INVESTIGATING ENERGY CONSUMPTION OF CRYPTOCURRENCIES

An overview by:

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CONTEXT

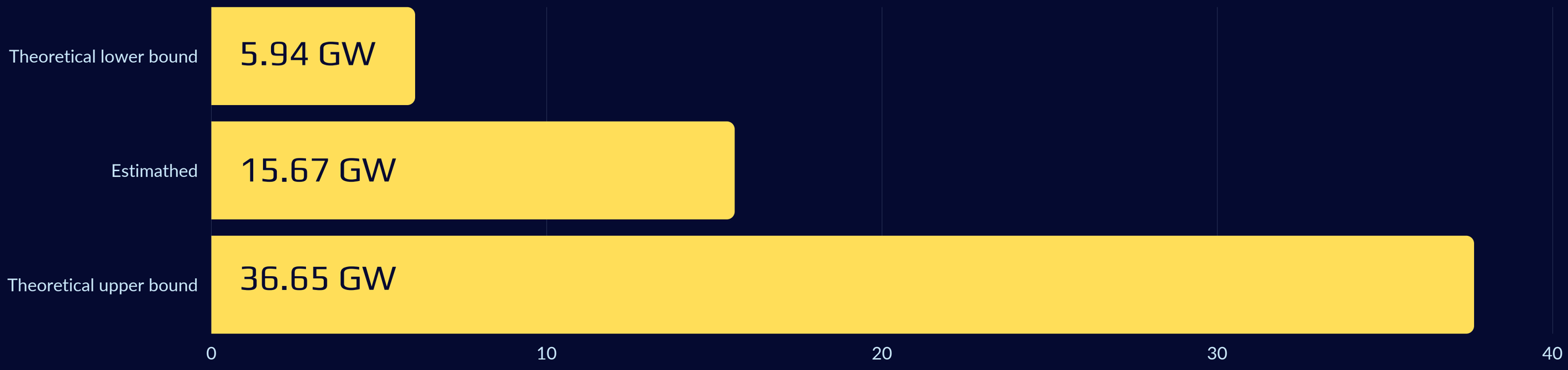
Cryptocurrencies have the potential to improve our daily lives in many ways, as the technology behind them is based on a ledger that cannot be manipulated. This means, that we don't need a central entity to validate the transactions, making it accessible to everyone and cutting the fees on payments. However, we have to ask ourselves:
"At what price compared to the enviromental footprint we are being given access to these technologies?"

METHOD

This work is based in the first part on a data analysis to compare two different consensus algorithms, namely Proof of Work (PoW) and Proof of Stake (PoS) and their relative energy consumption. In the second part, a Likert scale survey was conducted and i coded a Python script(click the icon above to see the source code) to analyze and highlight the most important aspects of buying cryptocurrencies for different categories of investors.

BITCOIN NETWORK POWER DEMAND

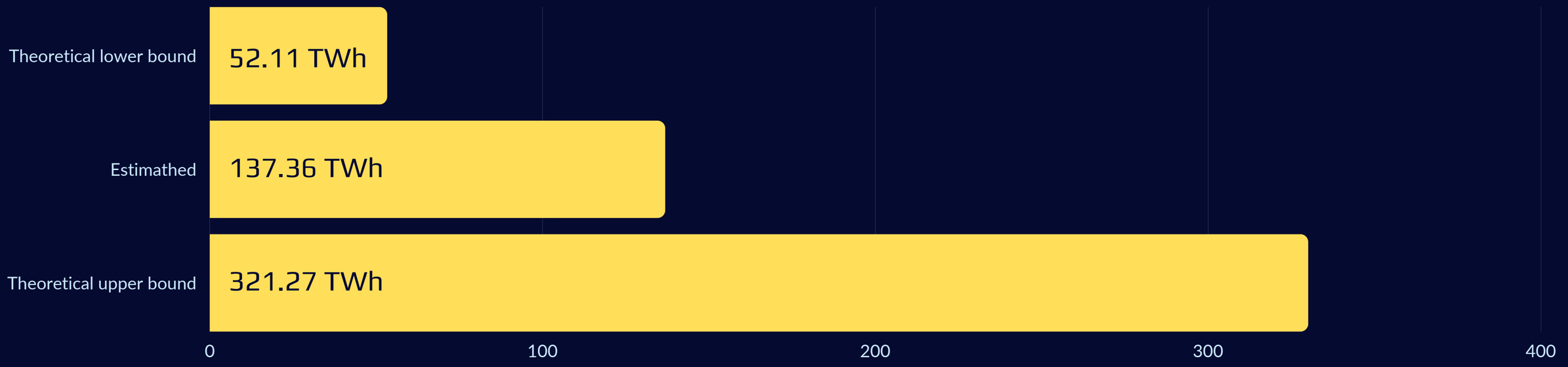
Daily consumption updated to 20/04/2022



* Data provided by the Cambridge Centre for Alternative Finance : https://ccaf.io/cbeci/index

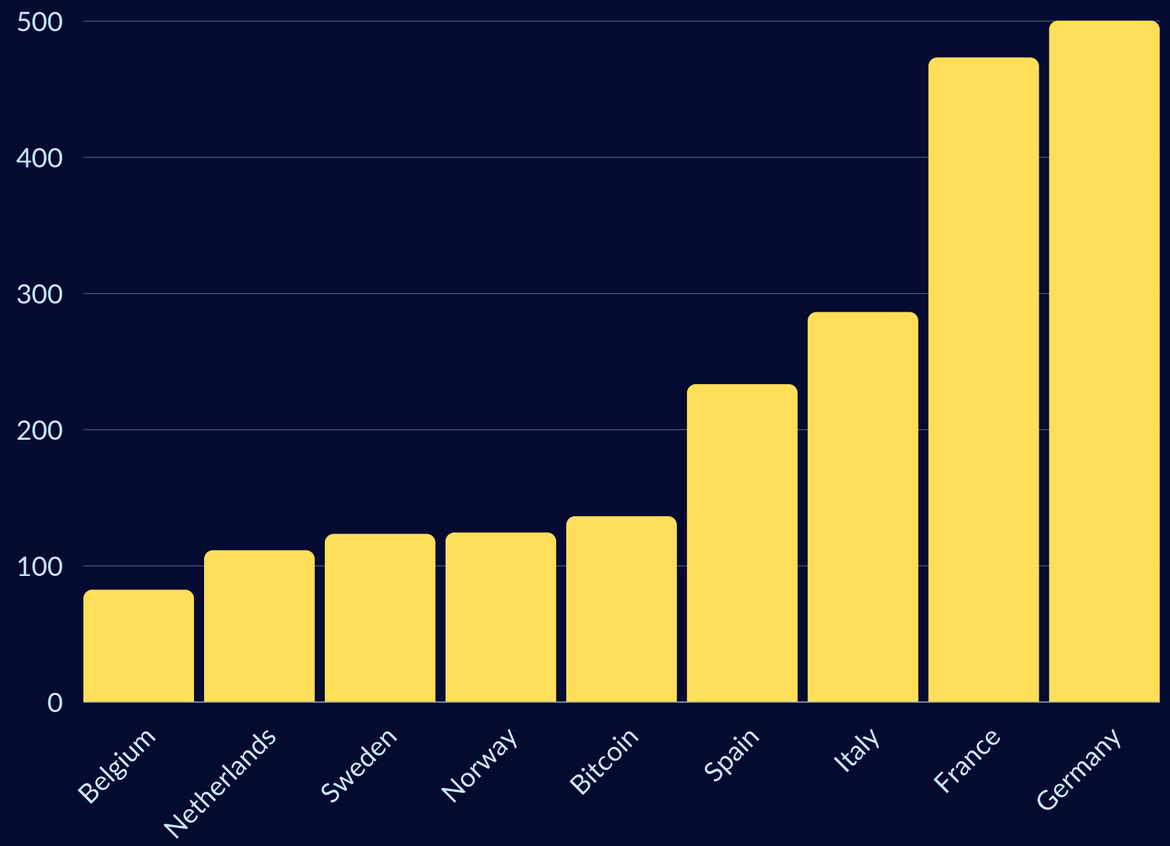
BITCOIN NETWORK POWER DEMAND

Annualised consumption updated to 20/04/2022



* Data provided by the Cambridge Centre for Alternative Finance : https://ccaf.io/cbeci/index

ANNUAL ENERGY CONSUMPTION OF MAJOR EUROPEAN COUNTRIES COMPARED TO BITCOIN

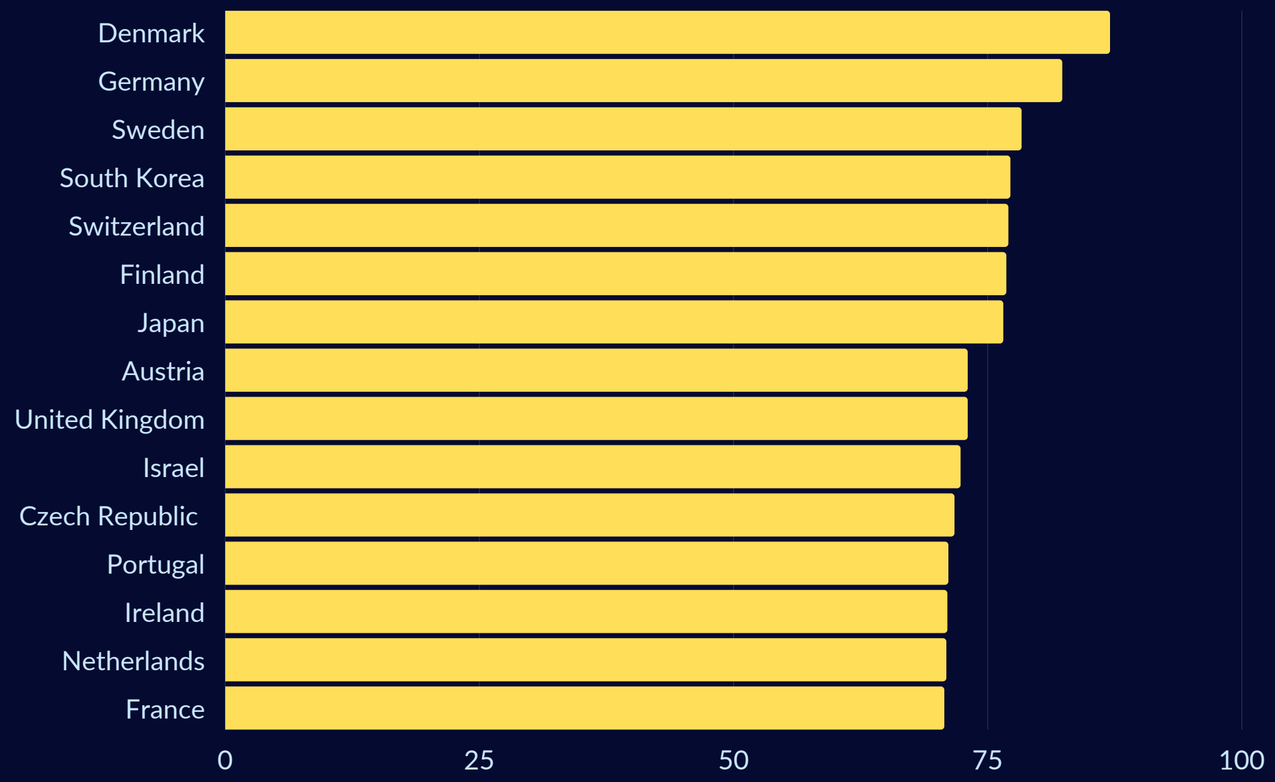


Electricity net consumption espressed in bilion of KWh and related to year 2020

* Data provided by EIA U.S. Energy Information Administration: https://www.eia.gov/international/data/world/electricity/electricity-consumption

IS THIS A PROBLEM?

ANALYSIS OF THE MOST SUSTAINABLE COUNTRIES FOR CRYPTOCURRENCY MINING

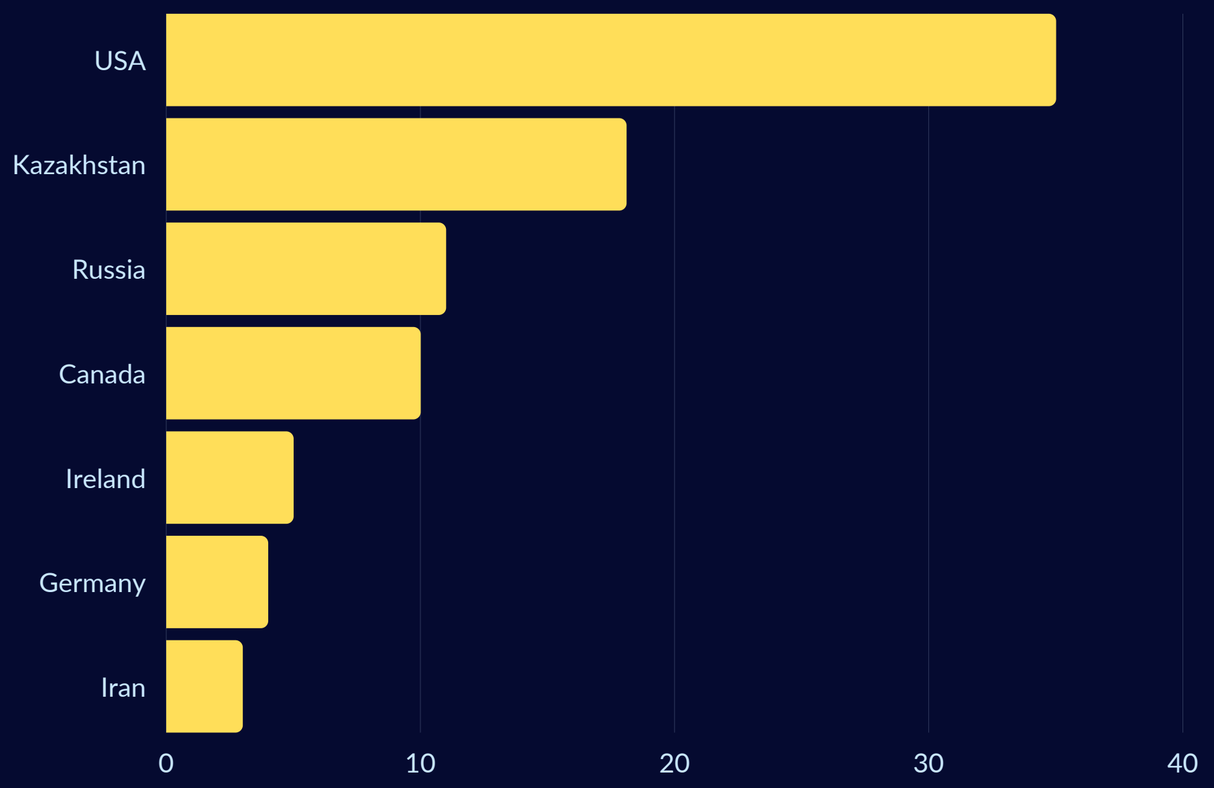


HOW THIS INDEX IS CALCULATED?

- Environmental Performance Index has been used as a starting point, which provides a quantitative basis for comparing, analyzing, and understanding the environmental performance of 180 countries; from the point of view of which is the most sustainable and environmentally friendly
- Electricity price of each country
- Sustainability of the energy that is produced in each country
- Average temperature of the country where cryptocurrency mining is intended to be performed
- Cryptocurrency Mining/Trading Ban
- Human capital index on 0-1 scale

* Data provided by a scientific paper called: "Cryptocurrency Mining fron an economic and Enviromental Perspective. Analysis of the Most and Least Sustainable Countries" by: S.L.N Alnso, Javier Jorge-Vàzquez, Miguel A. E. Fernàndez and Ricardo F. R. Forradellas

ANALYSIS IN PERCENTAGE OF THE TOP COUNTRIES INVOLVED IN BITCOIN MINING



HOW THIS PERCENTAGE IS CALCULATED?

Based on what University of Cambridge says:
"All the information are based on an exclusive sample of geolocational mining facility data collected in partnership with several Bitcoin mining pools."

BTC.com Poolin ViaBTC foundry

Keep in mind that: China officially banned Bitcoin mining, so for this reason it's not on the chart

* Data provided by the Cambridge Centre for Alternative Finance : https://ccaf.io/cbeci/index

E-WASTE PROBLEM

- Much of the e-waste production associated with mining is due to a device called an Application-Specific Integrated Circuit (ASIC), which is an integrated circuit customised for a particular use, rather than being intended to be general-purpose like a GPU
- It is estimated* that during the period from June 2019 to June 2020, 27.1 kilotons of e-waste were generated from them and during the same period, 2.92 million new ASICs were produced.

* Source: "The Ecological Footprint of Blockchain" by: Lukas De Loose

POSSIBLE SOLUTION:
USE CONSENSUS ALGORITHMS OTHER THAN PROOF OF WORK

- In Proof of Work (PoW), also known as “Nakamoto consensus” as the pseudonymous creator of Bitcoin invented it, Distributed Ledger Technology (DLT) participants willing to update the shared ledger need to prove that they performed a certain amount of computational work; they do so by submitting solutions of computationally intensive cryptographic problems and, thus, proving the spending of substantial energy resources.
- In Proof of Stake (PoS), DLT participants willing to update the shared ledger need to prove having a ‘stake’ in the system, meaning to possess a certain quantity of the specific cryptocurrency native to the DLT system itself.
- In Proof of Autorithy (PoA), a subset of participants with a special role in the system act as ‘notaries’; they are the only participants authorized to perform ledger updates employing cryptographic signatures. With PoA, individuals earn the right to become validators, so there is an incentive to retain the position that they have gained. In practice, there are also hybrid models that are partially decentralized.

ANALYSIS OF APPROXIMATE ENERGY CONSUMPTION PER TRANSACTION

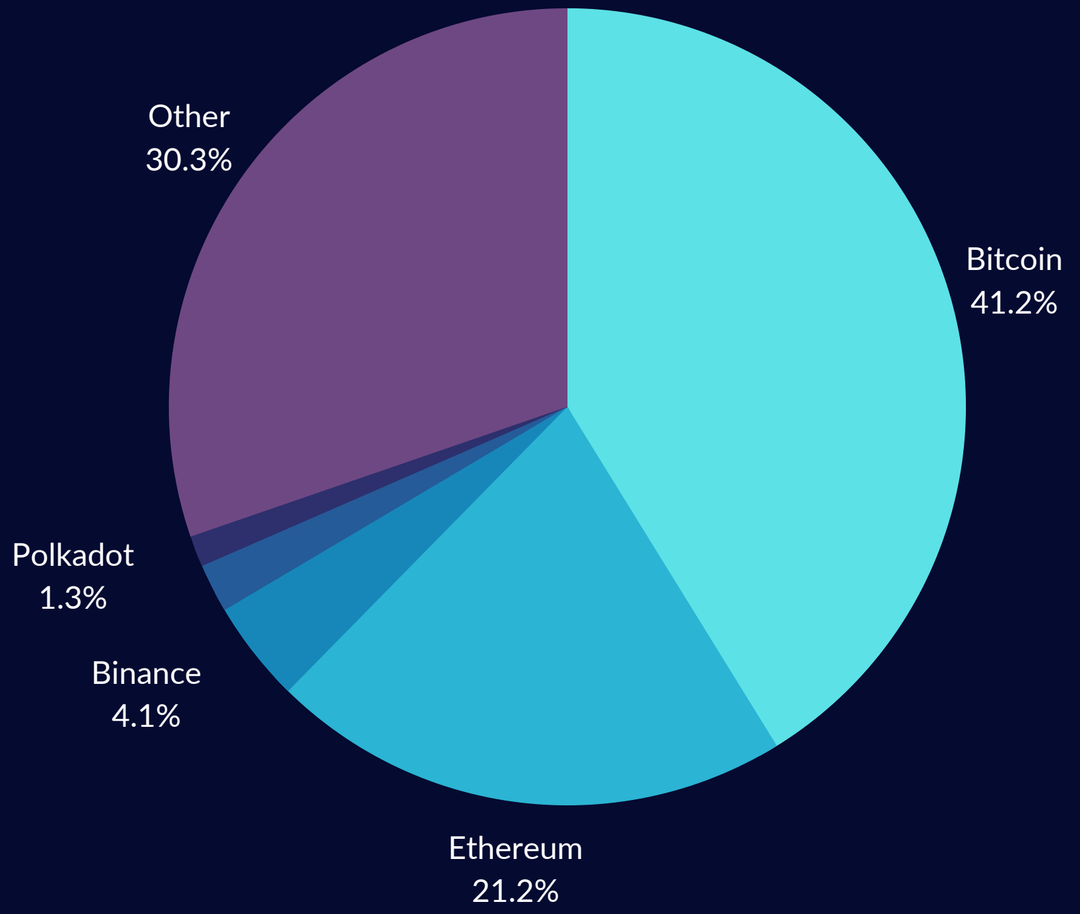
Highly Efficient Centralized System	Traditional Centralized System	Permissioned PoA Blockchain
$5 * 10^{-2}$ J	0.5 J	1 J

Permissionless PoS Blockchain	Permissionless PoW Blockchain
1 kJ	1 GJ

Source: Addressing the Sustainability of Distributed Ledger Technology di Carlo Gola and Johannes Sedlmeir; one Joule corresponds to maintaining a power of 1 Watt for 1 second, i.e., 1 J = 1 Ws.

ANALYSIS OF CRYPTOCURRENCIES MARKET SHARE

Name	PoW protocol	DLT
Bitcoin	Yes	Permissionless
Ethereum	Yes	Permissionless
Binance	No	Permissioned
Cardano	No	Permissionless
Polkadot	No	Permissionless



Source: Coinmarketcap data and market information

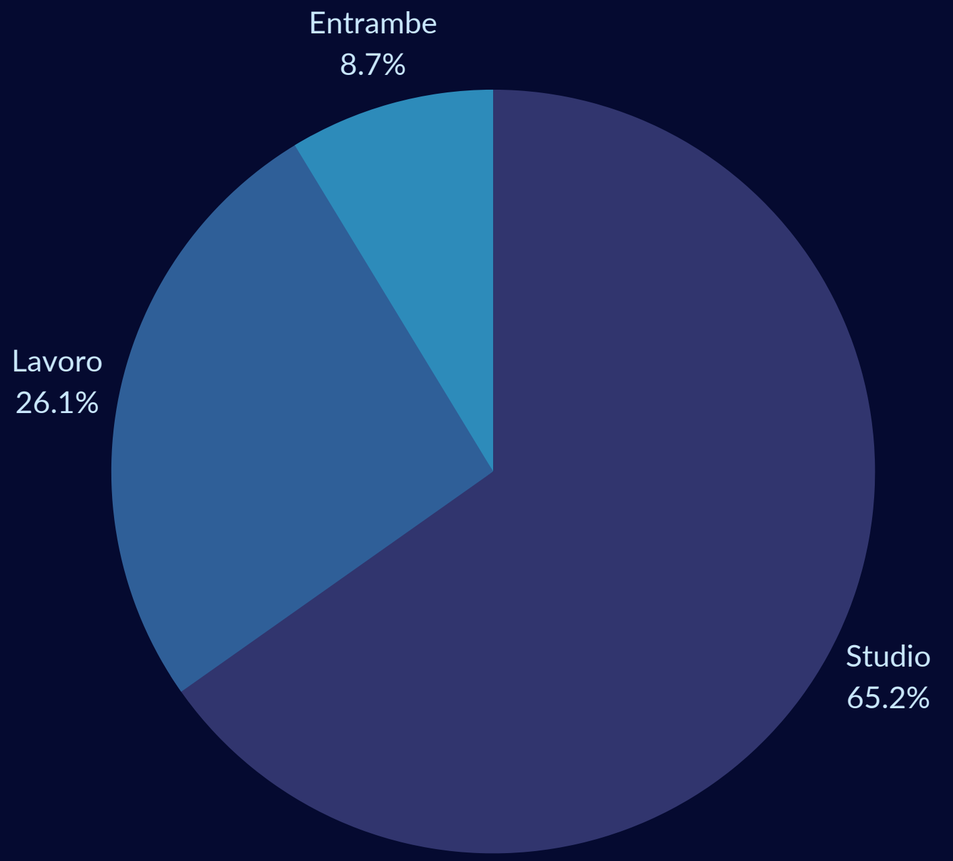
CRITERIA OF THE SURVEY

- Earnings: In which, the importance that is given when purchasing cryptocurrencies, of a possible economic return in the short to medium term is assessed.
- Project: In which, the importance of the mission and vision of the project behind the purchase of cryptocurrencies is assessed.
- Algorithm: In which, the importance placed on the consensus algorithm behind the purchase of cryptocurrencies is assessed.
- Social: In which, we assess the importance given to gathering information from various social and internet sources prior to purchasing cryptocurrencies.
- Influence: In which, one assesses the importance given to influence by other people before buying cryptocurrencies.

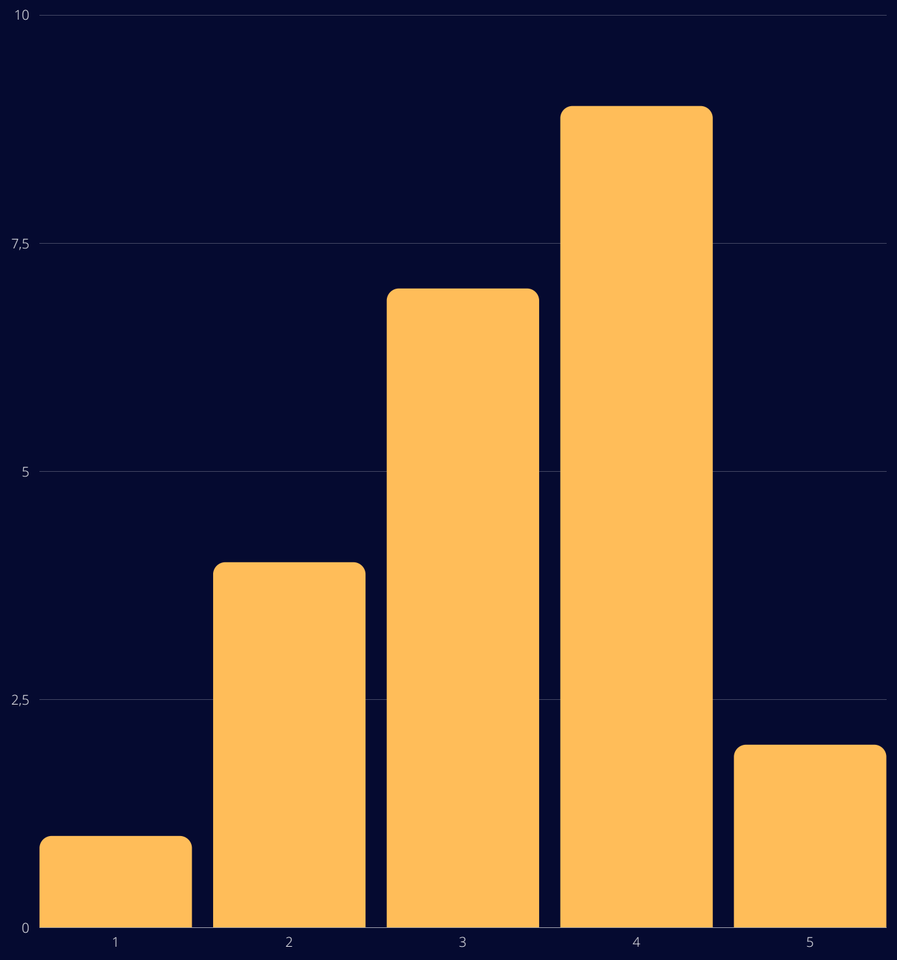
VISUALIZING CATEGORIES OF PEOPLE THAT COMPILED THE SURVEY

23 PEOPLE COMPILED THE SURVEY

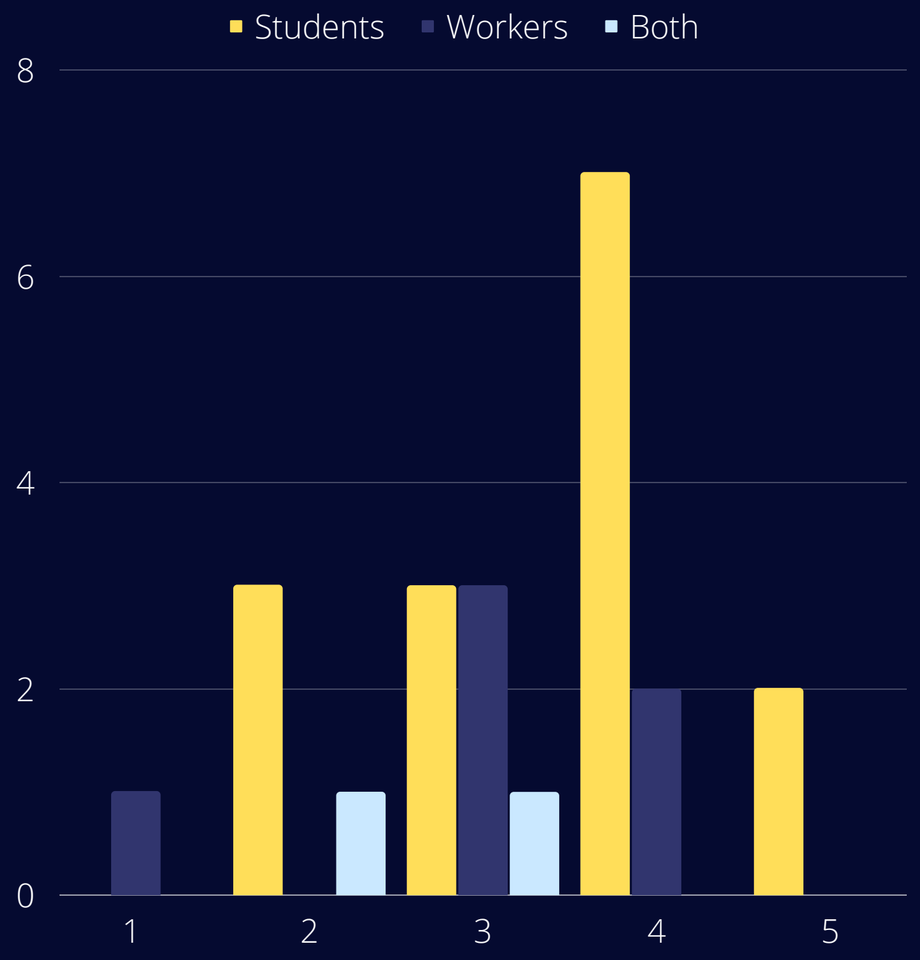
- 15 Students
- 6 Workers
- 2 Both students and workers



EARNINGS RESULTS

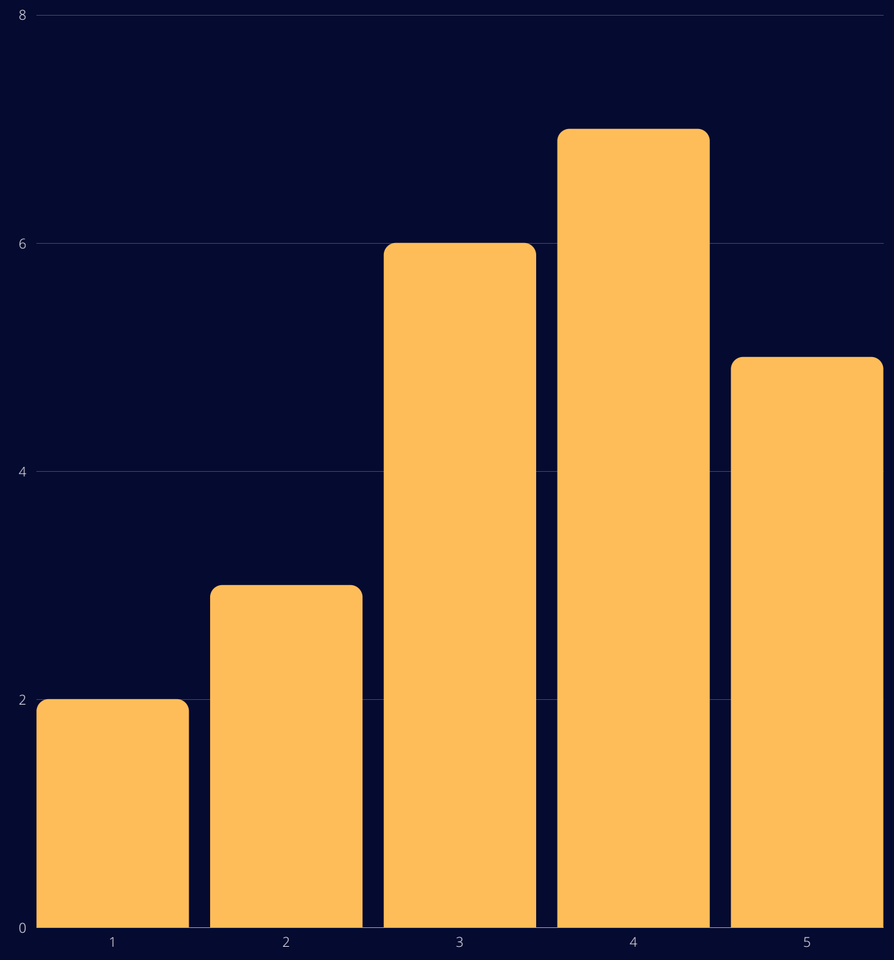


Mean: 3.30 Std: 1.01

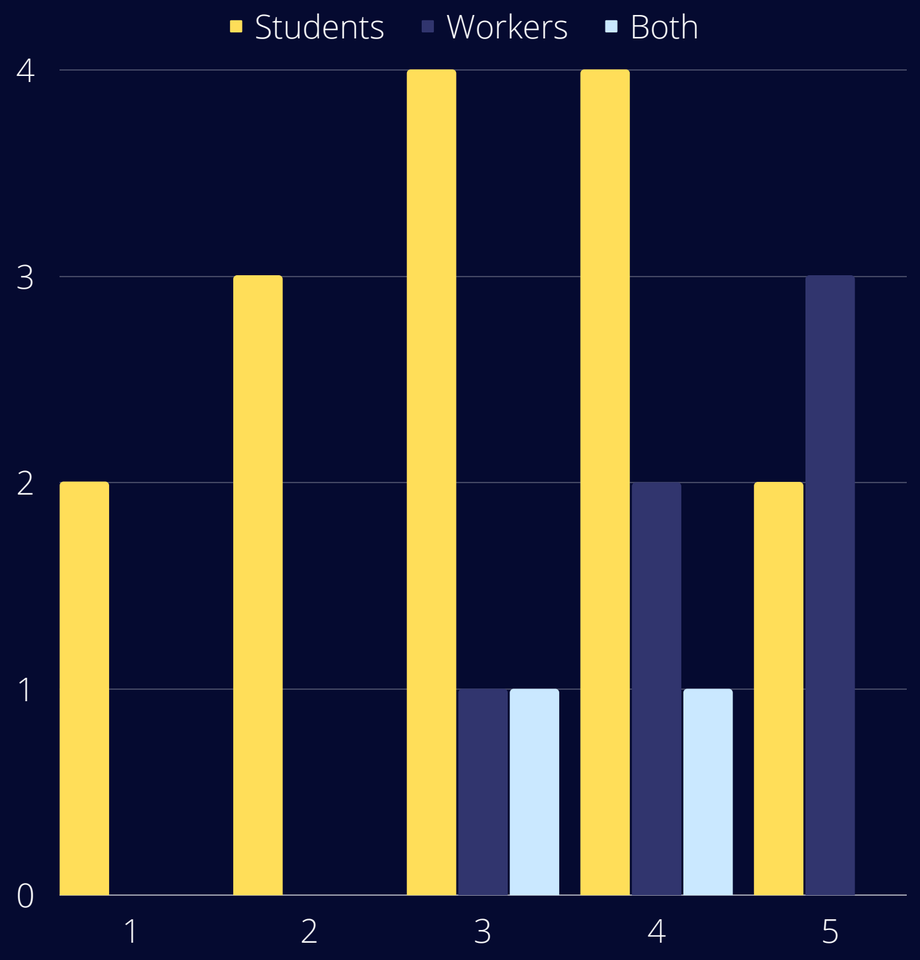


Mean: 3.53/3/2.5

PROJECT RESULTS

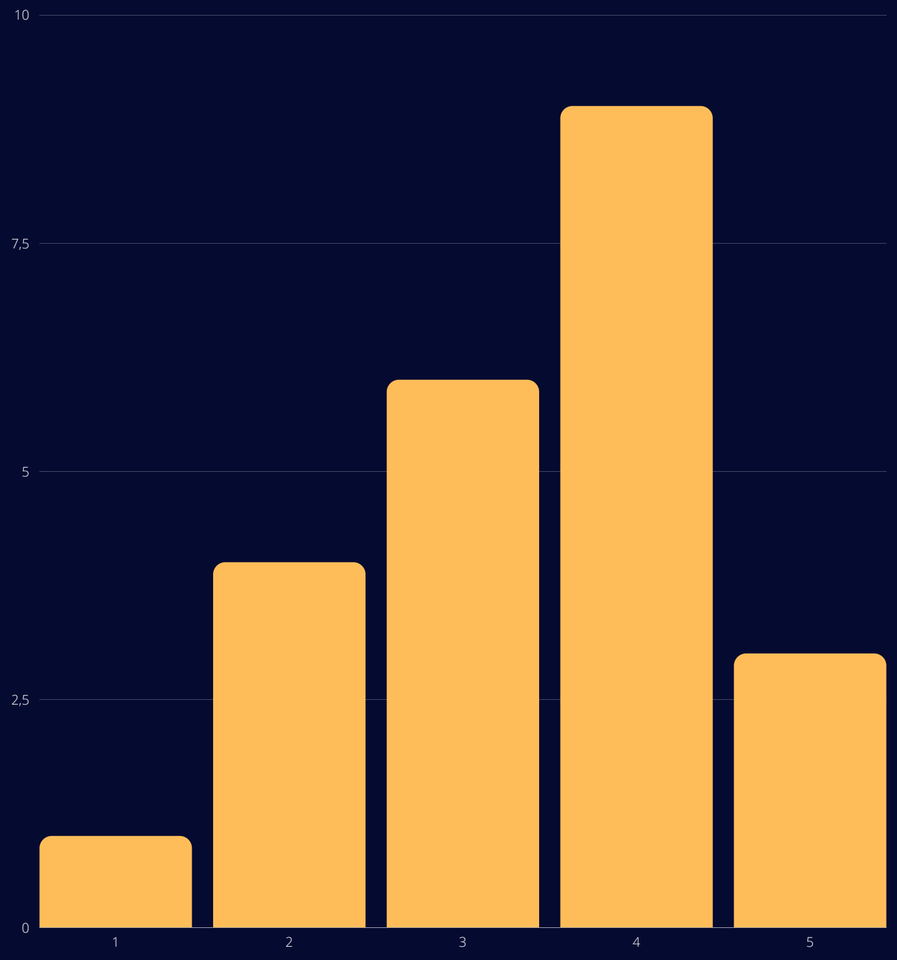


Mean: 3.43 Std: 1.23

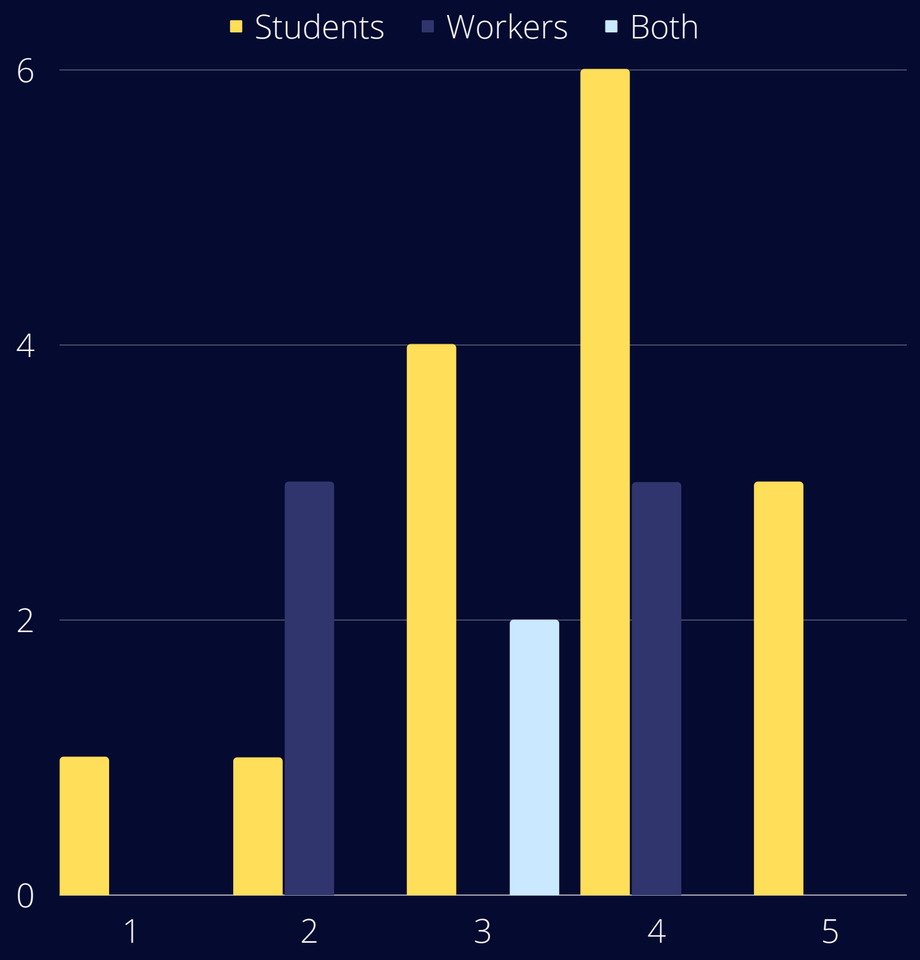


Mean: 3.06/4.33/3.5

ALGORITHM RESULTS

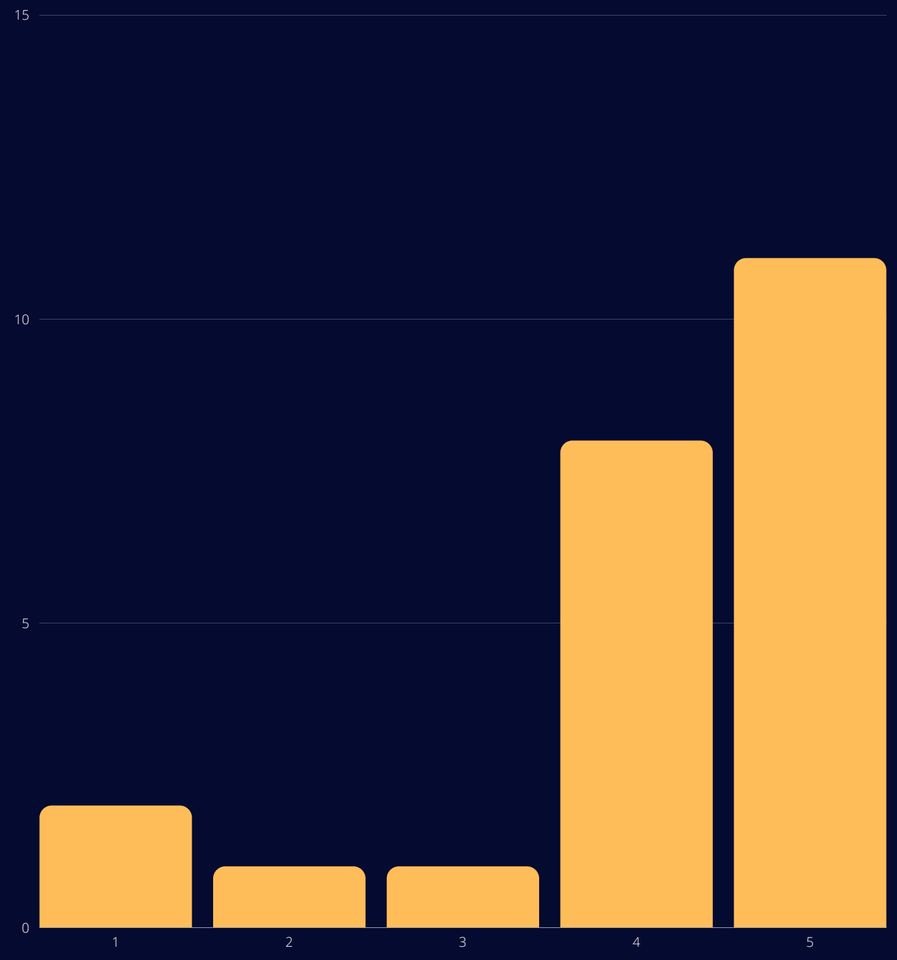


Mean: 3.39 Std: 1.07

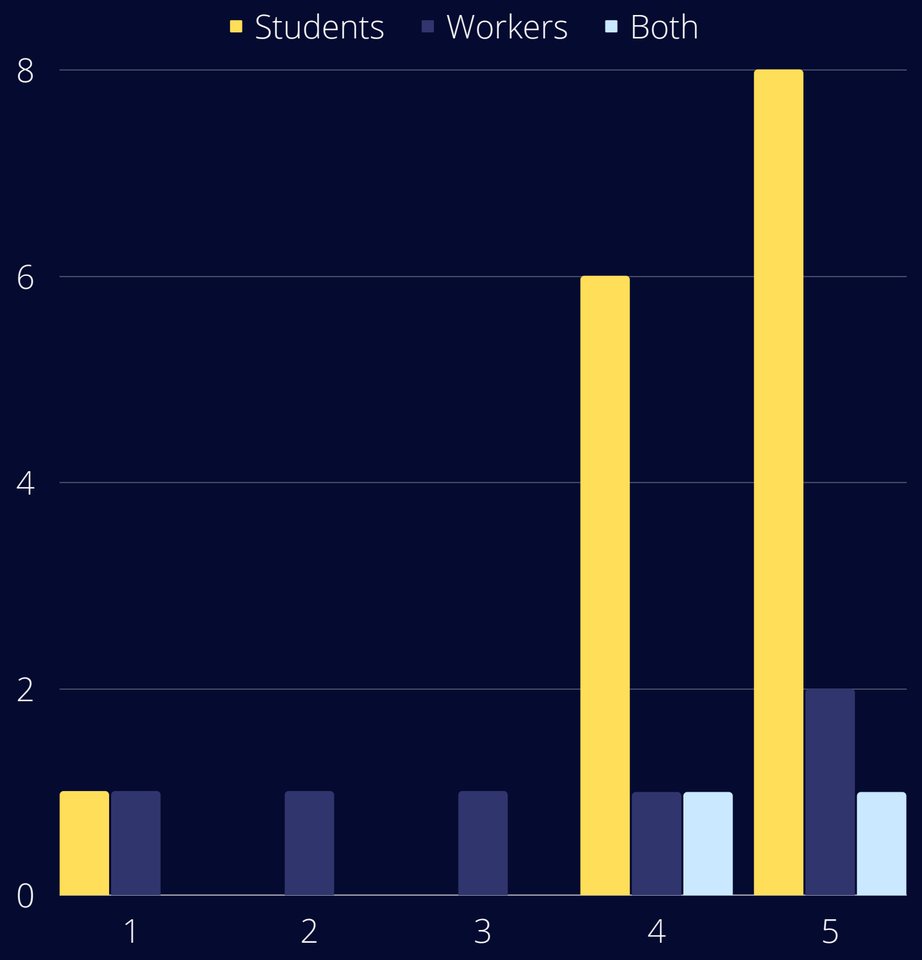


Mean: 3.6/3.0/3.0

SOCIAL RESULTS

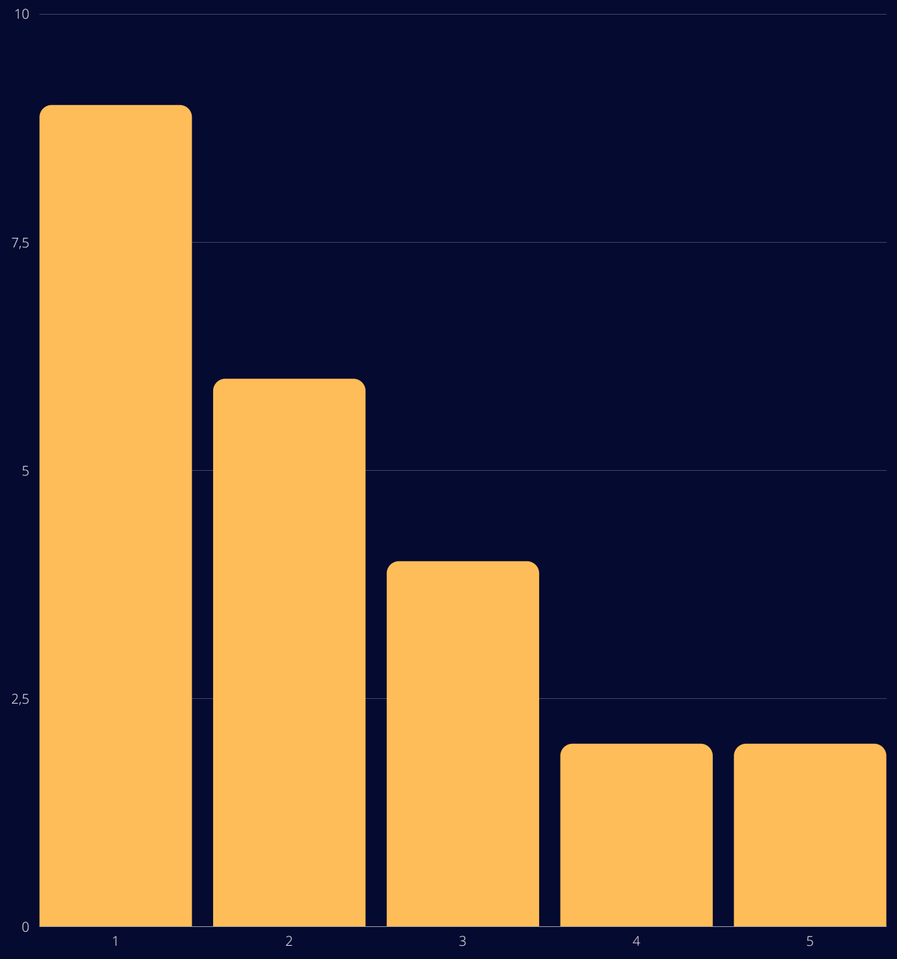


Mean: 4.08 Std: 1.23

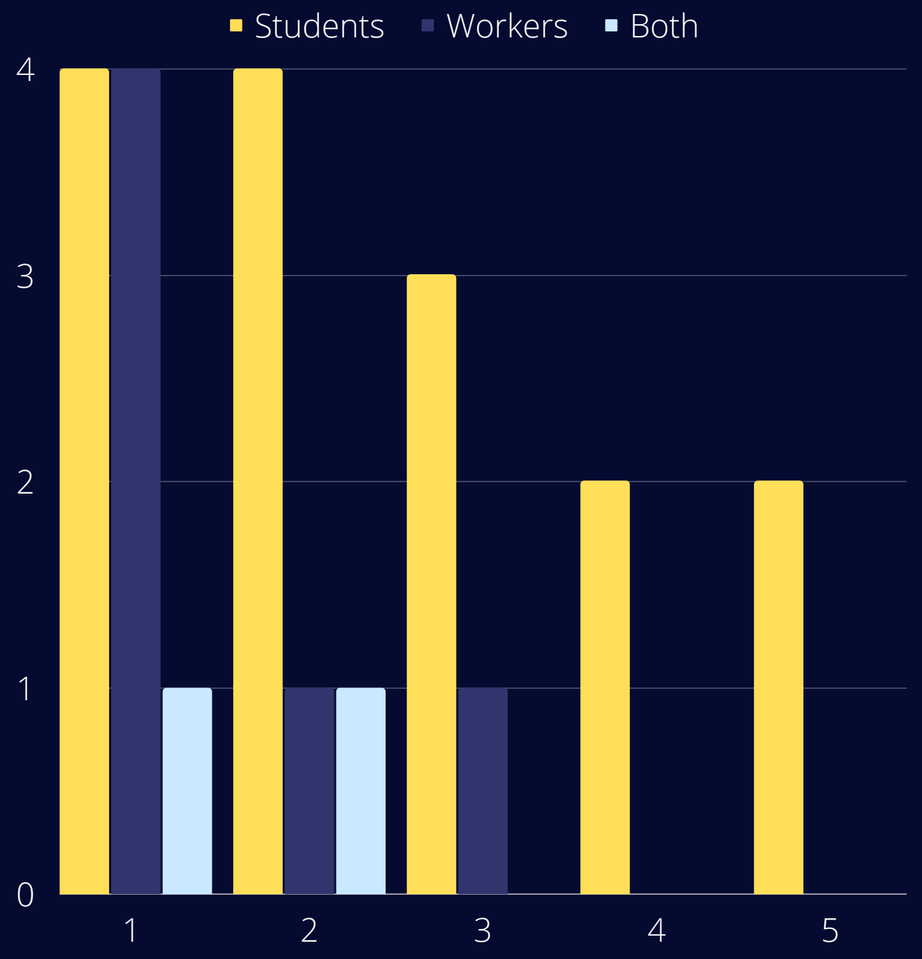


Mean: 4.33/3.33/4.50

INFLUENCE RESULTS



Mean: 2.21 Std: 1.31

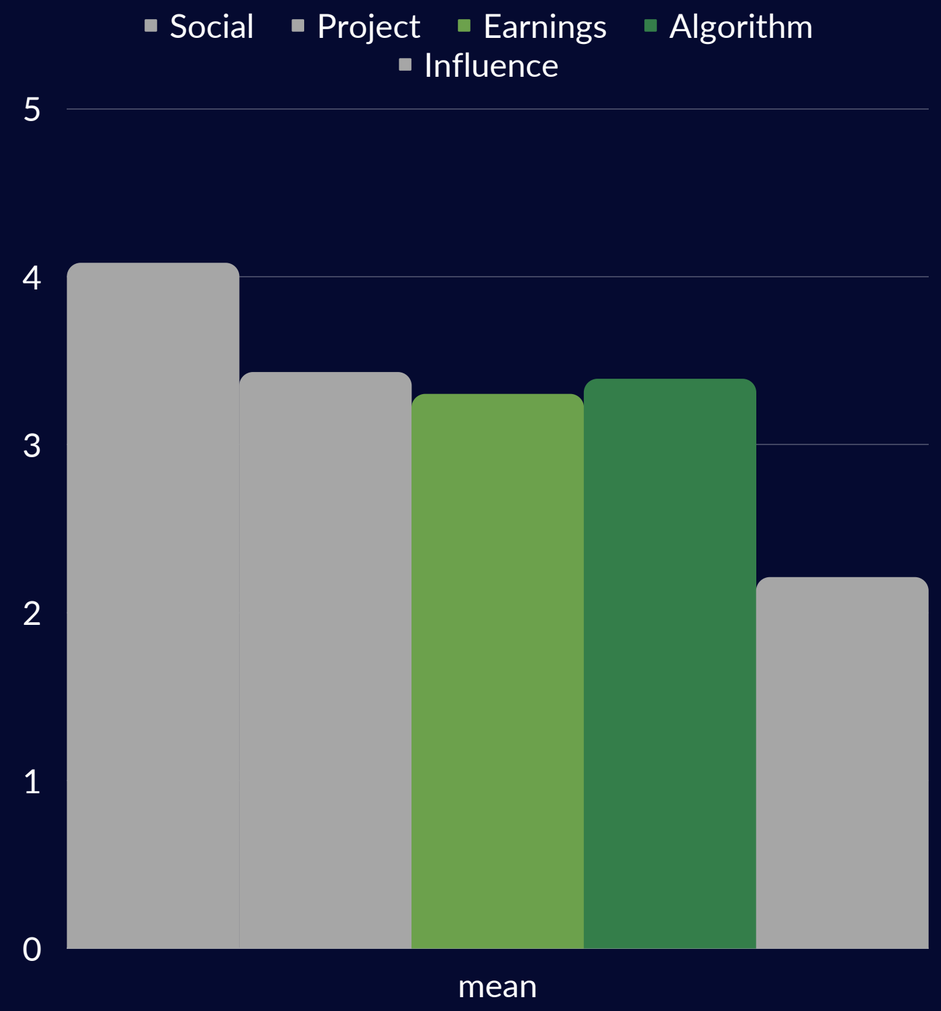


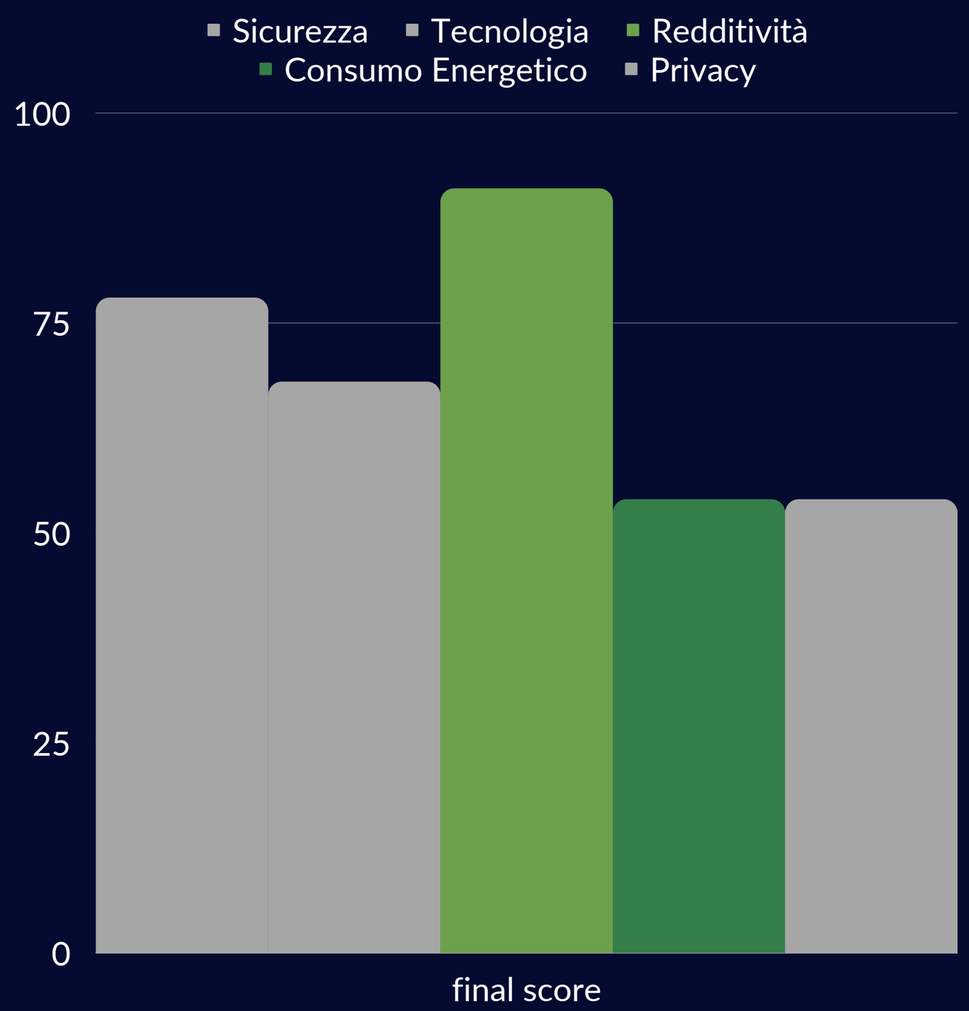
Mean: 2.60/1.50/1.50

CHARTS RESULTS

"All values are important, but some values are more important than others "

COMPARISON OF RESULTS





MAIN RESULTS

The results of this study, show that cryptocurrencies that use a PoW consensus algorithm, have a considerable energy consumption when compared to those based on PoS or PoA . Certainly in the future with the use of greener energy this problem would be mitigated, but in the present, we already have a solution. However, it is worth asking at this point (given the market share) how much is still worth the initial philosophy of having a currency created in 2009 as a response to the global economic crisis, free from a central entity, safe and without fees. My doubt, also seen the results of the survey is that there is a thin veil of hypocrisy in all this, since in the ranking of the mean, consensus algorithm exceeds the gains, but if placed before a choice, the gains win over everything else. It would be the case, then, to start considering Bitcoin a safe haven asset and no longer a currency, however, effectively losing all initial meaning.

CONCLUSIONS

- Although there were far fewer workers than students participating in the survey, it would seem that those who already have income from a job are less obsessed than those who don't earn any money with making money from cryptocurrencies.
- Students, (perhaps having more free time on their hands) place much more importance than workers on documenting cryptocurrencies, it should be investigated further however, on what specifically they gain information.
- There seems to be a lot of skepticism from both workers and students toward influencers who advertise cryptocurrencies.