Usage of BESS to Monitor Wind Power Generation

Abdullatif Al Omair

***Abstract* — The purpose of this case study is to study and identify the integration of Battery Energy Storage System (BESS) with renewable energy to compensate with any deficiency would occur due to lack of wind speed or sun radiation. This study provides a practical understanding by reporting the finding in literature on BESS and its last technology and applications. By the end of this case study it is expecting to define the appropriate time to buy energy to charge the battery and the appropriate time to sell according to a give wind data based and market cost.**

***Keywords*—wind energy, battery storage, power generation, renewable energy**

I. Introduction

The need for renewable energy is increasing and governments thinking seriously to start implementing the green and clean energy to reduce the heavy cost of conventional generation specialty for non-oil producing countries. There are many challenges in integrating renewable to the grid and some constraint must be considered to ensure reliable and sustainable power supply toward any variation in load or frequency. The variability and uncertainty are questionable in wind power where it is very difficult to predict or forecast the power after a certain time which is making it difficult to commit with customer or system operator about a certain amount of power to be deliver. In addition, that, the power trading is a concern where producer must define the best time to sell or to be connected to the grid. BESS had been introduced to bride all gaps and ensure a smooth power supply driven to the network overcoming the lacking in wind speed. Advanced BESS is a combination of different technologies where battery is used and supper capacitor is used too. The operating concept of BESS is to monitor the wind power generation and to compensate for any deficiency might occur during the generation. Thus, if power derived is not sufficient then BESS will support the grid by discharge the energy where if the wind power generation is high enough it will charge the BESS.

BESS utilizes the battery to provide the required energy in a small amount for a long period where super capacitor is utilized to provide a huge amount of energy within a small-time frame.

Although BESS technology plays an important role to increase the penetration of wind power into the electricity grid but there are significant associated challenges:

- BESS is still expensive,
- A large BESS is required for high penetration of wind power and normally BESS is over-dimensioned.
- A complicated control circuitry is required for an efficient operation of BESS.
- Capacity Optimization and accurate sizing is vital for cost effective solutions.

There is technology called Monotonic Charge and Discharge of individual batteries in a BESS. The Monotonic Charging/Discharging originates from the fact that consistent charging/discharging direction of batteries in the BESS reduces the battery ageing and prolongs the battery lifetime. The main goal is to find the optimal capacity of each individual battery in a BESS and derive a monotonic charge/discharge strategy for the selected battery capacity.

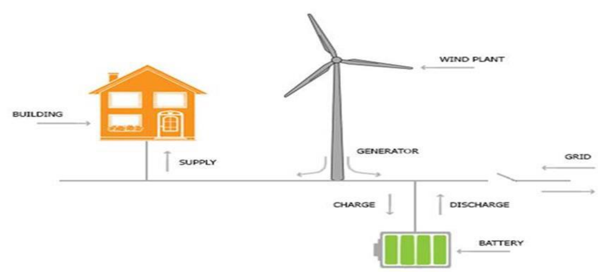

Figure 1: Wind Power plant with BESS [1]

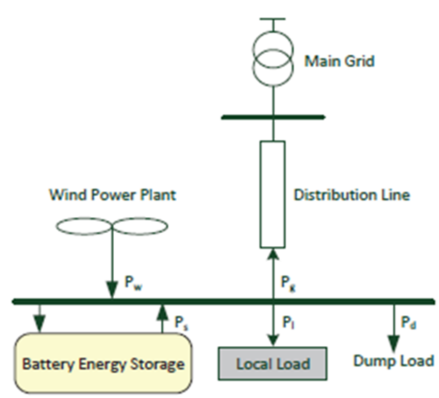

Figure 2: A general diagram showing how BESS is connected to the grid [2]

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II. METHODOLOGY

We are going to run a MATLAB code that will do the simulation of charging and discharging of battery during the wind power plant generation. The main objective is to be able to know exactly when to discharge and when to charge. This will depend on the availability of wind generation and the cost of market power supply. Consider a typical wind power plant coupled with battery energy storage system (BESS). Suppose that the BESS is utilized to maximize the income for the owner of wind power plant. The objective of this problem is to propose an optimal charge/discharge strategy for BESS, which will maximize the income (energy sold x cost of energy per unit). Therefore, will do the following:

- Select an appropriate BESS size.
- Operate the selected BESS in 30% − 70% operation band.
- Propose a charge/discharge strategy to maximize the profit for the period of one day (24 hours) based on the given profile of market price.
- Assume ideal linear battery model with 100% charging/discharging efficiency.

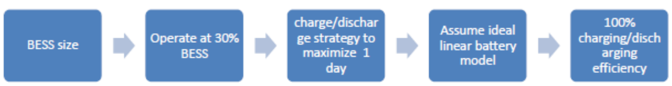

Figure 3: Flow chart of BESS

III. RESULTS AND DISCUSSIONS

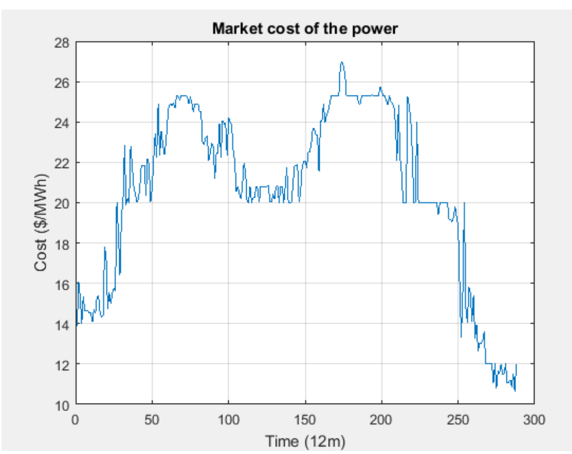

Figure 4: Market cost of power

Figure 4 represent the cost of energy for MWh during the day, we can see that in some interval we have a high price of energy where we can utilize that for discharging the stored energy to sell at that price and earn more money and there is some other time where we should not sell but buy from the grid to charge our BESS where price is dropped down. It is very difficult to track all points and react accordingly but we would have an optimum level that will give us a good revenue.

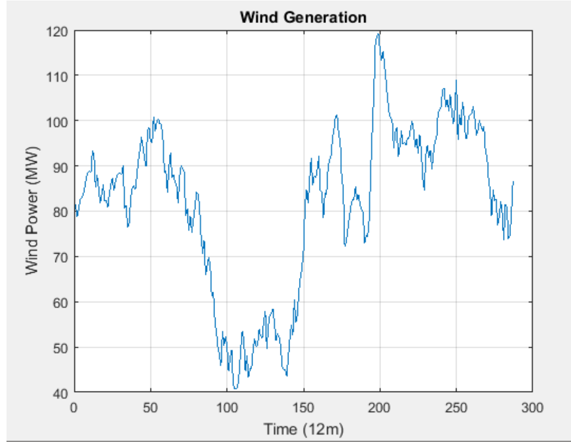

Figure 5: Wind Power Generation

Figure 5 represent the wind power generation for 24 hours we can see that he generation is varying up and down where the BESS will contribute and compensate for any lack in the wind power output to smooth that power output which mean a sustainable power supply to the served customers. We should not discharge during the period from zero to around 25 and from 200 to 300 as prices are low. We should utilize this window to buy and charge the BESS.

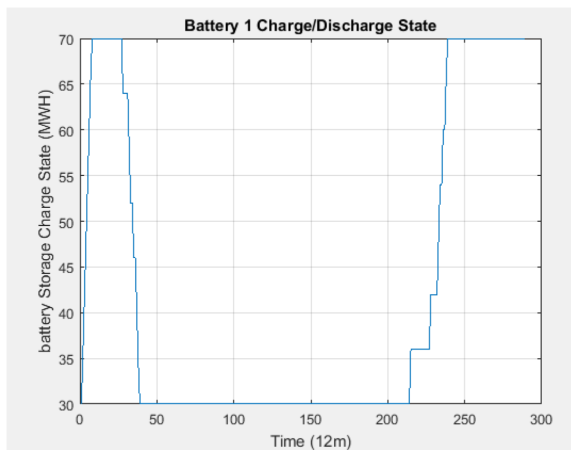

Figure 6: Optimum charge of & discharge in Battery 1

Figure 6 represent charging and discharging of battery. We have selected 20 in market cost to be a threshold where we can sell or discharge if price goes to 20 $ or above as we can cover more areas under the market price and wind power output. We have discharged the battery during the low prices in the market.

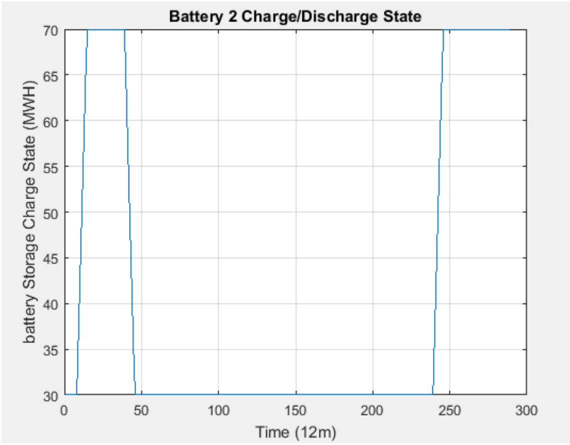

Figure 7: Optimum charge & discharge in Battery 2

Figure 7 shows the status of battery 2 where we have done the same, charging during the low prices and discharge during the highest. simultaneously, we are maintaining the wind power output needs.

IV. RECOMMENDATIONS

To get the highest possible revenue from discharging battery and capacitor it is recommended to:

- Use the best product in the market that have longer life time and faster response. In addition to that less constraint. For example, Flow battery have no upper or lower limitation where we can maximum charge and discharge.
- Look for the best control technology that provide less time for calculation and processing to catch up with the variation in wind power output and market prices.

V. RESEARCH AIM

The aim of the research is to study and identify the integration of Battery Energy Storage System (BESS) with renewable energy to compensate with any deficiency would occur due to lack of wind speed or sun radiation.

VI. CONCLUSION

BESS is the best solution that will keep the renewable sustainable and reliable and a good area of investment too. It is a solution for any deficiency might observed or occurred in the system. BESS will provide a good motivation to all investors to go and invest in this field as it will encourage all renewable energy companies to have a great backup and support for any discontinuity of delivering the power supply to the end user customer.

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