BLOCKCHAIN-BASED FULLY PEER-TO-PEER ENERGY TRADING STRATEGIES FOR RESIDENTIAL ENERGY SYSTEMS

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Abstract—Blockchain and peer-to-peer (P2P) are tightly linked when it comes to decentralization and autonomous transactions. To meet the financial and security needs of photovoltaic consumers, this paper develops a block chain-based P2P power transaction mechanism. A real-time and day-ahead P2P trading mechanism has been developed. In the day-ahead market, the open P2P trading mode and the decentralized electricity pricing system are used, while in the real-time market, the P2P pool trading mode and the electricity price mechanism based on the supply/demand ratio are used. Additionally, Ethereum-based smart contract rules are intended to guarantee the platform's safe operation and effective intelligence. Prosumers can provide a declaration to the P2P blockchain platform detailing their own electricity consumption based on the P2P mechanism of the blockchain intelligence platform's prosumer contract.

For establishing stable and dependable routes in heterogeneous multi-hop wireless networks, we propose E-STAR in this paper. E-STAR combines energy-aware and trust-based routing protocols with payment and trust systems. The payment system charges packet senders and rewards nodes that relay other people's packets. The trust system uses multi-dimensional trust values to assess the competence and dependability of the nodes in relaying packets. For use in routing decisions, the trust values are attached to the public-key certificates of the nodes.

I. Introduction

A. P2P POWER TRANSACTION

THE exchange of electricity between individuals or organizations without the involvement of a centralized utility company is referred to as peer-to-peer (P2P) power transactions. Blockchain technology and smart contracts make it possible to conduct this kind of transaction. There are a number of advantages to peer-to-peer power transactions, including the capacity to cut costs and boost energy distribution efficiency. They also make it possible to integrate renewable energy sources into the grid and give customers more control over how much energy they use. A blockchain platform connects the participants in a P2P power transaction, allowing them to exchange energy credits or tokens that represent the amount of energy they are purchasing or selling. The use of smart contracts to automate the buying and selling of energy ensures that transactions are transparent and secure. Power Ledger is one platform for peer-to-peer power transactions. Using blockchain technology, it enables individuals and businesses to trade electricity with one another. We Power is another illustration, enabling producers of renewable energy to sell their excess energy directly to consumers. In general, peer-to-peer power transactions have the potential to upend the conventional energy sector and give consumers more control over how much energy they use and how much it costs.

B. PEERS-TO-PEER ENERGY TRADING

Peer-to-peer energy trading is a type of energy trading in which individuals or businesses can buy and sell energy directly with one another without using utility companies as intermediaries. The utilization of cutting-edge digital technologies like blockchain and smart contracts, which make it possible for parties to carry out transactions that are both secure and transparent, makes this kind of trading feasible. Participants in a peer-to-peer energy trading system can use renewable energy sources like wind turbines or solar panels to generate their own energy and sell any excess energy to other network members. As a result, communities and individuals can become more energy independent and less dependent on traditional energy providers. Peer-to-peer energy trading has the potential to cut down on energy costs by eliminating the middleman and allowing participants to directly negotiate prices with one another. This can likewise boost the improvement of environmentally friendly power sources, as people can bring in cash by selling the overabundance energy they create. Peer-to-peer energy trading faces a number of obstacles, including the requirement of a secure and dependable digital infrastructure, regulatory obstacles, and an ample number of participants to ensure the system's viability. Peer-to-peer energy trading has the potential to change the energy industry and make it possible for a more decentralized and sustainable energy future despite these obstacles.

C. BLOCKCHAIN

The digital ledger technology known as blockchain makes it possible to keep records of transactions or data in a secure and open manner. The data are protected by cryptography, and the ledger is maintained by a decentralized computer network known as nodes. The fundamental idea behind blockchain is to develop a tamper-proof, decentralized system in which transactions can be recorded and verified without a centralized authority. Cryptographic methods, distributed computing, and consensus algorithms are used together to accomplish this. Bitcoin, a blockchain-based digital currency that uses blockchain technology to record all transactions, is the most well-known application of blockchain technology. Beyond crypto currency, however, blockchain technology has numerous potential applications in supply chain management, voting systems, and digital identity management. There are public, private, and consortium (or hybrid) blockchain among the many types of blockchain. While private blockchain are only accessible to authorized users, public blockchain are accessible to anyone. Consortium blockchain, which combine the two, are utilized for multi-organization collaborations. By making it possible for transactions and record keeping being secure, transparent, and efficient, blockchain technology has the potential to transform numerous industries.

II. LITERATURE REVIEW

A. QUANTIFYING MARKET EFFICIENCY IMPACTS OF AGGREGATED DISTRIBUTED ENERGY RESOURCES

Khaled Alshehr and others , has proposed in his paper that distributed energy resources (DERs) can participate in wholesale electricity markets by aggregating them through a profit-maximizing intermediary. In particular, we investigate the extent to which the profit-maximizing nature of the aggregator counteracts the market efficiency benefits brought about by the widespread implementation of DERs. To investigate the strategic interactions between an aggregater and DER owners, we employ a game-theoretic framework. The stochastic nature of the DER supply is taken into account by the proposed model. In order to measure the efficiency loss caused by the aggregator's strategic incentives, we explicitly describe the game's equilibrium and provide examples. The effects of uncertainty and the amount of DER integration on market efficiency as a whole are shown by our numerical experiments. According to our research, there are arguments about which design is best for incorporating DERs into wholesale electricity markets. Should they be combined by third-party, for-profit aggregators, perhaps in competition for the wholesale electricity market's supply of prosumers? Or, in order to leverage the supply capacities of resources at the grid-edge, should a non-profit organization, such as an independent distribution system operator, be established? We have provided a framework for quantifying the advantages of various design choices, despite the fact that the debates themselves are beyond the scope of this paper.

B. MULTI-AGENT BASED TRANSACTIVE ENERGY MANAGEMENT SYSTEMS FOR RESIDENTIAL BUILDINGS WITH DISTRIBUTED ENERGY RESOURCES

M. S. H. Nizam and others This paper proposes that proper management of building loads and distributed energy resources (DER) can provide grid assist services in transactive energy (TE) frameworks and save consumers money. However, the majority of TE models require external entities (such as Aggregators) to manage building loads and DER units, and in some instances, consumers are required to provide crucial information about their electricity demand and usage, compromising their privacy. To address the grid overloading and optimize building costs, this paper introduces a transactive energy management framework for residential neighborhood buildings. Using a multiagent system architecture, the energy management system achieves decentralized coordination while still protecting consumers' privacy and giving them full decision-making authority. A brand-new event-triggered transactive market algorithm is developed in which active consumers' energy supply flexibility is procured by the regional grid operator to prevent transformer overloading, and buildings trade energy to maximize profits. For residential buildings, a two-step energy management system that participates in the real-time transactive market to maximize profits schedules building loads and DER units in the day ahead stage to minimize consumer costs and inconveniences. The degradation of residential storage devices for energy trading is included in the development of an optimal bidding model for the buildings. The effectiveness of the proposed method for effective mitigation of transformer overloading at a cost that is negligible in comparison to the cost of replacing the transformer is demonstrated by case studies and analyses utilizing actual building data and electricity tariff from Australia. Additionally, the findings indicate that the proposed system has the potential to save consumers between 15 and 20 percent in terms of costs while minimizing their inconveniences and the degradation of storage devices. This paper proposes a transactive energy management framework based on MAS to prevent grid overloading.

C. OPTIMAL ENERGY MANAGEMENT OF ALL-ELECTRIC RESIDENTIAL ENERGY SYSTEMS IN THE NETHERLANDS

Tom Terlouw and others This paper proposes that all-electric energy systems are a promising alternative to energy systems that use natural gas. As a result, the goal of this paper is to demonstrate a straightforward approach for identifying all-electric demand profiles. Following that, these demand profiles are utilized in an optimization problem by incorporating battery electric vehicles (BEVs) and electricity storage in the form of lithium-ion batteries. In addition, various approaches to sizing lithium-ion battery systems are contrasted. The findings demonstrate that while the Photovoltaic Self-Consumption (PVSC) ratio remains high, optimal sizing may reduce the already installed storage capacity per household, thereby lowering investment costs. In order to increase the economic viability of all-electric system layouts, it is therefore recommended to make use of battery systems that are the right size. When a large number of BEVs are included in the transition to all-electric energy systems, large peak absorption peaks occur on the grid. ce. IV. Conclusions This paper began by offering a method for developing all-electric demand profiles for Dutch households. Following that, an optimization framework employs these demand profiles, including BESS and BEV. From a techno-economic point of view, various approaches to sizing the BESS are proposed and compared.

2.4 ELECTRICITY MARKET DESIGN FOR THE PROSUMER ERA

et al., Parag. Prosumers are agents that both produce and consume electricity, as this paper proposes. Prosuming presents the opportunity for consumers and vehicle owners to reevaluate their energy practices with the growth of small and medium-sized agents using solar photovoltaic panels, vehicle-to-grid, smart-meters, electric automobiles, home batteries, and other "smart" devices. The electric utility industry of today will likely undergo significant changes over the coming decades as the number of prosumers grows. These changes will offer opportunities for the system to become more ecologically friendly, but they will also bring with them a lot of unknowns and risks that need to be identified and managed. Policymakers and planners require knowledge of how prosumers could be effectively and efficiently integrated into competitive electricity markets in order to develop future strategies. Grid integration for prosumers, peer-to-peer models for prosumers, and community groups for prosumers are the three promising potential markets we identify and discuss here. We also provide a number of disclaimers and complexities to discourage optimism. We argued in this Perspective that at least three engagement platforms and models could be used to integrate prosumers into the energy system.

D A COMMUNITY-BASED ENERGY MARKET DESIGN USING DECENTRALIZED DECISION-MAKING UNDER UNCERTAINTY

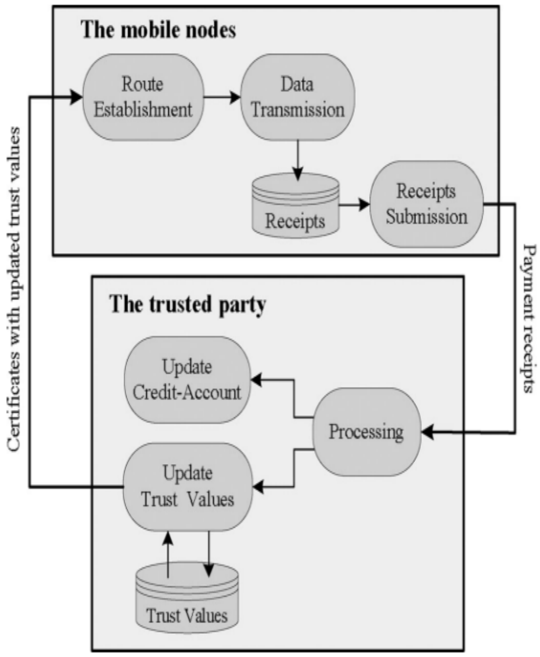
Jose L et.al. In order to improve the sustainability and efficiency of energy systems, it has been proposed in this paper to shift to a user-centric approach. In the energy transition, massive integration of new economic agents like prosumers and mobile or stationary storage will be crucial. A design for a community-based local energy market (CB-LEM) that allows members to trade energy through a local pool is presented in this paper. A Community Manager (CM) is in charge of coordinating the day-ahead pricing. The fact that each agent participates in determining the local market price while also deciding on its own scheduling issue in the face of uncertainty regarding the generation and storage of renewable energy is a novel aspect of this work. In order to complete the proposed design, real-time operation and ex-post settlement of the local market by the CM are also explained following day-ahead clearing.

3. EXISTING SYSTEM

For determining the bilateral trading preferences of households participating in a fully Peer-to-Peer (P2P) local energy market, this paper proposes two novel approaches. The participants' demand for surplus power is the foundation for the first strategy, while the network distance is the foundation for the second. For each strategy, the price and quantity of energy traded are evaluated in light of the bilateral trading preferences. A decentralized completely P2P energy exchanging market is created to produce the outcomes in a day-ahead setting. In addition, the decentralized P2P trading market is implemented on a digital platform using a permissioned blockchain-smart contract platform. The simulations make use of actual data from a residential neighborhood in Amsterdam, Netherlands, with a variety of distributed energy resources. All P2P trading participants' grid interactions and energy procurement costs are lower in the two strategies than in the baseline scenario, according to the findings.

4. PROPOSED SYSTEM

As a secure protocol for establishing stable and dependable routes in HMWNs, we propose E-STAR in this paper. A trust-based and energy-aware routing protocol is combined with the trust and payment systems of E-STAR. E-STAR aims to locate and select the best nodes for routing. Credits, or micropayments, are used in the payment system to charge nodes that send packets and reward relaying nodes. An offline trusted party is required to manage the credit accounts of the nodes because a trusted party (TP) may not participate in the communication sessions. Receipts, or proofs of relaying packets, are created by the nodes and sent to TP. The installment framework can animate the egotistical hubs to transfer others' bundles to acquire credits. By rewarding the nodes that relay more packets, such as those at the network center, it can also enforce fairness. However, the payment system is not enough to guarantee the stability of the route. It may motivate rational nodes not to break routes in order to acquire credits, but routes may still be broken for other reasons. Low resources, node failure, and malicious attacks are examples of these causes. Public key authentication, electronic commerce, decision-supporting tools, and more are just a few of the many uses for trust systems. To evaluate the nodes' trustworthiness, competences, and dependability when relaying packets in HMWNs, trust management is essential. The purpose of ESTAR's integration of the routing protocol with payment and trust systems is to improve the stability and dependability of the route; A multidimensional trust system based on processing payment receipts is what we propose; ESTAR encourages nodes to not only relay other people's packets even if they have a lot of credits, but also to stabilize the routes and accurately report their energy capability to increase their chances of participating in future routes. To establish stable routes, we propose energy-aware and trust-based routing protocols. ESTAR, in contrast to the majority of the schemes that are currently in use, aims to identify and select the beneficial nodes for routing.

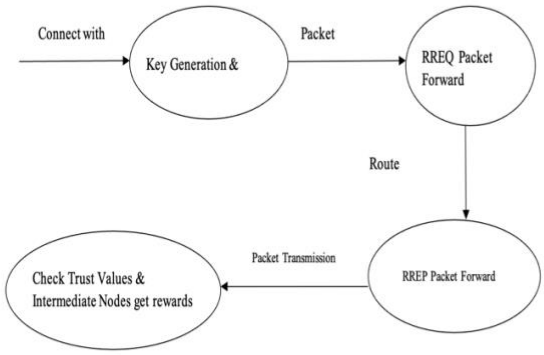


4.1 DATA TRANSMISSION PHASE

Messages are sent from the source node to the destination node. Through a route that includes the intermediate nodes NX, NY, and NZ, allow the source node NS to send messages to the destination node ND. For the ith information parcel, NS figures the mark S(i)= {H(H(mi), ts, R,i)} KS+ and sends the bundle < R, ts, I, mi , jS (I) > to the principal hub in the course. R, ts, and mi are the ith message, the route establishment time stamp, and the concatenation of the identities of the route's nodes (R = IDS, ID X, ID Y, IDZ, and IDD, respectively). H (d) is the hash esteem came about because of hashing the information d utilizing the hash capability H () :{ the signature of d using the private key of NS is d K S +. By allowing TP to verify that NS has sent i messages, the purpose of the source node's signature is to guarantee the payment and ensure the message's authenticity and integrity. For the purpose of creating the receipt, each intermediate node verifies j S (i) and stores jS (i) and H (mi). Due to the fact that jS (i) is sufficient to demonstrate the transmission of i messages, it also removes the previous ones (j S (i - 1) and H (mi - 1)). Because the smaller-sized H (mi) is attached to the receipt rather than mi, signing H (mi) rather than mi can reduce the size of the receipt. The destination node creates a one-way hash chain by iteratively hashing a r and om value hS S times to produce the hash chain h S,hS - 1,...,h 1,h0, where h i- 1 = H (h i) for 1 = i = S and h0 is referred to as the hash chain's root. In order to link the hash chain to the route and authenticate it, the node sends the signature to the source node during the route establishment phase.

4.2 UPDATE CREDIT-ACCOUNT AND TRUST VALUES PHASES

The trust values of the nodes are updated and the charges and rewards of the nodes



are determined by TP. Before using the receipt's unique identifier (R, ts), TP first determines whether it has been processed. After that, it computes and hashes the signatures of the nodes to confirm the legitimacy of the receipt. If the hash value of the result is the same as the cryptographic token on the receipt, then the receipt is valid. By ensuring that hashing hi times result in s h0, TP verifies the destination node's hash chain. TP clears the receipt by remunerating the halfway hubs and charging the source and objective hubs. The number of hashing operations required to derive h0 from hi can be used to calculate the number of delivered messages and the number of sent.

Messages that have been signed by the source node.

4.3 ROUTE ESTABLISHMENT PHASE

The best available route and the shortest reliable route are the two routing protocols discussed in this section. In the BAR protocol, the destination node chooses the best route, whereas SRR determines the shortest path that can satisfy the trust, energy, and path-length requirements of the source node. There are three processes in the routing protocols: 1) delivery of the route request packet (RREQ); 2) Selecting a route; and 3) delivery of the route reply packet, or RREP.

5. CONCLUSION

In order to establish stable and dependable routes in HMWNs, we have proposed E-STAR, which makes use of payment/trust systems and a trust-based and energy-aware routing protocol. E-STAR encourages the nodes to relay other people's packets and to keep the route stable. It also reduces the likelihood that the routing protocol will select the nodes that report an incorrect energy capability. We evaluated the over-head and route stability of the proposed SRR and BAR routing protocols. By taking into account a variety of factors, such as the route length, the route reliability determined by the nodes' previous behavior, and the route lifetime determined by their energy capability, our protocols are able to make well-informed decisions regarding routing. SRR creates routes that can satisfy the energy and trust requirements of source nodes. It is useful for establishing low-overhead routes that avoid low-trust nodes, such as malicious nodes. Destination nodes create the most dependable routes for BAR, but they incur more overhead than SRR. E-STAR is able to secure the payment and trust calculation without making false accusations, as the analytical results have shown. In addition, the simulation results have shown that by establishing stable routes, E-STAR can boost the packet delivery ratio.

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