Hindawi
Journal of Sensors
Volume 2023, Article ID 9862857, 1 page
https://doi.org/10.1155/2023/9862857

Retraction

Retracted: Automatic Demand Response Method for the Energy Storage Resource System Based on the Blockchain Technology Combined with Sensors

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Xie, Y. Xu, Q. Yu, C. Hong, L. Zhang, and M. A. Shah, "Automatic Demand Response Method for the Energy Storage Resource System Based on the Blockchain Technology Combined with Sensors," *Journal of Sensors*, vol. 2022, Article ID 9101849, 10 pages, 2022.

Hindawi
Journal of Sensors
Volume 2022, Article ID 9101849, 10 pages
https://doi.org/10.1155/2022/9101849

Research Article

Automatic Demand Response Method for the Energy Storage Resource System Based on the Blockchain Technology Combined with Sensors

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Received 14 December 2021; Accepted 23 February 2022; Published 29 March 2022

Academic Editor: Pradeep Kumar Singh

In order to improve the efficiency of the automatic demand response of the energy storage resource system, a user authentication and key agreement scheme for wireless sensor networks based on blockchain is proposed. The user does not need to register with the gateway node. As the light node of the blockchain network, the two can directly authenticate each other. The user obtains the public information of the sensor node from the blockchain through the client and verifies its legitimacy. It solves the problem that the traditional wireless sensor network user authentication scheme cannot be applied to the distributed Internet of things environment and the authentication process is low in security and efficiency. Mode 1 is the disordered charging mode. The charging facility provides continuous constant power charging service for the connected response subject until the user leaves. If the response subject is full before this, the charging will stop. Mode 2 is the BADR operation mode under charging optimization only, that is, the V2G function of PEV is not considered. In this case, $0 \leq P_{l,k} \leq P_l^{\max\ c}$. Mode 3 is the BADR operating mode with V2G functionality in mind. The ELN load characteristics under the above three operating modes are discussed, respectively. Calculate and compare with economy on both sides of supply and demand. The experimental results show that the discharge compensation coefficient will not affect mode 2. In mode 3, as the compensation coefficient increases (from 0.4 to 1.2 at intervals of 0.2), the average total cost of the PEV cluster continues to decrease and the average total cost of the energy local network (ELN) system increases monotonically. Comparing the curves of the economic impact of the compensation coefficient on both sides of mode 2 and mode 3, it can be seen that the reasonable setting of the compensation coefficient is one of the key parameters for controlling the distribution of benefits. It proves that the proposed blockchain-based automated demand response (BADR) method can not only meet the satisfaction of energy demand but also coordinate the available energy storage resources in the system, so that the load level curve can track the output of new energy to the greatest extent and improve the balance between supply and demand of the system, which is suitable for a large-scale decentralized energy storage system.

1. Introduction

Most of the current Internet of things systems use a centralized architecture, and the central server stores and processes the data of the terminal equipment. However, with the continuous increase of the Internet of things terminal equipment, the amount of data information is also increasing, which has increased the burden on the central server, making its processing speed slower [1]. At present, under this centralized architecture, the device authentication scheme of the Internet of things is mainly based on symmetric keys and public key cryptosystems. The former has key management problems, while the latter requires a trusted third party, which is easy to cause a single point of failure and internal tampering attacks [2]. As shown in Figure 1, in this scheme, the blockchain network acts as the network layer of

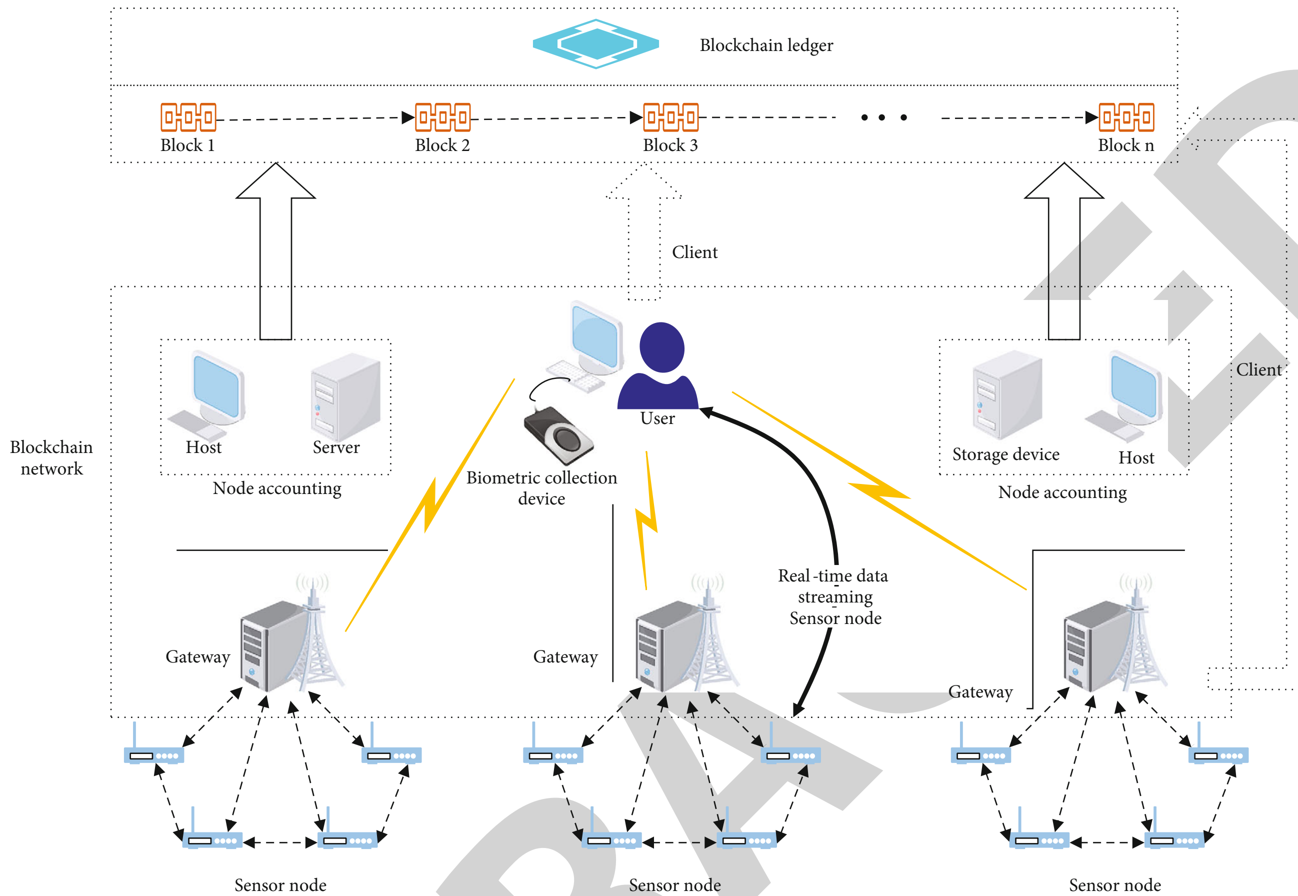

Figure 1: Architecture diagram of the scheme system.

the Internet of things, consisting of servers, storage devices, gateway nodes, and user devices. Servers and storage devices are ledger nodes that hold and synchronize the complete blockchain ledger. Gateway nodes and user devices are light nodes that use clients to interact with the blockchain network without having to keep and synchronize full ledgers. Meanwhile, the sensor node writes its public information for identity authentication to the blockchain ledger through the gateway node; for the wireless sensor network (WSN) as the perception layer of the Internet of things, its existing user authentication schemes cannot meet the requirements of large-scale Internet of things systems. At the same time, authentication schemes in a multigateway environment all need to rely on a trusted third party or gateway node and the authentication process needs to transfer information between multiple gateways, which is complicated in the interaction process [3]. On the basis of the current research, a blockchain-based wireless sensor network user authentication and key agreement scheme is proposed. The user does not need to register with the gateway node. As the light node of the blockchain network, the two can directly authenticate each other. The user obtains the public information of the sensor node from the blockchain through the client and verifies its legitimacy. It solves the problem that the traditional wireless sensor network user authentication scheme cannot be applied to the distributed Internet of things environment and the authentication process is low in security and efficiency.

2. Literature Review

The study on multienergy demand response mainly focuses on modeling and optimization analysis. Lucas et al. established a two-stage stochastic demand side management model for a commercial microgrid considering the comprehensive price mechanism and discussed the influence of BES and PEV configurations on system operating cost [4]. Tao et al. put forward an ADR method based on the mixed integer programming architecture to realize energy management of smart homes by comprehensively considering the dynamic electricity price model and user satisfaction constraints, and the results show the effectiveness of this centralized control method in reducing electricity cost and peak shaving [5]. Wu et al. built the optimized operation framework of a microgrid with PEV of logistics distribution as the optimization object and realized the suppression of RES output fluctuation with the goal of minimizing the total operating cost of the system [6]. Jindal et al. used the deep learning model to study the operation strategy of multienergy systems and used the flexible load control technology to improve the willingness of users to participate in demand response [7]. Zhou et al. studied the optimization problem of using the energy storage system to compensate for the fluctuation of the distributed photovoltaic output [8]. Kang et al. studied the multienergy system of source-load interaction from the perspective of price mechanism. By combing

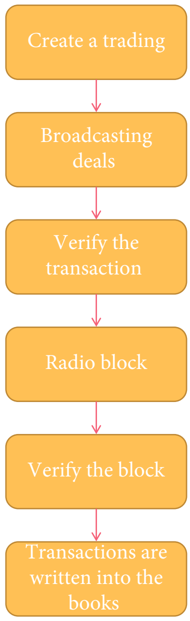

FIGURE 2: Working principle of blockchain.

the application and development of the cutting-edge automatic demand response technology, energy storage technology, information and communication technology, power metering technology, intelligent control technology, and load aggregation technology in the multienergy field, it provides reference for the research on the supporting technology of demand response and promotes the smooth progress of demand response [9]. Lopez-Rodriguez and Hernandez-Tejera established different response evaluation systems, which can quantitatively calculate the response effect according to the user's response and reduce the uncertainty of user response by limiting the participation of users with poor response effect [10]. Li et al. proposed a security model and protocol based on blockchain, which can be applied to WSN to ensure the validity and integrity of password authentication data and the peer-to-peer trust level from the beginning to the end of the network life cycle [11]. Zhang et al. proposed a security authentication mechanism based on blockchain, which can be applied to WSN with limited computing, storage, and energy, so that sensor nodes can safely move from one cluster to another [12]. Subsequently, Liang et al. proposed to apply the blockchain and smart contract technology to the identity authentication of Internet of things devices and designed a distributed system called trust bubble. Each bubble is a secure virtual area, and the devices in this area can conduct mutual identification authentication [13]. Xu et al. proposed an adaptive authentication and authorization scheme for Internet of things gateway based on blockchain, which mainly authenticates and authorizes devices at the gateway level and can add Internet of things devices without any physical intervention [14]. Zou et al. applied the blockchain technology and zero-knowledge proof to the smart meter system, proposed how to prove their identity by not disclosing information such as public keys, and studied how to enhance the anonymity of the blockchain to protect privacy [15]. Chen et al. designed a distributed trust model of the Internet of things based on the blockchain, with a built-in reputation mechanism. Without going through the traditional blockchain delay, end-to-end trust between Internet of things devices can be realized without relying on any common trust root, as shown in Figure 2 [15]. Chen et al. combined the blockchain technology with the sensor-based PUF authentication mechanism to ensure that the transactions between users and Internet of things devices, such as commands, status, alarms, and actions, cannot be changed through a nonmining consensus mechanism [16]. This paper is aimed at the ELN system with PEV cluster, pv power generation system, and BES, to achieve the internal independent supply and demand balance of the ELN system with high-permeability RES and improve the RES absorption level, to explore an ADR solution based on the block chain technology for the energy storage system (ESS) composed of PEV cluster and BES.

3. Application of Blockchain in the System

3.1. ELN under the Blockchain

3.1.1. Nodes and Its Operation Mode. Since the blockchain itself is attached to the node, determining the node is one of the prerequisites for using the blockchain technology. Battery energy storage (BES) and pure electric vehicle (PEV) clusters are part of the energy storage system, and the difference calculation unit between them and the smart meter is regarded as a node in the automatic demand response (ADR) project. Nodes are divided into full nodes and light nodes. Since the amount of information in the blockchain in this study is relatively small and can be reset regularly, all nodes in the energy storage system are set as full nodes. The full node has computing power, but only the balance calculation unit comes with a smart meter that can measure the real-time power of the ELN system [17].

In the node, supposing that the scale of PEV is n, the set is N and the response body set composed of the PEV cluster and BES is N^+. BES can be regarded as a special type of "PEV power battery" with all-time access and no travel power demand. When $i \le n$, the responding subject refers to the PEV power battery. When $i > n$, the response body refers to BES.

For $\forall i \in N^+$, its state space is expressed as follows:

$$X_i = \left[T_i^{\text{in}}, T_i^{\text{left}}, S_i^{\text{ini}}, S_i^E, Q_i^{\text{nom}}, P_i^{\max c}, P_i^{\max d}\right]. \quad (1)$$

In the formula, $T_i^{\text{in}}, T_i^{\text{left}}$ represent the time when the responder i connects to the ELN and the expected leave time, respectively. S_i^{ini}, S_i^E represent the initial state of charge (SOC) of the response body and the expected SOC when leaving the ELN, respectively. SOC represents the ratio of battery residual energy to battery capacity; therefore, $0 \le S_i^{\text{ini}} \le 1$, $0 \le S_i^E \le 1$. Q_i^{nom} represents the energy storage capacity of the response body. $P_i^{\max c}, P_i^{\max d}$ represent the rated charge and discharge power, respectively.

Node information mainly includes the IP address, private key, public key, power adjustment scheme, blockchain, information temporary storage database, response body information database, and charging and discharging information database, where the information temporary storage database is used to temporarily store the received information. The charge and discharge information database is used to store the charge-discharge status and charge-discharge power of all nodes. The response body information database stores the state space parameters of all networked nodes [18].

The operation of the node follows the following rules:

(1) When a response body enters the network, it will become a new node with its own IP address and calculate and generate its own private key and public key

(2) After the response body accesses the network, it uploads its parameters to the response subject information database, broadcasts them to the whole network together with the public key, and downloads the blockchain and response body information database from other nodes of the node network [19]

(3) Each node creates an empty block at intervals of Δt

(4) With the help of the real-time power provided by the smart meter, the difference calculation unit calculates and saves the compensation demand at intervals of Δt and broadcasts it to the entire network

(5) After receiving the new compensation demand, each node independently responds to the system demand according to formula (2) in combination with its own situation to form a power adjustment scheme

$$P_{i,k+1} = P_{i,k} + \varphi_i(\mathrm{UL}_{i,k} - P_{i,k}\mathrm{vPTR}_k). \tag{2}$$

In the formula, φ_i is a parameter that affects the convergence speed of the algorithm. $\mathrm{UL}_{i,k}$ represents the charge/discharge urgent level parameter of the response body i in the k period. vRTP_k represents the virtual price signal in the k period.

3.1.2. Block Structure. As mentioned before, the blockchain is a data ledger shared by all nodes, which is formed by linking blocks from beginning to end in chronological order. Every node encapsulates the received transaction data and codes at intervals of Δt into a data block with a time stamp and links it to the current longest main blockchain to generate the latest block. A new block contains two main parts: block header and block body. The block header encapsulates the version number of the current block, the address of the previous block, the time stamp, the Merkle root, and the system compensation demand corresponding to the period [20]. The block body encapsulates the binary Merkle tree and transaction database containing the energy interaction information and the corresponding hash value. Since the node of the block chain in this paper is full nodes, all hash value branches in the block body are reserved. The lowest hash value branch corresponds to each transaction in the transaction database. In addition to the transaction object and transaction content, the transaction also contains an embedded smart contract corresponding to the transaction.

3.2. Decentralized BADR Process. For example, if the current SOC level of a certain response body is higher, it will be more willing to participate in the needs of the response system V2G (vehicle to grid) and have greater response ability than others with lower SOC levels. On the other hand, when a response organization approaches the expected time of leaving the network, the response speed required by the response organization to the response system (V2G) will also be reduced compared with those of other response organizations expected to leave the network later [21]. Taking into account that the system compensation has two states, positive and negative, the charge and discharge urgent levels are used to characterize the ability of response body to compensation requirements of the system G2V (grid to vehicle) and V2G.

For mobile energy storage PEV, when the system has V2G requirements, that is $P_k^{\mathrm{com}} < 0$, its urgent level can be characterized according to the current amount of electricity that still needs to be replenished and the remaining time to connect to the network, shown as follows:

$$\mathrm{UL}_{i,k}^{\mathrm{V2G}} = \frac{P_i^{\max}\,{}^{c}\eta_{i,k}^{p}\left(T_i^{\mathrm{left}} - T_k\right) - E_{i,k}}{Q_i^{\mathrm{nom}}}. \tag{3}$$

In the formula, T_k represents the current k period. $E_{i,k}$ represents the energy that the responder i still needs to supplement in the k period. The characterization form is $E_{i,k} = (S_i^E - S_{i,k})Q_i^{\mathrm{non}}$, where $S_{i,k}$ represents the SOC level of the responder i in the k period. $\eta_{i,k}^p$ represents the power exchange efficiency, which is related to the power exchange direction: when $P_{i,k} \geq 0, \eta_{i,k}^p = \eta^{c,\mathrm{PEV}}$. When $P_{i,k} < 0$, $\eta_{i,k}^p = 1/\eta^{d,\mathrm{PEV}}$. Where $\eta^{c,\mathrm{PEV}}$ and $\eta^{d,\mathrm{PEV}}$ represent the charge and discharge efficiencies of PEV batteries, respectively [22].

From a logical point of view, if the V2G urgent level of a response body is very high, then, it will in turn be more inclined to be unwilling to accept G2V charging power. Therefore, when G2V power ($P_k^{\mathrm{com}} \geq 0$) is required, the urgent level of PEV of the ith vehicle in the k period can be defined as follows:

$$\mathrm{UL}_{i,k}^{\mathrm{G2V}} = \frac{1}{\mathrm{UL}_{i,k}^{\mathrm{V2G}}}. \tag{4}$$

In particular, considering that the BES in the system will always be connected to the network, there is no concept of expected off-grid time. Therefore, the urgent level of charging and discharging of the BES is only determined by its current remaining power:

$$\begin{aligned} \mathrm{UL}_{i,k}^{\mathrm{V2G}} &= S^{\max,\mathrm{BES}} - S_{i,k}, \\ \mathrm{UL}_{i,k}^{\mathrm{G2V}} &= S_{i,k} - S^{\max,\mathrm{BES}}. \end{aligned} \tag{5}$$

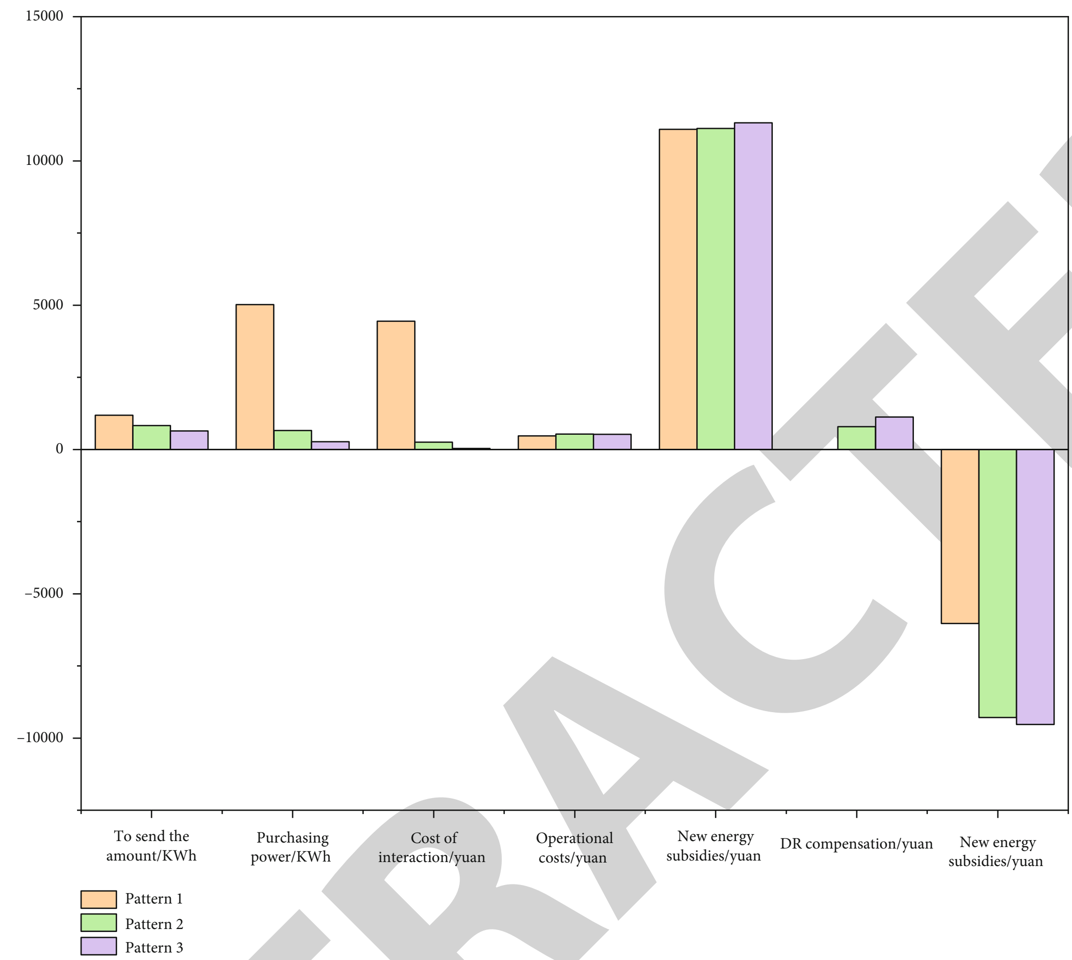

FIGURE 3: Economic data statistics.

In order to ensure that the response body such as mobile energy storage PEV can reach the desired SOC level during the expected off-grid time, consider using battery thresholds to measure whether the response body needs to respond to system compensation requirement P_k^{com} [23].

$$\phi_{i,k}^{\mathrm{resid}} = \frac{E_{i,k}}{P_i^{\max c} \eta_{i,k}^{p} \left(T_i^{\mathrm{left}} - T_k \right)}. \tag{6}$$

It can be seen from the formula that $\phi_{i,k}^{\mathrm{resid}} = 0$ represents that the energy storage PEV has been fully charged. $\phi_{i,k}^{\mathrm{resid}} = 1$ means that the vehicle can still be fully charged if the vehicle continues to be charged before leaving the grid. In order to ensure the needs of mobile energy storage PEV users, consider setting a threshold (ϕ^{TH}), when the following formula holds:

$$0 < \phi_{i,k}^{\mathrm{resid}} \leq \phi^{\mathrm{TH}}. \tag{7}$$

The mobile energy storage PEV will respond to P_k^{com} and automatically adjust the response power according to the established rules. Otherwise, the mobile energy storage PEV will no longer respond to the compensation demand P_k^{com} and will continue to charge at the rated power and this type is a mobile energy storage PEV in an unresponsive state.

(1) When the battery threshold of the response body satisfies formula (7)

(a) If the system is in the G2V demand state, that is, $P_k^{\mathrm{com}} \geq 0$, adjust the power demand according to formula (8):

$$P_{i,k+1} = P_{i,k} + \varphi_i \left(\mathrm{UL}_{i,k}^{\mathrm{G2V}} - P_{i,k} \mathrm{vPTR}_k \right) \tag{8}$$

(b) If the system is in the V2G demand state, that is, $P_k^{\mathrm{com}} < 0$, adjust the power demand according to formula (9):

$$P_{i,k+1} = P_{i,k} + \varphi_i \left(-\mathrm{UL}_{i,k}^{\mathrm{V2G}} - P_{i,k} \mathrm{vRTP}_k \right) \tag{9}$$

(2) When the battery threshold of the response body exceeds the set threshold ϕ^{TH}, that is, $\phi_{i,k}^{\mathrm{resid}} > \phi^{\mathrm{TH}}$, charge with rated power, $P_{i,k+1} = p_i^{\max c}$

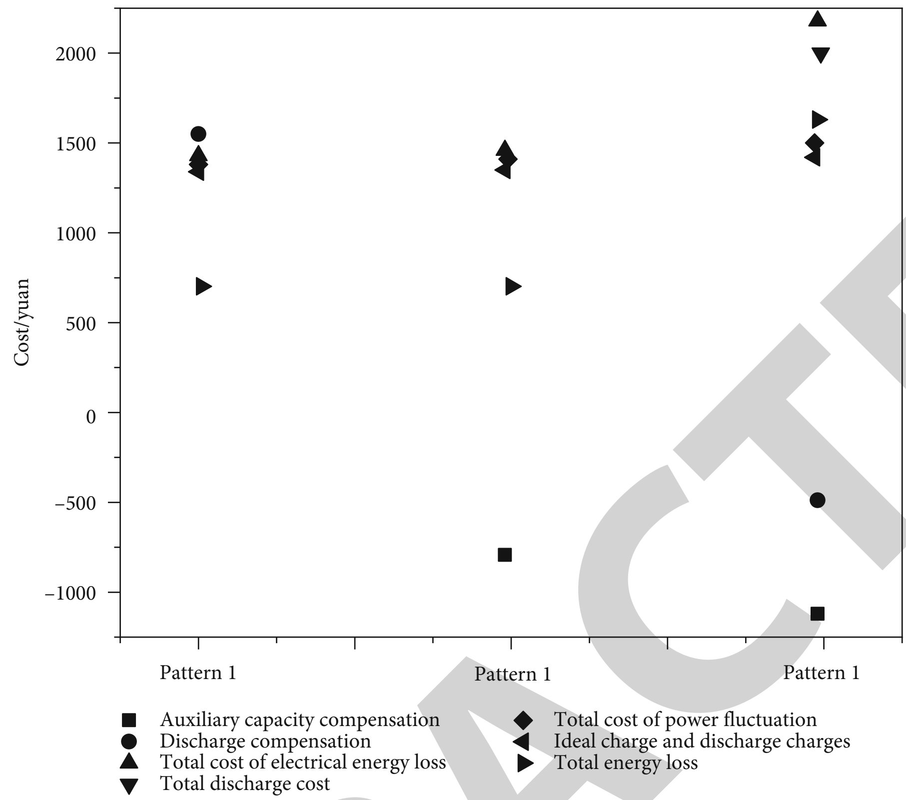

Figure 4: Comparison of cost composition and power loss of the PEV cluster under 3 modes.

4. Experimental Results and Analysis

For different types of ELN, the travel laws and basic load characteristics of the connected PEV clusters are not the same. The study shows that the travel laws and load characteristics of vehicles in the office building area have good coordination potential with curves of wind and photovoltaic power generation [24]. According to the economic calculation model, in the three modes, the economic statistics data on the supply and demand sides of the ELN system are shown in Figure 3. The comparison of cost composition and the amount of power loss of the PEV cluster is shown in Figure 4.

The following conclusions can be drawn from the analysis of the above calculation results:

(1) As shown in Figure 4, using the ADR of the energy storage system as a means to improve the internal supply and demand balance capability of the ELN system is an effective way to reduce the interactive power of the system, increase the RES self-consumption rate, and thereby reduce the total cost of the ELN system

(2) Comparing mode 2 and mode 3, the V2G function makes mode 3 more advantageous in load characteristics but the participation of PEV in the V2G process brings excessively high power fluctuation cost, discharge cost, and power loss cost, making mode 3 not optimistic in demand side economy, which significantly highlights the contradiction between the mining demand for auxiliary services of the energy storage system and the current insufficient battery technology

(3) By comparing the costs of supply and demand sides, it can be seen that the contradiction can be alleviated by balancing the benefit distribution on both sides of the supply and demand (that is, reasonable control of DR compensation) [25]

In order to further demonstrate the efficiency of the BADR method, the simulation calculation time under different response body scales was counted and compared with the centralized management method. The results are shown in Figure 5.

As can be seen, the computing of the proposed method increases linearly with the scale of the response body, while the computing of the centralized management method will increase rapidly with the scale of the response body. When the scale reaches 180, the calculation time exceeds the time interval Δt, resulting in the method cannot be applied to real-time management [26].

The simulation result comparison of relevant load characteristics and economic indicators of the ELN system under different uncertainty levels for the three operating modes are shown in Figures 6–8.

Through the analysis of Figures 6–8, the following conclusions can be drawn:

(1) With the increase of the uncertainty J, the net load volatility and the average cost on both sides of the

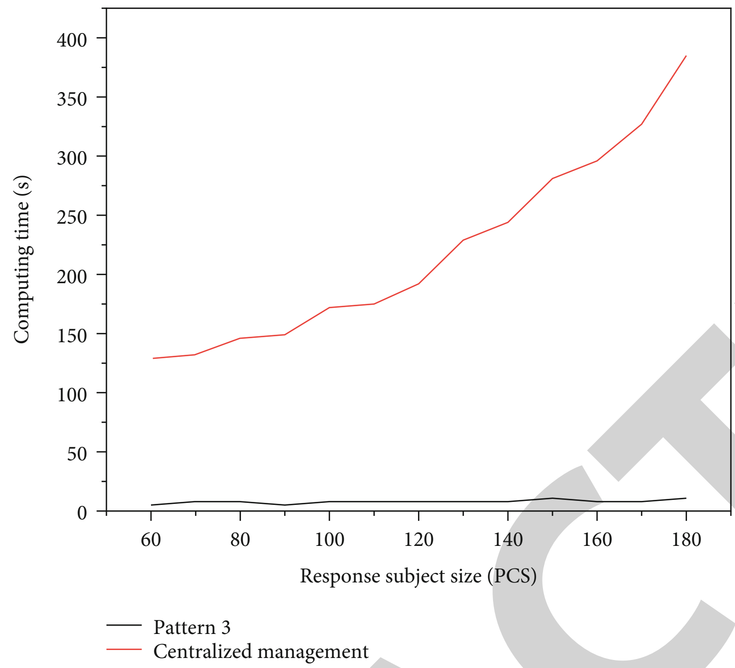

Figure 5: The impact of the response body scale on the simulation calculation time.

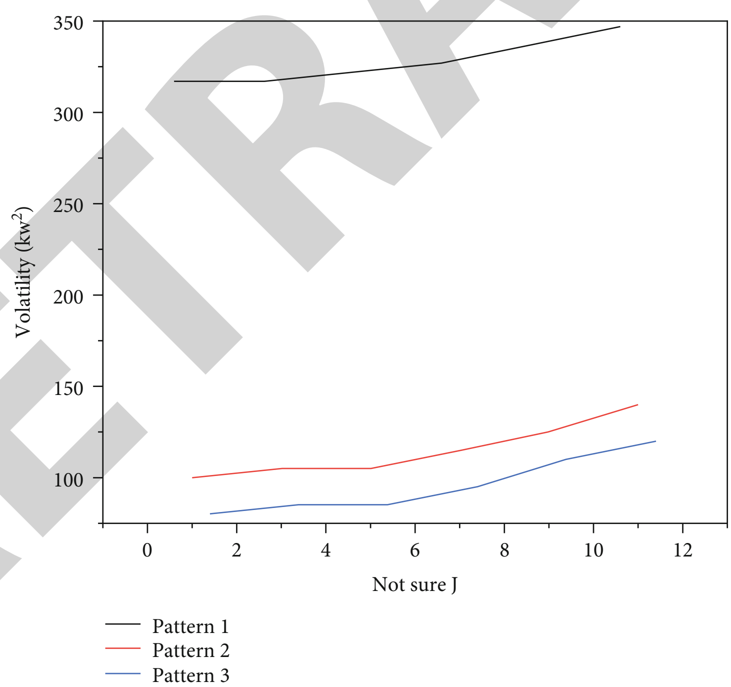

Figure 6: Net load volatility.

system under the three modes show an upward trend (except for the total cost of the PEV cluster under mode 1), indicating that the randomness of the RES output and load demand will have an adverse impact on the system operation economy and load characteristics and will intensify with the increase of uncertainty

(2) The proposed decentralized BADR method has a certain ability to deal with uncertain environments, which can respond to system compensation needs in real time, give full play to the coordination role of the energy storage system in interactive response, and improve the system load level and economy

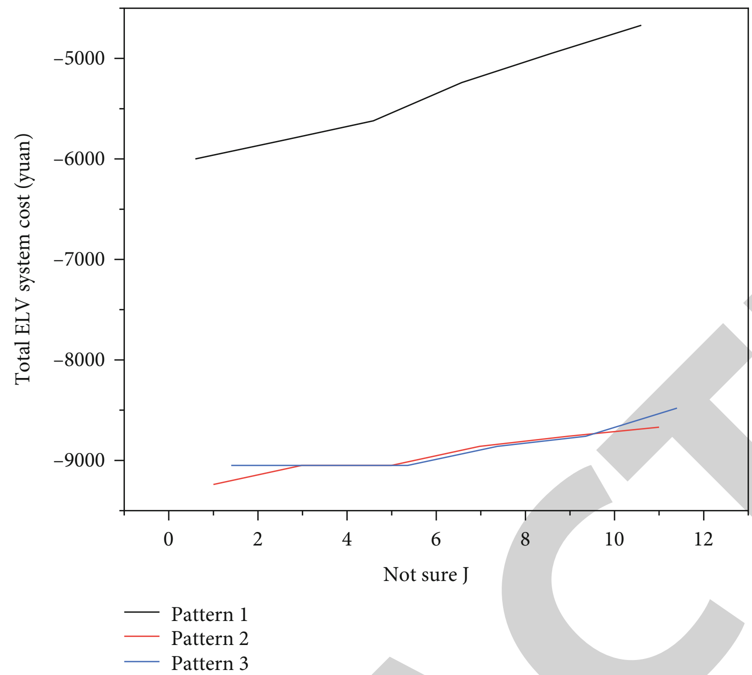

Figure 7: Total cost of the ELN system.

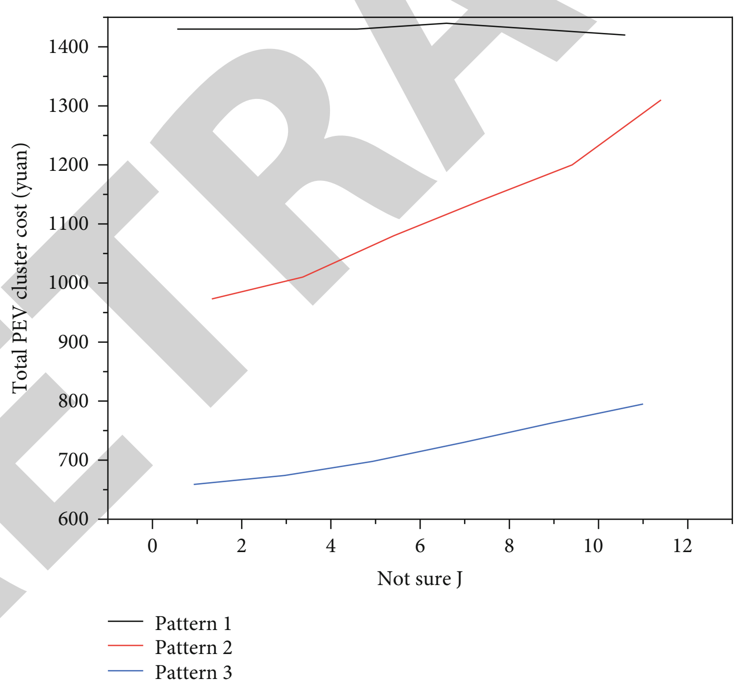

Figure 8: Total cost of the PEV cluster.

(3) Comparing mode 2, we can see that the system load characteristics under mode 3 are the best but it does not perform well in the economics of PEV clusters. The reason is that the benefits brought to the system by reducing the fluctuation rate of unit net load cannot be accurately calculated at present. In this regard, there are two improvement methods suggested in this paper: (1) improve the assessment and compensation mechanism of ADR projects—ensure that the implementation effect of ADR project matches the benefits and (2) control of benefit distribution—increase DR compensation in a reasonable manner to ensure the response willingness of the response body

The PROPOSED BADR method can coordinate with the available energy storage resources in the system while satisfying the satisfaction of energy demand, make the load level curve track the output of new energy to the maximum extent, and improve the balance of the supply and demand of the system and is suitable for the large-scale decentralized energy storage system. The detailed analysis of PEV cluster costs and ELN system operating costs shows that the BADR method can effectively improve the economy of both sides of supply and demand and reduce bilateral costs. However, in the practical application process, it is necessary to guarantee the organization coordination of multiple participants by means of improving the compensation mechanism and reasonable distribution of benefits, so as to improve the flexibility of system operation.

5. Conclusion

For the two-way authentication between Internet of things devices and between devices and users, a secure authentication and key agreement scheme of Internet of things based on blockchain is designed. For WSN user authentication, a blockchain-based WSN user authentication and key agreement scheme is designed, where the public identity information used for authentication of Internet of things devices, users, gateway nodes, and sensor nodes is written into the blockchain ledger to avoid malicious tampering. However, in the actual application process, it is also necessary to improve the compensation mechanism and rationally distribute the benefits to ensure the organizational coordination of multiple participants, so as to improve the flexibility of system operation.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] X. Yang, Y. Zhang, J. Lu, B. Zhao, and H. Pan, "Blockchain-based automated demand response method for energy storage system in an energy local network," *Proceedings of the CSEE*, vol. 37, no. 13, pp. 3703–3716, 2017.

[2] P. Claudia, C. Tudor, A. Marcel, A. Ionut, S. Ioan, and B. Massimo, "Blockchain based decentralized management of demand response programs in smart energy grids," *Sensors*, vol. 18, no. 2, p. 162, 2018.

[3] D. Xiang, H. Tian, X. Yang et al., "Automatic segmentation of retinal layer in oct images with choroidal neovascularization," *IEEE transactions on image processing: a publication of the IEEE Signal Processing Society*, vol. 27, no. 12, pp. 5880–5891, 2018.

[4] A. Lucas, D. Geneiatakis, Y. Soupionis, I. Nai-Fovino, and E. Kotsakis, "Blockchain technology applied to energy demand response service tracking and data sharing," *Energies*, vol. 14, no. 7, p. 1881, 2021.

[5] Q. Tao, X. Cui, S. Zhao, W. Yang, and R. Yu, "The food quality safety management system based on block chain technology and application in rice traceability," *Journal of the Chinese Cereals and Oils Association*, vol. 33, no. 12, pp. 102–110, 2018.

[6] G. Wu, B. Zeng, R. Li, and M. Zeng, "Research on the application of blockchain in the integrated demand response resource transaction," *Zhongguo Dianji Gongcheng Xuebao/Proceedings of the Chinese Society of Electrical Engineering*, vol. 37, no. 13, pp. 3717–3728, 2017.

[7] A. Jindal, G. S. Aujla, N. Kumar, and M. Villari, "Guardian: blockchain-based secure demand response management in smart grid system," *IEEE Transactions on Services Computing*, vol. 13, no. 4, pp. 613–624, 2020.

[8] Z. Zhou, B. Wang, Y. Guo, and Y. Zhang, "Blockchain and computational intelligence inspired incentive-compatible demand response in internet of electric vehicles," *IEEE Transactions on Emerging Topics in Computational Intelligence*, vol. 3, no. 3, pp. 205–216, 2019.

[9] B. O. Kang, M. Lee, Y. Kim, and J. Jung, "Economic analysis of a customer-installed energy storage system for both self- saving operation and demand response program participation in South Korea," *Renewable and Sustainable Energy Reviews*, vol. 94, no. OCT., pp. 69–83, 2018.

[10] I. Lopez-Rodriguez and M. Hernandez-Tejera, "Infrastructure based on supernodes and software agents for the implementation of energy markets in demand-response programs," *Applied Energy*, vol. 158, no. NOV.15, pp. 1–11, 2015.

[11] S. Li, Q. Zeng, F. Chen, and X. Huang, "A cost-effective planning method for automatic measurement based on task similarity and octopus optimization," *Measurement Science and Technology*, vol. 32, no. 9, p. 095001, 2021.

[12] J. Zhang, R. Jiang, B. Li, and N. Xu, "An automatic recognition method of microseismic signals based on eemd-svd and elm," *Computers & Geosciences*, vol. 133, p. 104318, 2019.

[13] Z. Liang, J. Zeng, X. Huang, and G. Zhu, "Research on automatic access test method of soa service based on electric power enterprise," *Boletin Tecnico/Technical Bulletin*, vol. 55, no. 14, pp. 713–718, 2017.

[14] R. Xu, C. Yu, E. Blasch, and G. Chen, "Enhanced luminescence property of InGaN/GaN nanorod array light emitting diode," *Optical Engineering*, vol. 58, no. 4, p. 1, 2019.

[15] W. H. Zou, P. L. Zhou, L. N. Sun, L. Q. Liu, and Y. U. Haibo, "Flexible wearable sensor based on graphene/pedot: pss composite material," *Scientia Sinica Technologica*, vol. 49, no. 7, pp. 851–860, 2019.

[16] C. L. Chen, Y. Y. Deng, W. Weng, M. Zhou, and H. Sun, "A blockchain-based intelligent anti-switch package in tracing logistics system," *The Journal of Supercomputing*, vol. 77, no. 7, pp. 7791–7832, 2021.

[17] P. P. Ray, B. Chowhan, N. Kumar, and A. Almogren, "Biothr: electronic health record servicing scheme in iot-blockchain ecosystem," *IEEE Internet of Things Journal*, vol. 8, no. 13, pp. 10857–10872, 2021.

[18] S. M. Alrubei, E. A. Ball, J. M. Rigelsford, and C. A. Willis, "Latency and performance analyses of real-world wireless iot-blockchain application," *IEEE Sensors Journal*, vol. 20, no. 13, pp. 7372–7383, 2020.

[19] H. H. Cho, H. T. Wu, C. F. Lai, T. K. Shih, and F. H. Tseng, "Intelligent charging path planning for iot network over blockchain-based edge architecture," *IEEE Internet of Things Journal*, vol. 8, no. 4, pp. 2379–2394, 2021.

[20] V. Leung, X. Wang, F. R. Yu, D. Niyato, and S. Pack, "Guest editorial: special issue on blockchain and edge computing

techniques for emerging iot applications," *IEEE Internet of Things Journal*, vol. 8, no. 4, pp. 2082–2086, 2021.

[21] S. Hong, "P2p networking based internet of things (iot) sensor node authentication by blockchain," *Peer-to-Peer Networking and Applications*, vol. 13, no. 2, pp. 579–589, 2020.

[22] R. Sahay, G. Geethakumari, and B. Mitra, "A novel blockchain based framework to secure iot-llns against routing attacks," *Computing*, vol. 102, no. 11, pp. 2445–2470, 2020.

[23] H. Si, C. Sun, Y. Li, H. Qiao, and L. Shi, "Iot information sharing security mechanism based on blockchain technology," *Future Generation Computer Systems*, vol. 101, pp. 1028–1040, 2019.

[24] J. Dogra, S. Jain, A. Sharma, R. Kumar, and M. Sood, "Brain tumor detection from MR images employing fuzzy graph cut technique," *Recent Advances in Computer Science and Communications*, vol. 13, no. 3, pp. 362–369, 2020.

[25] K. Sharma and B. K. Chaurasia, "Trust based location finding mechanism in VANET using DST," in *2015 Fifth International Conference on Communication Systems and Network Technologies*, pp. 763–766, Gwalior, India, 2015.

[26] A. Sharma and R. Kumar, "Performance comparison and detailed study of AODV, DSDV, DSR, TORA and OLSR routing protocols in ad hoc networks," in *2016 Fourth International Conference on Parallel, Distributed and Grid Computing (PDGC)*, pp. 732–736, Waknaghat, India, 2016.