

A Concept Proposal for peer-to-peer Power Exchange by Market Mechanism

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Abstract— Electricity has been delivered from high voltage centralized power generating plants to low voltage users based on physics theory. It will not be sustainable when more and more decentralized energy has been installed to the society. To manage millions generation sites, the energy delivery system based on market mechanisms can be an answer. In this paper, we propose a platform that exchange power between individual consumers using digitalgrid technology and blockchain that can digitally control power.

I. INTRODUCTION

The future grid will have millions of consumers and prosumers interacting each other bi-directionally. It can be said that the internet era of power as the impact of zero marginal cost renewable energy is sensational to the energy network. Therefore, the tendency of installing renewable energies into power grids will be accelerated with economic and environmental reasons. For centralized system, it is difficult to manage the balance of all of those millions of users. There is a need for a mechanism of distribution of electric power that improves overall efficiency and stability while conducting distributed management by individual users. However, there are technological difficulties to realize individual pairs of electrical interconnections dispersed by power constraints, and in terms of infrastructure functions such as electric power, security demands.

There is the possibility that it can be solved by using block chain technology developed for cryptographic currency such as bit coin. Blockchain is a technology to store history data with a peer-to-peer type distributed server using a digital signature function or a hash function. This technology has been demonstrated into energy exchange field by Werth et al. [1], and Abe et al.[2] - [4]. These papers proposed that power can be interchanged between peer-to-peer based on the system directive by software definition. The applications of block chain technology to electric power field have been reported mainly in Europe and the United States including Innogy, Brooklyn Microgrid, Consensusys, etc. as of 2017[5-7]. They are mainly providing their services as a record ledger of the result of power exchange. There to study on the balancing between supply and demand including power control

In this research, we developed a power distribution platform that realizes exchange matching of users and delivery of power exchange control based on the matching by applying blockchain and digitalgrid technology.

II. PLATFORM

The proposed platform in this research is developed on the

concept model Tanaka et al. [8]. Through this platform, we provide a matching function that matches the electricity supply and demand based on market mechanism. Addition to that we provide the electricity delivery function based on the contract result with digitalgrid technology [2].

Fig.1 shows overview of the platform. It consists of three main parts; consumer system, API, and blockchain system. We set up a communication device a DGR (Digital Grid Router) power control inverter and DGC (Digital Grid Controller) at the consumer's site. The flow of this system is shown in Fig.2; (1) measurement and bidding, (2) contract, exchange matching is done by blockchain system, (3) confirmation and delivery preparation, (4) power delivery execution, (5) completion record, verification by smart-meter record. The transaction unit at that time shall be 0.1 kWh as the minimum unit. At the beginning, DGC measures the amount of electricity, power generation, charging rate. DGC also predicts future demand and supply up to the next 24 hours. Then, the bidding position is determined according to the policies of each user. Based on that judgment, DGC bids on 48 power markets provided every 30 minutes in 24 hours prepared on the blockchain system via API server. Based on the agreement between DGC and service provider, this API server is responsible for connecting to the block chain as a substitute for DGC, which has a trust relationship and limited

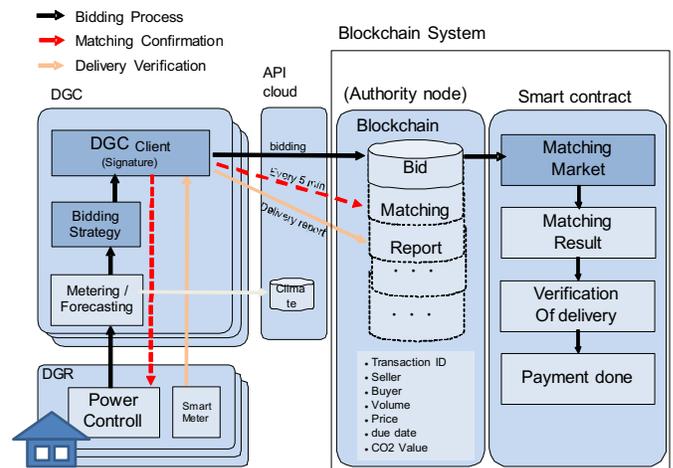


Fig. 1. Overview of power exchange platform

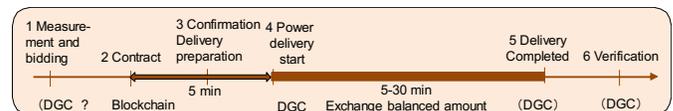


Fig. 2. Flow of auto power exchange transaction

computing resources. However, the DGC has a secret key, and by attaching a digital signature to the message from the DGC, the server prevents the server from tampering with the DGC message contents. Then smart contracts on the blockchain system, which provides market mechanisms, matches the supply and demand by the market function of the double auction system and then records the result of the contract in the block chain. Assume a block chain on the cloud, payment settlement of supply and demand is recorded the result. Fig.3 shows DGC developed in this project.

This platform proposed in this paper is a digital grid demonstration project "Development of digital grid router (DGR) and power interchange settlement system to accelerate the introduction of renewable energies" as shown in Fig.4.

III. CONCLUSION

In this paper, we propose a platform to procure electric power exchange based on the policies of individual users using the market mechanism. It also provides auto-power delivery using DGC and DGR according to the result of market. It can be possible to achieve simultaneous equal amounts within a certain minutes, which fits a constraint when using the grid, because the amount of power exported and the

electricity network. We will also consider installing an electric power identification function to measure individual renewable energy ratio and realize bidding with renewable energy priority.

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Fig. 3. Digital Grid Controller

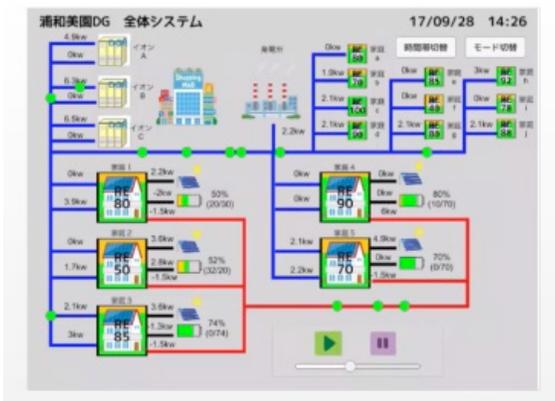


Fig. 2. Demonstration Project of this platform

amount of received power can be determined with the same amount. We plan to develop for demonstration by clarifying issues to realize these distribution mechanisms on the current