Distributed Ledger Technology and Digital Transformation of the EU Building Sector

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1 Introduction

- The European building sector is at the centre of the EU's climate neutrality agenda. Buildings account for approximately 40% of final energy consumption and 36% of energy-related greenhouse gas emissions, making building renovation and energy efficiency improvements essential for achieving the EU's 2030 and 2050 climate targets. Despite the progress achieved through the Renovation Wave initiative, renovation rates remain below the levels required to deliver a fully decarbonised building stock.
- At the same time, the revised Energy Performance of Buildings Directive (EPBD) introduces a new generation of digital tools, including Building Renovation Passports, Digital Building Logbooks, Smart Readiness Indicators and Building Automation and Control Systems. These instruments are expected to create a digital ecosystem capable of supporting smarter renovation decisions, better monitoring of building performance and increased participation in energy markets.
- Within this context, Distributed Ledger Technology (DLT), commonly known through blockchain applications, has emerged as a potential enabler of secure, transparent and automated energy and building services.

2 Methodology

- This study applies a qualitative policy and technology assessment framework to examine the role of DLT in EU building decarbonisation. The methodology combines four analytical steps. First, relevant academic and grey literature published between 2018 and 2025 was reviewed to identify DLT applications in energy, buildings, MRV, smart contracts and energy communities. Second, EU policy and legislative documents were analysed, including the EPBD Recast, EED, RED III, Data Governance Act and Digitalisation of the Energy System Action Plan. Third, five InEExS business cases were assessed to examine how DLT functions in real or near-market building decarbonisation services. Finally, barriers were classified into three categories: regulatory and market design barriers, data governance and interoperability barriers, and socio-technical and distributional barriers. This framework enabled the development of a phased policy roadmap for responsible DLT integration.

3 Policy Landscape

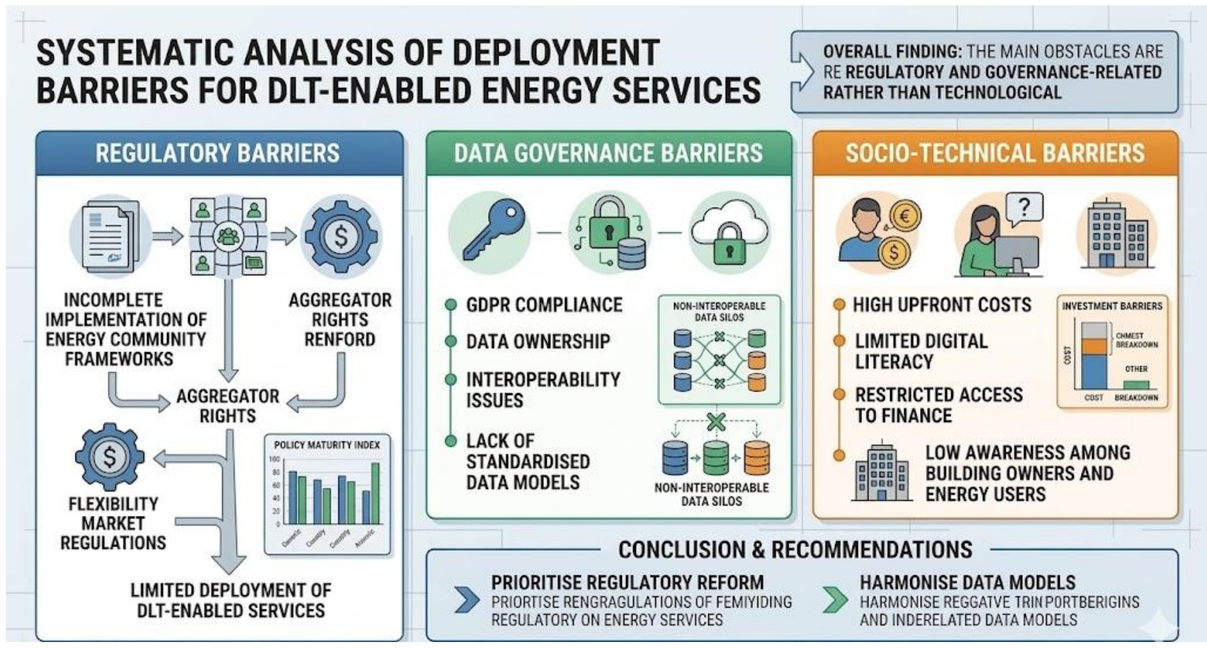
- The EPBD recast establishes a digital governance framework for building decarbonisation through BRPs, DBLs, SRI, BACS, and national energy performance databases. In parallel, the EED strengthens energy savings obligations and monitoring requirements, while RED III promotes energy communities and citizen participation. These policies create the foundations for digital building ecosystems and trusted data exchange. DLT can potentially complement these instruments by enhancing transparency, traceability, and automation, particularly in areas such as energy communities, performance-based contracts, flexibility markets, and building performance verification.

Table 1: DLT Business Cases for Building Decarbonisation

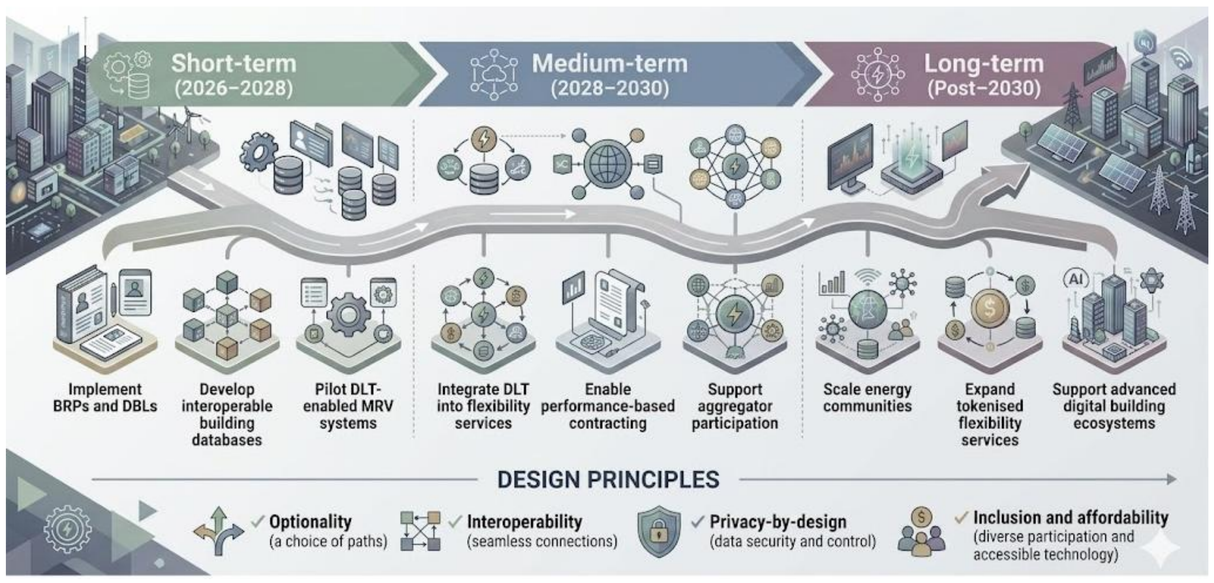
Business Case	Country	Application	Main DLT Function
BC1	Germany	Pay-for-performance PV contracts	Energy savings verifications
BC2	Spain	Energy cooperative self-consumption	Smart contracts and incentives
BC3	Greece	Gas boiler efficiency services	Measurement and verification
BC4	The Nordics	EV charging flexibility	Transparency of flexibility services
BC5	Conceptual	Decentralised Energy Efficiency Power Plant	Tracking contracts and savings

- **Key finding:** DLT was technically feasible across all cases but depended heavily on regulatory readiness and data governance arrangements.

4 Barriers



5 Towards a Policy Roadmap for DLT Integration



6 Discussion

- DLT can support building decarbonisation by improving transparency, traceability, and trust across building and energy ecosystems.
- The most promising applications include Measurement, Reporting and Verification (MRV), Digital Building Logbooks (DBLs), Building Renovation Passports (BRPs), energy communities, flexibility markets, and performance-based energy contracts.
- The analysed business cases demonstrate that DLT is technically feasible and can enhance the integrity and automation of energy-related transactions and services.
- The main barriers are not technological but arise from regulatory fragmentation, limited interoperability, data governance challenges, and incomplete market frameworks.
- Successful deployment depends on the existence of interoperable digital building infrastructures, recognised MRV methodologies, and clear legal frameworks for energy communities and aggregators.
- DLT should be considered a complementary enabling technology that supports the implementation of EPBD digital instruments rather than a standalone solution.

7 Conclusions

- ✓ DLT can provide significant value as a trusted backend layer supporting the digital transformation of the European building sector.
- ✓ The technology is particularly relevant for secure data management, automated contractual arrangements, transparent energy transactions, and verifiable energy performance monitoring.
- ✓ Regulatory readiness, governance frameworks, and data interoperability are the primary determinants of successful deployment.
- ✓ Building Renovation Passports, Digital Building Logbooks, Smart Readiness Indicators, and national building databases constitute the essential foundations upon which DLT applications can be developed.
- ✓ A phased implementation approach is required, prioritising digital building infrastructures before large-scale deployment of DLT-enabled services.

- ✓ Future DLT solutions should be guided by four key principles:
  - Optionality
  - Interoperability
  - Privacy-by-design
  - Inclusion and affordability

Literature

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