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Modelling charging and discharging switching strategy for battery energy storage system

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ABSTRACT – Battery energy storage system is design to continuously supply power when there is deficit of energy generation and production from the hybrid renewable energy system. In other word, the battery energy storage system integrated in the hybrid renewable energy system acts as an uninterrupted power supply for such kind of systems. Therefore, a strategic control to charge and discharge battery energy storage system is required to allow the system to operate without any disturbance. This paper introduces charging and discharging switching strategy for battery energy storage system. The adopted method alternatively charge and discharge each battery energy storage system without deteriorating the batteries health at every State-of-Charge (SoC) and Depth-of-Discharge (DoD) of 20%. The obtained results from the simulation have successfully validated the methodology of developed charging and discharging switching strategy for battery energy storage system, which is based on 20% of SoC and DoD.

1. INTRODUCTION

Battery as energy storage has been incorporated into the renewable energy systems to smooth the fluctuating output power to connected output load. Referring to [1], research of modelling and simulation for battery as energy storage is always a concerning issue. Therefore, many approaches with various methods [2], [3], [4] have explained that application of battery as energy storage is an effective approach to reduce the fluctuating impact on the renewable energy power system. Henceforth, all these approaches and methods are used to strategically charge and discharge the battery during its operation to avoid damages to the batteries. At the same time, these methods also avoids the battery being overcharged or under discharged.

This paper proposes the charging/discharging switching strategy that manage and control the batteries charging or discharging.is modelled and simulated using Simulink-MATLAB. Section 2 presents the methodology of charging/discharging strategy. Section 3 explains results and discussions obtained to validate the proposed approach using the Simulink-MATLAB. Modelling and and followed by conclusion in Section 4.

2. CHARGING/DISCHARGING SWITCHING STRATEGY METHODOLOGY

The BESS charging/discharging switching strategy (Figure 1) is proposed to sense and measure BESS State of Charge (SoC) status during the charging/discharging process. Referring to Figure 1(a), when the BATT A STORAGE SoC and BATT B STORAGE SoC are less than or equal to 20%, the charging/discharging switching strategy begins BATT A STORAGE charging process. Therefore, BATT A STORAGE starts charging and stops charging when it's SoC is 20% higher compared with BATT B STORAGE. Then, charging process is switched to BATT B STORAGE. BATT A STORAGE is connected to the load for discharging, if required. At SoC 100%, both batteries stop charging and always ready for any potential discharging process.

BATT B STORAGE has the priority to start discharging if it's SoC is at 100%. BATT B STORAGE will discharge at the rate of 20% and when the SoC is 40% equal or lesser compared with BATT A STORAGE, the discharging process is switched to BATT A STORAGE. This process continues until both batteries SoC reaches at 20%, then discharging process is HALTED and return to charging process.

3. BATTERY SIMULATION OUTPUT

This section presents the results of the charging/discharging switching strategy, which is based on the Batteries SoC. Then BATT B STORAGE is connected to the load for discharging as shown in Figure 1. As shown Figure 2, BATT A and BATT B STORAGES SoC =100%.

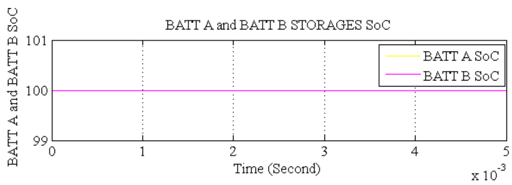

Figure 1 BATT A and BATT B STORAGES SoC = 100%.

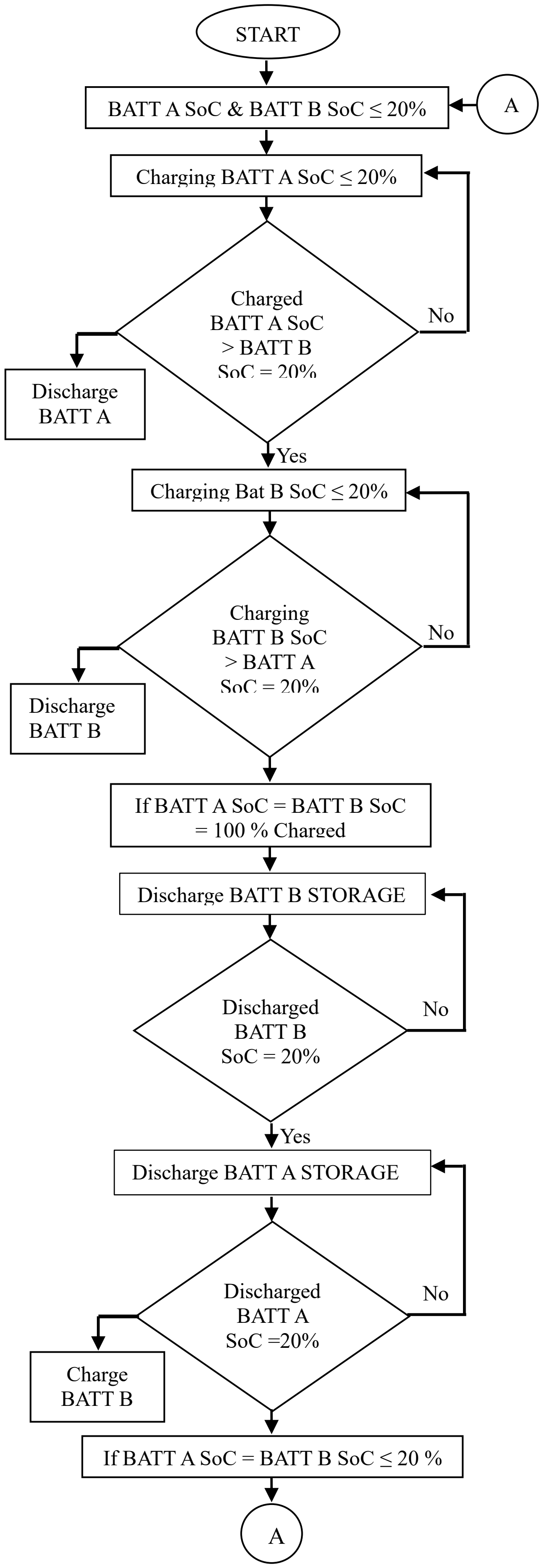

Figure 2 Charging/Discharging Switching Strategy BATT A STORAGE.

As shown in Figure 3, BATT A STORAGE SoC = 100% and BATT B STORAGE SoC = 80%. Then the discharge process is switched to BATT A STORAGE SoC as shown in Figure 3. As shown in Figure 4, BATT A STORAGE SoC = 80% and BATT B STORAGE SoC = 100%. Then the discharge process is switched to BATT B STORAGE.

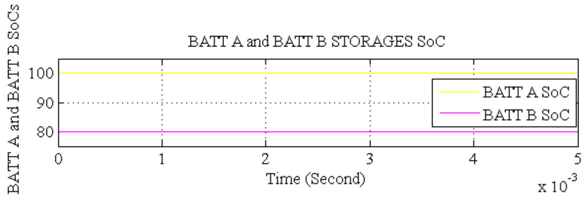

Figure 3 BATT A STORAGE SoC = 100% and BATT B STORAGE SoC = 80%.

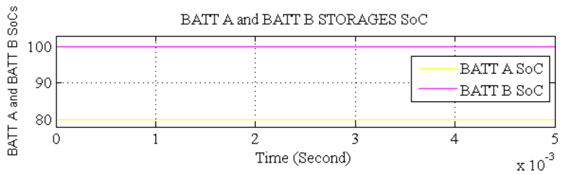

Figure 4 BATT A STORAGE SoC = 100% and BATT B STORAGE SoC = 80%

4. CONCLUSIONS

The results and discussion presented in Section 3 validates the modelling and simulation of charging/discharging strategy operation presented in Figure 1.

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REFERENCES

[1] Xia T., Li M., Zi P., Tian L., Qin X., and An N. (2016). Modeling and simulation of battery energy storage system (BESS) used in power system. *Proc. 5th IEEE Int. Conf. Electr. Util. Deregulation, Restruct. Power Technol (DRPT 2015*). 2120–2125.

[2] Zhu Y., Zhuo F., and Shi H. (2013). Power management strategy research for a photovoltaic-hybrid energy storage system. *2013 IEEE ECCE Asia Downunder,* 842–848.

[3] Tran D. and Khambadkone A. M. (2013). Energy management for lifetime extension of energy storage system in micro-grid applications. *IEEE Trans. Smart Grid 4(3),* 1289–1296.

[4] Mingyu L. *et al.* (2016). Design of energy storage control strategy to improve the PV system power quality. *IECON 42nd Annu. Conf. IEEE Ind. Electron. Society,* 2022–2027.