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Enhancement of Micro-grid Resiliency by Multiple Battery Energy Storage System utilizing Local Measurements

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Abstract

Aiming to achieve clean energy based power generation, renewables such as solar, wind play a crucial role . For reliable power supply to the critical loads, storage systems are deployed which stabilize the system voltage during transients . The developed controller achieves desired power-sharing among Battery Energy Storage System (BESS) in different mode of operation of micro-grid. Converter interfaced BESS controller is developed which facilitates smooth transition between the operating modes of BESS which are Power Regulation Mode (PRM), Constant Voltage Mode (CVM), and Voltage Regulation Mode (VRM).

Introduction

To improve the micro-grid resiliency and reliability, multiple energy storage systems such as BESS are installed at micro-grid sites [1]-[2]. Control transitions among the operating modes based on switching logics deteriorate the transient performance of the converter control [3]-[5]. Local measurement based control solution is proposed without utilizing communication links and considers the life of the battery units by maintaining the optimal State of Charge (SoC).

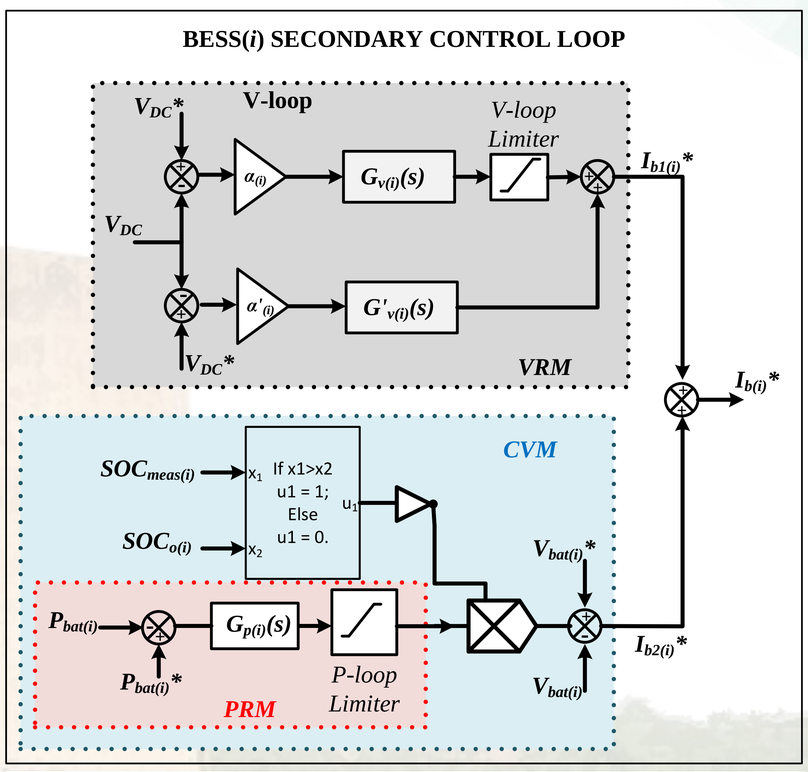
Control Methodology

The controller ensures three operating modes and smooth transition among them. The modes are-

(1) PRM when DC bus voltage is regulated by the grid and charging or discharging of the battery is in constant current mode,

(2) CVM when the battery needs to be charged in constant voltage mode, and

(3) VRM when the DC bus voltage is regulated by BESS.



Conclusions

- **System voltage is stabilized leading to enhancement in microgrid reliability during heavy transients such as utility disconnection.**
- **Plug and play operation of BESS is successfully achieved, facilitating the onset of storage units in microgrid.**
- **The transient response is improved due to simultaneous working of the control loops depending upon SOC.**

Industrial Significance

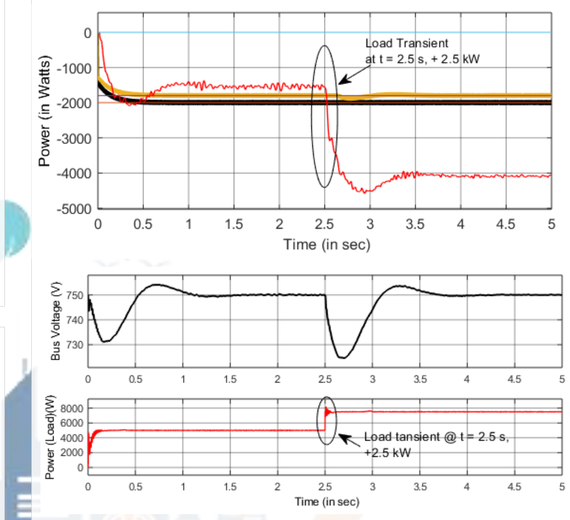
- Such a scheme facilitates inclusion of renewable energy sources in the conventional distribution network.
- Storage systems can be installed to support microgrid voltage during transients such as disconnection of conventional grid.
- The developed controller ensures longevity of the storage systems by maintaining the optimal SOC.

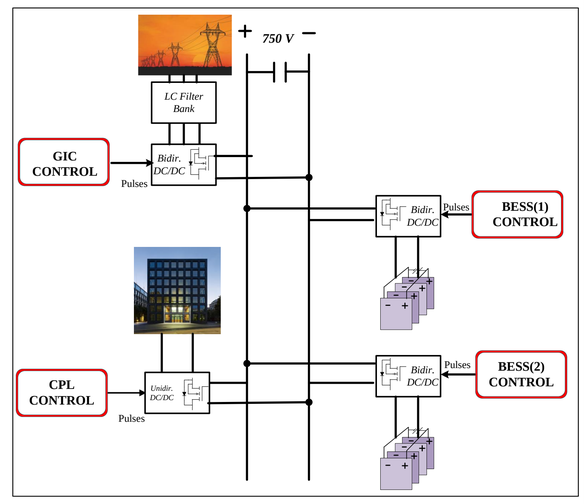
Technology Readiness Level: The scheme is validated in real-time conditions and is ready to be implemented at microgrid sites.

Result

The results validate the operation of storage units during different system conditions. Case studies are detailed for the system shown below.

- *Load transients*

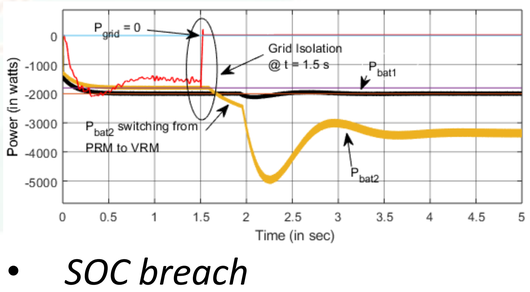


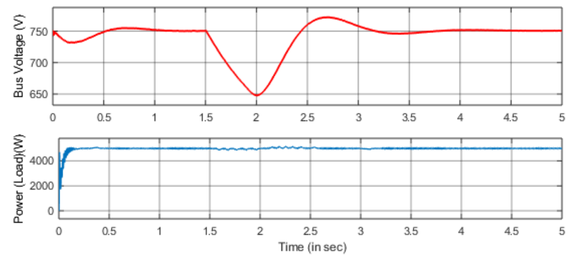


The load transients are stabilized by VSC connected utility and the BESS operates in PRM as expected.

- *Utility disconnection*

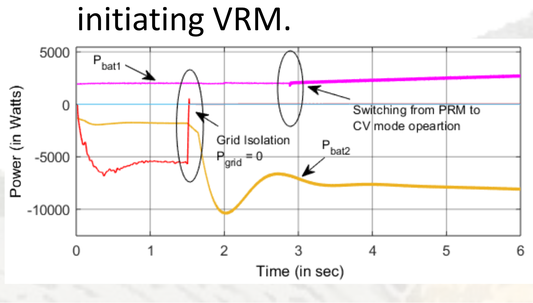
The accidental islanding is arrested using BESS(2) with higher α. BESS(1) maintains PRM. Voltage is stabilized by BESS(2) after grid disconnection.

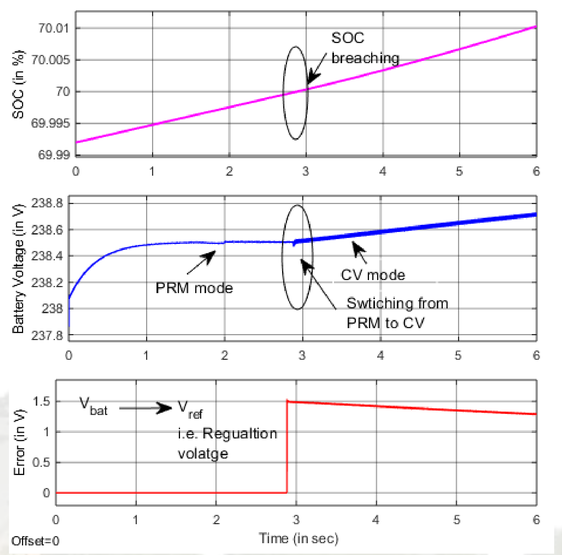




- *SOC breach*

1. The *CVM* is initiated by BESS(1) when SOC breaches 70 %.
2. Battery terminal voltage is regulated in this mode to ensure that the BESS does not overcharge the storage units.
3. Grid disconnection is realized at t = 1.5 s with BESS(2) initiating VRM.





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