed mining machines with cheap energy. The purpose of designing such a token was to reduce the price of electricity for those who mine cryptocurrencies and especially Bitcoin. However, it has a great potential to become a new source of green energy which can bring power to those in need. By investing in KWATT token, users can help 4NEW expand its operations to different countries in developing areas of the world. The KWATT Coin will represent a certain hashing capacity per coin. 4NEW does not charge energy fees for mining; the only cost to a coin holder is the cost of the coin. This means that a coin holder will be able to mine all cryptocurrencies for the lifetime without spending an additional penny for their energy bill. 4NEW relies upon the waste to energy model. [27]

In this model, the company is paid for the waste that it processes and the sale of byproducts such as fertilizer, organic materials and clean water. The startup costs to this mechanism are funded by the coin sale, and the plant's overhead is funded by cash flow generated from collection of waste and revenue from sale of byproducts. Additionally, 4NEW, and the 4NEW team will retain a portion of the KWATT Coins (and their associated mining capacity) which will provide an additional revenue stream moving forward. The relevant token is distributed to the interested investors through an Initial Coin Offering by exchanging Euros, Dollars, Bitcoins, Ethers and

[26] SolarCoin, (2018). Introducing SolarCoin, Available at: https://solarcoin.org/

[27] 4NEW, (2017). Introducing the KWATT Coin – Tokenized Electricity. page 9. Available at: https://4new.io/wp-content/themes/4new/images/whitepaper.pdf

many other (crypto)currencies with KWATTs. The coin holders will spend their tokens by buying electricity from 4NEW Company directly. ICO will work as an investment tool since 4NEW is willing to expand its operation in different regions in order to spread the cheap electricity potential to several spots of the country.

CHAPTER 4: Artificial Intelligence in Energy Sector

4.1 Energy-Efficient Buildings and Grids Using Artificial Intelligence

Artificial Intelligence (AI) offers multiple applications in order to render a building eco-friendly and it concerns both companies and consumers. For example, a utility company can use AI so as to predict energy consumption in a region or a neighborhood. In this way, the company can prevent power disruptions more accurately and more efficiently than before. Network operators can have a clear image of the system's condition and tackle problems at its root as Artificial Intelligence offers total control of the grid. Anomalies' detection becomes simpler and maybe in the near future a super-computer could deal with them by its own according to the orders of its programmer. In addition to that, machines can take into consideration different types of information and by combining them to foresee energy consumption of a single household in order to offer better customer services and propose more rationalized energy consumption over time.

The Spanish company Nnergix offers weather analytical services as it exploits data of meteorology, analytics and energy in order to predict the performance of solar panels and wind turbines in a day. This kind of information is used by the Transmission System Operators (TSOs) in order for the small and large producers of solar and aeolic energy to know the amount of power they will create themselves. In this way, the company can propose the employment or unemployment of reserves to meet the needs of the market. This offers a high level of security and disruption control as consumers can rationalize their energy consumption according to grid's condition. In most of the blackout cases, consumers do not know how many megawatts are consumed and probably if they knew they could switch off some appliances to avoid blackouts in the future. Less blackouts equals to more grid's stability which will bring down the cost of energy generation. Furthermore, renewable energy sources obtain a permanent and stable share in energy production as their contribution will further stabilize energy prices and create a spirit of environmental protection.

As for the consumers, they can have the control of their usage by asking from the utility company an analytical consumption report. In that manner, people will extenuate their power expenditure. This can be done by smart meters which keep an

archive of data about every watt depleted in the building. A typical example of a gadget which helps people at their houses is the Nest Learning Thermostat by Nest Labs. This company produces among other gadgets thermostats, smoke detectors and security systems like cameras. Once you possess every apparatus of Nest you can connect all of them to the house's Wi-Fi and create a smart house. As it is a Google subsidiary, all of its appliances can communicate through Google Home voice command gadget. If our home is cold inside we can ask from the smart thermostat to increase the heating inside the house or even better, if we fall asleep and we forget to turn the heating off, Nest's smart thermostat adjusts the temperature according to your ordinary choice as it can recognize patterns over time. We can imagine the environmental footprint of a smart house if we install except from thermostats some smart light bulbs or smart switches in every electronic appliance inside the house. It can reduce the price of our electricity bill and manage better the power consumed to avoid energy waste. If we apply this technology to offices and working places the money saving is multiplied and hundreds of kilowatts are not spent arbitrarily.

The oil and gas industries are facing major challenges – the cost of extraction is rising and the turbulent state of international politics adds to the difficulties of exploration and drilling for new reserves. In the face of major problems, the energy industry is turning towards data for solutions. Royal Dutch Shell, one of the 'supermajor' energy companies and the world's fourth-largest company by revenue, has been developing the idea of the 'data-driven oilfield' in an attempt to bring down the cost of drilling for oil. Surveying of potential sites involves monitoring the low-frequency seismic waves that move through the earth. Probes are put into the earth at the spot being surveyed, which will register if the pattern of the waves is distorted as they pass through oil or gas. In the past, this would involve taking a few thousand readings during the typical survey of a potential drilling site. But now technology has advanced to the level where it's possible to take more than a million readings – vastly increasing the amount of data gathered during exploration. This gives a far more accurate image of what lies beneath. Data from any prospective oil field can then be compared alongside those from thousands of others around the world, to enable geologists to make more accurate recommendations about where to drill.[28]

[28] Marr, B., (2017). Beyond the Big Data Buzz – How Data is Disrupting Business in Every Industry in the World. KoganPage, page 12.

4.2 The Three Stages of Energy Handling

4.2.1 Upstream Stage

Artificial Intelligence in upstream stage can offer several benefits and surpass many constraints that exist today. Upstream stage of oil and gas includes all the stages of exploration and production (E&P) concerning those resources such as exploration of an oil or gas deposit, proceeding to drilling stage and finally producing oil or gas from a well. Upstream stage is the most important and the most complex sector of energy management as it is the most risky, regulated and technologically intensive sector of oil and gas circle. The riskiness of upstream stage lies within the environmental safety risks a drilling may have or within the futile results of a well at the end of the day after spending millions of dollars and wasting valuable time.

Computers used in the upstream energy stage have the potential to calculate a mass of data which can reduce any type of risk by providing the optimal choice for every different occasion. They can also enhance the productivity of other machines which are connected to the same platform and finally minimize the operational costs of a drilling or searching by adjusting the rhythm of extracting oil and gas from soil or collecting all the necessary information before coming to a conclusion. For instance, a computer can suggest a location for drilling the precision of which is unprecedented. In this case, an energy company can predict its return on investment (ROI) in order to channel any remaining capitals to other projects.

The application of Artificial Intelligence in upstream stage could include computers which are able to control and deliver real-time information about exploration and production of resources. Data concerning the rate of pumping oil out of the soil or the pressure of gas in the reserve are some of the most common information a scientist needs to know in order to proceed with the process. Estimations about geological, physical and chemical conditions are calculated simultaneously providing scientists with many different ways to achieve one single purpose. Identifying patterns is the best way to find alternative paths and other optimal solutions to a problem. Imagine a single platform that hosts maintenance records, production data, seismic frequency data, drilling logs and much more important information about resource extraction.

One significant example of Artificial Intelligence application in the upstream stage of energy is that of ExxonMobil, working together with Massachusetts Institute of Technology (MIT) on a project that will result in retrieving data from the bottom

of the oceans where human beings do not possess the means to discover its potentials. This project concerns a self-driven robot, which is based on the principles of Curiosity robot exploring planet Mars on behalf of NASA. The purpose of constructing such a machine is to reach places that no one else has ever reached and save as much information as possible. According to ExxonMobil, there are multiple deposits of oil existing under the bottom of the oceans and detection of them is now feasible with this kind of technology.

Natural seeps hold a respectable amount of oil reserves and by using Artificial Intelligence robots we can guarantee that there will be no wasteful drillings. In other words, less money is spent and the environmental footprint of a company can be reduced significantly. According to ExxonMobil's representatives, company's mission is "to have these submersibles embody the reasoning of the scientists that program them. We want the explorer to do the science without the scientist there. They need to be able to analyze data, keep themselves out of harm's way and determine novel solutions in novel situations that go beyond basic mission programming. They need to have some common sense and the ability to learn from their mistakes".[29]

4.2.2 Midstream Stage

Oil wells and natural gas reserves are not located in the same areas as refineries and consumption regions. For that reason, transportation, storage and processing of energy concern both producers and consumers. It is characterized as a sector of low capital risk but of high regulatory complexity. Its low risk lies within the low expertise of that sector as it is not demanding in terms of either transport natural gas with a pipeline or to store crude oil in a tanker. It is neither demanding in terms of cost nor in terms of technological equipment. Its high regulatory complexity exists basically due to the fact that in the case of pipelines, natural gas may pass from the soil of multiple countries with different legislations on energy and different pricing policies like countries of the European Union and other third countries.

Another crucial stage of midstream stage is fractionation which includes the separation of natural gas from other valuable liquids that are used in petrochemical industry and manufacture. After the separation of materials, storage conditions must be precise in the gas of natural gas because pressure is the most important

[29] Sennaar, K. (2017). Artificial Intelligence in Oil and Gas – Comparing the Applications of 5 Oil Giants. [online] Techemerge. Available at: https://www.techemergence.com/artificial-intelligence-in-oil-and-gas/. [Accessed 22 August 2017].

parameter that can cause malfunctions in a natural gas infrastructure. For that reason, a series of applications and state-of-the-art technological tools are used to prevent dangerous situations and facilitate the whole process of energy transportation and processing.

A specific application of Artificial Intelligence in midstream stage could be a real-time intelligent system with forecasting and optimization capabilities for better decisions and operating performance. In other words, this system could forecast extreme conditions (meteorological, geological or even security holes) which could pose a threat to the sustainability of the infrastructure. The real-time nature of the system can feed scientists with a huge amount of data that when processed can come to a very valuable conclusion. In addition to that, such a system could oversee the process of oil and gas transmission and adjust the rate of accumulation of resources in certain points of the infrastructure. Due to the fact that midstream stage was in the past part of the upstream stage, Artificial Intelligence application has similar characteristics in both cases.

4.2.3 Downstream Stage

The downstream stage includes oil refineries, petrochemical plants, petroleum product distributors, and natural gas distribution companies which operate based on the following stages: refining of oil and gas, end-user consumption (selling refined products) and wholesale/retail marketing. As for refining, it is a very complex and very expensive stage of energy sector as a great amount of derivatives and substitutes of fuels. Each derivative demands certain criteria such as temperature, pressure, added substances or even special storing conditions. Above all these criteria is cost of refining that can vary depending on certain international developments like global oil prices. It is a stage which is quite demanding in modern technology and high expertise staff in order to keep to final prices as competitive as possible.

The way oil and gas companies price their products is really important to bear in mind because it entails some risks. Refining sector is a margin business which means that the space a company has to shape its pricing formula has certain solid limitations that may be a plafond in prices that an end-consumer is willing to pay or the global prices of oil and gas. To convert it into a mathematical equation, the margin of an energy downstream company is formed when we extract the cost of production of a resource from the end-consumer price plafond he is willing to pay.

As for marketing policy of both wholesale and retail, this stage includes all those methods a company will use in order to attract wholesale clients such as utility companies, municipalities, manufacturers and ports/airports or retail clients such as apartments and small enterprises.

The application of Artificial Intelligence in downstream energy stage can result in the creation of platforms which can offer predictions and insights based on certain algorithms. It can rationalize the way a computer deals with data as information itself is not 100% precise in order to predict the future. Now computers are searching for patterns which help researchers put data into groups with similar characteristics. The goal of Artificial Intelligence is to reduce the costs of research through more efficient data management. By applying predictive algorithms and proceeding to scenario analysis the final operation costs are lower and the percentage of predicting correctly a future situation is greater.

Specific examples of Artificial Intelligence in downstream stage could be certain platforms which can aggregate different data components and put them in different categories based on consumption habits, payments methods or risk of not paying in time. Different packages including discounts could increase the interest of many customers to apply for a package in our company. This will increase the personalization of a company to its customers by providing them so personalized offers that match perfectly their needs. If this practice becomes all the more widespread and all companies use this kind of technology then the final cost a consumer is paying will be reduced in the long-run. Artificial Intelligence will be beneficial for both companies and consumers. Consumers will observe a reduction in the energy bills and companies will be able to rationalize their financial prospects locating quickly enough the insolvent customers.

Another use of Artificial Intelligence by electricity utility companies can be the detection of overload patterns in real time by calculating weather conditions, consumption habits in specific locations, the risk of a blackout and maintenance records of the infrastructure. By utilizing Artificial Intelligence in electricity grids it is easier to determine the supply and demand balance with much more accurate algorithms and tools. One example of intelligent computers anticipating energy demand is Google, which is applying power prediction algorithms in its energy demanding data centers. Now Google has announced that is willing to apply the same algorithms to the National Grid of the United Kingdom in order to rebalance the supply and the demand of energy reducing costs and increasing energy efficiency

at the same time. The company's estimation is that 10% of energy usage could be saved just by optimizing the existing infrastructure.[30]

The endeavor began when an Artificial Intelligence laboratory (DeepMind) was acquired by Google in 2014 to use it as a hub for Artificial Intelligence researches. One of the first applications was the optimization of air-conditioning system in a Google's data center, where DeepMind minimizing energy consumption and furthermore boosting energy efficiency. The whole system is based on computers using complex algorithms applied on information about energy demand. The computer then offers us patterns of energy consumption under certain conditions and predicts accurately peaks in the system by enabling more intensively the renewable sources in the energy mix of the country. Until now, renewable sources were confronted as untrustworthy because of their major disadvantage which is the inability to operate under certain meteorological conditions such when the sky is cloudy or there is no rain for weeks.

"Cloud energy model" is very attractive at the moment and for that reason the management of decentralized energy grids is essential for the sustainability of energy resources. For example, if the system operator of a grid can handle the flow of energy properly then there will be less need to generate extra power from large utility infrastructure. Taking into consideration that multiple buildings will host energy production equipment (solar panels mainly), they will be able to both receive and offer energy to neighboring buildings. This practice will decrease the production of energy in huge nuclear or carbon-based power plants. This decrease in production cost will convey a decrease in the electricity bill of the consumers and the general minimization of electricity consumption will be translated in less CO2 emissions. Regulating the whole grid in such a way that system operator can have a real time access to infrastructure's data could rationalize both the energy flow and the production cost of large energy providers. Artificial Intelligence appears useful in similar cases when large cities can be semi-autonomous from a unique central point of energy production.

Open Energi is a UK-based company which offers consulting services to other companies willing to rationalize their energy consumption in order to save money by not affecting its operation. A group of educated scientists assess every aspect of a

[30] Shead, S. (2017). Google's Deepmind wants to cut 10% off the entire UK's energy bill. [online] Business Insider UK. Available at: http://uk.businessinsider.com/google-deepmind-wants-to-cut-ten-percent-off-entire-uk-energy-bill-using-artificial-intelligence-2017-3 [Accessed 13 May 2017].

company's modus operandi that could affect its energy demand. After that, a feasibility report is published in order to identify the flexibility the company can offer. In the next step, the company which needs to reduce its energy costs agrees to automate its equipment by using the "Dynamic Demand 2.0". Dynamic Demand minimizes electricity costs and maximizes income opportunities during peak price periods by reducing consumption. Its greatest benefit is that machine learning algorithms continually optimize energy consumption and contributes to the saving of resources. In other words, it uses machine learning to identify and automate operational efficiencies and optimize asset performance against business productivity targets, cutting costs and carbon. Artificial Intelligence can create an efficient and adaptive framework that can look across multiple assets on a customer's sites and, given all the operational parameters in place, intelligently optimize their behavior so that they consume energy in the smartest way to save energy, cut costs and earn revenue. An Artificial Intelligence model can make decisions in real-time about how all these sites and assets should be managed to deliver the most value (wind turbines, solar panels, geothermal equipment, batteries used for energy storage); when, where and how much flexibility exists, when to charge and discharge the battery, and when to use, store or export energy generated by the solar panels. This practice is called "portfolio level approach".

The portfolio level approach is divided into three phases, early training phase, late training phase and control phase. In the first stage, the Artificial Intelligence machine tries to identify the basic patterns of the company's operation and control its portfolio. The optimal control strategy is not taken for granted in this level and for that reason the behavior of the machine is unpredictable because of the data it receives. In the second stage, the machine is adjusting itself to the company's environment and because it follows a better control strategy than before and it is rewarded for that reason. Finally, in the third level the machine follows the optimal control strategy and corresponds accurately to the needs of the company as expected.[31]

Codford Biogas is a Wiltshire-based business which recycles food waste to generate renewable electricity. The methane gas produced powers three Combined Heat and Power (CHP) engines capable of generating 3.7MW of renewable electricity for export to the grid – enough to power 4,000 homes. Codford Biogas realized its

[31] Bironneau, M. (2017). How AI is shaping the future of energy. [online] Power Responsive. Available at: http://powerresponsive.com/ai-shaping-future-energy/. [Accessed 19 June 2017].

CHP engines could earn new revenues by optimizing when and how much electricity they generate to provide flexibility to the UK grid but did not want to disrupt how its plant operated. By connecting its engines to Open Energi's Dynamic Demand 2.0 platform it has been able to automate and optimize its operation. Codford Biogas' CHP engines have successfully provided a real-time balancing service known as Dynamic Frequency Response to National Grid. The service earns Codford Biogas income with zero disruption to operational performance.[32]

4.3 Artificial Intelligence in Energy Retail Market

Artificial Intelligence can be used in energy trading too as many specialists claim that will bring a new revolution in the way traders shape the price of commodities in the relevant exchange market. In order for a machine to apply Artificial Intelligence to the commodities' market first one should insert a huge amount of data to the computer that vary from pricing algorithms to behavioral patterns of buyers and sellers which have statistically been calculated. Next step includes supervised model training where scientists separate information into groups of similar characteristics and then are used as training material for the computer. At this stage the machine is tested to validate that can offer trustworthy data and follow the expected method of assessing information. If needed, scientists can use clustering algorithms of unsupervised learning to discover deeper patterns which are not evident to a human eye. After this step we need to set our trading policy in order to know whether we are reaching our goals or if it is in our benefit to continue or change strategy. The next step resembles to a monitoring process during which we assess both the accuracy of the machine's output data and whether we reached our goals by using the trading policy our machine proposed. If the results were not the ones we were expecting, we will return to the second step in order to train again our machine. Last but not least, the fifth step includes the process of running the model in real-life conditions as a simulating model. This step is called "paper trading" and is vital for those scientists who assess the validity of our approach. If the machine's output data are credible and solid then we have achieved to create a complex predictive machine which can help us save money by calculating the perfect timing to buy or sell commodities and optimize the manner a commodity exchange operates.[33]

---

[32] Open Energi. (2018). Case Studies. [online] Open Energi. Available at: http://www.openenergi.com/case-studies/. [Accessed 23 February 2018].

[33] Kuttruf, S. (2018). A Machine Learning framework for Algorithmic trading on Energy markets. [online] Medium, Towards Data Science. Available at: https://towardsdatascience.com/https-

Artificial Intelligence can be used as a means to deter energy theft especially in developed countries where poverty is devastating and people cannot pay their utility bills. Countries like India or Brazil are on the top of the list and the cost for the utility companies is immense as there is a large gap between cost of production and revenues earned by bill payments. Energy thieves are tampering with the electricity meter device and are bypassing the control of the company. However, Artificial Intelligence device can identify usage patterns, payment history or other customer information that when compared to the current situation can demonstrate irregular customer behavior. A utility company can collect several data from every customer by using Artificial Intelligence devices and launch dynamic payment strategies which means that the ability of a customer to pay his bill is the decisive factor that will shape the final price.

The rationale behind smart devices is that they will replace time-consuming manual inspections, but the fact that smart devices operate automatically renders them susceptible to manipulation. The company will at first use supervised machine learning material because as we mentioned above, machine's behavior at the first stage of training is unpredictable. In that case, a scientist will manually choose cases which imply fraudulent activity. After a period of multiple assessments of such cases, the machine can recognize a pattern and from that time on it is capable of operating automatically disengaging scientists from customer monitoring process.

By creating a personal file for every consumer, an energy provider can submit better customer service and more personalized offers or discounts. In this way, the company can increase its margin by knowing at the same time which is the price that can make a customer quit our company. That is why personal data of customers is the new trend that will revolutionize the manner companies treat their clients and companies should be capable of managing the huge mass of data in order to provide the machine with robust and solid information in order to receive accurate output. This practice can be beneficiary for both the customers, who can have personalized treatment and for energy providers, who can rationalize their revenues.

In addition to that, there is a company which managed to merge Blockchain, Artificial Intelligence and Internet of Things is Robotina. Electricity is one of the key energy sources, probably the most important one. The ever higher price of electricity, unstable electrical networks as well as growing consumption of electrical

---

medium-com-skuttruf-machine-learning-in-finance-algorithmic-trading-on-energy-markets-cb68f7471475. [Accessed 16 July 2018].

energy, seriously endangers our lifestyle and natural environment. The price of electricity is significantly influenced by the uncontrolled peaks on the grid like when a high number of customers use the electricity at the same time. This means a constant demand for enlarged electricity production when it is actually not needed at all. The surplus of electricity goes to waste if not used immediately. Equally important as the surpluses, there are the deficits of electrical energy in the network, which means that the electricity has to be bought at much higher prices than normally. All of the above problems are influenced by unstable sources, such as solar and wind power plants that produce the electricity only when the weather is favorable, electric vehicles as new type of means of transportation which relies on electricity and the current technology, which hasn't enabled a price-favorable storage facility of larger quantities of electrical energy yet.

Applying several state-of-the–art technologies, the Robotina Platform reduces electric energy consumption, lowers electricity costs and optimizes the functioning of the entire electricity grid by monitoring and controlling real-time electricity consumption and distributed production. Thus it manages the devices and collects and processes the data from platform users. This data is then offered to the network operators or electric energy producers. Using smart technology the Robotina Platform solution will help optimize the consumption of electricity by automatically turning off a device when in use (but not needed) or switching it on when the tariff is cheapest. Additionally, one can earn money by allowing power consumption flexibility to the grid and by collaborating in group buying, power trade, aggregated data sales, crowd financing and by activities in the platform's marketplace. Last but not least, the user will significantly contribute to a greener environment and sustainable development of mankind.[34]

One interesting aspect of Artificial Intelligence is that it can facilitate customer service in a remarkably constructive manner. One application has already happened in multinational companies which receive thousands of phone calls and e-mails per day. A customer calls his energy provider and a voice command machine answers the call automatically. The customer then speaks using key-words such as "I have a black-out at my house" or "I want to speak with the service department". The machine identifies those key-words and offers proposals "For customer service

[34] Robotina, (2018). Internet of Things, Artificial Intelligence and Blockchain Empowering Energy Consumers. Robotina ICO Light Paper, Available at: https://robotinarox.io/wp-content/uploads/2018/07/Robotina_LP.pdf

please press 1". This trend might not be new however many customers complain that they feel uncomfortable when they have to wait for hours until they reach the most suitable person to solve their problem. For example, a false in the energy bill can be solved if one visits a shop of the provider but what happens if the customer lives in a remote village? What will be the quality of customer service offered to him? Phone-call centers belong to the past according to marketing experts as immediate answers to one's question is the challenge of our era. "Time is money" and a customer's time is even more valuable because it is strongly correlated to satisfaction of his needs. The same practice is applied to e-mail communication too using "chatbots". Key-words are identified and a company can serve its customers. An example of such an application of Artificial Intelligence is the case of Shell's Virtual Assistant which proposes which lubricant is the best for a vehicle, an industrial unit or even a construction machine.

Last but not least, customers can use Artificial Intelligence platforms of energy providers in order to calculate whether they can benefit from a switch of providers inserting data such as how much money a customer is willing to pay per kilowatt hour and if their house is based on "green technology". This permits customers see the bigger image which helps contrast different prices, offers and technologies. This is the type of transparency that everyone needs in order to be competitive. The system operator will not be the only one to have access to such information as customers have more power now than before. In a different case, a customer can have access to his personal data collected by his energy provider. In this way he can observe how much energy each device consumes and monitor his own total energy consumption. Then, he can proceed to measures in order to rationalize his energy expenses and buy more "green" devices.

To sum up with the three levels of energy management, Artificial Intelligence can offer quality improvement of output data as the identification and the categorization is done fast enough and correctly by avoiding any human constraint and shedding light to demystify dark data. The predictive capacity of AI is significantly important in terms of environmental protection and energy saving. It can provide us with a better quality of working and greater safety in workplaces because heavy tasks are automated and working accidents will be reduced sharply. Finally, the interconnected operations done by using Artificial Intelligence will rationalize the way tasks are performed and the production procedure will take less time and will demand less money.

Conclusion

Energy sector undergoes several changes every year as it is both an energy-intensive, capital-intensive and technological-intensive industry. Every technological innovation that occurs is assessed in order to prove its application in the relevant sector. Blockchain technology decentralizes all traditional centralized structures concerning financial institutions or utility companies. Users of decentralized platforms can acquire more power over their personal data included in a digital transaction while security is multiplied due to the lack of a central point of failure in the system. On the other side, cryptocurrencies are offering Blockchain users an alternative to fiat currencies or use tokens which correspond to a certain percentage of an asset if not an asset as a whole. Power trading is facilitated and electricity bills can be paid through cryptocurrencies. Finally, Artificial Intelligence delivers new potentials in the Energy sector as data mining and deep learning have emerged in the field of statistics where scientists can identify hidden patterns in data inserted in a super-computer. Those patterns can offer useful information about prediction or decision-making procedures. Energy companies operating in upstream, midstream and downstream stages can benefit more from AI while smart devices can play a major role for those consumers willing to rationalize their electricity consumption. At this moment, we should try to answer the three questions posed at the introduction of this paper and undertake to offer persuasive explanation about each one of them.

How can energy consumers and producers benefit from modern technologies?

There are multiple benefits for both consumers and producers of energy when adopting modern technology achievements as their interests are strongly interconnected. The fluctuation of operating cost of a utility company will result in a fluctuation of the final price to be paid by consumers. For that reason, major companies are interested in the potentials of decentralized and digitalized types of technology in order to create a new kind of relation with their customers. The challenge which Blockchain technology has to answer is whether it can serve as a modern tool in the Energy sector and render traditional centralized platforms obsolete. However, this will be related to the pace of the general technological changes happening as the large scale application it is promising cannot be realized at the moment, at least not without serious delays and problems.

As for Blockchain, Peer-to-Peer (P2P) transactions can aid at achieving that goal as direct payment channels by surpassing the involvement of banks will reduce the

cost of payment. In addition to that, transaction fees' elimination will save millions for companies and hundreds for their customers. It is a classic example of a win-win situation between producers and consumers. The rationalization of transaction policy by those utility companies which excludes other intermediaries, renders the whole payment procedure more flexible and faster than ever before. However, the main challenge for both parties is transaction data protection as hacking may be rare in decentralized environments but it can never be totally eradicated. The fact that information can be stored in every node within the system can characterize Blockchain as a radical proposal for data storing. Approximately no one can tamper with our data as no one can have the power to control more than 50% of the nodes. Information security is guaranteed in this way while no central authority can affect the whole transaction process. This is more beneficial for countries with authoritarian regimes as those governments tend to oversee every transaction made by a consumer in order to observe any suspicious act.

The adoption of Blockchain technology in the Energy sector though can be applied on certain processes which concern metering and billing of energy transactions. Others claim that clients' documentation and Proof-of-Ownership status could be equally influenced by Blockchain. It is worth noting that a utility company can obtain a renewable energy certificate in this manner and be seen by every participant in a more transparent way. Energy metering can be ameliorated through the instant information exchange between consumers and producers. A building with an installed metering machine delivers data on real time basis in order to provide the best services possible and inform the customers for their personal consumption. As for energy billing, the data retrieved from metering will be used in order to correctly price both energy and services. The use of cryptocurrencies as a new means of transaction is all the more attractive for many users who are investing a lot of money on cryptocurrency platforms.

Blockchain technology also provides great opportunities for "prosumers" who produce their own energy and they trade their excess to neighboring buildings in exchange for cryptocurrencies in most of the cases. This local level trading will be achieved by delivering its ultimate potentials when smart grids will be regulated enough and included in legal frameworks as the extension of distribution networks. Smart grids from their part facilitate energy flows between neighboring buildings as a prosumer can trade himself his energy excess with another person on a P2P basis. Smart grids demand smart contracts in order to operate according to the principle of

decentralization of Blockchain. Smart contracts include a chain of orders made by the creator such as the automatic payment of the prosumer when the amount of energy bought reaches our metering machine. Those predefined rules simplify and reduce the total amount of time needed to transact with other customers. Furthermore, the whole automated process respects the supply and demand balance which should exist in every network so as to avoid energy production that is never consumed. There is a solution for that challenge too but the timing is not right now to implement such as measure. Electric Vehicles (EV) can absorb the excess of electricity within a smart grid but at this moment EVs are quite expensive and the results of economic crisis of 2008 are currently evident. This lack of EVs in the cars' market has posed a threat for prosumers who are anxious that their electricity excess will remain unsold due to both lack of trust and the absence of electric vehicles.

As for cryptocurrencies, their application does not differ in any sector as its function focuses on transaction facilitation or capital hoarding. The advantages of cryptocurrencies are multiple as they propose a different financial environment for their users. First of all, cryptocurrencies cannot be counterfeited so acts of fraud are reduced to zero. Probably the best characteristic of cryptocurrencies is the elimination of transaction fees paid to banks or other intermediaries. The only fee paid is a very small amount of money (equal to cents in fiat currencies) which incentivizes the miner to add our transaction to the next block in the Blockchain. Banks all over the world have many times used their power to control their clients' accounts, with the more recent example of capital controls in Greece and the bail-in banking salvation in Cyprus. One way to secure a personal banking account is to adopt cryptocurrencies as their storing capacity will radicalize hoarding procedure. One user can print the encryption key of his wallet on a piece of paper and never be anxious if someone will tamper with his data. The fact that cryptocurrencies are internationally used has multiple benefits for their users as they do not obey to the rules of a central bank or a government and when transferring capitals to another country there are no additional charges and fees. Cryptocurrencies are far from replacing credit and debit cards as public's opinion has not been familiarized with the decentralized nature of cryptocurrencies.

As for Artificial Intelligence, its contribution is going to be greater in the near future because until now we use only some of its potentials in order to identify patterns in a huge amount of data collected from computers. When providing a

computer of Artificial Intelligence with information for each and every scenario, actually we are programming it to act according to our orders with precision, something that humans cannot achieve all the times. One of its uses in the Energy sector is the rationalization of energy storage as based on patterns, a computer can save or utilize energy according to the supply and the demand of the network. For example, if the price of kWh is more expensive today it can sell or not buy (in the case of a consumer) in order to gain from that situation. In case of emergence or accident, AI can act give solutions as the computer after programmed, can respond to a system's failure. With Artificial Intelligence scientists can oversee the whole system by trusting the responses of the computer to issues arising. Renewable energy sources can further expand and obtain a greater share in the electricity market as AI will utilize them when the moment is right by reducing its high cost of production.

Overall, Artificial Intelligence can use information and retrieve patterns from them in a way that humans would need much more time and resources to retrieve. Hence, there a lot of supporters of AI who believe that energy efficiency depends on Artificial Intelligence implementation as computers can find the best response to every given problem. In other words, the decision-making procedure will be rationalized and will increase the percentage of successful decisions. In addition to that, domestic energy consumption can be controlled by metering machines or smart thermostats which use a type of AI to use or save electricity. Its algorithms can forecast future electricity prices based on previous experience and a variety of other factors. It is true that Artificial Intelligence can contribute to the cleaner and cheaper energy for everyone but at this moment the academic, scientific and political class is deeply divided and most people are anxious that AI will have the opposite results than expected.

What are the weakest points of modern technologies?

Blockchain, due to its complicated nature, demands a lot of time, effort and most of all money. Investing in such a technological achievement can set an enterprise out of market if the financial timing is unfavorable. For that reason, multiple companies of every sector remain to competing with its adversaries with the traditional weapons of supply and demand. For those companies Blockchain technology has not yet proven its true potentials and claim that the time is not favorable for them. In order for the Blockchain to have a positive impact for both consumers and producers, enterprises have to cooperate with each other. The

dilemma for companies is the following: either to cooperate and increase their profits from the new digital market or to deny modern technologies and wait for that one company which will apply Blockchain and will bear all the risks (legal, financial, infrastructural) included in such a decision. The challenge for the enterprises staying out of the Blockchain market is to figure out whether the risk of abstaining is greater than the risk of adopting it as its potentials might grow faster than expected.

The solution to Blockchain's high adoption cost while its transaction speed prevails slow enough and its vulnerability towards hacking attacks in relatively high will be the turning point that could change the mind of many CEOs in order to channel capitals for further use of Blockchain technology. However, economies of scale and scope in the process of power distribution of electricity market companies does not let much space for optimism as the adoption of Blockchain technology will catapult operation costs at levels where managers cannot control in such a financial situation when specialists believe that another financial crisis is ante portas.

If a company takes the lead in the embodiment of Blockchain technology in the Energy sector for example, the lawmakers and regulators will have a basis on which they can proceed to a legal framework that will assist such companies to invest and grow further rather than estimate incorrectly the situation and undermine both the technological achievement and the industry. Tax treatment is another issue to be raised within the Blockchain community as it is currently unclear if decentralized technologies could become a factor for further taxation. This could literally destroy the main purpose of Blockchain technology which is the facilitation of worldwide transaction between users of the same platform. In addition to that, it is quite vague which institution bears the technical or legal responsibility in the case of an accident or a hacking attack. The lack of a central authority renders individual users more susceptible to cyberattacks at the end of the day.

On the other hand, electricity natural monopolies remain powerful as TSOs maintain total control over transmission networks. The fact that P2P energy dealing will take place based on the current TSO's lines makes Blockchain companies really suspicious about the increased risks of trying to collaborate with a monopoly-provider. If TSOs remain rigid and provoke problems in the cooperation process then smart grids will face a great delay in wider application. As a result, the prices of electricity will remain high enough as a burden for everyone buying power in the market and true decentralization will be never achieved.

Many critics are really cautious about the job losses Blockchain can bring along with radical changes in the Energy sector. The minimization of intermediaries' role will result in less staff needed in the banking sector which facilitates payments for energy companies or fewer employees in power supply as smart contracts may substitute them for economies of scale. Even though other jobs will be created, the entrepreneurs who will exit the market and who have a financial background will be replaced by programmers and new entrepreneurs of technological background. Automated procedures have both benefits and drawbacks and for that reason regulators should find the right balance between automated procedures and employability of professionals. The goal of new business models is already evident; however, it cannot be implemented without scarifying other factors before.

Another risk of Blockchain technology is its lack of flexibility after it has been adopted. The moment a Blockchain platform is published for use, no changes can happen that would require less than 51% of users' permission. This is the moment when "forks" occur and users are divided according to which version serves better their goal. It is difficult, if not impossible, to imagine a situation where one platform with two different and adversarial Blockchains serve the same purpose using the same rights for equipment use. Regulators will have a major challenge to tackle in such a case and the customers/users of the platform will be in the middle of a two companies' dispute. The rigid nature of Blockchain can become a major challenge for both companies and customers.

Nevertheless, the most dangerous challenge that Blockchain has to deal with is not relevant to its decentralized technology but relevant to what ordinary people and its users think about it. The first time the mass heard about decentralized ledger technology was when Bitcoin was blamed for being the main currency for drug dealing through the Internet. In the last few years its reputation is restored as big conglomerates are adopting it for commercial use and transaction's facilitation. The way companies will render Blockchain an attractive piece of technology is a matter of time as more and more researches take place to discover what Blockchain can offer to us. Finding and persuading the right investors to get involved in the relevant market cannot be an easy task as speculators would scare other interested parties from truly offering their know-how on decentralization.

Last but not least, privacy in a double-edged sword which can have both positive and negative impact on the further implementation of Blockchain technology. The negative aspects would be the lack of privacy as everything is

transparent on the Blockchain but this transparency does not mean that anyone can have access to our information. It means that every user can have access on transaction data without being able to identify the true identity of a user. Furthermore, many specialists of decentralized ledger claim that right now Blockchain is not big enough to become a prey for hackers and that is why the number of hacking attacks is relatively low. As Blockchain's code is written by humans, it is quite easy to include several mistakes (bugs) which cannot change when the platform is published. This fact makes hackers capable of tampering with data stored in the chain. Likewise, asymmetric cryptography of Blockchain renders transactions and wallet management very secure, however, at the same time if a user loses the password of his private of public key then he loses his assets too and this is repelling many individuals from trying to logging in Blockchain.

Cryptocurrencies' value volatility can absorb all the money a user has invested because cryptocurrencies' market is the ideal place for speculators who desire quick earnings from currency exchange. This is one of the main reasons why individuals do not convert their dollars or euros to Bitcoins (BTC) and this is an obstacle that Blockchain community should address first and then solve. Price fluctuation deters also professionals from accepting cryptocurrencies as a means of transaction because in the case of a double-spending problem the one with the highest risk rate is the seller who should wait for one hour to be sure the transaction was safe. This slow verification procedure has to be reduced to render Blockchain a mainstream transaction platform. In addition to that, cryptocurrencies are not considered as legal tenders by the majority of the world's High Courts because they deal with them as securities instead of currencies.

Cryptocurrency exchanges frauds have already happened as we mention in previous chapters either due to hacking cyberattacks or because of entrepreneurs who are looking for rich or hype-dragged investors in order to literally steal their money. Following the general hype following a new cryptocurrency is acceptable if we are looking to get involved in the relevant market for the first time, however, hype is created most of the times by all those speculators who are boosting a cryptocurrency's value in high levels just to maximize their profits. It is worth mentioning that entering the cryptocurrency world is relatively easy as liquefying cryptocurrencies is far harder. The reason is the same as hoarding money is easy while obtaining money back at once is almost impossible. The truth is that cryptocurrency-related companies are using fiat currencies to pay for better

equipment and its maintenance. However, this fact does not seem to count for customers who are willing to opt out at any moment when they observe that a drop of price is coming.

While cryptocurrencies are boosted due to rumors and general hype, they can also plummet for the same reasons. This is a phenomenon observed in traditional stock exchanges too where a rumor can bring down the value of a single stock immediately. For that logic, an investor should never spend money on cryptocurrencies that he is not ready to lose. This is a general advice for everyone willing to participate in markets with a high risk level. The only manner to safeguard some of our loss is to be adequately informed about cryptocurrency market and be careful of certain patterns which could alert us about an upcoming crisis. A solution for such an issue could be the entering of institutional investors in the relevant market in order to create an investing environment more stable with less possibilities of being attacked by speculators.

Additionally, the lack of a competent legal framework which could set certain boundaries on the way cryptocurrencies are exchanged of created. In this manner, both miners and investors would be sure that there is a safety net that is capable of discouraging speculation attacks and fraudulent practices form the part of cryptocurrency companies. The good news have multiplied in the last months as many developed countries and international organizations are legislating towards adoption facilitation. However, many steps have to be taken in order for the cryptocurrencies to become mainstream and useful in the real life. For example, the fact that cryptocurrency mining is too energy-demanding due to its Proof-of-Work protocol is a major issue for countries where the price of kWh is relatively high than in developing countries like China. This is not applied to all cryptocurrencies as a respectable amount of them run of other types of protocols.

Lastly, many academics and professionals assume that cryptocurrencies' technology is developing in a rhythm much faster than the average people who need time to sufficiently understand the potentials and the rationale behind it. When cryptocurrencies change so fast, only experts can be informed so that they can participate in the relevant market by fully understanding the rules it includes and follow them responsibly. Long-term experience is difficult to possess as cryptocurrencies have been introduced to the public in the last 3 years. Notwithstanding, the technology behind them is really complicated and for that

reason investors of high expertise benefit more than simple owners of cryptocurrencies.

The challenges that Artificial Intelligence can entail in the energy sector are mainly focused on technology and ethics. More precisely, one major issue addressed by AI's critics is the high level of cyberattacking by hackers as super-computers can become an easy target for terrorists willing to damage a natural gas pipeline. Digitalization of Energy bears both advantages and disadvantages. It facilitates certain procedures but at the same time it can become a point of failure for the system. This can happens because Artificial Intelligence does not operate on decentralized platforms but on the Internet as we know it now. Centralization includes the high risk of being attacked and for that reason researchers are not incorporating AI for general use but for certain experiments of machine testing.

Another issue of Artificial Intelligence is the unemployment it can cause as a super-computer can replace several employees who assess data and need much more time to conduct every single task. It is of vital importance for the regulators and governments to deal with AI as a tool for further economic and technological growth. Nevertheless, its supporters claim that the jobs lost from Artificial Intelligence will be overshadowed by the large number of professionals needed to control and assess data of super-computers. This is mainly an ethics issue as we should find a solution in order to safeguard all those professionals who will lose their jobs and try to exploit their know-how so as to aid Artificial Intelligence. However, it is a technological problem at the same time as we can identify a dilemma of whether we should use AI in its full capacity or upgrade super-computers to a certain point that can be totally controlled. There are many philosophers claiming that the moment we offer consciousness to a machine we should consider it a human being under the prism of sociology. The point from which a robot running on AI is becoming a servant for humans is vague at the moment and it is not going to be solved any time soon.

We, the ordinary people, tend to underestimate the significance of Artificial Intelligence. For example, we consider super-computers as simple computers which can solve mathematical equations really fast. AI's potential is greater as smart meters can reduce electricity prices or prolong the life of an electrical device in our household. Maybe the fact that Artificial Intelligence has not yet become widely known about its current achievements has led us all believe that its contribution is inconsiderable. What we should do in order to change that mentality is to accept

change and try to search and inform ourselves about what we can do to facilitate Artificial Intelligence's integration in our everyday life.

Artificial Intelligence has divided governments, scientists, religions and basically every society in the world. The rhetoric and the arguments accompanying the debate remind us the tensions prevailing about nuclear energy. Supporters of Artificial Intelligence from the one side and disputants of from the other side all originating from different socioeconomic backgrounds. Nonetheless, the assertions of both groups cannot be bridged by a proposal promising the right balance between the adoption of Artificial Intelligence and the rejection of it. For that reason, a list of the major benefits and drawbacks of AI is following in order to illustrate better the greater image of this technology.

What will be the future of modern technologies in the Energy sector?

One of the main developments in the Energy sector will be the interoperability of multiple Blockchain platforms. The level of standardization however, is not clear yet because it depends on many other factors such as legal frameworks, regulator's willingness to facilitate decentralization, financial obstacles and Blockchain's scalability challenges. The only possible remedy to the problem of delayed application in wider use is eventually the cooperation between energy companies in order to be the ones which will create the status quo of the new innovative future and will set the base on which the regulators will legislate. For that reason, it is a great opportunity for energy companies to speed up and proceed to the formulation of a new energy market which embraces the decentralization technology. The cooperation standards will be agreed in advance by every participant so as to avoid misunderstandings which could erode the momentum of Blockchain.

The sectors mainly under consideration will be identity verification, payment methods and security measures as more and more technology enterprises invest in Blockchain. Secure transactions, identity protection and facilitation of use through encryption should be addressed as the components of great significance for the upgrade of energy markets. For example, the abolition of Proof-of-Work by many Blockchain platforms as a non-eco-friendly and quite expensive means of tackling the Byzantine Generals Problem is considered a first step towards further optimization of decentralized technology. Embracing more practical solutions instead of cost-demanding and power-demanding tools will reduce ultimately the price of a company's product or service.

European utility companies have claimed that in the next years they will adopt Blockchain technology in order to rationalize network operation by encouraging smart grids where possible and the use of smart contracts as a means of transaction and power consumption identification. The next goals of leading energy companies is to increase the percentage of electric mobility at least in the developed world where it is more feasible to happen and renewable power origin certificates which will concern electricity prosumers who trade their power excess with their neighbors. On the other hand, as soon as the operating cost of renewable energy sources becomes less expansive, major energy companies will adopt them in order to diversify their portfolio. Network management is far enough at this moment as the entering of multiple TSOs and DSOs is not possible but with the application of smart grids the regulators will take into consideration the further liberalization of those two energy markets.

The standardization of P2P energy trading schemes will be delayed as people do not seem to appreciate the benefits of modern technologies mainly due to the high cost to acquire and maintain the necessary equipment. Most likely to happen is the combination of successful and innovative applications based on Blockchain technology with existing solution proposals like those mentioned before (electric mobility, renewable power origin certificates and network management). The supporters of Blockchain technology who are hoping for the total radicalization of energy markets should bear in mind that radicalization comes with a high cost of changing every sector or energy generation, transmission and trading and no company will ever agree on such a proposal.

The use of cryptocurrencies and tokens in the energy sector will be on the rise in the next years as asset tokenization is offering great potentials for the future. Energy trading can be facilitated as smart contracts permit the exchange of tokens (tokenized electricity and tokenized fiat currencies). Security Token Offerings (STO) will be multiplied in the near future even though there is a major disadvantage concerning the inadequate legal framework which considers security tokens as securities and not as assets like bonds and shares of a company. Furthermore, the trading of cryptocurrencies as in exchanges as if they were fiat currencies can create profits for potential investors. Right now it has become a really attractive environment for funds willing to invest in digital currencies because of their value fluctuation which entails a high risk which equals high profit level.

The next application potential of cryptocurrencies in energy sector is related to an opportunity concerning Blockchain's smart contracts which will run on a certain protocol permitting energy dealing in exchange for digital currencies. Even though cryptocurrencies are not yet utilized widely by the majority of people, the fact that new start-ups are created every day contributes to the further research of their potentials while offering thousands of jobs in a totally new market. Local smart grids, in which energy trading is happening in exchange for cryptocurrencies, can gain a greater share in the electricity market and stabilize local energy markets. This occurs mainly because smart contracts eliminate the possibility of debts within users and adjusts energy supply and demand according to users' needs.

Artificial Intelligence's potential in the energy sector is mainly focused on the emerging role of "data mining" and "deep learning". Prediction programs which can deliver, based on patterns observed by the machine running on AI, possible blackouts in electricity networks or a leak of a natural gas pipeline. The need for cheap and clean energy is vital for two basic reasons. First, cheap energy will reduce the prices of almost every product or service provided especially in the developed countries where the electricity prices are relatively higher than in countries like China or Iran. Cheaper energy would equal to more attractive conditions for cryptocurrency mining and facilitation for electrical vehicles use. Second, cleaner energy can be achieved through accident prevention through the use of smart meters and other devices which can predict dangerous situations on the grid. Cheaper and cleaner energy are two communicating vessels which fulfill the same purpose of Artificial Intelligence implementation in the energy sector which is the rationalization of used power by balancing supply and demand according to the network's condition.

It is worth mentioning that people should adopt a more eco-friendly attitude concerning energy consumption in order for Artificial Intelligence to achieve its goal. Consumers can install smart meters and thermostats which provide feedback about energy consumption of a building. The purpose of smart meters is to make people understand that they can minimize their energy consumption so as to pay less for power. Households and businesses can benefit from such an implementation which can save a lot of money. This fact will ultimately reduce the price of kWh as less energy is generated by utility companies.

Last but not least, renewable energy sources can benefit from Artificial Intelligence as solar panels and wind turbines can easily be controlled through the

Internet by a computer operating on AI. Until now, many professionals of energy sector believed that renewable energy is too expensive to massively deploy but with the almost infallible potentials of Artificial Intelligence, renewable energy can become standardized in the short-run. Searching for patterns is data is a task that can be conducted by machines with by far better results. That is why deep learning is so necessary in statistics' sector. Artificial Intelligence can assist people with their everyday problems by offering valuable information to both producers and consumers of energy.

To sum up, modern technological achievements have multiple potentials in order to facilitate and rationalize energy production, transmission and consumption. Their adoption by the majority of consumers and by the large-scale energy companies is related to multiple factors (financial, legal and technological). The revocation of centralized structures concerning energy sector has rendered crucial the fact that Blockchain technology should be in the first row of technological developments of the future. Such decentralizing technologies promise better, faster and cheaper transactions while users gain more control over their information and assets. The use of cryptocurrencies though underlines the necessity to digitalize a sector which needs automation in order to become more competitive for its participants. Artificial Intelligence can cover all innovative ideas and provide information about identified patterns in them. It is interesting enough to see what next years can bring for those modern technologies as technological developments are so rapid that we have to adjust and exploit the means we possess in order to facilitate our energy utilization.

REFERENCES

Website Sources

Augur. (2018). *The Future of Forecasting*. Available at: https://www.augur.net/

Bironneau, M. (2017). *How AI is shaping the future of energy*. [online] Power Responsive. Available at: http://powerresponsive.com/ai-shaping-future-energy/. [Accessed 19 June 2017].

Blockchain Technologies Website. (2018), Available at: www.blockchaintechnologies.com

CoinSutra. (2018). *A Comprehensive Beginner's Guide to Factom Cryptocurrency*. Available at: https://coinsutra.com/factom-cryptocurrency-fct/

CoinSutra. (2018). *Golem – A Decentralized Sharing Economy Of Computing Resources*. Available at: https://coinsutra.com/golem-decentralized-sharing-economy-computing-resources/

Energy Premier. (2018). *How it Works*. [online] Energy Premier. Available at: https://energypremier.com/en [Accessed 19 November 2018].

GitHub.com. (2018). *What is Proof of Stake*. Available at: https://github.com/ethereum/wiki/wiki/Proof-of-Stake-FAQs#what-is-proof-of-stake

Kuttruf, S. (2018). *A Machine Learning framework for Algorithmic trading on Energy markets*. [online] Medium, Towards Data Science. Available at: https://towardsdatascience.com/https-medium-com-skuttruf-machine-learning-in-finance-algorithmic-trading-on-energy-markets-cb68f7471475. [Accessed 16 July 2018].

Medium Website. (2018), Available at: www.medium.com

Open Energi. (2018). *Case Studies*. [online] Open Energi. Available at: http://www.openenergi.com/case-studies/. [Accessed 23 February 2018].

Sennaar, K. (2017). *Artificial Intelligence in Oil and Gas – Comparing the Applications of 5 Oil Giants*. [online] Techemerge. Available at: https://www.techemergence.com/artificial-intelligence-in-oil-and-gas/. [Accessed 22 August 2017].

Shead, S. (2017). *Google's Deepmind wants to cut 10% off the entire UK's energy bill*. [online] Business Insider UK. Available at: http://uk.businessinsider.com/google-deepmind-wants-to-cut-ten-percent-off-entire-uk-energy-bill-using-artificial-intelligence-2017-3 [Accessed 13 May 2017].

SolarCoin, (2018). *Introducing SolarCoin*, Available at: https://solarcoin.org/

Books & Papers

4NEW, (2017). *Introducing the KWATT Coin – Tokenized Electricity White Paper*.

Bambara, J. J. and Allen R. P. (2018). *A practical Guide to Developing Business, Law and Technology Solutions*. McGraw-Hill Education.

Berentsen, A. & Schär, F., (2018). *A Short Introduction to the World of Cryptocurrencies*. Federal Reserve Bank of St. Louis Review.

Casey, M. J., Vigna, P. (2018). *The Truth Machine – The Blockchain and the Future of Everything*. St. Martin's Press.

Crosby, M., Nachiappan., Pattanayak, P., Verma, S., Kalyanaraman V. (2015). *BlockChain Technology - Beyond Bitcoin*. California: Sutardja Center for Entrepreneurship & Technology.

Drescher, D. (2017). *Blockchain Basics - A Non-Technical Introduction in 25 Steps*. Frankfurt: Apress.

Gupta, R., (2017). *Future of Bitcoins – A Study*. Delhi, India: Journal of Internet Banking and Commerce.

Hammond, K., (2015). *Practical Artificial Intelligence for Dummies*. New Jersey: Narrative Science Edition.

Hurwitz, J. & Kirsch, D. (2018). *Machine Learning for Dummies*. New Jersey: IBM Limited Edition.

Kizer, A., Hezir, J,. Kenderdine, M., & Savitz. S, (2018). *Can Blockchain Enable Faster, Cheaper, and More Secure Energy Services?*. The ICER Chronicle, Edition 9.

Marr, B., (2017). *Beyond the Big Data Buzz – How Data is Disrupting Business in Every Industry in the World*. KoganPage.

Puthal, D., Malik, N., Mohanty, S. P., Kougianos, E., Yang, C. (2018). *The Blockchain as a Decentralized Security Framework*. [pdf] Future Directions, page 3. Available at: https://www.researchgate.net/publication/323491592_The_Blockchain_as_a_Decentralized_Security_Framework_Future_Directions [Accessed 9 March 2018].

Robotina, (2018). *Internet of Things, Artificial Intelligence and Blockchain Empowering Energy Consumers*. Robotina ICO Light Paper.