FEDECOM Internal Market Watch Newsletter Edition 6 (Q1 2026)

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BACKGROUND:

The first five editions of the internal market watch newsletter investigated the FEDECOM pilot countries (Ed. N° 1, Q2 2023); the 15 Exploitable Results (Ed. N° 2, Q1 2024); the customer segments and business model archetypes (Ed. N° 3, Q3 2024); energy trading including blockchain, cross-border, and guarantees of origin (Ed. N° 4, Q2 2025); and finally digital twins and other enablers for energy communities, as well as more on block-chain-based P2P energy trading (Ed. N° 5, Q3 2025).

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For this 6th Edition, we delve further into 2 key FEDECOM topics:

Part 1. Blockchain-based P2P energy trading:

- 1.1) Authoritative reviews and state-of-the-art surveys (10 entries)
- 1.2) Consensus, market clearing, and transaction governance (7 entries)
- 1.3) Trading architectures, market design, and security mechanisms (14 entries)
- 1.4) Engineering and applied blockchain implementations (8 entries)

Part 2. Energy community sector coupling:

- 2.1) Core concepts, policy and system integration (12 entries)
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- 2.4) Cross-cutting trends, digital and infrastructure context (15 entries)

Part 1. Blockchain-based P2P Energy Trading

4 categories, a total of 39 entries

1.1) Authoritative reviews and state-of-the-art surveys

- **(2025, Wiley IET)**: "A Comprehensive Review on P2P Energy Trading: Market Operations, Blockchain Applications, and Future Directions"; Analyzes advancements in P2P energy trading with blockchain integration.
- **(2025, Elsevier)** "P2P Energy Trading using Blockchain Technology" Open access special issue of Energy Reports journal.
- **(2025, Frontiers in Blockchain):** "Revolutionizing the energy sector: exploring diversified blockchain applications in peer-to-peer energy trading"; Surveys blockchain transformations in energy production, distribution, and P2P trading.
- **(2024, Nature Scientific Reports):** "Applications of blockchain technology in P2P energy trading"; Reviews blockchain applications in P2P energy trading, including secure communication and real-world projects such as PowerLedger in India.
- **(2024, Frontiers in Energy Research):** "A review of P2P transaction loss and blockchain"; Examines blockchain's role in reducing losses in P2P trading, including Ethereum-based smart contracts.
- **(2024, Energies)** "A Review of P2P Energy Trading Markets: Enabling Models and Technologies"; P2P market architectures, bidding strategies, auction models, optimization and enabling technologies in P2P energy trading.
- **(2024, University Canada West):** "A Literature Review of Blockchain Technology for Efficient Energy Systems"; survey of recent blockchain research for P2P energy and related decentralized systems.
- **(2024, Oxford Academic)** "Applications of blockchain technologies in artificial electricity market settlement and clearing" – Reviews blockchain use for settlement and clearing in electricity markets, covering tamper-resistant transaction records and smart-contract-based market logic.
- **(2022, Frontiers in Computer Science)** "A survey on peer-to-peer energy trading for local communities: Challenges, applications, and enabling technologies" – Broad survey of P2P models, market structures, enabling ICT and blockchain, with emphasis on community-level deployments.
- **(2021, Applied Energy via RePEc):** "P2P energy trading: A review of the literature"; This paper reviews six topics: trading platforms, blockchain, game

theory, simulation, optimization, and algorithms.

1.2) Consensus, market clearing, and transaction governance

- **(2025, Renewable and Sustainable Energy Reviews):** "A review of blockchain consensus mechanisms for P2P electricity trading"; Provides a taxonomy of consensus mechanisms applied to P2P electricity trading platforms, with cases.
- **(2025, Nature Scientific Reports):** "Blockchain consensus mechanism and method for P2P electricity trading"; Introduces a priority-based consensus for secure and timely P2P electricity trades.
- **(2025, Springer):** "Decentralized P2P energy trading: A blockchain-based pricing and game theory approach"; includes dynamic energy pricing and game-theoretic market mechanisms.
- **(2025, Scientific Reports):** "Blockchain Consensus Mechanism and Method for P2P Electricity Trading"; introduces a novel consensus design to improve trust, latency, and data integrity in decentralized retail energy markets.
- **(2025, Scientific Reports)** "Comparative evaluation and simulation of blockchain consensus mechanisms for secure and scalable peer-to-peer energy trading in microgrids" – Compares PoW, PBFT and PoS-like variants for P2P trading, focusing on throughput, latency and security trade-offs.
- **(2022, MDPI AG)** "A Smart Contract-Based P2P Energy Trading System with Dynamic Pricing on Ethereum Blockchain" – Proposes the DT-P2PET scheme where Ethereum smart contracts, IPFS off-chain storage and a tailored consensus process coordinate P2P trades and dynamic pricing in smart grids.
- **(2021, IEEE):** "Review of Market Clearing Method for Blockchain-Based P2P Energy Trading"; Surveys market clearing techniques for blockchain-based P2P energy trading in microgrids.

1.3) Trading architectures, market design, and security mechanisms

- **(2025, Energy Informatics):** "Blockchain-Powered P2P Energy Trading"; Presents a framework for secure, decentralized P2P energy trading using blockchain cryptography.
- **(2025, arXiv):** "Secure and Decentralized P2P Energy Transactions using Blockchain Technology"; proposes a secure Ethereum-based mechanism for decentralized bidding among DER participants.
- **(2025, Scientific Reports):** "Prosumer Web City: Blockchain-enabled P2P energy

trading for DER-rich urban districts"; outlines a scalable market-based framework for integrating smart buildings into P2P electricity systems.

- **(2024, Taylor and Francis)**: "Blockchain-based P2P renewable energy trading and management"; Proposes a smart contract model for secure P2P renewable energy trading with enhanced traceability and efficiency.
- **(2024, arXiv):** "Decentralized P2P Trading based on Blockchain for Retail Electricity Market"; Designs a Hyperledger-based P2P market with AI-driven optimisation for DER networks.
- **(2024, Applied Energy):** "Blockchain-enabled peer-to-peer energy trading and resilient grid operation"; discusses architecture for resilient blockchain P2P trading in microgrids, emphasizing data integrity and security.
- **(2024, Applied Energy):** "A blockchain-based optimal peer-to-peer energy trading framework"; decentralized multilayer P2P trading framework for DER coordination and optimal market performance.
- **(2024, arXiv)** "P2P multi-energy trading in a decentralized network" — extends P2P trading research across electricity, heat, hydrogen, and other energy carriers.
- **(2023, Applied Energy):** "A privacy-preserving trading strategy for blockchain-based P2P electricity transactions"; Introduces a three-layer architecture using homomorphic encryption for secure on-chain P2P trading.
- **(2023, ArXiv):** "Social Factors in P2P Energy Trading Using Hedonic Games"; integrates social interaction and coalition formation into blockchain-based P2P trading mechanisms for energy communities.
- **(2023, ArXiv):** "Modelling the Formation of Peer-to-Peer Trading Coalitions and Prosumer Participation Incentives in Transactive Energy Communities"; economic analysis of local market models, centralised vs fully decentralised.
- **(2022, Scientific Reports)** "A blockchain based lightweight peer-to-peer energy trading framework for secured high throughput micro-transactions") – Designs a lightweight P2P trading architecture integrating IoT devices and blockchain to reduce overheads while maintaining security and privacy.
- **(2022, MDPI AG)** "Blockchain-Based Peer-to-Peer Transactive Energy Management Scheme for Smart Grid System") – Presents a decentralized architecture (DT-P2PET) with on-chain smart contracts and off-chain storage, focusing on profit maximisation, bandwidth efficiency and security.
- **(2021, Computers in Industry)** "Blockchain-enabled Peer-to-Peer energy trading" Proposes an architecture addressing the scalability–security–decentralisation trilemma via a second-layer solution, validated using RENeW Nexus trial data.

1.4) Engineering and applied blockchain implementations

- **(2025, Scientific Reports):** "P2P Energy Trading using Blockchain in Multi-Microgrid Systems"; presents a layered control scheme for autonomous P2P energy trading in distributed communities.
- **(2025, IEEE):** "Blockchain and Energy Trading"; Reviews blockchain-enabled P2P solutions addressing energy trading challenges in digital and e-commerce-oriented markets.
- **(2024, Energies):** "Stakeholders' Perceptions of the Peer-to-Peer Energy Trading Model Using Blockchain Technology" stakeholder perception and pilot insights from real P2P blockchain trials across multiple countries, including Malaysia and Europe.
- **(2024, Memorial University)** "Design and implementation of peer-to-peer energy trading using the IoT and Blockchain Method") Engineering study with an IoT server, private Ethereum network and user interface enabling participants to buy/sell energy in a lab-scale P2P setting.
- **(2024, IEEE)** "A Real-Time Simulation for P2P Energy Trading Using a Distributed Algorithm" Builds a real-time simulation environment for P2P trading, coupling small-scale renewables, storage and blockchain-based market logic to test performance under different scenarios.
- **(2022, Scientific Reports)** "A blockchain based lightweight P2P energy trading scheme for smart grids") – Demonstrates an implemented prototype integrating IoT meters and blockchain to run micro-level P2P trades with reduced computation and communication overhead.
- **(2021, MDPI AG):** "A Smart Contract-Based P2P Energy Trading System with Dynamic Pricing" Experimental implementation on Raspberry Pi–based testbed, showing how Ethereum smart contracts execute trades, dynamic pricing and anti-double-spend checks in real time.
- **(2021, IEEE):** "Credit-Based P2P Electricity Trading in Energy Blockchain Environment"; Proposes a credit-based system to improve reliability in blockchain-enabled P2P electricity trading.

Part 2. Energy community sector coupling

4 categories, a total of 42 entries

2.1) Core concepts, policy and system integration

- **(2025, EWI Cologne)** "Sector Coupling – EWI topics page" – Research hub summarising EWI projects and publications on electricity-heat-gas coupling, hydrogen, and flexibility.
- **(2024, ICLEI)** "Sector coupling – A Key Concept for Accelerating the Energy Transformation" – Report summarising local government roles and policy instruments to use sector-coupling technologies (heat pumps, e-mobility) for renewable integration.
- **(2024, DBDH)** "Sector Coupling / Smart Energy System" – Describes sector coupling in district-energy systems as a key strategy for low-carbon, integrated smart energy, linking district heating, electricity and other vectors.
- **(2023, REN21)** "Renewable Energy Systems and Infrastructure: Sector Coupling" – Global overview of sector coupling as a way to integrate more renewables, with examples of local and community-based initiatives.
- **(2022, Springer)** "Economics of Sector Coupling" – Analyses economic drivers, cost structures and welfare effects of sector-coupling investments and policies in integrated energy systems.
- **(2022, Springer)** "Economics of Sector Coupling" – Analyses economic drivers, cost structures and welfare effects of sector-coupling investments and policies in integrated energy systems.
- **(2021, European Commission)** "Energy system integration – EU strategy for energy system integration" – Sets out the EU strategy to link electricity, gas, heat and other carriers, stressing electrification, hydrogen, and digitalisation to optimise the whole system.
- **(2021, GIZ)** "Sector Coupling and Green Economy" – Programme description showing how sector coupling in transport and industry can support a green economy in partner countries. [giz]( )
- **(2021, IRENA)** "Sector Coupling" – White-paper style definition and discussion of sector coupling as interlinking power with heating, cooling, mobility and industry to raise renewable shares and system flexibility.
- **(2021, Interreg Europe)** "Policy brief on smart energy management" – Highlights

the EU Strategy for Energy System Integration and smart, decentralised management across electricity, heat, cold and gas.

- **(2020, ETIP SNET)** "WHITE PAPER Sector Coupling: Concepts, State-of-the-art and Perspectives" – Systematic overview of sector-coupling concepts, current technologies and future perspectives for European grids and markets.
- **(2018, European Parliament)** "Sector coupling: how can it be enhanced in the EU to foster grid stability and decarbonise?" – Parliamentary study analysing how sector coupling can support grid stability, renewable integration and decarbonisation, and which EU measures can accelerate it.

2.2) Energy communities and sector-coupled local systems

- **(2025, Elsevier)** "Advancing renewable energy community planning through integrated sector-coupling and economies of scale" – Demonstrates how planning tools for renewable communities exploit energy sharing and sector coupling to cut costs and emissions.
- **(2025, Springer)** "Energy Communities' Archetypes and Operational Scenarios Using Agents and Embedding Heating and Transportation" – Agent-based study defining energy-community archetypes that integrate heating and transport services.
- **(2025, SSRN)** "Sector Coupling for Energy Communities: Synergies between Mobility and Heating Services" – Examines an energy community coupled with EVs and district heating, showing lower electricity and heat costs via integrated operation.
- **(2025, PV Europe)** "Integrating energy communities into sector coupling" – Article presenting the FEDECOM project and how communities will support sector-coupled operation and flexibility markets.
- **(2024, Elsevier)** "An energy community as a platform for local sector coupling" – Proposes an energy-community reference architecture to coordinate electricity, heat and mobility in a multi-energy system. [sciencedirect](
- **(2024, PMC)** "Demonstrating clean energy transition scenarios in sector-coupled and renewable-based energy communities" – Shows how sector coupling and RES-based communities enable flexible intra- and inter-community exchanges and grid-friendly operation.
- **(2024, LIFE LOOP)** "Report on Selected Business Models for the Development of Community Energy" – Reviews EU community-energy business models, including pathways to multi-vector and sector-coupled services.

- **(2022, Elsevier)** "From energy communities to sector coupling:a taxonomy for regulatory experimentation in the age of the European Green Deal" – Develops a taxonomy of regulatory sandboxes and demonstration projects linking energy communities and sector coupling. [sciencedirect](
- **(2022, BRIDGE)** "Energy Communities: tools to build them and make them thrive" – Includes a case study on digital tools for sector-coupled electricity and hydrogen in a technology park energy community.

2.3) Sector coupling in multi-energy, heat and hydrogen systems

- **(2025, Energy journal)** "Techno-economic analysis of flexible sector coupling between electrical and thermal sectors" – Case study for Oskarshamn DH showing how flexible coupling with thermal storage and heat pumps reduces LCOE and emissions under certain price scenarios.
- **(2025, Nature Communications)** "Electricity- and hydrogen-driven energy system sector-coupling in net-zero CO2 emission pathways" – Uses multiple models to show that electricity and hydrogen shares in EU final energy may reach about 60% and 6% by 2050.
- **(2023, DTU working paper)** "Increased heat-electricity sector coupling by constraining …" – Analyses how constraining biomass in heat supply encourages more flexible power-to-heat use and better integration of variable renewables.
- **(2021, Fern)** "More and more district heating networks in Europe are switching from combustion to large heat pumps" – Reports the trend of European DH systems replacing fossil boilers with large heat pumps, improving efficiency and decarbonisation potential.
- **(2021, H2 Knowledge Centre)** "Sector Coupling and Business Models Towards Sustainability: The Case of the Hydrogen Vehicle Industry" – Studies business models in the hydrogen vehicle sector and how sector coupling supports sustainable deployment.
- **(2020, Renewable and Sustainable Energy Reviews)** "Modeling and optimization of multi-energy systems in mixed-use districts: A review of existing methods and approaches" – Reviews optimisation methods for district-scale multi-energy systems coupling power, heat, gas and sometimes mobility.

2.4) Cross-cutting trends, digital and infrastructure context

- **(2026, Enlit Europe)** "Flexibility, digitalisation and the energy nexus: How EU

projects are shaping smarter energy systems" – Summarises several EU projects where digital platforms coordinate flexibility resources and sector-coupled assets (electricity, heating, cooling).

- **(2025, European Parliament study)** "Increasing Flexibility in the EU Energy System" – Analyses current and future flexibility needs and highlights how digitalisation, storage, demand response and sector coupling jointly enable a more resilient EU power system.
- **(2025, Energy Policy)** "Electrification, flexibility or both? Emerging trends in power systems" – Examines how rapid deployment of flexible devices and sector-coupling assets changes system operation and market design, stressing the need for digital tools.
- **(2025, CERRE)** "Flexibility in the Energy Sector" – Policy report describing how digital technologies, data centres and energy-intensive industries can provide flexibility and support sector coupling in decarbonised systems.
- **(2025, Hanwha Data Centers)** "Renewable Energy for Digital Infrastructure: A 2025 Guide" – Outlines how co-locating renewables, storage and data centres, managed with advanced digital control, can turn digital infrastructure into a flexible, integrated energy asset.
- **(2025, SDU – Centre for Energy Informatics)** "Enabling sector coupling of energy-intensive industrial production through energy informatics solutions" – Describes a digital twin platform that uses IoT, big data and AI to unlock flexibility and sector-coupling options in industrial processes.
- **(2025, Eurelectric)** "Response to the Strategic Roadmap for digitalisation and AI in the energy sector" – Emphasises the need to plan data-centre and AI-infrastructure integration in a grid-friendly, sector-coupled way to avoid bottlenecks.
- **(2025, Free Electrons)** "Enabling Grid Flexibility: The Role of Demand Response and Energy Storage in the Future of Energy" – Discusses how DR and storage, supported by digital platforms and new utility-innovator partnerships, become core flexibility pillars in integrated systems.
- **(2025, Clean Energy Transition Partnership opportunity)** "Digital tools for integrated infrastructures" – Describes R&D on AI-based control, digital twins and multi-agent systems for cross-sectoral infrastructure planning and operation (electricity, heat, mobility).
- **(2025, Siemens)** "Infrastructure Transition Monitor 2025 – Energy chapter" – Explores how digitally enabled energy infrastructure, including sector-coupled assets and flexible loads, evolves toward net-zero systems.

- **(2024, DTU)** "Flexible Integration of Data Centres into the Energy Sector" – PhD thesis showing that data centres can act as sector-coupling interfaces between electricity and district heating, providing flexible loads and decarbonised heat when supported by proper market and policy signals.
- **(2024, Clean Energy for EU Islands)** "The Role of Sector Coupling in Planning the Transition of a Clean Energy Island" – Presentation showing how a grid IT platform, KPI visualisation and a decentralised DR trading platform support sector-coupling and flexibility on islands.
- **(2024, nLIGHTEN)** "Emerging Trends in Data Centers: Redefining the Industry for 2025" – Highlights how increased renewable sourcing, energy-efficiency and proximity to grids position data centres as flexible loads in integrated energy systems.
- **(2024, Watson Farley & Williams)** "M&A Trends for Renewable Energy & Digital Infrastructure in Germany – The Outlook for 2025" – Discusses growing investor interest in assets where renewables, storage and digital infrastructure (including data centres) converge.
- **(2023, ITU & World Bank)** "Green data centers: towards a sustainable digital future" – Recommends using waste-heat recovery and sector coupling so that data centres support decarbonisation rather than burdening local energy systems.