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**Project Title:** Design and implementation of a pilot for blockchain-based peer-to-peer energy exchange platform along with extraction of development requirements for an operational pilot

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#### Keywords:

Blockchain, smart contract, peer-to-peer energy exchange platform, microgrid, Ethereum, hyperlieger, renewables and distributed generation

#### Project Necessity:

The microgrid includes a set of distributed generation sources such as wind turbines, diesel generators, fuel cells and photovoltaic systems, and energy storage systems that can be controlled by electrical power management systems which can be operated in a network or island fashion. Several factors such as the growth of electricity consumption, the demand for better quality electricity, the competitiveness of the market, the conversion of large to small investors, the tendency to use renewable, and clean and distributed energy have led consumers to choose the role of the producer. For this reason, it seems that it is necessary to have a platform that can provide peer-to-peer interactions and exchanges between different entities. Recently, the use of blockchain technology has been considered to meet this requirement due to its many benefits. Blockchain can be considered as a type of information storing and retrieval system on the network that works based on the consensus of users. For this reason, this project was defined to extract the pilot of a blockchain-based peer-to-peer energy exchange platform. In this regard, first the concepts of microgrid were studied, then the various parts of the pilot platform of peer-to-peer energy exchange platform were analyzed and designed considering the blockchain approach as a service. In the next step, the different parts of the platform of peer-to-peer energy exchange were implemented and tested. Finally, the requirements and requirements for implementing an operational pilot with well-known models were proposed.

#### Project Goals:

This project is defined in four different stages based on following goals:

- Investigation of microgrid structure and related concepts
- Analysis and design of blockchain-based peer-to-peer energy exchange platform
- Implementation a pilot for blockchain-based peer-to-peer energy exchange platform
- Extract the requirements of an operational pilot

### **Abstract:**

Microgrids provide many benefits to the reliable supply of the power grid. One of the basic requirements in microgrids is to create a platform for energy exchange between local producers and consumers. Blockchain technology is one of the best options for creating a peer-to-peer energy exchange platform in microgrids. The development and implementation of more than 60 projects in this field in the world prove this idea. Ethereum network along with PoW consensus algorithm has been used in the infrastructure of most of projects. Of course, in addition to the consensus algorithm, the platforms used in these projects differ in many parameters, including security, number of transactions per second, blockchain type, and programming languages. blockchain technology can reduce the dominance and power of the electricity network managers. The main problem that the peer-to-peer energy exchange platform seeks to solve is the creation of a decentralized electricity trade between production-consumers and consumers, as well as the promotion and expansion of the use of renewable energy. Using consortium blockchain, smart contract, energy token, e-wallet is the solution that most successful platforms in the world such as Restart Energy, WePower and Brooklyn Microgrid have used. Some of the challenges in implementing a blockchain-based peer-to-peer energy exchange platform pilot in Iran are addressed in this project.

In this project, peer-to-peer energy exchange platform was analyzed and designed considering the structure of Iran's electricity industry. First, the analysis was performed on the existing and important platforms in the world in terms of the blockchain platform, smart contract, energy token, digital wallet, and management portal. Then, considering the exclusivity of the situation of Iran's electricity network, a platform is designed accordingly and the conceptual model of the proposed platform ecosystem based on the reference model of the European Energy Intelligent Network is presented. The implemented platform was evaluated and tested using different scenarios. These tests include the unit test and the integrity test.

Finally, the main obstacles and challenges of designing an operational pilot implementation were examined. The main components of blockchain-based energy market implementation in the microgrid were extracted and the case was fully described.

### **Steps and Methodologies:**

In the first phase of the project, the structure and concepts related to microgrids were studied. The existing situation of the country in terms of microgrids and distributed generation sources was studied. Finally, examples of the most important blockchain-based microgrids in the world along with their economic benefits were analyzed.

In the second phase of the project, the focus was on analyzing and designing a pilot peer-to-peer energy exchange platform. At this stage, the requirements in terms of blockchain platform, smart contract, energy token, e-wallet and management portal are examined and based on them, the conceptual model of the proposed platform is presented.

In the third stage, the required functions and capabilities in terms of blockchain platform, smart contract, energy token, e-wallet and management portal have been implemented based on the conceptual model of the proposed platform ecosystem.

In the fourth stage, the main obstacles and challenges of an operational implementation were examined. The main components of blockchain-based energy market implementation in the microgrid were extracted and the case was fully described.

### **Main Results (technical outputs, patents, papers, books, reports, etc.):**

This project has been done in four stages, and consequently, four product have been prepared as follows:

- Investigation of microgrid structure and related concepts
- Analysis and design of a blockchain-based peer-to-peer energy exchange platform
- Implementation of blockchain-based peer-to-peer energy exchange platform
- Extraction of development requirements for an operational pilot