

## TRUST - digital TuRn in EUrope: Strengthening relational reliance through Technology

### **BCT For Energy Applications** Policy Brief

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## BCT for energy applications

The transition to a sustainable energy landscape, driven by awareness of climate change and the finite nature of fossil fuels, has led to significant policy changes in Europe. Electrification, is a key strategy for decarbonization. Renewable Energy Sources (RESs), energy storage systems and electric vehicles have transformed energy systems towards a decentralized electricity supply, introducing both opportunities and challenges. By promoting peer-to-peer (P2P) energy trading and implementing decentralized flexible energy demand management strategies, these local systems can achieve better energy allocation and integrate distributed resources more efficiently. P2P trading allows users to trade locally produced energy at competitive prices, minimizing transmission losses and optimizing grid utilization. In this P2P energy exchange environment, data management systems are essential. Blockchain technology (BCT), with its Distributed Ledger Technology (DLT) capabilities, offers a robust solution to ensure security, transparency and immutability of energy transaction data. Implemented through smart contracts, BCT enables automated and coordinated P2P energy trading, facilitating decentralized management of DERs and unlocking transactional energy systems. This decentralization supports energy flexibility, improves coordination among multiple actors, and enables scalable participation in flexible energy markets.

### ▪ P2P energy trading and Demand-Side Management in microgrids

Successful implementation of P2P energy trading and decentralized flexible energy management require advanced tools to ensure stakeholder (i.e., end-user to system operator) participation and secure interactions across multiple market levels (i.e., forward to real-time market). Thus, BCT, with its decentralized and immutable ledger capabilities, offers a promising solution. By enabling transparent and secure P2P energy transactions, blockchain enhances trust among participants while providing robust data management capabilities. Through cryptographically signed and distributed data, BCT prevents manipulation and ensures data integrity by eliminating central authorities or intermediaries. Transactions are immutable and transparent, and user anonymity is preserved via public wallet addresses

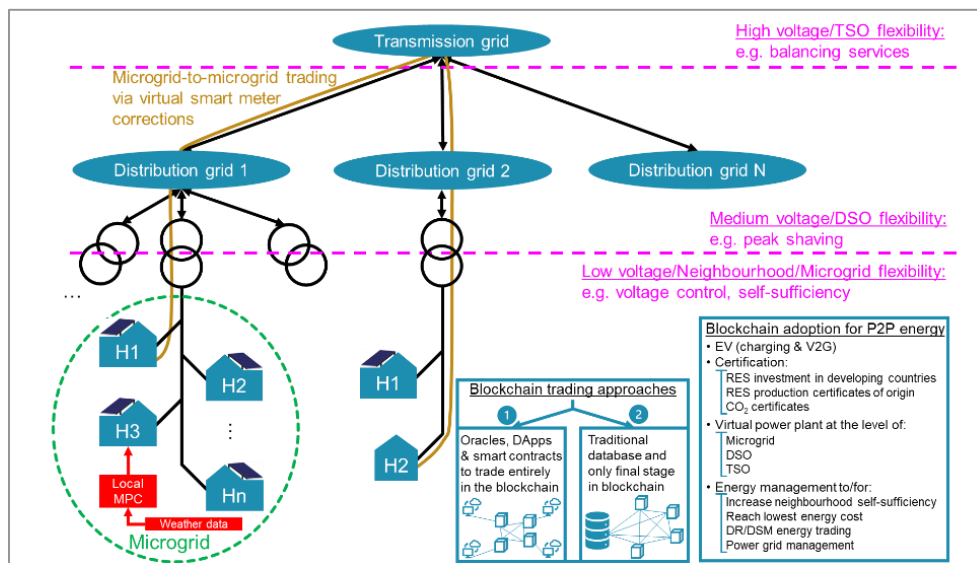
### ▪ Distributed Ledger Technologies: Blockchain for reliable data management in microgrids

Blockchain provides a certification framework for microgrid operations. When used as a P2P communication tool for automated execution of optimized energy management strategies (via smart contracts), it ensures economical, flexible and secure system operations. However, the exchange of energy activities and flexibility services within the microgrid can generate significant amounts of data from different DERs and automation systems. This may lead to data congestion and high transaction costs, which pose challenges for large-scale adoption of BCT. Scalability and performance issues, such as validation latency and transaction throughput, further exacerbate these challenges. These limitations can compromise security and decentralization, which are critical for enabling P2P interactions in microgrids. Thus, the integration of BCT in microgrid is compared with the "blockchain

trilemma" (i.e., scalability, security and decentralization), where only two out of three key attributes can be achieved simultaneously with the current technology

- **Market structures for Blockchain-based microgrids**

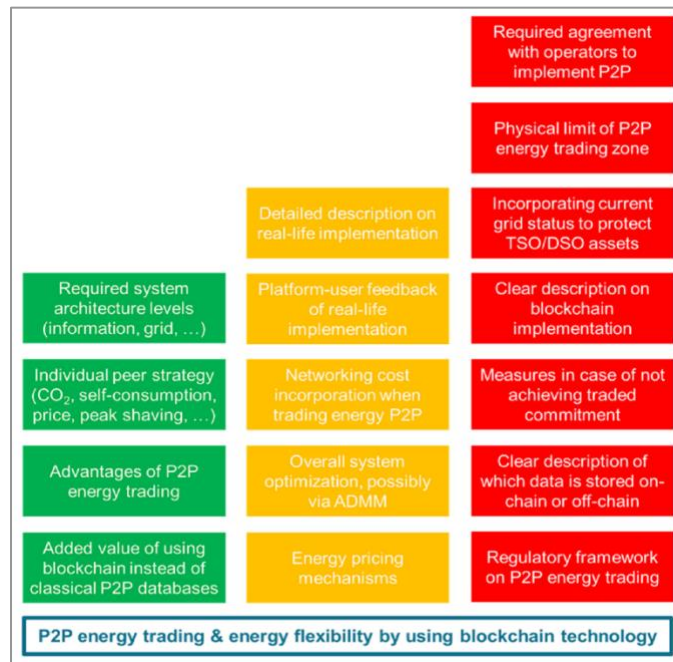
To successfully integrate multiple DERs, it is crucial to define the market structure and microgrid boundaries to govern the P2P trading and flexibility services. This requires an understanding of peer organization models and the most suitable market mechanisms and DSM strategies enabled by blockchain. Figure 1 provides an overview of BCT applications for P2P energy trading within the evolving energy landscape, highlighting various levels of implementation, which are explored further in this discussion.



**Figure 1** Overview of blockchain adoption for P2P energy trading purposes

- **Blockchain-based microgrids: main challenges**

Figure 2 provides an overview of the current research landscape. The figure uses green to highlight well-established research areas, red to denote aspects with minimal or no existing knowledge, and yellow to indicate areas of ongoing research where further exploration is needed to reach conclusive outcomes. A significant gap in the state of the art concerns the description of how BCT is practically implemented in P2P energy trading.



**Figure 2** Progress in defining flexible blockchain-enabled P2P microgrids

Currently, in the legal context of European competition law, no legislative initiatives specifically address the challenges that blockchain technology may pose in this field. So far, it has not yet generated a sufficient body of case law to justify detailed regulatory intervention. Therefore, further actions will be needed in this direction, in the near future.

## About TRUST Project

TRUST promotes an interdisciplinary research program, involving academic and non-academic institutions, in order to understand the role of trust in the implementation of digital technologies and suggest actual means of development.

Assuming that the digital transformation of European society can be fully achieved only if technologies evolve in a trustworthy environment, the project analyses the mutual influence between trust and digital technologies in order to raise relational reliance in people-to-people, people-to-business and people-to-authorities interactions.

The attention is on blockchain technology (BCT) as one of the most relevant forms of Distributed Ledger Technology. BCT is considered a trust-building machine as it creates new forms of relational reliance. BCT projects the issue of trust in a new dimension that we intend to explore, in adherence with the initiatives and key actions promoted by the EC in the Communication "Shaping Europe's digital future" (COM (2020) 67final), where it is remarked that trust and digital transformation of society go hand-in-hand.

The research and knowledge transfer programme evolves around key topics, such as: the development of a suitable regulatory framework for the effective integration of BTC in a trust-based society; the transition towards a fair and competitive peer to peer economy; the applications of BTC in the field of AI, to assure security and trust; the development of new models of collaborative governance for smart and trust-based cities.

The consortium gathers expertise from different backgrounds (legal, economic, engineering), belonging to EU countries, as well as Israel and China. Complementary research perspectives, innovative training and international/intersectoral cooperation will boost staff careers development by studying how the use of digital technologies can shape a trustworthy European environment, in which citizens are empowered in how they act and interact, and promote economic growth as well.

## Partners of TRUST Project



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