

# MAKING CRYPTOCURRENCY GREENER

The cryptocurrency Bitcoin devours large amounts of energy. Responsible for this is the proof-of-work process that legitimizes all digital currency transactions. A study by ETH Zurich commissioned by the Swiss Federal Office of Energy has quantified the energy consumption and shows ways in which power consumption could be curbed by switching to less energy-intensive cryptocurrencies. If users of digital currencies are swayed by environmental arguments, those cryptocurrencies that consume less energy might become more popular and valuable in the long term.



Cryptocurrencies do not need a central authority such as a central bank to authorize monetary transactions. A consensus mechanism ensures that the currency cannot be manipulated. In the case of Bitcoin, the mechanism consists of the - very energy-intensive - proof-of-work process. Photo: Shutterstock

For some, cryptocurrencies are mumbo jumbo. For others, they are the expansion of the economy by digital means. Among those already using digital currencies as a means of payment is the canton of Zug. There, both individuals and legal entities have been able to settle their tax bills with the cryptocurrencies Bitcoin and Ether since February 2021. In the first year, 41 private individuals and 21 companies used this option.

The tax payments are processed via Bitcoin Suisse AG. This company exchanges the cryptocurrencies into francs and transfers them to the Zug Finance Directorate. The canton thus bears no exchange rate risk. Cryptocurrencies are also important for tax authorities in another respect. People who earn a profit from the mining of digital money must pay tax on this income. "Mining cryptocurrencies by providing computing power in exchange for compensation results in taxable income," the Zug Finance Directorate states.

### Twice the Swiss electricity consumption

A great deal of effort is required to make banknotes and coins counterfeit-proof. This also applies to digital currencies such as Bitcoin. The latter operates on the basis of blockchain technology. Blockchains are an instrument for storing information on distributed computers without a central controlling agency (authorities, central bank). The fact that the information stored in the blockchain cannot be manipulated is ensured by a consensus mechanism. In the case of Bitcoin, this consists of the proof-of-work procedure (see text box p.3). This procedure is responsible for the substantial energy consumption of the Bitcoin currency, as a study commissioned by the SFOE now shows.

The author of the study is Dr. Vlad Coroamă, a lecturer in Smart Energy at the Department of Computer Science at ETH Zurich up to the summer of 2021. Coroamă estimated the energy consumption of cryptocurrencies and found that bitcoin consumes over 100 TWh of energy per year. This amounts to twice the annual electricity consumption of all of Switzerland. Put another way, Bitcoin requires 25 to 50% of the amount of electricity consumed by all data centers in the world for data processing (excl. cryptocurrencies). To provide all this energy, 10 power plants with the output of the Gösgen nuclear power plant are required.

### Protection against manipulation

The study also investigated the exact source of this vast pow-



In the canton of Zug, the tax administration and individual businesses now accept payments with cryptocurrencies such as Bitcoin or Ethereum. Photo: B. Vogel

er consumption: virtually all of it (> 99%) is accounted for by the proof-of-work process, i.e. the consensus mechanism used by Bitcoin to legitimize the digital currency among all users. In addition, electricity is also required to send coordination messages via the Internet to all who participate in the mining of the cryptocurrency. However, at 6,000 kWh, this consumption is vanishingly small. The power consumption for the decentralized storage of the blockchain, a file with a current data volume of around 455 gigabytes, is also comparatively low at 30 to 3,000 MWh.

The study not only shows the massive power consumption of the proof-of-work process. It also describes the way towards less energy-intensive forms of digital currency. This is all the more important as blockchain technology is not only the basis of cryptocurrencies, but is likely to be used for many other areas in the future thanks to additions such as "smart contracts" and "non-fungible tokens" (NFT).

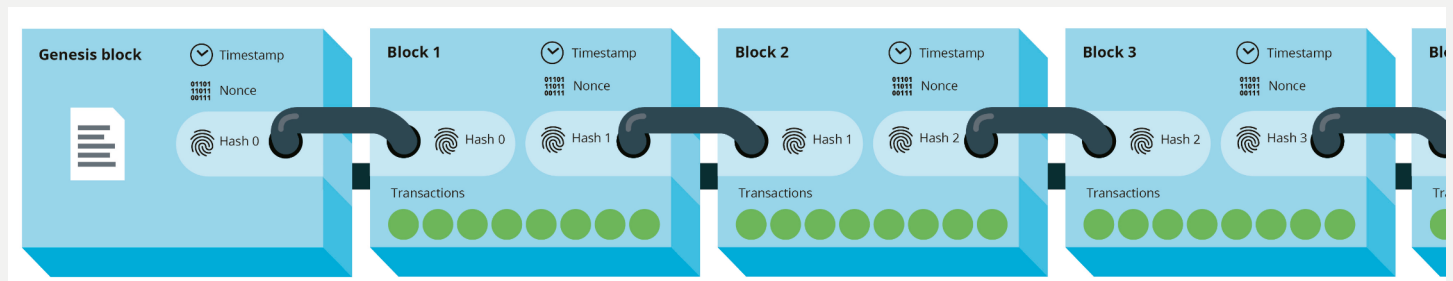
### Alternatives that use less energy

"Blockchain technology is not necessarily associated with high energy consumption, because there are more energy-efficient alternatives for storing data in a blockchain in a tamper-proof way," says Coroamă. While the proof-of-work process requires a lot of energy, the proof-of-stake process uses over a thousand times less energy. That's one reason why Ethereum, the second-largest cryptocurrency behind Bitcoin, decided to switch to proof-of-stake as a consensus mechanism. In principle, the proof-of-stake procedure works in such a way that people who own a certain share ("stake") of the cryptocurrency randomly become "auditors" who - in return

## IT COSTS A LOT OF ENERGY TO PUT ONE'S TRUST IN BITCOINS

A digital currency like Bitcoin knows neither banknotes nor coins; it exists only virtually. In simple terms, the currency consists of a list of accounts ("ledger"), in which it is noted how many Bitcoins are in which accounts. This ledger is not managed and controlled by a centralized authority such as by a bank, but is stored on numerous computers worldwide. Currently, identical copies of the ledger are stored on about 15,000 computers. Account holders can prove their ownership by means of a private key and thus initiate transfers.

Since Bitcoins are traded and change accounts in the process, the ledger must be updated continuously. This happens approximately every ten minutes. With each update, the most recent transactions are summarized in a file ("block"), which is then appended to the last block created. Thus, over the years, a string of blocks ("blockchain") has been created, which in total contains all account transactions carried out with Bitcoin to date. The blockchain of Bitcoin currently consists of a good 700,000 blocks with a total file size of 455 gigabytes. The copies of the blockchain on the 15,000 participating computers are continuously updated to contain the most current information.



But what if someone tried to pocket Bitcoins by appending a block with manipulated information to the blockchain? To prevent this from happening, only people who have previously solved a very demanding cryptographic puzzle that involves elaborate work (hence the name 'proof-of-work') can append a new block. This task is precisely the reason for the very high energy consumption of Bitcoin: solving the cryptographic puzzle - i.e. the proof-of-work - currently requires an average of 280 calculations. This requires as much electricity every 10 minutes as 400 four-person households consume in a year.

The cryptographic effort protects the currency from manipulation - and is at the same time the lifeblood of proof-of-work-based digital currencies like Bitcoin. Because whoever makes this effort and pays the corresponding energy costs is paid for their work: For the successful encryption of a block, 6.25 new Bitcoins (with a current value of around 300,000 francs) as payment awaits, plus transaction costs. Without this remuneration, 'mining' Bitcoins would not be attractive. If one calculates the cost of the electricity needed to encrypt a block, one arrives (at a Swiss household electricity price of 20 Rp.) at a cost of over 330,000 francs. Bitcoin mining is thus attractive for people who have access to cheap electricity. BV

for financial compensation - guarantee the reliability of the system.

While Ethereum is switching to the energy-saving proof-of-stake procedure, there are other cryptocurrencies such as EOS, Tezos or TRON that have been using this procedure for longer. In addition, other cryptocurrencies exist that use

other, also more energy-friendly procedures as a consensus mechanism (e.g. "proof-of-allocation").

### Searching for the lever

"In cryptocurrencies and other blockchain applications, we already have solutions today that use comparatively little energy. Thanks to this advantage, I think proof-of-stake cur-





The CERN research center near Geneva requires 428 GWh of electricity per year, mainly to operate the Large Hadron Collider, a particle accelerator. The cryptocurrency Bitcoin requires over 250 times more electricity. Pictured: a part of the CERN computer center. Photo: B. Vogel

rencies have a better future than proof-of-work currencies,” says Coroamă. It will be interesting to see what, if any, levers private companies and policymakers will use to encourage a move toward frugal blockchain technologies, he adds. Coroamă points to public administrations or companies that recognize cryptocurrencies as a means of payment.

In the canton of Zug, there are so far no measures aimed at giving preference to cryptocurrencies that use less energy. “There are currently no considerations on this topic in the canton of Zug, as only a few transactions have taken place,” says Finance Director Heinz Tännler. Such preferential treatment is also not an issue among Swiss banks, according to a spokesman for the Swiss Bankers Association. So far, only a few banks in Switzerland offer services for the purchase, trading and keeping of cryptocurrencies. Moreover, the energy-intensive mining of cryptocurrencies only rarely occurs in Switzerland.

### Handling through ESG criteria

At the same time, the spokesman for the Bankers Association points out that when advising private clients, irrespective of the asset class chosen, the banks would, among other things, guide them towards including ESG criteria in their decisions. These criteria stand for the aspects of the environment (Envi-



The Itaipu power plant on the border between Paraguay and Brazil was the most powerful hydropower plant in the world when it opened in 1984. Its generators can produce up to 14 GW of power. That's about the same amount of power consumed by the cryptocurrency Bitcoin. Photo: Shutterstock

ronment), health and safety (Social) and sustainable corporate management (Governance). The ESG criteria thus provide a means of at least addressing the high power consumption of cryptocurrencies in advisory discussions.

Meanwhile, the high energy consumption of blockchain technologies based on proof-of-work is the subject of lively international debate. For example, in a recent regulatory proposal, the EU Parliament toyed with the idea of restricting the use of cryptocurrencies based on the energy-intensive proof-of-work process. The proposal was ultimately rejected. However, the idea of including the mining of cryptocurrencies in the EU taxonomy for sustainable activities by 2025 in order to reduce the carbon footprint of cryptocurrencies is still on the table.

### Internationaler expert dialogue

The SFOE took Vlad Coroamă's study as an opportunity to introduce the topic to experts under the umbrella of the International Energy Agency. There, experts from 12 countries including Switzerland exchange information and experience and develop proposals for the efficient use of energy. “The topic is meeting with a very strong response internationally,” says Roland Brüniger, external head of SFOE's Electricity Technologies research program.



Advertisement for “the money of tomorrow.” Sustainability-minded investors should consider energy consumption of the different cryptocurrencies before investing. Photo: B. Vogel

- A **webinar** with Vlad Coroamă as part of the IEA Technology Collaboration Program “Energy Efficient End-use Equipment” (subprogram ‘Electronic Devices and Network Annex’/EDNA) is available [here](#).
- The **final report** on the project “Blockchain energy consumption - an exploratory study” is available [here](#) in English.
- For **information** on the topic, please contact Roland Brüniger ([roland.brueniger\[at\]brueniger.swiss](mailto:roland.brueniger[at]brueniger.swiss)), external head of SFOE’s Electricity Technologies research program.
- For more **technical papers** on research, pilot, demonstration, and flagship projects in electricity technologies, visit [www.bfe.admin.ch/ec-strom](http://www.bfe.admin.ch/ec-strom).