Droop Control Method Based on the State of the Charge Balancing of Different Energy Storage Systems in DC Microgrids

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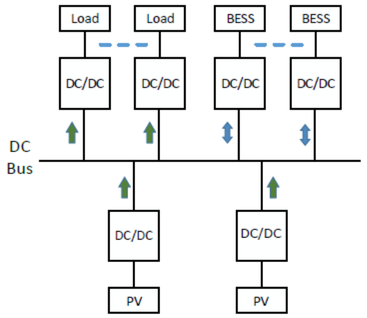
Overview

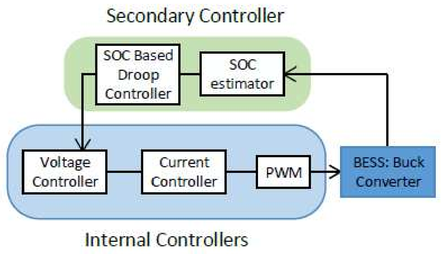
Challenges in DC microgrids:
- ✓Employing a control algorithm that ensures power balance.
- ✓Paralleling the resources: the amount of power each of them produce or absorb.

Droop Control Method



BESS might be exposed to:
- ➢Deep discharging
- ➢Overcharging

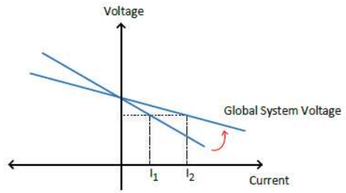
It is desirable that:
- ✓In the discharging operation, the BESS with higher SoC provides more power.
- ✓In the charging operation, the BESS with lower SoC absorbs more power .



Method

Objective: Balance the SoC of each BESS to avoid:
- over charging
- deep discharging

✓Prolong the lifetime of BESS



✓Charging Process: $m_i = m_c * SoC_i^n$

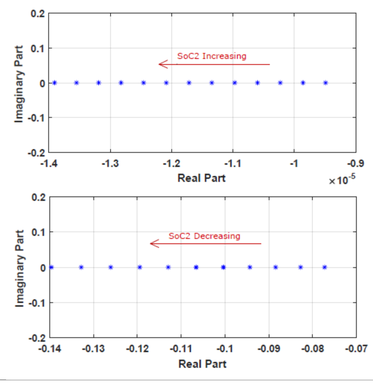
✓Discharging Process: $m_i = \frac{m_d}{SoC_i^n}$

$$P_{o1} \sim \frac{1}{SoC_1^n}, P_{o2} \sim \frac{1}{SoC_2^n} \dots P_{ok} \sim \frac{1}{SoC_k^n}$$

$$P_{o1} \sim SoC_1^n, P_{o2} \sim SoC_2^n \dots P_{ok} \sim SoC_k^n$$

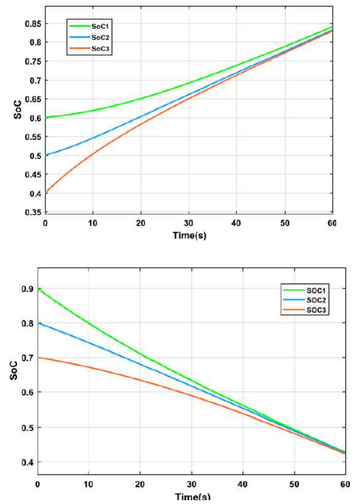
In charging operation mode: if SoC_i is greater than SoC_j :
P_{oi} is lower than P_{oj}

➡ The increasing speed of SoC_i is lower than SoC_j

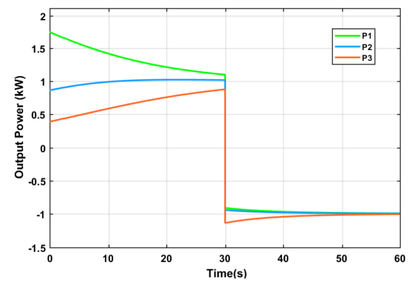


Results

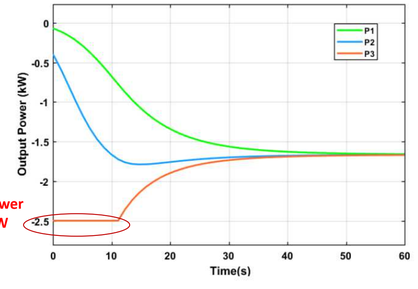
Numerical Solving:



Simulation Results: Case1:



Case2:

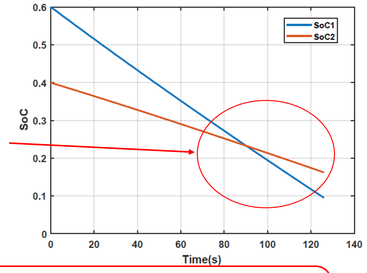


Limit power to 2.5 kW

Future Works

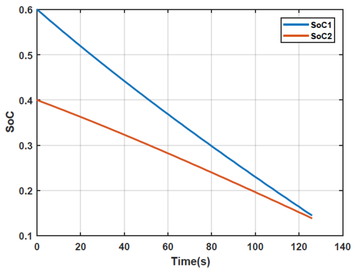
- The capacities of BESS are considered the same.
- However, in practical operation, the BESS have different capacities.

The SoC balancing is not achieved due to difference in the Capacities of BESS.



The droop coefficient for each BESS shall contains the BESS capacity.

$$R_{d_i}^* = \frac{R_{d_i}}{C_e(p.u)}$$



References

[1]"Implementation of hierarchical control in DC microgrids"
[2]"SoC Balancing Strategy for Multiple Energy Storage Units with Different Capacities in Islanded Microgrids Based on Droop Control"
[3]"Double-Quadrant State-of-Charge-Based Droop Control Method for Distributed Energy Storage Systems in Autonomous DC Microgrids"