ENERGY TRADING FROM VIRTUAL POWER POINT WITH BLOCK CHAIN TECHNOLOGY IN RIAU, INDONESIA

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Abstract - As many as 150 villages in one of the regions in Indonesia, Riau (Sumatra Island) is still having a deficit of electricity. This is due to the unavailability power plant in these villages caused by the process of providing a complex and costly power Plant. Whereas in the Riau region itself has the potential to have power plant from renewable energy source such as palm oil plantations whose can at least establish a power. Researchers do not just rely on one energy source, but alternatives power plants owned by the government which have been developed in Sumatra Island, will also be used as energy supplier. But, concerning the location of each power plant that is not close to the houses that need it, so the available power plants will be integrated into virtual power plant (VPP). This VPP will integrate one participating unit with the other through a remote-control unit and power trading will happen. It will be distributed to places in need through central IT Control system which will be managed by the government (PT PLN). For making more efficient distribution, researches apply a decentralized distribution system with block chain that make third party involvement is eliminated. Block-chain in this power trading will be applied by integrating heat rate data from VPP that is in group of power trading, so it can be used to do power trade with other VPP directly. With this block-chain system in this power trading from the VPP, it will allow for better transparency and lower costs in power trading. This research is using descriptive method and can be used as an advice for PT PLN to develop the electricity system in Indonesia especially in Riau.

Index Terms - Block chain, Energy Distribution, Power Trading, Virtual Power Plant.

I. INTRODUCTION

Indonesia is a country that has a considerable development target in 34 of its provinces. The development process carried out by the government requires a large and flat energy supply, especially electricity. But it is unfortunate that the supply of energy is still not evenly distributed because the spread of electricity is currently still implementing an on-grid system. The On-Grid system still has disadvantages because the On-Grid system only relies on conventional Power plants that require large-scale and complex development. Therefore, researchers will apply the Off-Grid System. This Off-Grid system will be applied through a Virtual Power Plant (VPP) which will integrate government-owned renewable Energy sources in large areas in Indonesia. Each region will obtain energy sources from energy providers that already exist in major cities on each island. The energy provider is referred to as the participating unit, and the system of the Virtual Power Plant will integrate participating units with one another through a remote-control unit for power trading to occur and then distributed to areas in need through the central IT control system. This IT control system will be held by the government itself considering that in Indonesia the production branches which are important to the state and control the livelihoods of many people must be controlled by the state to be used for the people's prosperity (Law No. 33 paragraph 1 and 2 of 2004). Power trading in this VPP is still not effective because there is still a third party that must be passed from the seller to the buyer, therefore the researcher applies the block chain system in power trading through this VPP. The block chain technology is implemented by integrating data containing the heat rate from VPP which is incorporated in the power trading group that can be used by VPP to trade power with other VPPs directly so that the IT Control System is merely a supervisor of this decentralized system not as a gateway.

In this paper, we will explain how to integrate renewable energy sources in various regions in Indonesia, especially Riau with VPP. The main energy source for the VPP is palm oil plantation and will be supported by CSR program from various palm oil plantation in Riau. The reasons for using palm oil plantation as the main energy source are the palm oil company produce energy more than enough to power the palm oil factory itself. It will be a waste if a lot of energy that palm oil factory produce aren't use in the right way.

II. THEORETICAL BACKGROUND

A.Off-Grid

To fulfill electricity for remote area in Riau, an Off-Grid system look alike is implemented. This is because On-Grid system is not effective in order to pursue a rapid development target, this is because the system only relies on conventional power plants that require large-scale and complex development. Off Grid system does not require a complex infrastructure and known as 'a stand-alone power plant' because it

can work even it is not tied with local system. In this research, Off-Grid system is formed in VPP.

B. Virtual Power Plant (VPP)

VPP works similar with the energy micro-generation. Even it has same principal with Off-Grid system, it applies Collaborative Network discipline. It uses renewable energy sources such as wind, hydropower, and biomass units from different stations nearby to distribute energy for consumer who need it. This VPP system will be run by participating agents that are getting connected through remote control so the energy trading can occur. In VPP, a forecast information about the energy availability from all network will be given to every agent through VPP platform then the traded energy will be distributed to areas that need through the central IT control system in real time. For the security system in VPP loop, a worldwide smart grid cyber-security will be needed regarding VPP is very vulnerable forms of cyber-attacks. There are lot of benefits from using VPP: lower at cost, promote efficiency in using renewable energy (lower energy loss), reducing emission and more sustainable, transparency in energy trading. For making the system more effective and efficient, a block chain system will be used to eliminate third parties.

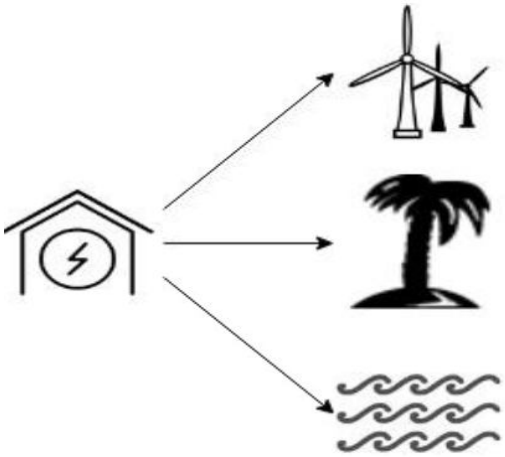


Fig 1. VPP can be in the form of hydroelectric power plants, wind power plants, palm oil plants

C. Block-chain

Block chain is a list of data record that grow and linked by using cryptography. The data record, called block, are linked by cryptography that makes each block unique. The data that have been recorded in the system itself can't be modified, so it is resistant to manipulation of the data. Basically, block chain is an open, distributed ledger, that typically managed by peer-to-peer network collectively adhering to a protocol for validating new blocks. In the early of block chain, this technology only used in Bitcoin trading system. This breakthrough of trading system making a huge step for another trading, not only for crypto-currency. Block chain can be used in other type of trading, like energy. Right now, Indonesia use PT PLN as third person in terms of energy trading. Energy trading with block chain technology can be used to eliminate the third person and make each power plant and other participating unit join the energy trading, for better transparency and lower cost. Not only that but using block chain technology as a ground for energy trading put every participating unit into trust each other because block chain make the data record more secure and detect fraudulent activities.

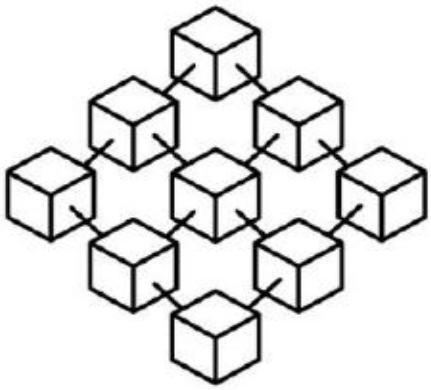


Fig 2. Illustration of how Block chain works

III. DEVELOPING VIRTUAL POWER PLANT WITH BLOCK-CHAIN SYSTEM

A.Participating Agents/ Units and Corporate Social Responsibility

In VPP loop, there are several participants involved in:

- Producer-Consumer (Prosumer): This agent type is called so because they are agent who responsible to process the palm oil plantation as their power supply and also use it as their electricity power source. Housing or manufacturing company can apply their -selves to be this agent with some requirements to be passed. These Prosumer agents are divided or grouped based on their zones so the energy distribution will be more effective and strong. There will be a head station for every zone and it is controlled by trained teams from PT PLN.

The head station will compile data about all consumption needed by the consumer from their zone for every time scale (by a week, month or year) so the head station can figure out the quantity of power needed in their zone. After compiling data, the head station from each zone will produce energy based on the data and put it on VPP market platform so other head station or zone can see each other progress. If they are lack of energy supply, each Prosumer can sell and buy energy from each other Prosumer with price that has been fixed based on block chain agreement at the current situation. The transactions between the Prosumer agents are based on Heat Index posted from

VPP platform. If other Prosumer agents do not have adequate power supply, they can request it to Indirect Controller agent. With this kind of trading, it will push every zone to use their energy storage more effectively so they do not need to purchase energy from other station or zone.

- Indirect Controller: These agents focus on maintaining the chain of VPP. They will not be involved directly to other agents, but their existence will be needed if other agents need helps. This role is taken by PT.PLN (Indonesian government owned electricity company). This agent also manages for agent registration to enter the VPP loop.

When registered and qualified agent enter the VPP loop, Indirect Controller detail information will be added to VPP's agent database so other agent can choose agent they want to do the transaction with. The database contains information about the agent's history in using energy from VPP; service provided by the agent, their zone. This agent also has a role in securing the VPP system. The security system in this VPP is as same with security system from Crypto-currency in Block chain. With this system, each agent can't have an access to other's energy storage without passing a 'gate'.

- Corporate Social Responsibility role in VPP loop is as a VPP station provider and supplier for the oil palm plantation and other attributes needed to build the VPP power station.

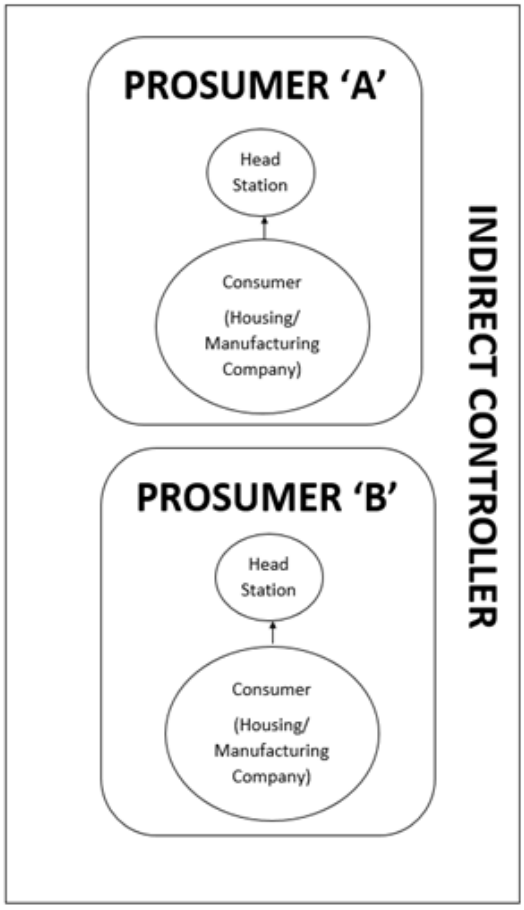


Fig 3. Illustration for Agent Types in VPP

B. Workflow

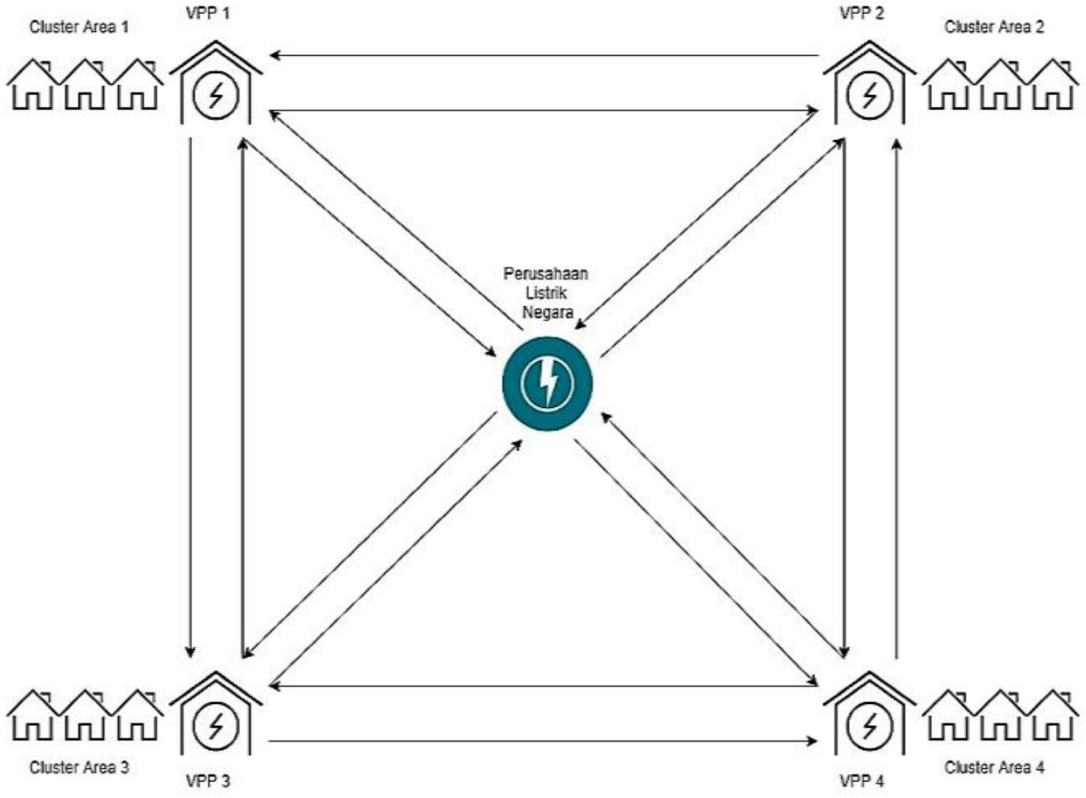


Fig 4. Scheme about How Energy Trading in VPP with Block-chain System

This trading occurs between the National Electricity Company (PLN) Indonesia as the main supervisor and electricity provider, and Area Clusters that have their own Virtual Power Plant. In this trading system, PLN Indonesia created a block chain system that contained cluster data and heat rates of all VPPs incorporated in this trade so that Indonesian PLN and all joined VPPs had folders integrated with each other.

Then the transaction occurs if in one cluster area there is a lack of energy, the cluster area can buy energy from the other cluster area. This transaction can be done with a P2P (Peer-to-Peer) system. Every energy transaction will be recorded in the block chain system which will be verified by all parties joined in trading.

Transactions recorded are:

- Sender
- Receiver
- Amount of Energy sent

If the transaction has been verified by all parties, then the transaction data will be recorded and encrypted which will then become the new block. So that each block will contain transaction data, the key from the previous block, and the key for the next block.

After that, the transaction data will be encrypted so no one can change transaction data that will help Indonesian PLN as a supervisor to oversee every energy transaction. Because everyone knows the transactions that occur, there is transparent energy trading. PLN Indonesia also acts as a back-up of electricity if there is a shortage by one cluster area and another cluster area cannot make a transaction. Clusters that experience shortages can also buy energy through the Indonesian National Electric Company, whose transactions will still be recorded in the Indonesian PLN block chain and VPP. With this system, each cluster area will not experience energy shortages and energy use can be more efficient and more efficient.

CONCLUSION

As we know, Riau has a lot of palm oil plantation, with their own energy production (small scale power plant) from palm oil source. This small scale factory size of power plant, produce energy more than enough to power the palm oil factory itself. It will be a waste if a lot of energy that palm oil factory produce aren't used in a right way. Each palm oil factory can produce different energy, depends on the condition every factory. With using block chain technology for energy trading from virtual power plant, there will be even distribution of energy. Not only give every palm oil plantation even distribution of energy, but with this block chain technology, every palm oil factory in Riau can contribute to the people that live around it. The shortage of energy that village experience will be no longer exist. With workflow that has been elaborated above, trading energy can be possible to do if every participating unit and also third person (PT PLN) willing to share their information and trust every component in trading system.

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