A Converter-Based Battery Energy Storage System Emulator for the Controller Testing of a Microgrid with Dynamic Boundaries and Multiple Source Locations

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Background and Motivation

- Microgrid (MG) with dynamic boundaries and multiple source locations is a future MG concept that can bring more local flexibility and resiliency
- Controller is a core component in a MG
- Converter-based hardware testbed (HTB) can provide a practical testing environment for MG controller testing
- No suitable BESS emulator is available for controller HTB testing of the MG with dynamic boundaries and multiple source locations

Converter-based HTB

- HTB utilizes a power circulating structure
- MG components are emulated by power converters
- Actual MG controllers are placed in the loop for testing

BESS Emulator Development

- Requirements of different functions in the MG controller are considered in the development of BESS emulator

<table>
<thead>
<tr>
<th>Function type</th>
<th>Function block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-time functions</td>
<td>Energy management, PV load forecasting</td>
</tr>
<tr>
<td>Steady-state functions</td>
<td>Finite state machine, PQ balancing</td>
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<tr>
<td>Transition functions</td>
<td>Planned islanding control, Reconnection control, Black start, Protection coordination</td>
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</tbody>
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MG with Dynamic Boundaries and Multiple Source Locations

- Microgrid boundary can be expanded or shrunk based on available DER power
- Multiple islands can be formed in the islanded mode
- This microgrid has more complicated transitions
- Microgrid controller functions include long-time functions, steady-state functions and transition functions

Experimental Demonstration

- Developed BESS emulator is validated on HTB first
- The developed BESS is used to support the MG controller testing

Conclusion

- A BESS emulator is developed for controller HTB testing of a MG with dynamic boundaries and multiple source locations
- The BESS emulator can support different operation conditions
- Practical environments of HTB are considered in the development