MANTECH Publications

Journal of Smart Grid and Related Technology
Volume 4 Issue 1

Integration of Block Chain and Digital Grid Routers for Load Balancing and Bidirectional Power Flow in Microgrid

Prakash Kerur*, Dr. R.L. Chakrasali**

Associate, Professor

Department of EEE

*KLEIT, Hubli, Karnataka *, SDMCET, Dharwad, Karnataka***

Corresponding author's email id: *prakashkerur@gmail.com*, pratisatu@yahoo.co.in***

Abstract

In response to the situation of increasing energy demand day by day it is necessary to fulfill the requirement of consumers. The power generated by the base load plants is not sufficient to meet the demand. Therefore it is necessary to introduce the distributed generation to meet the demand. The government is promoting renewable energies such as solar or wind power plant installation because of green energy. The renewable-energy penetration and controlling is challenging task in centralized power distribution. To find the solution to this problem is essential. To overcome this problem a smart grid or micro grid concept was introduced which is one of the principal concerns of the scientific community is the energy transition and energy efficiency. In micro grid the power flow and exchange is done with group of people in a particular areas. It would optimize the energy consumption by setting consumption patterns, adapted to a specific situation, taking into account different parameters like the price, the user preferences, or the parameters of the appliances of the house. Thus a numerical management is needed to load balancing and distribution of energy. A block chain is a distributed, decentralized transaction ledger, which is owned, maintained and updated by each user. It carries peer-to-peer energy exchanges among citizens of a same microgrid, without a central control body, based on smart contracts. The digital grid router solves the problems of different renewable source integration in smart grid. . The Digital Grid divides power systems when frequency is synchronized

into various sizes. Each small grid is connected asynchronously with a digital grid router (DGR). This paper focuses on load balancing with peer to peer transactions in microgrid using block chain and bidirectional power flow using digital grid routers.

Keywords: *Block Chain, Digital Grid Router, Microgrid, Bidirectional Meters, .Load balancing*

INTRODUCTION

Worldwide, 48% of the electrical energy comes from fossil energy, which leads to a major problem due to the scarcity of these energies. The remaining energy to meet the demand is from renewable. Overall, renewable energy accounted for an estimated 60 to 70% of net additions to global power capacity in 2019. Ongoing capacity growth and geographical expansion of renewable power technologies are driven by a number of factors, including rising electricity demand in some countries, green house effect etc. with increase in demand targeted renewable energy support mechanisms and continuing cost declines particularly for solar PV and wind power. The aim is to promote local energy production, and then avoid the energy transportation and avoid the line loses over long distances. However, the production of energy by renewable energies is not fixed all the time. It is continuously varies depending upon the weather conditions. Here initial cost of installation is more but running cost is very less compare to other renewable sources.

In addition to the scarcity, this kind of energy control the pollution considerably the environment, both atmosphere and waters, due to greenhouse gas emissions. It is in the interest of all to come up with solutions. The energy consumption increases from year to year. Getting to better management of our energy consumption seems paramount. A possible solution could be the exploitation of renewable energies as primary energy. This would amount to integrate a numerical regulation of the energy production. The solution of renewable energies is a good initiative, but it does not remain without flaws. The disadvantages of renewable energies are their intermittent production, it depends on the weather (sun, wind, tide). A numerical aspect able to manage these disadvantages could optimize the integration of clean energies

within the current production system. It is in this perspective that the Smart Grid was born by setting up a network connected to homes, consumer's appliances and renewable energy. The electric power sector has begun to change profoundly over the few years. At that same time, Blockchain technology has emerged as a powerful tool to manage complexity monetary transactions and in a digital world. The confluence of the two trends explains the surging investment in new ventures that apply block-chain to energy.

BLOCK CHAIN TECHNOLOGY

This technology allows for peer-to-peer monetary transactions without a central control body. The Block chain is based on the decentralization of the data in order to remove the central part representing the confidence part of the current system. The Bit coin has given birth to other types of Block chain, like the Ethereal. This technology earlier is applied to financial transactions. Now it is applied to power trading, in order to smooth consumption curve and balance between generation and consumption Block chain technology is introduced. The Block chain is a kind of transaction history, like a huge ledger that appeared with the Bit coin. To know the feasibility of integrating Blockchain into a Smart Grid model, it is necessary to know the issues and parameters to be considered. For this purpose, an in-depth study of this technology is expected. The Blockchain was introducing to promote local energy production. Peer-to-peer energy transactions could reduce the high electrical demand for the existing grid, and Blockchain could secure and memorize transactions. In block chain technology the smart contracts will have the role to automatically satisfy some conditions or rules of consumption, among citizens. These contracts might contain the user preferences or the consumption patterns of appliances.

The Blockchain Applied To The Smart Grid

After knowing the concept of the Blockchain this is applied to power transfer between the IPPs. The block diagram shows the development of a Blockchain adapted to a smart grid model. This first block chain approach is a combination of several block chains, which gives us the Electric Chain, in reference to the electrical aspect of the chain. This is applied to microgrid electric network.

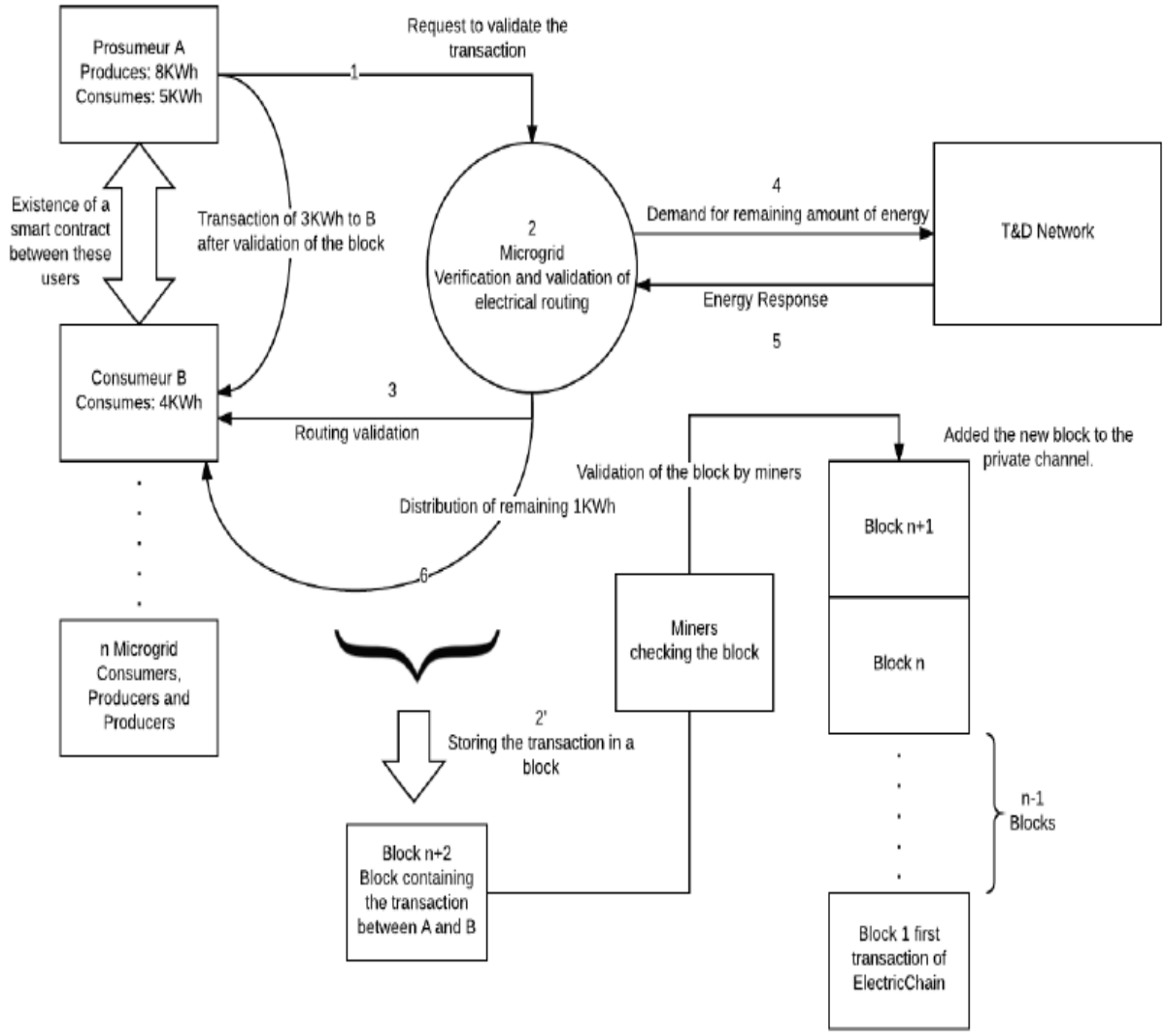

Fig.1 Block diagram of block chain load balancing

The decentralization aspect provides peer-to-peer exchange flexibility. By merging the initial Smart grid model and the Electric Chain, Fig summarizes the process which relates the progress of a transaction between two IPP of the same microgrid.

Background

"A" produced 8 kWh, he consumes 5 kWh, he still has 3 kWh.

"B" needs 4 kWh.

A smart contract is established between those two IPPs (transaction rules).

Microgrid level:

- A Transaction wanted to be carried out between two IPPS of the same microgrid according to the rules of the smart contract (A and B), "A" wants to send 3 kWh to "B".

- The microgrid checks whether it is possible to perform a transaction, based on the electrical routing and the power line support.

- Once the routing is validated, the microgrid allows to "A" to transmit the amount of energy to "B", concerning the capacity of the lines to support the transaction.

- The microgrid demand the 1 kWh left for "B" to the T&D network for meeting conditions of the transaction.

- The network provides the remaining 1 kWh to the microgrid.

- Finally, the microgrid sends to "B" the 1 kWh.

Digital Grid Router

The DGR is a multiterminal AC/DC/AC power conversion device. In order to construct a DG, bi-directional power flow and asynchronous interconnection become the main factors. Big cities contain several microgrids with their own energy pattern and clock chain. The main function of Digital Grid is to integrate different types of renewable energy to the grid and the power exchange among the individual power produces (IPP) .The concept of a DG divides the power grid, the frequency of which is synchronized into various sized power grids. Divided grids are called digital grid cells (cell). Cells are able to do isolated operations in the cell because cells have some distributed generation an and energy capacitor system which has various sizes. Cells are connected together asynchronously via a DGR, which can export and import power among multiple cells at the same time as shown in Figure1

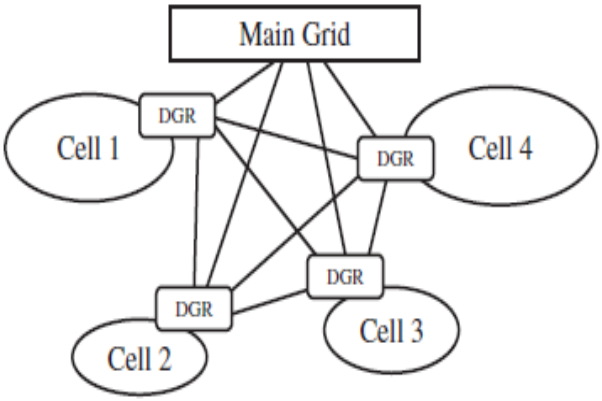

Fig.2. Digital grid cells

A Digital grid router is a multi-terminal converter composed of bi-directional DC/AC inverters. Each terminal is able to export and import the energy from the neighboring cells. Each leg is connected to main grid. Each leg is able to connect to the power grid asynchronously and the other leg can connect to its own grid (cell) and maintain its frequency, phase and voltage.

The features of a digital grid router DGRs have an IP address. It is possible that power is able to supply selectively. The influence of an accident is minimized by switching the DGR off as an accident occurs. Figure 4 shows the internal structure of a DGR

Bi-directional power flow is the main feature of a Digital Grid.. This function solves power exchange between the individual power produces (IPP). If surplus power that is caused by renewable energy sources, which is by photovoltaic power generation and wind power generation. Surplus power is a charged energy capacitor system which has various sizes in cells as it generates. If the energy capacitor system is met, cells have to supply to somewhere. Thus, a DGR looks for other cells with capacity, and the DGR supplies surplus power to there. The function of bi-directional power flow is important for supplying power to other cells. This function is the feature that it is not used in the current grid. Thus, if surplus power generates in the current grid, the consumers drain power to main power grid as backward flow. The current grid is not able to cope with surplus power. It is difficult for the current grid to solve problems of renewable energy sources. This is an important factor.

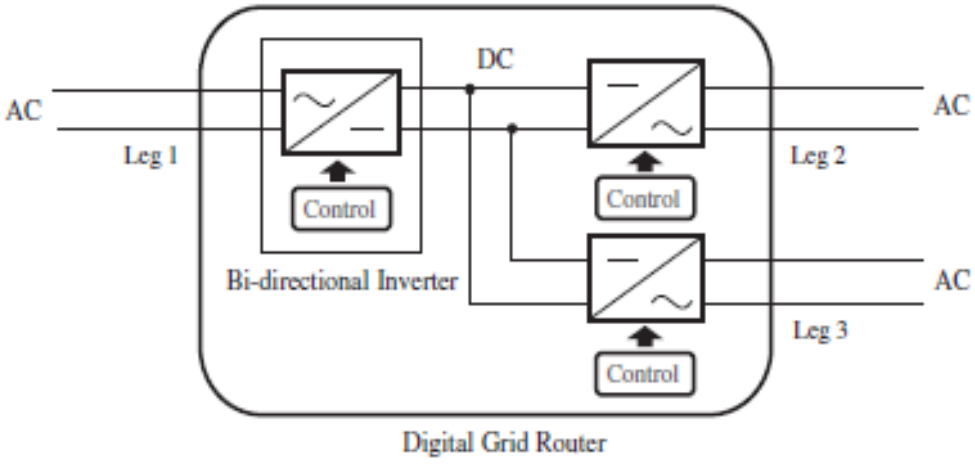

Fig.3. Digital grid router

CONCLUSION

This study investigated the current block chain and digital grid router for load balancing and bidirectional power flow in microgrid environment which consists of solar and wind power hybrid generation. The micro grid operated in decentralized mode or centralized mode for the operation. The power flow among the IPPs through individual IP address of DGR. The quantity of power flow is according to the load pattern which given by the consumer using block chain technology. With both the technology if smart meters are introduced it is possible to record the imported and exported energy form each IPP.

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