

REVIEW

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A Taxonomy of Transactive Energy and Peer-to-Peer Trading Optimization Models for Prosumer Flexibility, EV Coordination, and Local Grid Constraints

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Abstract

Transactive energy and peer-to-peer trading are key enablers of distributed energy markets. Optimization models drive these systems, but a systematic taxonomy linking models to prosumer flexibility, EV coordination, and grid constraints is lacking. This article develops a taxonomy of transactive energy and P2P trading optimization models. It classifies models according to their treatment of prosumer flexibility, EV integration, and local network constraints. A structured literature review of 27 articles published between 2017 and 2025 was conducted. Models were categorized across market, optimization, flexibility, EV, and network-integration dimensions. The taxonomy organizes models by market mechanism, optimization method, and depth of grid and flexibility integration. It reveals significant gaps in holistic multi-vector coordination. The taxonomy provides a systematic framework for comparing optimization models in local energy markets. It also identifies research needs for integrated, grid-aware, flexibility-oriented transactive systems.

Keywords Transactive energy, Peer-to-peer trading, Optimization models, Prosumer flexibility, EV coordination, Grid constraints

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Introduction

Transactive energy and peer-to-peer trading have emerged as complementary paradigms for coordinating distributed energy resources in increasingly decentralized power systems. Early P2P microgrid formulations demonstrated that prosumers could exchange surplus photovoltaic generation through structured market mechanisms rather than relying only on passive net-metering arrangements [1]. Battery-mediated energy sharing further showed that local flexibility can be coordinated across community assets to reduce grid imports and improve self-consumption [2]. These developments shifted attention from device-level control toward market-based optimization of distributed flexibility.

The optimization models used in these systems vary widely in architecture, decision variables, and assumptions about market clearing. Bilateral contract networks support direct negotiation among agents while preserving prosumer autonomy [3], whereas consensus-based markets use distributed coordination to reach feasible exchange quantities and differentiated prices [4]. Preference-aware transactive formulations add another layer by allowing agents to express heterogeneity in product type, source, or trading priority [5]. This diversity creates a need for a taxonomy that can distinguish not only centralized and decentralized clearing but also the depth of flexibility and grid modeling.

A central challenge is that P2P and transactive models do not treat the distribution grid consistently. Network-constrained trading formulations explicitly represent voltage and line constraints in low-voltage networks [6], while electrical-distance-based designs incorporate grid location into trading incentives [7]. Other models use losses, network charges, or congestion management as proxies for physical constraints rather than embedding full power-flow feasibility [8, 9]. As a result, market feasibility and grid feasibility are often linked only partially.

This review contributes a taxonomy that classifies optimization models for transactive energy and P2P trading along four axes: market mechanism, prosumer flexibility, EV coordination, and local grid constraint treatment. Reinforcement-learning and game-theoretic models demonstrate how algorithmic choices shape agent behavior and market outcomes [10, 11]. Blockchain-enabled and smart-contract-based designs add institutional and settlement layers to optimization-based trading [12, 13]. By integrating these strands, the article provides a structured basis for comparing models without presenting new experiments or empirical data.

Need for Taxonomy

Existing reviews provide valuable overviews of P2P electricity markets, connected energy communities, and prosumer participation, but their classification schemes often emphasize market architecture more than optimization-model structure. Broad surveys explain the evolution of P2P systems and their enabling technologies [14], while community-oriented reviews identify challenges in scaling local markets and coordinating diverse participants [15]. Literature reviews of P2P energy trading further synthesize applications and mechanisms but do not always map flexibility, EVs, and grid constraints into a unified model taxonomy [16]. A more explicit classification is therefore needed to connect market design choices with physical-system integration.

A new taxonomy should make visible how models progress from economic exchange to operational coordination. Prosumers can participate through flexible loads, batteries, photovoltaic self-consumption, and strategic bidding, but these resources are represented with different levels of technical detail across studies [17, 18]. EV-focused trading and charging-payment models introduce mobility, charging windows, and V2G capability, which require categories beyond stationary prosumer flexibility [19, 20]. Network-aware models additionally require separate dimensions for voltage, congestion, losses, and DSO coordination because these constraints determine whether local trades can be physically realized [21, 22].

Review Method

Search strategy

The review followed a targeted search strategy focused on peer-reviewed journal articles published from 2017 to 2025 in transactive energy, P2P trading, distributed optimization, prosumer flexibility, EV coordination, and distribution-grid constraints. Search strings combined terms such as transactive energy, peer-to-peer energy trading, optimization, prosumer flexibility, electric vehicle, voltage, congestion, distributed optimization, and distribution network. Foundational P2P market studies were included where they established optimization or market-clearing concepts directly relevant to the taxonomy [1, 3]. Network-aware and EV-oriented studies were then added to ensure that the corpus captured both economic and physical coordination mechanisms [6, 20].

Inclusion/exclusion criteria

Articles were included when they proposed, reviewed, or systematically classified optimization, market-clearing, pricing, coordination, or trading models for transactive energy or P2P energy systems. Studies on game-theoretic incentives [11], coalition formation [23], two-stage mechanism design [24], and prosumer participation in flexibility markets [18] were retained because they directly inform taxonomy dimensions. Articles were excluded when they were not peer-reviewed

journal papers, fell outside the 2017–2025 period, or focused only on hardware, policy, or empirical forecasting without a trading or optimization model. Conference papers, theses, reports, standards, websites, and preprints were not used.

Study selection and screening

The screening process first separated broad review articles from model-specific contributions so that prior classification insights did not dominate the proposed taxonomy. Review articles on P2P trading, connected communities, and prosumer opportunities helped define the conceptual boundaries of the field [14–17]. Model-specific studies were then screened for explicit treatment of market architecture, pricing, flexibility, EV behavior, and grid constraints. Blockchain, reinforcement-learning, and multi-agent models were retained where their solution method changed the market or coordination logic rather than serving only as an implementation detail [10, 12, 13].

Classification framework

The classification framework used four primary axes: market mechanism, flexibility representation, EV coordination capability, and network-constraint integration. Centralized, decentralized, distributed, bilateral, auction-based, coalition-based, and blockchain-enabled models were distinguished because they allocate decision authority differently [3, 4, 13, 25]. Flexibility was coded according to whether models used passive prosumers, flexible demand, batteries, PV self-consumption, aggregated portfolios, or strategic willingness to trade [2, 18, 26]. Network treatment was coded separately as absent, tariff-based, loss-aware, congestion-aware, electrical-distance-aware, or power-flow-constrained, reflecting the range from economic abstraction to operational grid feasibility [7–9, 22].

Table 1 provides a comprehensive overview of the literature search and screening process, highlighting the main focus areas, initial relevance targets, screening criteria, and the resulting set of included references that form the foundation of the study.

Table 1. Literature Search and Screening Summary

Search theme	Main model focus	Initial relevance target	Screening emphasis	Included references
Transactive energy optimization, prosumer flexibility	Market-based control, preference-aware trading, flexibility valuation	5–7	Optimization structure and explicit prosumer decision variables	[2, 5, 11, 18, 24, 26]
P2P energy trading with EVs	Charging payment, EV participation, V2G readiness, mobility-sensitive exchange	5–7	EV-specific constraints, charging windows, and trading interaction	[19, 20]
Local grid constraints in P2P trading	Voltage limits, congestion, losses, DSO coordination, electrical distance	4–6	Physical-network feasibility rather than only economic clearing	[6–9, 21, 22]
Taxonomy and review literature	Review scope, classification categories, research gaps	3–4	Systematic synthesis and relevance to local energy-market models	[14–17]
Distributed optimization and market algorithms	Consensus, bilateral contracts, reinforcement learning, game theory	4–5	Solution method and decentralization of decision authority	[3, 4, 10, 23, 25]

Network-aware distribution-grid markets	Grid-aware pricing, ancillary services, network charges, constraint preservation	4–5	Integration between local market clearing and distribution operation	[7-9, 22, 26]
Final included corpus	Journal articles from 2017–2025	27	Peer-reviewed relevance to taxonomy dimensions	[1-27]

Transactive Energy Models

Centralized vs. decentralized transactive systems

Transactive energy models differ first in where optimization authority is located. Centralized designs use a market operator, aggregator, or platform to clear trades, which can simplify feasibility checking but may reduce privacy and autonomy [1]. Decentralized and distributed formulations allow agents to negotiate or update decisions locally, as in bilateral contract networks that coordinate exchanges through agent-level agreements [3]. Consensus-based markets further decentralize coordination by iteratively aligning local decisions without requiring a single actor to solve the full market problem [4].

Market-based mechanisms

The reviewed models use several market mechanisms, including bilateral negotiation, auctions, coalition formation, product differentiation, and incentive-compatible mechanisms. Game-theoretic models characterize strategic prosumer behavior and motivational incentives for participation [11], while virtual microgrid formulations use game structures to coordinate local exchange among distributed agents [25]. Coalition formation models treat groups of prosumers as dynamic market participants whose cooperation can improve welfare or reduce costs [23]. Mechanism-design approaches add incentive compatibility by structuring rules so that strategic agents reveal useful information for community energy exchange [24].

Optimization objectives and constraints

Optimization objectives in transactive energy models commonly include cost minimization, social welfare maximization, self-consumption improvement, peak reduction, and participant utility. Multi-class energy-management formulations show that prosumer preferences can become explicit optimization dimensions rather than external assumptions [5]. Ancillary-service trading models extend objectives beyond energy exchange by allowing nanogrids to provide flexibility services across multiple local markets [26]. When local network impacts are modeled, objectives may also incorporate losses, congestion relief, or network charges to align economic trades with distribution-system operation [8, 9].

Flexibility integration in transactive models

Flexibility integration ranges from simple surplus-deficit trading to detailed models of batteries, controllable demand, and strategic prosumer willingness. Community battery control demonstrates how storage can mediate local energy sharing while coordinating temporal flexibility across participants [2]. Prosumers-as-market-participants frameworks emphasize that flexibility must be modeled not only technically but also institutionally, because participation depends on opportunities, rules, and incentives [17]. Flexibility-market frameworks then connect P2P energy trading with wider service provision, allowing prosumers to participate in both exchange and grid-support mechanisms [18].

Table 2 categorizes transactive energy models based on market structure, coordination methods, flexibility management, and grid-integration depth, providing representative studies to illustrate the diversity and evolution of approaches in enabling prosumer participation and network-aware energy exchange.

Table 2. Classification of Transactive Energy Models

Model class	Market structure	Optimization or coordination method	Flexibility handling	Grid-integration depth	Representative studies
Operator-cleared community trading	Centralized local clearing	Welfare or cost optimization	PV surplus, demand response, storage	Usually limited unless constraints are embedded	[1, 27]
Bilateral transactive contracting	Decentralized bilateral exchange	Contract-network optimization	Prosumer preferences and bilateral commitments	Indirect unless network terms are added	[3, 5]
Consensus-based local market	Distributed multi-agent clearing	Consensus iteration or distributed optimization	Flexible supply and demand offers	Can support grid-aware extensions	[4, 6]
Game-theoretic transactive market	Strategic decentralized participation	Non-cooperative or cooperative game	Participation incentives and strategic bids	Often economic rather than full power-flow based	[11, 23, 25]
Mechanism-design energy community	Rule-based strategic market	Two-stage or incentive-compatible design	Strategic prosumer flexibility	Moderate, depending on network-fee design	[18, 24]
Multi-market flexibility platform	Coordinated energy and service trading	Multi-market optimization	Energy, storage, and ancillary-service flexibility	Stronger when DSO services are represented	[18, 26]
Network-aware transactive system	DSO-linked local market	Constrained optimization or locational adjustment	Flexibility used for congestion or voltage support	High when losses, voltage, or congestion are explicit	[8, 9, 21, 22]

P2P Trading Models

Architectures and communication topologies

P2P trading architectures can be centralized, decentralized, distributed, or hybrid depending on the role of the market platform and communication topology. The early microgrid model by Zhang, Wu, Zhou, Cheng, and Long framed P2P trading as structured local exchange among prosumers with market coordination [1]. Bilateral contract networks represent a more decentralized architecture because agents form direct trading relations without relying entirely on central dispatch [3]. Blockchain-based platforms introduce a distributed ledger layer, where the communication topology supports settlement, transparency, and automated execution in addition to energy matching [12, 13].

Pricing and matching mechanisms

Pricing and matching mechanisms determine whether P2P trading behaves like a local pool, a negotiated bilateral market, or a differentiated product market. Peer-to-peer price and strategy models explicitly calculate trading prices

between prosumers and consumers inside a microgrid, showing how local incentives shape exchange outcomes [27]. Product-differentiated markets allow agents to value electricity according to attributes such as origin or preference, which changes matching beyond pure price minimization [4]. Electrical-distance-driven trading adds a locational signal so that matching is influenced by grid proximity as well as economic willingness [7].

Solution algorithms

The reviewed P2P models use optimization algorithms that range from centralized mathematical programming to distributed consensus, reinforcement learning, game theory, and blockchain-enabled smart execution. Reinforcement-learning models allow customer-to-customer trading strategies to adapt under uncertainty and incomplete information [10]. Game-theoretic and coalition-based methods formalize strategic interaction among prosumers, enabling analysis of incentives and stable group formation [11, 23]. Blockchain-based models then shift part of the solution architecture from optimization alone to verifiable settlement and automated transaction enforcement [12, 13].

EV-specific P2P trading features

EV-specific P2P trading models add charging demand, mobility constraints, payment settlement, and potential V2G flexibility to the local market problem. Blockchain-based EV trading and charging-payment systems show how charging transactions can be coupled with secure peer exchange and settlement [19]. EV contribution studies extend P2P optimization by considering how vehicle batteries participate in energy trading while meeting charging requirements [20]. These models differ from stationary storage because EV availability is time-varying, user-dependent, and linked to transport behavior as well as electricity-market incentives.

Table 3 classifies peer-to-peer (P2P) trading models according to architecture, pricing or matching mechanisms, solution methods, EV integration, and network-constraint handling, highlighting how different approaches accommodate prosumer participation, electric vehicle interaction, and grid-aware coordination.

Table 3. Classification of P2P Trading Models

P2P model class	Architecture	Pricing or matching mechanism	Main solution method	EV integration level	Network-constraint treatment	Representative studies
Community microgrid trading	Centralized or platform-assisted	Local clearing price or negotiated exchange	Mathematical optimization	None or indirect	Usually simplified	[1, 27]
Bilateral P2P contracting	Decentralized	Bilateral contracts and preference-aware negotiation	Distributed optimization	Limited unless EV agents are modeled	Usually absent or add-on	[3, 5]
Consensus-based P2P market	Distributed	Iterative price and quantity agreement	Consensus algorithm	Possible but not central	Moderate when network constraints are coupled	[4, 6]
Game-theoretic P2P market	Decentralized strategic interaction	Utility-driven pricing, coalition benefits, strategic bids	Non-cooperative or cooperative game	Indirect unless EVs are strategic agents	Mostly economic abstraction	[11, 23, 25]

Blockchain-enabled P2P trading	Distributed ledger supported	Smart-contract settlement and transparent transaction rules	Optimization plus blockchain execution	Strong in charging-payment models	Usually limited unless linked to DSO constraints	[12, 13, 19]
Network-aware P2P trading	Hybrid market-DSO coordination	Network charges, loss allocation, electrical distance, congestion signals	Constrained optimization or tariff-based coordination	Possible but not always explicit	Stronger treatment of voltage, congestion, losses	[7-9, 21, 22]
EV-integrated P2P trading	Platform-assisted or decentralized	Charging prices, V2G compensation, local energy exchange	Optimization with EV constraints	Explicit charging and battery participation	Emerging and often partial	[19, 20]

Prosumer Flexibility

Types of prosumer flexibility

Prosumer flexibility in transactive energy and P2P trading models appears as temporal, spatial, strategic, and service-oriented capability. Temporal flexibility is represented through battery charging and discharging, flexible loads, and controllable import or export decisions, as shown in community battery energy sharing models [2]. Strategic flexibility appears when prosumers choose trading partners, price preferences, or willingness to participate in market mechanisms [5]. Service-oriented flexibility extends the role of prosumers from energy exchange to ancillary service provision and local grid support [26].

Modelling flexible loads and storage

Flexible loads and storage are typically modeled through constraints on energy balance, charging limits, capacity bounds, and intertemporal state transitions. Battery-based P2P sharing models explicitly show how storage shifts surplus photovoltaic generation across time and participants [2]. Prosumer participation frameworks expand this view by treating storage and demand flexibility as market resources that must be matched with incentives, rules, and compensation mechanisms [17]. Flexibility-market designs then formalize how prosumers can provide both trading and grid-support services within integrated local market structures [18].

Aggregation and disaggregation

Aggregation is used when individual prosumers are represented through collective portfolios, virtual microgrids, or community-level market agents. Virtual microgrid trading models show how distributed prosumers can be coordinated as a collective economic entity while still retaining agent-level decisions [25]. Coalition formation models similarly represent flexible aggregation as a strategic process in which participants form groups to improve trading outcomes [23]. Disaggregation remains important because participant-level constraints, preferences, and willingness to trade determine whether aggregated flexibility can actually be delivered [24].

Flexibility valuation and participation

Flexibility valuation depends on whether a model treats prosumers as passive price takers, strategic agents, or multi-service market participants. Motivational game-theoretic models emphasize that participation requires incentives aligned with individual benefits rather than only system-level cost reductions [11]. Peer-to-peer pricing models further show that

local prices influence whether prosumers prefer self-consumption, bilateral exchange, or grid transactions [27]. The taxonomy therefore distinguishes technical flexibility availability from market-participation readiness, because a controllable resource becomes useful only when the market design can activate it [18].

EV Coordination

EVs as flexible market participants

Electric vehicles introduce mobile, time-dependent flexibility into local energy markets because their availability depends on user travel behavior and charging needs. Blockchain-based EV trading and charging-payment systems model EVs as active agents that can buy, sell, or settle charging transactions in a P2P environment [19]. Optimized P2P trading systems with EV contributions further treat vehicle batteries as flexible assets that can support local balancing while satisfying energy requirements [20]. This makes EV coordination distinct from stationary storage, even when both are represented through battery constraints.

Smart charging and V2G representation

Smart charging models coordinate charging time, charging rate, and local energy exchange to reduce cost or improve system efficiency. EV-integrated P2P models commonly include charging-demand constraints, but only some formulations move toward bidirectional vehicle-to-grid participation [20]. When blockchain settlement is used, the EV trading model also requires secure payment and transaction verification in addition to energy optimization [19]. The taxonomy therefore separates unidirectional charging coordination from V2G-capable participation because the latter adds export decisions, battery degradation concerns, and stronger grid-service potential.

Aggregated EV flexibility

Aggregated EV flexibility can support local markets when many vehicles are coordinated through a platform, aggregator, or community trading mechanism. Multi-market nanogrid models show how flexible distributed assets can participate in both energy and ancillary service markets, a structure that can be extended to EV fleets when availability is aggregated [26]. Prosumer flexibility-market frameworks similarly indicate that distributed resources require coordination rules that connect individual constraints to market-level service commitments [18]. EV aggregation therefore fits between individual P2P exchange and system-level grid-service provision.

Mobility-aware trading limitations

Mobility-aware trading remains underdeveloped relative to stationary prosumer and storage models. Many P2P frameworks classify EVs as flexible batteries, but this simplification can ignore travel schedules, charging-location uncertainty, and user preferences [19]. EV contribution models improve this by including charging requirements within optimized local exchange, yet they still often focus more on electrical feasibility than transport-system coupling [20]. This gap suggests that future taxonomies should distinguish EV-presence models, EV-charging models, and fully mobility-aware EV market models.

Network Constraint Treatment

Voltage constraints

Voltage constraints are among the most important local-grid limitations because P2P trades can alter injections and withdrawals across low-voltage feeders. Decentralized P2P trading under network constraints explicitly embeds low-voltage network feasibility into the market-clearing problem [6]. Network-aware models with independent agents further seek to preserve local trading autonomy while respecting distribution-grid restrictions [22]. The taxonomy classifies

voltage treatment as absent, indirectly priced, approximately constrained, or explicitly constrained through power-flow relations.

Congestion and line limits

Congestion treatment varies from complete omission to explicit line-capacity management within local market optimization. Distribution network congestion management models connect the timing of P2P trades to feeder loading, showing that trade sequences can affect congestion outcomes [9]. Studies on local electricity markets and low-voltage grid operation further demonstrate that uncontrolled local trading may create operational stress if network impacts are ignored [21]. For this reason, congestion is classified separately from voltage, because a model may address one constraint without fully resolving the other.

Loss allocation and network charges

Loss allocation and network charges provide intermediate mechanisms between purely economic P2P trading and full grid-constrained optimization. Peer-to-peer trading models that consider power losses and network fees show how transaction costs can reflect grid usage without requiring every market participant to solve detailed power-flow equations [8]. Electrical-distance-driven trading similarly uses grid location as a signal to encourage trades that are more compatible with distribution-network operation [7]. These approaches are taxonomically important because they represent grid awareness through market signals rather than hard operational constraints.

DSO coordination and market feasibility

DSO coordination becomes necessary when local energy markets must guarantee that cleared trades are physically feasible. Network-constrained and independent-agent models show that preserving prosumer autonomy must be balanced with distribution-system security [6, 22]. Low-voltage grid operation studies indicate that local market designs can create both opportunities and risks depending on how the DSO interacts with the market layer [21]. The taxonomy therefore distinguishes models with no DSO role, passive DSO validation, active DSO constraint provision, and co-optimized market-grid operation.

Proposed Taxonomy

Taxonomy dimensions

The proposed taxonomy classifies transactive energy and P2P trading optimization models along four dimensions: market mechanism, flexibility treatment, EV coordination, and network-constraint integration. Market mechanism captures whether the model is centralized, decentralized, distributed, bilateral, auction-based, game-theoretic, coalition-based, or blockchain-enabled [3, 4, 12]. Flexibility treatment captures whether prosumers are modeled as passive agents, flexible demand, storage-enabled participants, strategic traders, or providers of grid services [2, 5, 18]. EV coordination and network constraints are separated because EV integration does not automatically imply voltage, congestion, or DSO feasibility treatment [19, 20].

Figure 1 presents the proposed multidimensional taxonomy linking market mechanisms, prosumer flexibility representation, EV coordination capability, and local distribution-grid constraint treatment in transactive energy and peer-to-peer trading optimization models.

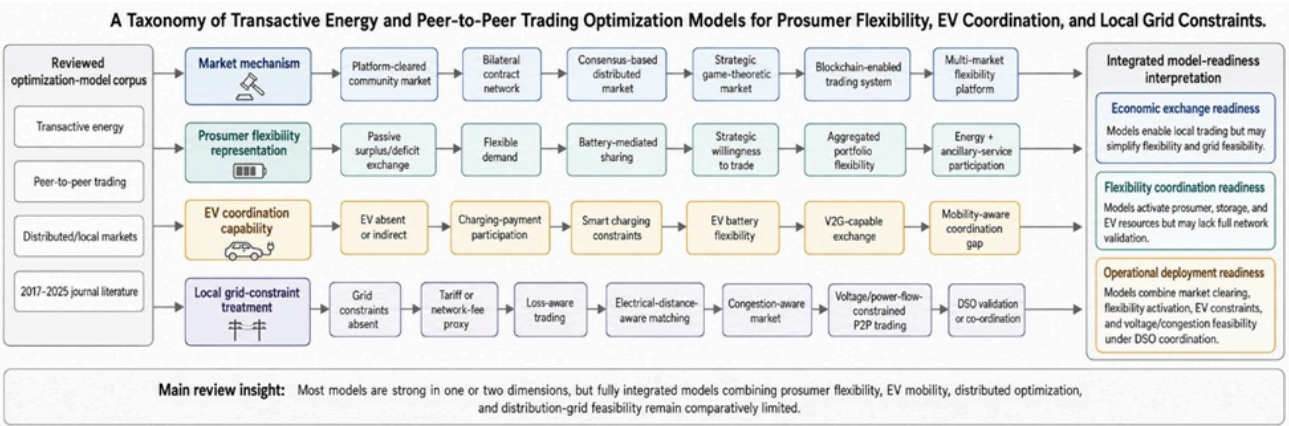


Figure 1. Multidimensional Taxonomy of Transactive Energy and Peer-to-Peer Trading Optimization Models

Model classes

The taxonomy identifies seven major model classes: platform-cleared community markets, bilateral contract networks, consensus-based distributed markets, game-theoretic strategic markets, blockchain-enabled trading systems, EV-integrated P2P systems, and network-aware local markets. Platform-cleared and bilateral models represent early structural alternatives for P2P exchange [1, 3]. Consensus, game-theoretic, and coalition-based models extend this structure by changing how agents coordinate and reveal preferences [4, 11, 23]. Blockchain-enabled, EV-integrated, and network-aware models then add settlement, mobility, and physical-grid dimensions to the basic trading problem [13, 19, 22].

Classification logic

The classification logic is hierarchical but non-exclusive, because a single model can combine several features. A blockchain-enabled EV charging-payment model, for example, belongs to the blockchain class because of its settlement architecture and to the EV-integrated class because charging is explicitly modeled [19]. A network-aware P2P formulation may also use decentralized optimization, meaning that it should be coded both by solution architecture and by grid-integration depth [6]. The taxonomy therefore uses a matrix rather than a linear typology so that hybrid models can be compared without forcing them into a single category.

Taxonomy matrix

Table 4 summarizes the complete taxonomy matrix and maps representative optimization models to flexibility, EV, and network-constraint dimensions. The matrix shows that reviews and broad frameworks provide conceptual integration, while many model-specific studies emphasize only one or two dimensions at a time [14–17]. Network-aware studies provide the strongest treatment of voltage, congestion, losses, and DSO coordination, but they do not always include EV mobility or multi-service flexibility [7–9, 22]. Conversely, EV-focused trading models integrate charging behavior but still require deeper coupling with distribution-grid constraints and flexibility-market operation [19, 20].

Table 4 presents a comprehensive taxonomy matrix for transactive energy and P2P trading optimization models, systematically mapping market mechanisms, coordination logic, prosumer flexibility, EV integration, and network-constraint handling, while indicating the depth of grid integration and representative studies to illustrate the landscape of research and practical implementations.

Table 4. Complete Taxonomy Matrix for Transactive Energy and P2P Trading Optimization Models

Taxonomy class	Market mechanism	Optimization or coordination logic	Prosumer flexibility treatment	EV coordination capability	Network constraint treatment	Grid integration depth	Representative references
Platform-cleared community market	Centralized or operator-assisted local trading	Market-clearing optimization	PV surplus, storage, demand shifting	Absent or indirect	Usually simplified	Low to moderate	[1, 2, 27]
Bilateral contract network	Decentralized direct exchange	Bilateral contract optimization	Preference-aware trading and contractual flexibility	Usually absent	Indirect unless extended	Low to moderate	[3, 5]
Consensus-based distributed market	Distributed P2P coordination	Iterative consensus and distributed clearing	Flexible supply and demand offers	Possible but not central	Can include network constraints	Moderate to high	[4, 6]
Strategic game-theoretic market	Non-cooperative or cooperative market	Game theory, incentives, coalition formation	Strategic willingness to participate	Usually indirect	Mostly economic abstraction	Low to moderate	[11, 23-25]
Blockchain-enabled P2P system	Distributed ledger supported trading	Smart contracts plus market optimization	Transactional flexibility and automated settlement	Strong when used for charging payment	Usually limited unless DSO-linked	Low to moderate	[12, 13, 19]
Multi-market flexibility platform	Coordinated energy and service market	Multi-objective or multi-market optimization	Energy, storage, and ancillary-service flexibility	Extendable to EV fleets	Partial through service signals	Moderate	[18, 26]
EV-integrated P2P trading	Local trading with mobile storage agents	Charging optimization, settlement, or V2G scheduling	EV battery and charging flexibility	Explicit	Emerging and often partial	Moderate	[19, 20]
Loss-aware and tariff-aware P2P trading	P2P market with network usage signals	Pricing, fee allocation, or loss-aware optimization	Flexible trades adjusted by network cost	Possible but not central	Losses and network charges	Moderate	[8]
Electrical-distance-	Locationally informed P2P matching	Distance-based	Location-sensitive	Usually absent	Electrical-distance proxy	Moderate	[7]

aware trading		matching or pricing	prosumer exchange				
Congestion-aware market	Local market linked to feeder loading	Congestion management and timing coordination	Flexibility used to manage loading	Possible but not central	Line congestion	High for congestion	[9, 21]
Fully network-constrained P2P market	DSO-aware or power-flow-constrained trading	Constrained optimization with grid feasibility	Flexibility constrained by voltage and line limits	Possible but underdeveloped	Voltage, congestion, and feasibility constraints	High	[6, 22]
Review and synthesis framework	Taxonomic or conceptual classification	Literature synthesis	Broad prosumer roles and market opportunities	Identifies EV as emerging dimension	Identifies grid constraints as research gap	Conceptual	[14-17]

Figure 2 summarizes the implementation gap between existing peer-to-peer trading optimization models and fully integrated local energy-market systems that jointly coordinate prosumer flexibility, EV participation, and distribution-grid feasibility.

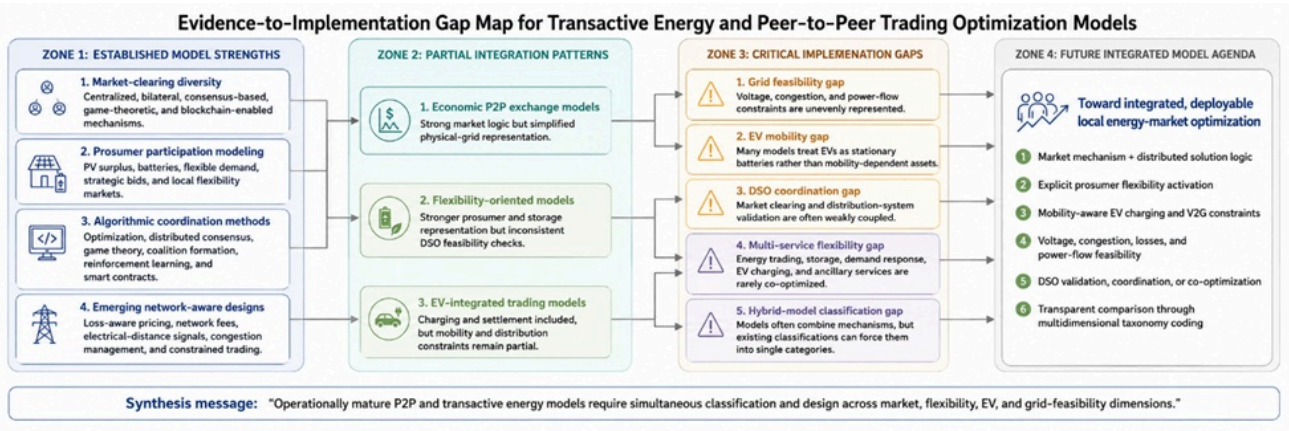


Figure 2. Evidence-to-Implementation Gap Map for Integrated, Grid-Aware, Flexibility-Oriented P2P Energy Markets

Conclusion

This taxonomy review classified transactive energy and peer-to-peer trading optimization models according to market mechanism, prosumer flexibility, EV coordination, and local grid constraint treatment. The central contribution is a structured matrix that connects market architecture with operational modeling depth. This helps distinguish models that merely enable local exchange from those that can coordinate flexibility and respect distribution-grid limits.

The review shows that many models are strong in one dimension but incomplete across the full set of taxonomy axes. Some models provide sophisticated market-clearing or strategic participation mechanisms, while others focus on blockchain settlement, EV charging, or network-aware feasibility. Fully integrated models that combine prosumer flexibility, EV mobility, distributed optimization, and voltage or congestion constraints remain comparatively limited.

The proposed taxonomy is useful for researchers, system designers, and local-market operators because it clarifies which modeling choices are appropriate for different implementation goals. Models intended for economic experimentation may not require detailed grid constraints, while models intended for operational deployment must include DSO coordination, voltage feasibility, congestion handling, or network-aware pricing. EV-enabled markets additionally require explicit treatment of charging windows, availability, and bidirectional participation.

Future research should develop integrated optimization models that connect local market clearing with flexibility activation, EV coordination, and distribution-grid security. Stronger links are also needed between decentralized solution methods and practical DSO validation processes. The taxonomy provides a foundation for comparing these future models systematically and for identifying where local energy-market designs remain technically or institutionally incomplete.

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References

- Zhang C, Wu J, Zhou Y, Cheng M, Long C. Peer-to-Peer energy trading in a Microgrid. *Appl Energy*. 2018;220:1-12.
- Long C, Wu J, Zhou Y, Jenkins N. Peer-to-peer energy sharing through a two-stage aggregated battery control in a community Microgrid. *Appl Energy*. 2018;226:261-76.

Morstyn T, Teytelboym A, McCulloch MD. Bilateral contract networks for peer-to-peer energy trading. *IEEE Trans Smart Grid*. 2018;10(2):2026-35.

Sorin E, Bobo L, Pinson P. Consensus-based approach to peer-to-peer electricity markets with product differentiation. *IEEE Trans Power Syst*. 2018;34(2):994-1004.

Morstyn T, McCulloch MD. Multiclass energy management for peer-to-peer energy trading driven by prosumer preferences. *IEEE Trans Power Syst*. 2018;34(5):4005-14.

Guerrero J, Chapman AC, Verbič G. Decentralized P2P energy trading under network constraints in a low-voltage network. *IEEE Trans Smart Grid*. 2018;10(5):5163-73.

Guerrero J, Sok B, Chapman AC, Verbič G. Electrical-distance driven peer-to-peer energy trading in a low-voltage network. *Appl Energy*. 2021;287:116598.

Paudel A, Sampath LP, Yang J, Gooi HB. Peer-to-peer energy trading in smart grid considering power losses and network fees. *IEEE Trans Smart Grid*. 2020;11(6):4727-37.

Zhou W, Wang Y, Peng F, Liu Y, Sun H, Cong Y. Distribution network congestion management considering time sequence of peer-to-peer energy trading. *Int J Electr Power Energy Syst*. 2022;136:107646.

Chen T, Su W. Indirect customer-to-customer energy trading with reinforcement learning. *IEEE Trans Smart Grid*. 2018;10(4):4338-48.

Tushar W, Saha TK, Yuen C, Morstyn T, McCulloch MD, Poor HV, et al. A motivational game-theoretic approach for peer-to-peer energy trading in the smart grid. *Appl Energy*. 2019;243:10-20.

Jiang Y, Zhou K, Lu X, Yang S. Electricity trading pricing among prosumers with game theory-based model in energy blockchain environment. *Appl Energy*. 2020;271:115239.

Esmat A, de Vos M, Ghiassi-Farrokhfal Y, Palensky P, Epema D. A novel decentralized platform for peer-to-peer energy trading market with blockchain technology. *Appl Energy*. 2021;282:116123.

Tushar W, Saha TK, Yuen C, Smith D, Poor HV. Peer-to-peer trading in electricity networks: An overview. *IEEE Trans Smart Grid*. 2020;11(4):3185-200.

Tushar W, Yuen C, Saha TK, Morstyn T, Chapman AC, Alam MJ, et al. Peer-to-peer energy systems for connected communities: A review of recent advances and emerging challenges. *Appl Energy*. 2021;282:116131.

Soto EA, Bosman LB, Wollega E, Leon-Salas WD. Peer-to-peer energy trading: A review of the literature. *Appl Energy*. 2021;283:116268.

Gržanić M, Capuder T, Zhang N, Huang W. Prosumers as active market participants: A systematic review of evolution of opportunities, models and challenges. *Renew Sustain Energy Rev*. 2022;154:111859.

Khorasany M, Gazafroudi AS, Razzaghi R, Morstyn T, Shafie-Khah M. A framework for participation of prosumers in peer-to-peer energy trading and flexibility markets. *Appl Energy*. 2022;314:118907.

Khan PW, Byun YC. Blockchain-based peer-to-peer energy trading and charging payment system for electric vehicles. *Sustainability*. 2021;13(14):7962.

Al-Sorour A, Fazeli M, Monfared M, Fahmy AA. Investigation of electric vehicles contributions in an optimized peer-to-peer energy trading system. *IEEE Access*. 2023;11:12489-503.

Dynge MF, del Granado PC, Hashemipour N, Korpås M. Impact of local electricity markets and peer-to-peer trading on low-voltage grid operations. *Appl Energy*. 2021;301:117404.

Tarashandeh N, Karimi A. Peer-to-peer energy trading under distribution network constraints with preserving independent nature of agents. *Appl Energy*. 2024;355:122240.

Tushar W, Saha TK, Yuen C, Azim MI, Morstyn T, Poor HV, et al. A coalition formation game framework for peer-to-peer energy trading. *Appl Energy*. 2020;261:114436.

Khorasany M, Razzaghi R, Gazafroudi AS. Two-stage mechanism design for energy trading of strategic agents in energy communities. *Appl Energy*. 2021;295:117036.

Anoh K, Maharjan S, Ikpehai A, Zhang Y, Adebisi B. Energy peer-to-peer trading in virtual microgrids in smart grids: A game-theoretic approach. *IEEE Trans Smart Grid*. 2019;11(2):1264-75.

Hu Q, Zhu Z, Bu S, Chan KW, Li F. A multi-market nanogrid P2P energy and ancillary service trading paradigm: Mechanisms and implementations. *Appl Energy*. 2021;293:116938.

An J, Lee M, Yeom S, Hong T. Determining the Peer-to-Peer electricity trading price and strategy for energy prosumers and consumers within a microgrid. *Appl Energy*. 2020;261:114335.