4E

Energy Efficient End-use Equipment
International Energy Agency

ENERGY EFFICIENCY POLICY BRIEF

Blockchain Energy Consumption

EDNA14

The 4E Electronic Devices and Networks Annex (EDNA) provides policy guidance to members and other governments aimed at improving the energy efficiency of *connected devices* and the *systems* in which they operate. EDNA is focussed on the increased energy consumption that results from devices becoming connected to the internet, and on the optimal operation of *systems of devices* to save energy.

This briefing summarises the key findings of a report titled *Blockchain Energy Consumption - An Exploratory Study.* The report was commissioned by the Swiss Federal Office of Energy and contains a detailed analysis of blockchain, its use in cryptocurrencies and beyond, and the resulting energy consumption. Though not an EDNA report, it relates to the digitalisation of the energy system and its findings are relevant for policy makers globally.

Observations for Policy Makers

- A blockchain is a public digital ledger which can be used to verify the ownership of both digital and real-world assets, for example cryptocurrencies, 'tokenised' artworks, real-estate and even energy.
- Changes in asset ownership are recorded in the blockchain and then validated by volunteer computer 'nodes'.
- Many blockchains employ a 'proof-of-work' mechanism to perform the validation function. This requires the validating nodes to have vast computing power, resulting in substantial electricity consumption. For Bitcoin alone, this now totals more than 100 TWh p.a., which is equivalent to the electricity consumption of the Netherlands.
- The nodes that undertake proof-of-work are rewarded with newly 'mined' cryptocurrency tokens. These computers are usually located where electricity is cheap.
- Alternatives to proof-of-work mechanisms exist, which use several orders of magnitude less energy, for example 'proof-of-stake'.
- Enacting policies to tackle the high energy consumption of blockchains is complicated, especially due to the lack of a central owner/operator that can be held responsible.

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MORE INFORMATION

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The Swiss report is available for download **here**. For further information please contact the EDNA operating agent at **steve@beletich.com.au**

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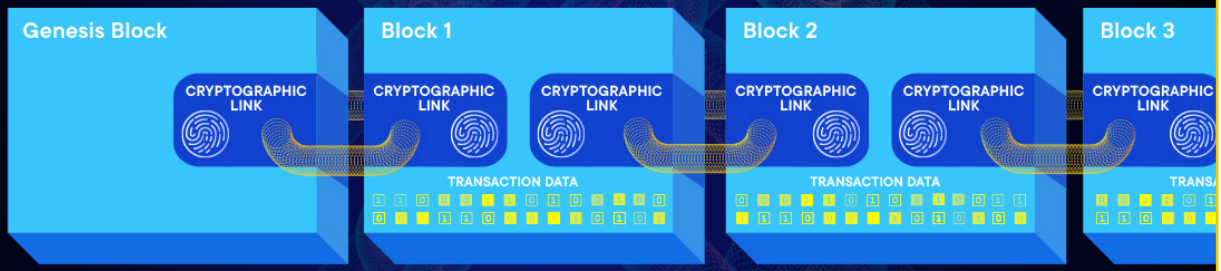
Key Findings

The Blockchain Explained

A blockchain is a set of digital records, called blocks, that are linked together using encryption. Participating computers (nodes) store a copy of the entire blockchain. Blocks, which contain information about recent transactions, are added at regular intervals, and each added block also contains encrypted information linking it to the previous block - thus forming a secure and irreversible 'blockchain'.



How Cryptocurrencies Employ the Blockchain

- Cryptocurrency units are publicly (i.e. on the blockchain) associated with accounts. Their ownership changes when a transaction occurs, e.g. to buy a product or service, and this is reflected as a transaction on the blockchain. Transactions are bundled and processed in batches, at the end of a set time interval.
- After each interval, a new 'block' of digital transaction records is created, recording all the transactions that occurred during that interval. Each new block is added to the blockchain and published without the oversight of a central authority.
- Bitcoin and some other cryptocurrencies use a 'proof-of-work' mechanism to verify transactions. This involves each block of transactions being verified by nodes who, in competition with each other, undertake an extensive trial-and-error effort to guess the answer to a complex cryptographic puzzle. The nodes that successfully solve the puzzle are rewarded with newly mined Bitcoin.

Some Cryptocurrencies Result in Excessive Energy Consumption

- Across all the competing nodes, the proof-of-work mechanism requires an immense computing effort, resulting in enormous energy use.
- Bitcoin miners are incentivised (by competition) to use more and more powerful and efficient computing hardware. However to stabilise the system, the Bitcoin algorithm reacts by increasing the difficulty of the puzzle. This impact outweighs any efficiency gains within the hardware.

Potential Solution to Reduce Energy Consumption

- To reduce the energy consumption of cryptocurrencies, it is necessary to move away from proof-of-work verification mechanisms.
- Alternative verification mechanisms exist that consume less energy, with the most promising known as 'proof-of-stake'. In this mechanism, nodes stake a minimum amount of cryptocurrency in order to become validators, which are then selected by an algorithm and awarded cryptocurrency. Adoption of proof-of-stake mechanisms has the potential to save more than 100 TWh per year (for each of the most popular blockchains).