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Block-by-Block to the digital euro: How blockchain digitizes the euro

As early as 2026, the digital euro (Retail CBDC) of the European Central Bank (ECB) and the Eurosystem could be introduced in the euro area. The final design decisions are still pending. One of the most important questions is which technology the digital euro should be based on.

The Blockchain Bundesverband e. V. (Bundesblock) advocates the use of Distributed-Ledger-Technology (DLT) in general and blockchain technology in particular. With this position paper, the Bundesblock shows the ECB and the Eurosystem the advantages these technologies could have for the digital euro.

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1. The digital euro (retail CBDC) - a project of the European Central Bank and the Eurosystem

The European Central Bank (ECB) and the Eurosystem have been considering the introduction of a digital form of cash since 2018. In July 2021, it was decided that a two-year investigation phase would be launched from Q1/2022. During this, the various design options for the digital euro (retail CBDC) will be worked out. On June 28, 2023, the European Commission will deal with the digital euro in a meeting.¹ This will be followed by the publication of the legislative proposal declaring the digital euro as legal tender. It is expected that a decision will be made in the fall of 2023 as to whether the two-year investigation phase will be followed by a two- to three-year implementation phase. The digital euro could be introduced as early as 2026 if the Eurosystem decides to do so, probably in 2024.² The question of which technology the digital euro will be based on has not yet been clarified. In point of view of the Blockchain Bundesverband e. V (Bundesblock), this question is being evaluated too late and with insufficient priority. In our view, the digital euro must offer clear added value for citizens and companies and therefore make the best possible use of the advantages of blockchain or distributed ledger technology (DLT).

From the perspective of the ECB and the Eurosystem, it is necessary to provide digital cash for citizens in order to achieve European sovereignty. Currently, holding cash is the only way consumers can hold central bank money. The largest amount of money is provided by banks - so-called commercial bank money or book money, which is under limited influence of the central banks. In the future, the digital euro will enable central banks to issue digital central bank money in addition to cash and use it, for example, to fight inflation.

¹ [https://ec.europa.eu/transparency/documents-register/detail?ref=SEC\(2023\)2454&lang=en](https://ec.europa.eu/transparency/documents-register/detail?ref=SEC(2023)2454&lang=en).

² https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov230424_progress.en.pdf.



2. Effects of a digital euro

2.1. Money forms

2.1.1. Retail CBDC = digital euro

Retail CBDCs (Central Bank Digital Currencies) are digital currencies issued by a central bank and intended for general use by the population. About 90% of all central banks currently deal with a CBDC.³ Unlike cryptocurrencies such as Bitcoin⁴ or Ether (Ethereum)⁵, which are operated by decentralized networks, retail CBDCs are provided and controlled by the central bank.

The introduction of a retail-oriented digital euro in the euro area offers several opportunities and prospects for households and companies. Examples include:

Convenience: A digital euro would enable consumers to carry out transactions directly from their bank accounts or wallets without having to rely on the availability of physical cash. This would make the purchasing process faster and more convenient.

Security: A digital currency would allow consumers to conduct their transactions more securely. They would no longer need to carry physical currencies, reducing the risk of loss or theft.

Cost savings: Digitization of payment transactions can reduce the costs of processing transactions. Costs for the production and distribution of physical cash could also be reduced if less cash was printed.

³ <https://cbdctracker.org>.

⁴ <https://bitcoin.org/bitcoin.pdf>.

⁵ <https://ethereum.org/en/whitepaper>.



New business opportunities: A digital euro could also create new business opportunities, especially for fintech companies and Industry 4.0 initiatives offering innovative payment solutions. With the digital euro they could take advantage of and develop new products and services.

Regulation: A digital currency would make it easier for regulators to track the flow of money and combat illegal activities such as money laundering and terrorist financing.

However, there are also concerns and challenges that need to be considered when introducing a digital euro in the retail sector. These include data protection concerns, cyber security risks, the need for a stable IT infrastructure, and possible implications for the role of banks, and payment service providers.

2.1.2. Wholesale CBDC

Wholesale CBDC, also known as interbank digital euro ("wholesale"), refers to the use of a centralized digital currency by financial institutions and other entities operating in the financial sector to facilitate payments and transactions. Unlike retail, where the digital euro is used as a digital version of cash for everyday use, wholesale is limited to the exchange of large amounts of money between financial institutions and businesses.

The introduction of the digital euro in wholesale trading can offer many advantages, such as faster and more efficient processing of transactions, lower costs and increased security. In particular, step-by-step transactions in securities trading can reduce transaction time from up to five days to instantaneous. By using CBDC in wholesale trading, credit institutions can also lower liquidity costs and reduce the risk of errors in the settlement of transactions. The introduction of



a CBDC can improve cross-border payments and facilitate trade between countries if there was a common standard for the various CBDCs.

However, there are also some challenges and potential impacts that need to be considered when implementing wholesale CBDCs. One challenge is to ensure that the system is secure and protected from cyberattacks. In addition, the impact on the existing banking system, regulators, and monetary policy must also be considered.

Overall, the introduction of wholesale CBDCs offers many opportunities and can improve transaction efficiency and security. However, it is important to consider the potential challenges and implications and to ensure the introduction of wholesale CBDCs is done in a carefully planned and coordinated manner. It is welcome that the ECB and the Eurosystem are exploring the benefits of DLT in the development of the Wholesale CBDC.⁶

2.2. The digital euro is not a stablecoin

Stablecoins are digital tokens that are tied to a stable asset such as a fiat currency (like the euro, but currently especially the US dollar) or commodities. Their goal is to avoid fluctuations in value by maintaining a stable valuation through appropriate backing. The value of a stablecoin is supported by a reserve of assets representing the underlying currency or asset. The reserve is managed by an organization (usually a private company) that attempts to keep the value of the stablecoin stable by hedging the amount of the issued token with the same amount of the deposited asset (in case of a currency).

⁶ <https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.pr230428~6a59f44e41.en.html>.



2.3. Commercial Bank Money Token as a supplement to the digital euro

The "**Commercial Bank Money Token**" (CBMT) is currently being pushed by the German Banking Industry (DK) and a consortium of banks, and associations.⁷ A CBMT still represents commercial bank money with all its features and services already offered by banks, but can enable new and additional functionalities that leverage DLT.

A CBMT can generate the most added value if it is provided directly on industry DLTs (CBMT is multi-DLT capable), it is independent of wallet owners and payment service providers, and the clearing and settlement mechanisms between banks are fully transparent (CBMT is a multi-issuer concept).

Commercial bank or book money is already a form of digital currency that is held in accounts at banks or other financial institutions and can be used for payments. In contrast, a digital euro is a digital currency issued by the central bank and thus central bank money.

A commercial bank money token, as proposed by DK, could serve as a complement to the digital euro, for example, by increasing the efficiency of transactions or facilitating the use of the digital euro. Such a token could, for example, be secured through the use of smart contracts and DLT, thus offering increased transparency and security.

There is a possibility that fiat money tokens could provide a bridge between the traditional financial system and the digital euro by facilitating the conversion of fiat money into digital currencies. Overall, commercial bank money tokens could help to promote the acceptance and use of digital currencies and thus facilitate the transition to an increasingly digital economy.

⁷https://die-dk.de/media/files/20230317_GBIC_Working_Paper_on_Commercial_Bank_Money_Token_V1.5.pdf.

3. User groups

3.1. Citizens (natural persons)

One overriding goal in the development of a digital euro must be the protection of citizens and their data. Privacy protection is crucial for acceptance of and trust in a digital euro. This was particularly evident during the consultation phase of the European Commission in 2022, when this was demanded with an overwhelming majority of feedback.⁸ Appropriate data protection measures must therefore be implemented, which in the best case ensure cash-like anonymity and the protection of users' personal information. The digital euro should be designed in such a way that the underlying infrastructure enables strong encryption, and multi-factor authentication can be used. Although cash is a rather critical means of payment in terms of money laundering prevention, the technology used in the digital euro allows suspicious activities to be tracked and monitored using algorithms and software. To protect the privacy of citizens, personal data, even by investigative authorities, should only be technically linked to an individual if a court order for access to data has been issued as a result of the activities.

3.2. Company (legal entities)

From the perspective of companies, the digital euro can be used as a means of payment to carry out transactions inside and outside the company. Integrating the digital euro into existing systems can enable payments to be processed seamlessly and efficiently. Furthermore, there should be no additional administrative effort as the digital euro is integrated into the existing currency system.

For accounting purposes, the wallet should be treated like a bank account. Seamless integration of wallets into existing treasury management systems is necessary for efficient cash management, enabling faster pooling.

⁸https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13392-Ein-digitaler-Euro-fur-die-EU/feedback_de?p_id=29585848.



Integrating the digital euro into wholesale transactions enables companies to reap the benefits of CBDCs, such as faster and cheaper transactions, especially cross-border payments, higher transparency and security. Businesses can also benefit from compliance conformity, as the digital euro is issued by the central bank and therefore meets all applicable regulatory requirements.

Overall, the digital euro offers companies a secure, efficient and convenient way to make payments inside and outside the company. It should be noted, however, that under the current plan, businesses are not allowed to hold a digital euro for an extended period of time. They can make and receive digital euro payments, but will likely have to liquidate the position at night. [Here, it would be welcome if companies could also have a holding limit of the digital euro.](#)

In the context of the Internet of Things and the platform economy, a digital euro allows the development of standardized interfaces and processes that make it easier for companies to implement new products.

In addition, the digital euro could be used as a basis for asset tokenization in the future, which would further increase the efficiency and speed of transactions in the digital economy.

4. Functionalities

4.1. Use Cases: PoS, E-Commerce, P2P, G2X

4.1.1. Point of Sale (PoS)

Customers can use a QR code or the data transmission via NFC interface (Near Field Communication) to approve the payment at the merchant's **point of sale (PoS)**. Both parties receive a direct response as to whether the transaction was successful. To do this, merchants need the necessary infrastructure, either in the form of new PoS or enhanced terminals. A transaction can be initiated either by customers or by retailers.



It would be good, if PoS payments were made possible at an early stage. The rollout is not currently planned for the introduction of the digital euro.

4.1.2. E-commerce

E-commerce providers also have the option of offering payment by digital euro on their checkout page. This service can also be provided by licensed providers and linked in the checkout process alongside other payment options.

The digital euro wallet can be offered as a browser extension for common browsers. Both parties receive a direct response as to whether the transaction was successful.

4.1.3. Peer-2-Peer (P2P)

Peer-to-peer (P2P) payments should also be possible. These transactions can be carried out on the smartphone or via a browser extension. To do this, users enter the necessary data or use a QR code and can thus transfer the data to another person in real time. Payment recipients see the payment including the civil name or a pseudonym.

4.1.4. Payment transactions with government agencies (G2X)

G2X are payments from public authorities such as governments or tax offices to citizens and vice versa. These can be taxes or government transfers, for example. In the first release, G2X will not be a use case of the digital euro, but will be extended to include this use case later. **Due to the difficulties of direct payments from governments to citizens during the Corona pandemic, this can add real value and should therefore be prioritized by the ECB and the Eurosystem.**



4.2. Privacy and data protection (anonymous for small amounts)

Privacy and data protection play a central role in the case of the digital euro, as even cash payments currently up to EUR 10,000 in Germany do not require proof of identity and thus remain largely anonymous.

Sharing personal data with merchants and P2P payments: The digital euro has the advantage over giro-, debit- and credit card-transactions in being held in a digital wallet. The information of this digital wallet can be limited to necessary items only:

The wallet address, the amount of the transaction and the information whether there are enough funds ("Yes/No" message). [Personal information of the wallet holder should not be disclosed for small amounts, but should remain anonymous.](#)

Information to wallet operators: wallet providers (both credit and e-money institutions), should have the following information:

[User identity, wallet address and transaction history - as it is already the case for checking and payment accounts. The transaction history is to remain anonymized in that only the wallet address is to be displayed, thus offering a higher level of protection and anonymization than the previous account overviews.](#)

Data disclosure in blockchain use cases: in this case, too, [only the necessary information should be disclosed, such as wallet address, transaction amount and information on whether there are enough funds for the transaction.](#)

Limitations: The limit here extends to small amounts, the threshold of which is still to be defined nationally or in the euro area. If the amount is exceeded, an identity check can be performed. [Payments with the digital euro should offer the same anonymity as cash payments. To prevent money laundering and terrorist financing,](#)



a transaction limit of €10,000 should be introduced in Germany. If countries introduce lower transaction limits for cash payments, these will also apply to payments with the digital euro.

4.3. Offline capability

As part of the design of the digital euro, the possibility of **offline capability** is also being discussed. Offline capability can be either temporary or permanent. Temporary offline capability refers to short-term Internet outages, while permanent offline capability refers to longer and indefinite outages caused by weather events or location in remote areas without Internet access. An important feature of an offline-enabled digital euro is that it must be issued or transmitted via a digital device. **An offline-enabled digital euro offers user benefits such as improved accessibility and privacy protection. To minimize the risk of theft or loss, an offline-enabled digital euro may require secure hardware and a PIN, password, or biometric authentication stored on the device in a separate chip.**

A **temporary offline functionality** allows users to continue to perform transactions during short offline periods when the Internet is temporarily unavailable. The online CBDC system is complemented by the offline functionality of such a system. The payee claims a portion of the payer's digital euro balance at the transaction time. The payer confirms this and these funds are blocked for further spending. The actual transfer of funds occurs at a later time when either the payer or payee is reconnected to the online system. Payment will be deferred until the Internet connection is restored.

A **permanent offline CBDC system** enables users to operate during extended offline periods when the Internet connection is permanently unavailable or undesirable. A permanent offline system is a standalone ecosystem supported by dedicated devices with local data storage. Devices with permanent offline functionality can



make P2P payments without being connected to the Internet. Settlement occurs at the end of the transaction. Thus, when the transaction is completed, the funds belong to the respective payee. The funds are also transferable, which means that the recipient can spend them in a follow-up transaction without waiting for them to be updated.

An offline CBDC must comply with applicable laws and set limits on account balances held offline, transaction amounts, and duration of offline time to prevent illegal activity. Security is another concern, as the technology is vulnerable to security threats such as hacking and malware. While implementation requires close collaboration between different industries, users also need to understand the technology to ensure smooth functioning.

In addition, an offline-enabled CBDC must be seamlessly integrated with existing payment systems to enable smooth usage.

An offline-enabled digital euro has a number of advantages, such as improved accessibility and robustness, as well as privacy preservation. However, there are also a number of challenges that must be overcome to successfully implement such a technology. Close collaboration between the technology/banking industry and regulators, as well as secure implementation, are critical to realizing the benefits of an offline-enabled digital euro.

4.4. Programmability

Smart contracts represent a self-executing functionality and enable the implementation of self-executing contracts whose conditions are written directly in code. Once the defined criteria are met, the contract is automatically executed. Integrating smart contracts into the digital euro would open up the potential for a wide range of applications, such as automated payments, decentralized financial services, and digital identity management. The ability to link the digital euro with



smart contracts could revolutionize the European financial market and usher in a new era of financial innovation and efficiency by making transactions safer, faster and cheaper, while meeting the requirements of European regulatory frameworks.

4.5. Interoperability

The interoperability of the digital euro with existing blockchains and payment systems would need to be thoroughly designed to enable smooth and efficient transactions while ensuring the security and stability of the financial system. This would require the creation of interfaces and communication protocols that enable seamless integration and exchange of information between the digital euro and other blockchain networks as well as traditional payment systems (with a so-called trigger solution).

Interoperability should also allow the digital euro to be used in existing wallets and payment infrastructures to provide users with a consistent and familiar user experience. At the same time, interoperability would need to ensure that legal and regulatory compliance is maintained, for example by meeting anti-money laundering (AML) and know-your-customer (KYC) requirements.

4.6. Accessibility

For the digital euro to be used by people living in the euro area, a high level of accessibility is crucial. In order to be widely accepted as a secure extension of cash, it must be similar to cash in all dimensions of accessibility - physical, technical, financial and social. Physical accessibility to the digital euro, for example, is only guaranteed if it also functions without a constant Internet connection, so it can be used in areas with inadequate mobile Internet. For high technical accessibility, on the other hand, the digital euro must be compatible with different devices and platforms and must not make high demands on the respective devices and users. In terms of financial accessibility, the costs for the



digital euro should be as low as possible, for example through account fees or transaction costs. In order to position the digital euro as a direct digital extension of cash, it should not incur any additional costs at all for users, just like cash. In the context of a digital euro for all euro area citizens, the social accessibility of the digital euro is a particularly important factor. Therefore, the digital euro must be designed in a way that it does not discriminate against any population groups and is equally usable and beneficial for all citizens of the euro area.

4.7. Node operator

Using blockchain technology as the basis for the digital euro, it would be conceivable for credit institutions and payment service providers to act as validators for the ECB's digital euro. Several design decisions would have to be made in order to ensure a secure, efficient and regulatory compliant system:

The choice of **consensus mechanism** is critical because it determines how node operators interact with each other to validate transactions and add new blocks to the blockchain:

Proof of Work (PoW), Proof of Stake (PoS), Proof of Authority (PoA) or Byzantine Fault Tolerance (BFT) would be conceivable, for example, offering different advantages and disadvantages in terms of security, energy consumption and speed.

The **number of operators involved, acting as validators**, affects the decentralization, security and scalability of the system. A larger number of validator nodes increases decentralization and security, but may result in lower scalability and speed.

The **credit institutions and payment service providers that can provide validator nodes** must have clear roles and responsibilities to ensure the integrity of the system. This may include how they validate transactions, create blocks, and receive rewards.



It is important to strike a balance between protecting the privacy of the user and meeting regulatory requirements such as AML and KYC. Design decisions should take into account what data is collected and stored by the validator nodes and how that data is used and protected.

The **governance structure of the digital euro** should clearly define how decisions on changes to the system are made and how the credit institutions involved can represent their interests. This may include the establishment of voting mechanisms or the involvement of regulators.

5. Issuance and custody of the digital euro

The digital euro should be customer-friendly, secure and attractive. To achieve this, it needs providers that meet the following criteria:

- They offer diverse and user-oriented services.
- They provide professional advice and support to users, especially to those who are less familiar with digital payments.
- They have retail experience and can integrate the digital euro into their existing products and channels.
- They are subject to strict regulation and supervision, which ensure the protection and integrity of the digital euro.
- They use an existing infrastructure to spend and store the digital euro efficiently and cost-effectively, without major investment or customization.

These criteria should be taken into account when selecting the specific solution for the issuance and custody of the digital euro. One obvious solution would be to entrust the issuance and custody of the digital euro to banks, savings banks and payment service providers.

6. Risks of the digital euro

The introduction and use of the digital euro entails various risks.

Technical risk: The [digital infrastructure for the digital euro must be stable, secure and resistant to attacks to ensure smooth operation](#). A failure of the technology can lead to a loss of confidence among users.

Data privacy risk: The digital euro will process users' personal and financial information. [Therefore, an appropriate data protection and security concept must be in place to ensure data protection and trust](#).

Regulatory risk: The introduction of the digital euro could lead to regulatory challenges, as various legal provisions at national and international level have to be taken into account. [Effective cooperation between regulators is needed to facilitate the implementation of the digital euro](#).

Market risk: The digital euro could have the potential to replace or change traditional banking services. This could impact the banking sector, especially small and medium-sized banks, which may not have the resources to cope with competition from the digital euro. By substituting commercial bank money for digital euro, credit institutions may lose fees, e.g., for the processing of instant SEPA payments.

Acceptance risk: Acceptance of the digital euro depends on the willingness of users to use it as a means of payment. [The introduction of the digital euro therefore requires a comprehensive communication strategy to promote user confidence in the new technology](#).



Currency risk: The digital euro could have the potential to influence the value of the euro on the foreign exchange market if foreign investors were granted easier access to the euro. [Appropriate monitoring and regulation is needed to ensure stability of the \(digital\) euro.](#)

Risk of financial market stability being jeopardized: Since the digital euro is to be issued by banks, credit institutions play an important role as intermediaries. The current plan is to provide one wallet per citizen - also to better control the holding limit. From the banks' point of view, a holding limit is necessary because otherwise unlimited commercial bank money could flow into the digital euro and thus into central bank money. This could lead to a significant outflow of commercial bank money, which is essential for issuing loans, and thus possibly jeopardize financial market stability. [In order not to take any risks, especially at the beginning of the introduction of the digital euro, a low holding limit should be chosen.](#)

It is important that these risks are taken into account in the development and introduction of the digital euro and that appropriate measures are taken to minimize the risks.



7. Conclusion

The ECB's project team - together with the Eurosystem - has already been working intensively on the digital euro for years. It is hard to imagine that the digital euro will not be introduced. Important design decisions will still be made or adapted by fall 2023. From the perspective of the Bundesblock, the digital euro should take advantage of blockchain technology to be able to enable new use cases. In its current design, it is difficult to see the added value beyond what has already been possible with commercial bank money for decades. In addition, the European Payments Initiative (EPI) will be launched in 2024 and will map the same use cases that are planned today with the digital euro at least two to three years earlier. Companies from the much-cited Industry 4.0 will be able to make necessary payment transactions only if the digital euro is based on a decentralized infrastructure. In addition, there would be potential for the emergence of new start-ups that could build a business model based on the ECB's foundation technology. This is the only way Europe would enable a model/solution nations like China, but also the USA, could learn from. There is still a chance to act and to listen to companies from the industrial sector as well as stakeholders like the Digital Euro Association e. V. (DEA)⁹ with its CBD Manifesto¹⁰ and to take their needs sufficiently into account.

The risks must be minimized. In particular, the privacy and data of citizens must be protected. Without the use of blockchain technology, the risks outweigh the opportunities of the digital euro.

If the digital euro is not built on a decentralized infrastructure such as blockchain or distributed ledger technology, it should be rejected.

⁹ <https://home.digital-euro-association.de/en>.

¹⁰ <https://cbdcmanifesto.com>.