

# Lightweight Energy Auction Smart Contract for Industrial Application

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**Abstract**—Electricity energy as one of the most, if not the most, essential aspects of human life in order to work and cycle well; energizing the minor part as an electronic device, way up to the significant and critical one, would not be possible to not requiring any electricity as the energy supply. No exception to the industrial and manufacturing sector, that colossal energy supply that is constantly reliably needed is so apparent. The condition imbalance of supply and demand, especially on industrial, could lead to numerous losses and significant financial disadvantages. Therefore, a solutive answer for the energy marketplace is needed to toss the imbalance of supply-and-demand issues. Blockchain-based smart contract of energy auction provides a secured auction system with underwhelming maintaining price for industrial to buy energy supply from an energy provider, safe and secured. It is a possible proposed smart contract that is developed to have a strongly secured, convenient, and lightweight.

**Index Terms**—Auction, Blockchain, Energy, Lightweight, Industrial, Smart Contract.

## I. INTRODUCTION

Energy is one of the primary essential factors to ensure human life running well, especially on 21<sup>st</sup> century, in which energy in the form of electricity would allow people to do numerous of activity. However, the lack of energy generators in some areas would lead to critical disasters and many casualties, especially in industrial areas where heavy machines of production, supply-demand disequilibrium, and its supply chain would be negatively affected due to lack of energy conditions, whether it is sudden or predicted. Indeed, the issue could be avoided by purchasing energy from an area that does not require high energy, with a significant surplus of energy generators [1], [2].

Energy demand for the industrial area that is possible would be fulfilled by purchasing some energy supply would be different from purchasing tools or an ingredient of a production. The energy trading process certainly requires a firmly secure and reliable platform that allows transactions that would be safe for providers and buyers

of the energy [2]. One of the methods that effectively the energy transaction way is by auctioning the energy; therefore, both the supplier and buyer would have the best value possible for the energy, reminding that it is an unlimited resource but need a significantly long and costly process to cycle the energy back to electricity, that makes it somehow limited [3].

Blockchain network is a recent technology with strong security with transparency and respect for data as its natural base characteristic of the network. Blockchain network built on a decentralized network with each entity involved in the network having equal, if not the same, information that the other entities have; therefore, it would give strong security that everybody is a backup, leads to its tamper-proof and data breach-proof of a network, glove-fitting for an important transaction, such as energy auction.

A smart contract is a method that could control the conduct of some transaction, and it has an application known as a "smart contract" on a blockchain network. For instance, a buy-sell transaction is one type of activity that makes use of a blockchain network [4], [5]; a smart contract is a program that manages that transaction, making it safer and simpler to complete. A smart contract could be used for much more than just buy-sell transactions; as it could be used to manage an auction [6], digital-currency wallet concept [7], manage a poll or vote [8], produce additive manufacturing [9], or handle any other type of activity.

We conducted the solution for energy trading platform with auction as its method in a form of a smart contract that deployed on the blockchain network, and tested on Ethereum network, that adopting every beneficial from blockchain decentralized characteristic. By developing energy auction smart contract, our focus and contribution is that,

- E-commerce smart contract built based on

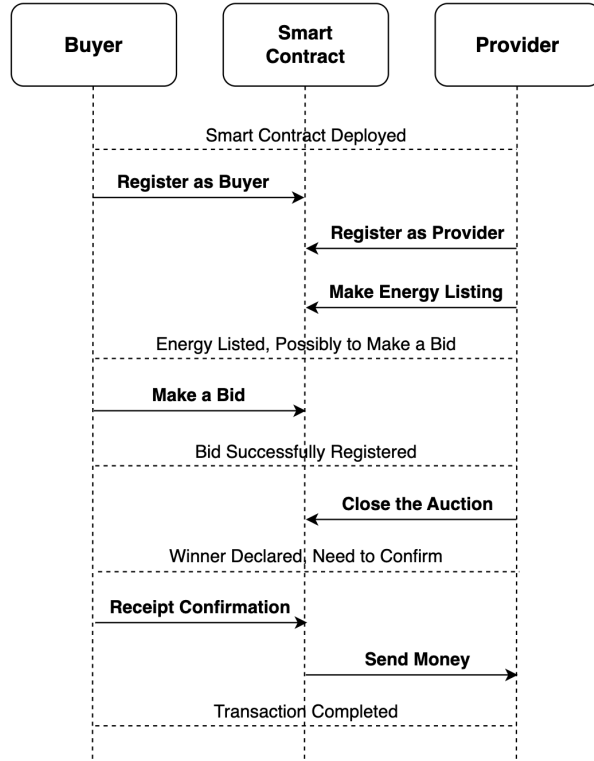


Fig. 1. Energy Auction Smart Contract Workflow

Ethereum blockchain network is secured and tamper-proof against data breach and manipulating.

- Smart contract allows people to do a secured buy and sell some item through a blockchain-based program that is transaction fraud-proof and convenient.
- Maximize gas uses of the smart contract as low as possible; therefore, the smart contract is working properly without causing so much cost for the user.

## II. PROPOSED SMART CONTRACT

This sections briefly explains the details of every function that builds the proposed smart contract as a single system for energy auction, and also would provides the details of the core algorithm of the energy auction process.

The proposed smart contract consists of several functions that are connected with a flow by all the entities that are using the smart contract, represented in Figure 1, and the functions are listed as follows,

- **RegisterPerson()**: function to register the smart contract user, whether to be a buyer or provider of the energy.
- **ListingEnergy()**: function to make a listing of energy by the provider.

- **AuctionStart()**: function to start the energy auction between buyers, the highest bid price would be declared as the winner of the auction, and proceed the energy transaction.
- **AuctionEnd()**: function to end the auction process manually and close the auction winner's state.
- **ReceivedConfirmation()**: function for confirming the receiving of the energy on the buyer side, therefore, the transaction would be safe.

The smart contract, primarily a way to communicate or do a transaction through a blockchain network, has significant empowerment due to decentralized network topology that allows a number of backups against data tampering and breaching. Although, with the advantages that smart contracts would have, it also some issues concerning their usage that would cost a high fortune. Logically, trade-offs would happen between beneficial factors; however, our primary focus of this proposed smart contract is to develop a lightweight smart contract that would allow users to have tamper-proof, strong security to do some important transactions and cost a little fortune for its users.

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### Algorithm 1: Energy Bid Function

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**input** : ID Number (Energy Listing), Bid Price, Provider's Address

**output**: Auction Winner's Address, Winner's Contact Information

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#### 1 Require:

- *Energy.Number* == ID Number;
- *Energy.Provider* == Provider's Address;
- (*Energy.CurrentPrice* + *Energy.IterationPrice*) < Bid Price;

#### 2 if Require **Passed** then

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3   Energy.Winner ← Buyer.Address;
4   Energy.CurrentPrice ← Bid Price;
5   Energy.Confirmed ← False;
6   Energy.BidClosed ← False;

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#### 7 else

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8   Revert state and show error;

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#### 9 end

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## III. RESULT AND ANALYSIS

As our focus for this research is the lightweight aspect that empowers the smart contract, the proposed smart contract is built with an effective way to develop the whole algorithm without sacrificing any lack of details information for parties involved in each transaction and auction, which would provide significantly more strength

TABLE I  
PROPOSED ENERGY AUCTION SMART CONTRACT GAS COST

Functions	Caller	Gas Used (Gas)	Gas Average Cost (ETH)
Smart Contract Deployment	Admin	2504057	0.0355576
Register as Energy Buyer	Buyer	148752	0.0021123
Register as Energy Provider	Provider	181084	0.0025714
Make a Listing for Energy (Auction Start)	Provider	197984	0.0028114
Make a Bid	Buyer	212047	0.0030111
Auction End Manually	Admin / Provider	40805	0.0005794
Receipt Confirmation	Buyer	35491	0.0005040

to its security. One of the effective methods to improve the lightweight of a smart contract is by separating each function to be only accessible to certain users or entities. Some of the functions could only be used by authority, and others by particular roles only; therefore, each user does not have to use every function to fulfill their transaction or auction needs successfully. As mentioned before, the lightweightness of a smart contract could be seen as the gas cost needed for the smart contract to be deployed and function on the Blockchain network, with the detailed information of the proposed smart contract gas cost represented in Table 1.

The proposed smart contract was built on solidity computer language with Remix IDE as its developing platform. It was deployed on several blockchain testnet networks and virtual blockchain networks, named Goerli and Rinkeby test network, Remix VM London, and Ganache virtual blockchain network. The smart contract was deployed and functioning successfully as the auction process of energy is successfully transacted between the provider and buyer of the energy, as the energy transaction information is completely stored on the blockchain network, and also with the registration method before the transaction, the provider and buyer detailed information has the same care.

All the necessary information is entirely recorded and safely stored on the blockchain network, as we rely on its decentralized behavior of the blockchain that would provide security by all the backups from each node involved on the network, which would conclude the tamper-proofness of the smart contract. The fundamental strength of the security of blockchain networks compared to the other topology also causes the high cost of processing the smart contract. However, this would not be an issue because the smart contract is built on a lightweight algorithm that would ensure the users for every entity would have the best transaction as an auction with robust security and an underwhelming cost.

#### IV. CONCLUSION AND FUTURE WORK

This research was conducted by proposing a blockchain-based solution for the energy auction market house in the form of a smart contract that would provide high security and be cheap in terms of functioning and maintaining its functionality. Therefore the user would have both significant benefits by using the proposed lightweight energy auction smart contract that focuses on industrial uses. The future of the smart contract idea would also be successfully functioning for other target areas, such as residential and commercial areas, due to energy demand would also be there that not limited by the industrial area. Also, not only the concept of energy auction, the auction primarily could be implemented on numerous other essential things, such as real property, artwork, or even the notorious recent technology such as Non-Fungible Token (NFT), which has to make sure the smart contract provides every detail and necessary information is available to access and transparent for every party that involves.

#### ACKNOWLEDGMENT

This research work was supported by Priority Research Centers Program through NRF funded by MEST (2018R1A6A1A03024003) and the Grand Information Technology Research Center support program (IITP-2022-2020-0- 01612) supervised by the IITP by MSIT, Korea.

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