Introduction:

The topic of my research is on "The Energy consumption challenge of crypto-mining". The main things that I will discuss are the efficiencies of mining, the challenges it brings to the environment, and how it is possible to improve the efficiency of the mining. My sources were obtained through a combination of the IEEE Xplore and Science Direct. They were chosen through an analysis of the abstract then, if deemed relevant to the topic, were further reviewed.

Improving the efficiencies of cryptocurrency mining:

Pavel V. Sukharev starts off by giving a brief overview of why he is interested in crypto mining. The currency being studied in this case is ethereum(the second most popular currency to mine). Defining the term "efficiency" is important here and is defined as: the count of correctly calculated actual values of ethash function per unit of power consumed by the PC ($(hashrate\ +\ (1\ -\ lost))\ \div\ the\ power\ consumed$). Three hardware focused methods are then used - memory overclocking, core overclocking, and GPU(graphics processing unit) undervolting. The first method, memory overclocking, can be very effective however this method does increase errors which in turn decreases efficiency. Core overclocking also is effective but increases power consumed by the GPU. The third method, GPU undervolting, can lead to stability issues. So, the key to maximizing efficiency is through trying to balance all three techniques without accumulating too many errors or drawing too much power. In order to achieve this, 2 of the variables are held constant while the third is tested through a series of tests. The tests are conducted by gradually increasing the clock rates, in order to increase hashrate, when overclocking. When undervolting, Pavel V. Sukharev gradually decreases the voltage to decrease the overall power draw. In the end the conclusion was that with his AMD Radeon RX570 he got a significant 73% mining efficiency increase through these methods mentioned. This is an important finding to know that these things are worth considering when wanting to increase the efficiency of mining for ethereum. Also, it is important to note that these findings will not be true for every graphics card due to the "silicon lottery" and the fact that certain gpus are made better than others.

Energy consumption:

Rusovs et al. analyze the fast growing mining industry and consider it an opportunity for renewable energy sources. Bitcoin mining at the end of 2017 reached global annual electrical energy consumption 30.2 TWh (terawatt-hours) and has grown tremendously since then. About half of the energy Mining goes into heat and every mine is responsible for 8,000- 13,000 kg of Co2 emission per each bitcoin. This is why earlier the topic of mining efficiency is so important because the more efficient mining farms are the less toll it will have on our environment. The cost of producing bitcoin depends on rig efficiency. But by using the entire community, the study finds a daily world hash rate. Then using this hash rate it is possible to estimate daily energy

consumption that is used to make bitcoin through blockchain.com. Since this 2018 study, popularity has surged but this same strategy can be used today to learn how much energy is consumed by this industry. Knowing all of these facts Dmitrijs Rusovs goes on to try and find a levelized cost of energy to estimate renewable energy efficiency in comparison with conventionally generated energy. Concluding that renewable energy can actually be a cost effective alternative.

Gundaboina et al. take 9 different types of cryptocurrencies and 10 different algorithms in order to take a look at mining effectiveness. Normally electricity demand studies are done purely off of bitcoin; however, all of the other currencies can not be ignored. These other currencies account for ⅓ of the total energy used for mining. Also, most of all of the energy estimations for cryptocurrencies are based on assumptions. So in this study the authors choose to evaluate dogecoin, a very rapidly growing cryptocurrency that is hard to track. Because currencies like this exist, there is a need for a way for better tracking of them in order to know how much they actually affect the environment. The article discusses how all energy forecasts are subject to uncertainties and underlying assumptions due to the many different techniques and different equipment that can be used. Using this as a basis, it is understood that most estimates can be considered not accurate. Still however, it is worth mentioning the energy consumption is so high that the environment does suffer.

Jingming Li et al. begin by discussing key terms in crypto in order to gain an understanding of how they work. This study on monero(an open-source cryptocurrency that focuses on privacy, security, and decentralization) is done to try and estimate crypto energy consumption. Monero is chosen because it is still mineable and also due to the fact that there is an available database for it. By using 5 different computers, data from a machine learning application, and data from a monero database the total energy use from 3 main countries was estimated to be 645.62 GWh in 2018. Monero mining may result in at least 19.12–19.42 thousand tons of carbon dioxide in 2018. However, like the previous study discussed, these numbers are gross estimations due to the wide variety of systems deployed and the use of encryption some miners use. So, more studies with larger sample sizes should be carried out on energy consumption from cryptocurrency mining.

Conclusion:

The findings in this literature review are that crypto mining can be improved and measured locally but it is almost impossible to accurately measure global effects of this industry. With 2 sources giving drastically different values it can be concluded that more research needs to be done and for us to really know how much power this industry consumes. For improvements in data collection, miners could unanimously report their data. researchers can then learn just how much of an effect this industry has on the environment.

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