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AI Enabled Crypto Mining for Electric Vehicle Systems

S.Radha Rammohan[1], A.Jayanthiladevi[2]
[1]Post-Doctoral Research Fellow, Srinivas University, School of Computer Science & Engineering, Presidency University, Bangalore, India
[2]Computer Science & Information Science, Srinivas University, Karnataka, India

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ABSTRACT

A virtual grid (VG) is an interconnected system that includes a decentralized power plant, flexible loads, and energy storage facilities. During peak demand, a VG can distribute the power provided by several interconnected units in an equitable manner, ensuring that the grid burden is spread out evenly. Electric vehicles (EVs) and other demand-side energy devices can help keep the energy market supply and demand in harmony with proper use. However, it might be difficult to maintain a consistent power balance due to the inherent unpredictability of the power units. Furthermore, the issue of protecting the privacy of communications between a VPP aggregator and the final facilities has not been thoroughly explored. In this paper, we provided detailed analytics on optimization-based crypto mining for electric vehicle systems. The simulation is conducted to test the efficacy of the model, and the results show that the proposed method has a higher rate of accuracy than other methods.

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Corresponding Author:

A.Jayanthiladevi
Computer Science & Information Science
Srinivas University
Karnataka
India
Email: drjayanthila@gmail.com

1. INTRODUCTION

The percentage of renewable energy sources in the global energy system has been rising during the past few years. Afterward, the grid output is sent to a wide range of consumers, including homes, businesses, public buildings, and government installations, as well as mobile users like those who operate electric vehicle fleets. A virtual power plant (VPP) is a system that aims to maximize the use of renewable energy sources through effective dispatch [1]. By connecting DERs, the grid, controlled loads, and EVs, the VPP facilitates the efficient use of all these systems (EVs).

Many VPP ideas have been created throughout the past decade [2]. Presently running VPP demonstrations focus a premium on ensuring efficient sharing and coordination of available resources. However, businesses also have a duty to think about how the aggregator, the power grid, and the customer data flow can affect the safety of their own data. The VPP also provides demand-side management resources to energy technology end-users, easing the development of smart storage and consumption practices [3].

The second quarter of 2019 saw 7.2% of electricity in the UK coming from net imports as domestic energy supply was insufficient to meet peak demands. Therefore, it is imperative to boost domestic energy production. With more people making the switch to EVs, the United States' ability to meet the rising demand for energy will be tested (EVs). The term vehicle-to-grid, or V2G for short, describes the method of hooking up automobiles to power lines. This is an intriguing approach to addressing the supply-and-demand mismatch [4]. Provisional hospitals set up in the wake of the COVID-19 epidemic are good examples of locations where the deployment of electric vehicles could help satisfy the recurrent needs of essential loads [5].

In traditional energy markets, where retailers are the main link between generators and consumers, easing wholesale energy transfers is a major challenge. This is due to the fact that traditional energy markets consider merchants to be the final stop in the supply chain. These merchants hold a small portion of the grid's physical assets but are solely responsible for administrative tasks like consumption metering and billing. The energy market can be made more efficient and competitive by strengthening retail outlets and connecting trading companies directly with one another. Conversely, this change requires the establishment of a robust platform that facilitates a more dispersed degree of effect and offers a secure venue for energy trade [6].

Another recent technological advancement that could be leveraged to build the aforementioned platform is Blockchain. Originally developed as Bitcoin [7] underlying technology, it has now been adapted to fit a wide range of uses, including P2P energy trading. Using a blockchain and the apps that are built on top of it can make it easier to conduct transactions between trustworthy parties. One example of how the consortium blockchain has been put to use is to enable trustworthy energy trades between electric vehicles [8]. In order to promote energy trading between stationary enterprises and electric vehicles, a blockchain-based method for demand response management (EVs) was effective [9].

Power consumption efficiency is still a major challenge when compared to conventional VPP demonstrations. Optimal supply and demand-side management of dispersed energy resources has been the subject of extensive study. Researchers in [10][11][12] looked at how to best deal with the intermittent nature of renewable energy sources from the supply side, but there was little discussion of how to best incorporate the end users of this energy. Vehicle-to-grid (V2G) networked electric vehicles can increase demand-side efficiency, according to [13][14][15]. Instead, these methods merely provide the VPP aggregator with idle vehicles. Although many constantly moving vehicles have distinct energy requirements, not enough has been done to accommodate them.

2. BACKGROUND

There are many VG applications where AI has been successfully implemented. The conventional models investigated economic dispatch and strategic bidding in the markets for electric vehicles. Deep learning methods were used to predict future energy output and consumption. The major goal of intelligent integrated methods is to provide an efficient demand response. These methods use a regular aggregator in conjunction with a group of graphics processing unit (GPU) servers, which results in high power consumption and high maintenance costs. The computing power of local devices is, therefore, still a restriction when it comes to quick training. Making do with a system designed specifically for local computing is both costly and restrictive [13].

The difficulty of integrating cyber and physical security in VPP systems is another issue. Centralized control algorithms that have been used in the past are a key focus. As more DERs have been added to the power grid, researcher attention has switched to assessing the viability of robust distributed architectures against cyberattacks. A threat remains that the data integrity gathered by the typical aggregator of the VPP will be attacked. Data leaks are an additional concern whenever raw data is being transferred.

To the best of our knowledge, no previous studies have taken into account the participation of electric vehicles with electricity consumption estimations, efficient computing for local devices, and secure communication between the VPP aggregator and EV nodes. A blockchain-based smart grid network that integrates EVs for the purpose of power management via AI is proposed in this study. To kick things off, we will go through a method of VPP power management developed for recharging electric vehicles that is based on the results of a neural network. The learning process incorporates FL technology because it safeguards the anonymity of raw data and improves the speed and quality of communication [14].

We used a hardware-based AI system to build a novel technique of communication between the aggregator and each EV node. This enables us to calculate the potential power output of an idle electric car, reducing the need for energy storage during peak demand [15]. Expanded ECUs connected to a vehicle CAN bus can benefit from the reconfigurable AI system. The combination of its fast processing and low power consumption makes it a promising choice for such an implementation. The system as a whole will be safer as we integrate additional blockchain-based features [16].

3. METHOD

Each block in a blockchain consists of transactions and a hash of the block before it, making it impossible to tamper with the ledger as a whole. The standard model of a marketplace for trading energy tracks transactions based on the quantity of energy exchanged and its given monetary value. Once the transactions have been verified, they will be made public and added to the block. Having the system set up in this way would prevent any unnecessary spending or double selling of energy. Before miners agree on what should go into the block, the block contents will not be uploaded to the distributed ledger.

It is common for those who have stakes to also own the high-powered computers used as miners. A blockchain could be public, private, or a combination of the two. In this work, the author proposes establishing a blockchain-based energy trading platform for private use. Information and conversations shared by the many users of this platform are depicted in Figure 1.

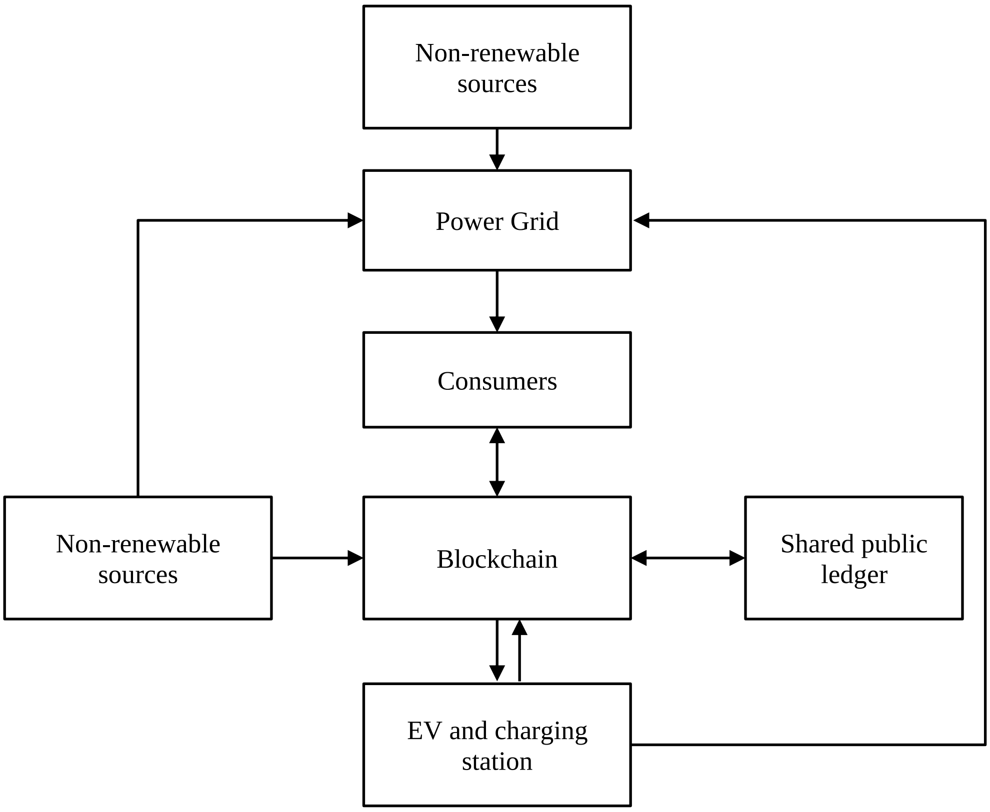

Figure 1. Proposed Architecture

Our proposed infrastructure incorporates not just one but three distinct types of blockchain nodes, in addition to traditional hardware components like smart meters that report on energy consumption and raw data.

3.1. Light Nodes

The term light node refers to a blockchain node with low system requirements, such as low memory and CPU speed. An illustration of our approach employing light nodes and electric vehicles will be provided. Because of their limited capacity, these nodes can only initiate transactions and cannot verify preexisting ones. In addition, new blocks cannot be added to the Blockchain by light nodes because doing so demands an excessive amount of resource-intensive computation.

3.2. Full Nodes

The term full node is used to describe a node that can hold the entire Blockchain. The study uses ultra-high-capacity data disks kept in smart homes and linked to either the network or the microgrid command center as full nodes. These nodes can initiate transactions and validate their legitimacy. When considering our proposed platform, we consider the MGCC to be a full node, the function of which is to verify transactions.

3.3. Miners/Validators

In a public blockchain, nodes acting as a group are known as miners, and they are responsible for adding new blocks to the distributed ledger. Miners can function without access to the full Blockchain. But miners with lots of Bitcoin storage space can act as complete nodes and keep the entire Blockchain in their computers. Full nodes with a lot of processing power are another type of miner. Proof-of-work consensus procedures are not used in private blockchains such as the one we propose. Miners now serve as validators instead. Methods like Practical Byzantine Fault Tolerance and Federated Byzantine Agreement are used by these validators because they are cheap to compute.

3.4. Mode Selection

Players can switch between consumer and prosumer roles in the game by logging onto the application server from afar. Aside from choosing the energy they need and where they need it, consumers and prosumers alike will be able to choose the energy sources in their area and the accompanying pricing. In order to verify the identities of users and create new accounts, developers can use Firebase authentication services.

3.5. Peer-Discovery and Optimization

Typically, the consumer will be the one to initiate a change in electricity service. In addition to learning about the energy sources of nearby prosumers, the aggregator also learns the prosumer names. Prosumers of all stripes can reduce their utility and transportation costs. At the point of final approval, only the top prosumers are presented to the buyer. Following the completion of certain preparatory processing, such as verifying the consumer account balance and the prosumer battery level, a transaction can be constructed depending on the conditions for an energy exchange that has been entered. The amount of energy to be transmitted and the cost associated with doing so are two such conditions. The transaction will then proceed in the manner just explained on the private Blockchain.

3.6. Energy Transfer and Payment

After prosumers and consumers agree on a price, the latter balance will be locked in at that level. After exchanging the predetermined amount of energy, the prosumer receives the predetermined amount of cryptocurrency as payment. Our proposed architecture does not involve the creation of a new cryptocurrency because it is based on a private blockchain. Instead, it can be used with any cryptocurrency, the value of which is set by the market. Every node in the network will be able to verify the method's veracity because it will be recorded in the Blockchain. Each participant, prosumer or consumer, is given a pseudonym at various points in the process to protect their anonymity. The identities of the other people involved in the energy trade are unknown.

3.7. Optimization Algorithm

There are two main types of optimization techniques that are presented here, and both of them are important to the success of the suggested algorithm. To kick things off, the aggregator will use the knapsack method to randomly pair off prosumers and order their costs. In the second model, the aggregator uses a first-come, first-served (FCFS) approach to pair clients with local prosumers depending on their locations. Users are connected with local prosumers through this mechanism.

The goal of the SOP is to find the best possible answer, which may be defined as the value that is both the lowest and the highest for a single objective function that includes all of the goals. Although this optimization technique might help planners understand the complexities of the issue at hand, it does not often generate novel ways of striking a balance between competing objectives.

However, if multiple goals are to be met at the same time, there is no optimal solution in a MOP. Compromises, trade-offs, non-dominated options, non-inferior alternatives, and Pareto-optimal solutions emerge as several goals interact with one another. Among the methods available, a comparison of SOP fitness can be used to show that one candidate stands out from the rest. However, MOP employs the idea of dominance to determine how efficient a solution is.

4. RESULTS AND DISCUSSION

Remote monitoring of prosumer and consumer energy trading is made possible by the graphical user interface (GUI) software component of the energy trading prototype. Its framework is modeled after the Energy Trading System described above, which is itself based on the mechanism for trading energy. Many variables, including the prototype target platform, IDE, language, and set of features, went into deciding what tools to use to build it. Android Studio was utilized because it contained the required IDE, language, and database.

To demonstrate the efficacy of our optimization method, we will evaluate it against state-of-the-art software. Customer tastes in a variety of categories have been revealed thanks to the algorithms. We used the aforementioned variables in the algorithm to obtain the total operational cost for each energy trading scenario we considered. Numerical comparisons, as illustrated in Figure 2, demonstrate the superiority of our technique over existing methods.

The operational cost for varying customer demand, estimated using different methods, is shown in Figure 3. The greater the number of prosumers, the greater the impact they will have on the overall energy consumption of the economy. To maximize battery use, the GA partners fewer prosumers than the FCFS scheme and the KPA under all conditions.

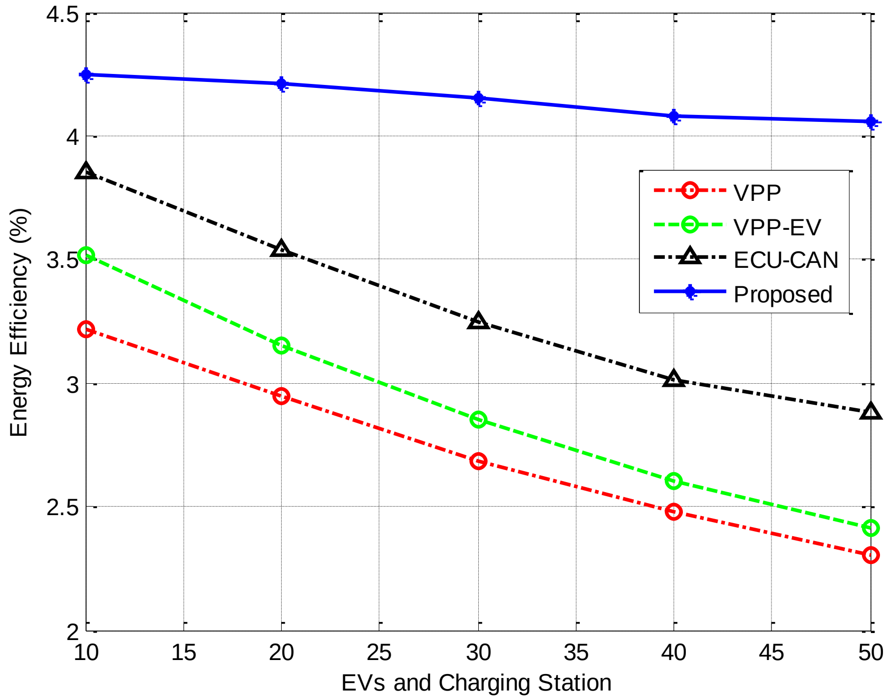

Figure 2. Energy Efficiency

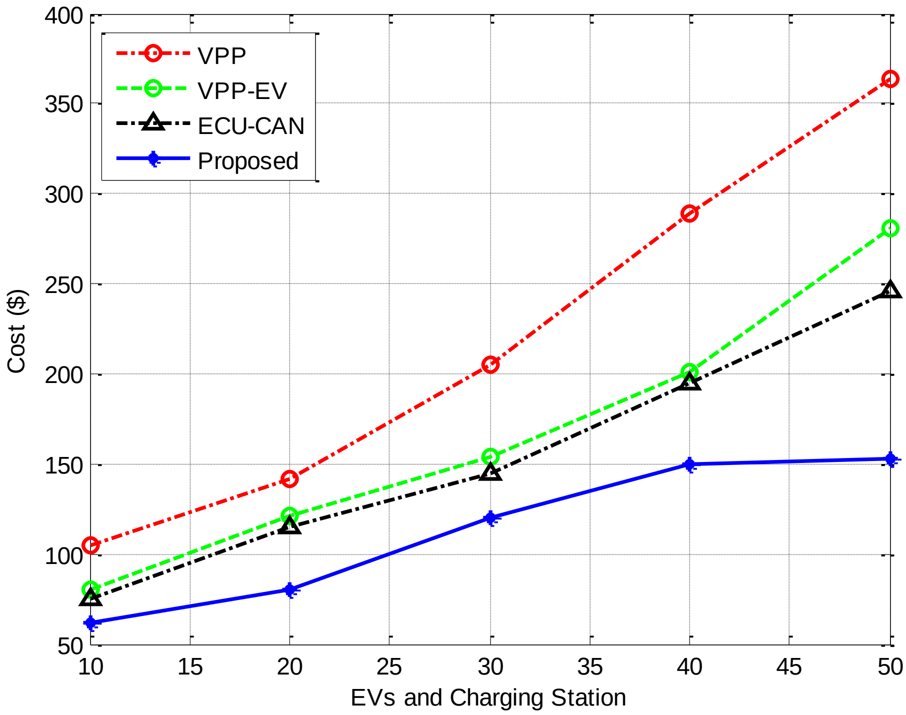

Figure 3. Operational cost

For a residence that consumes 120 kWh per month, operational costs are reduced by 13% under GA and 23% when compared to a KPA. In theory, thanks to the proposed method of cooperative efforts on both ends, prices may be lowered by as much as 4%. Our optimization strategy can reduce costs while raising output.

5. CONCLUSION

In this paper, we offer a system for energy trading in which prosumers and consumers make deals according to the difference between energy demand and supply. We used blockchain technology to create a prototype that links prosumers and consumers together, creating a trustworthy platform for the exchange of energy. Our numerical results show that our trading method reduces energy costs and increases battery capacity utilization among prosumers.

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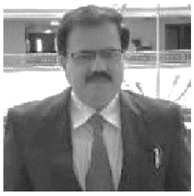
BIOGRAPHIES OF AUTHORS



S.Radha Rammohan1 currently working as Professor – School of Computer Science and Engineering (SOCSE), Coordinator – Professional Societies and International Affairs, SOCSE, DQAC Member, SOCSE, Presidency University, Bengaluru, Karnataka, India. I was working as a Professor and dean (University Press) at Dr.M.G.R.Educational and Research Institute, deemed to be a University with Graded Autonomy Status, Chennai-600095, Tamilnadu, India. I was also a visiting faculty member for Advanced Research Institute, Dr.M.G.R Educational and Research Institute. Currently, I am an advisor for the University's government-funded projects. Teaching, Research, Funded Projects, Placement Coordination, University Convenor - Institution of Engineers (India), student Chapter. I was sent to various countries by the University abroad to build up International Relations and extend academic support to the student community. He can be contacted at email: radharammohan.mca@gmail.com

A. Jayanthiladevi is presently working as a Professor of Computer Science and Information Science at Srinivas University, Karnataka, India. She was awarded the much-coveted PhD degree from Anna University, Chennai. She has been steadfast and sincere in bringing forth pioneering research publications on research topics and has published several highly impactful research publications. She presented many discoveries and research contributions at various ACM, IEEE, and Springer international conferences and journals. She is becoming a thought leader with significant experience and expertise in the computational life science domains, artificial intelligence, mobile communications, machine learning, and health informatics. Besides her research assignments, she guides and mentors a few students for their projects and research. She will definitely be an irreplaceable asset for any research lab in fulfilling the varying aspirations of her managers. Precisely speaking, she is highly dedicated, disciplined, and determined. Professional Member in ACM Women Member & IEEE Women in Engineering Membership. She can be contacted at email: drjayanthila@gmail.com