Study Committee C6

Active distribution systems and distributed energy resources

10396_2022

Coordinated Solar PV-BESS Control in BCM: Algorithm, HIL Testing and Learnings with Different Solar Profiles

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Motivation

- As solar PV adoption increases, its inherent variable nature can pose challenges to system operators to maintain normal grid operation
- The impact is more evident on smaller microgrids
- Coordinated operation of solar PV with Battery energy Storage System is explored and tested to mitigate the challenges of Solar PV integration

Method/Approach

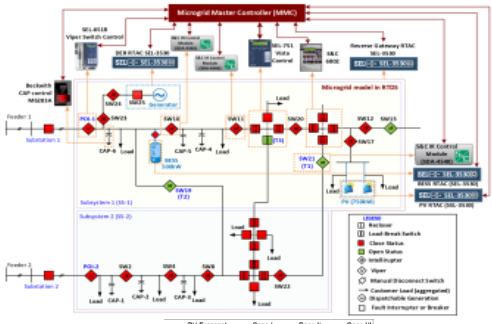
- ComEd partnered with the US DOE to develop a control architecture that coordinates the operation of solar PV and battery to enable steady and predictable output
- It maintains an unchanged output on a 15-minute basis even when the output of solar PV varies on minute-by-minute basis, and the model also considers the error that could occur in solar output forecasting
- The algorithm for solar and PV coordination has been implemented in the microgrid controller for Bronzeville Community Microgrid which will power approx. 7 MW load by utilizing a combination of 750 kW Solar, 0.5 MW/2 MWh BESS and 4.8 MW Natural Gas Generator

Solar PV and Battery Coordination (SBC)

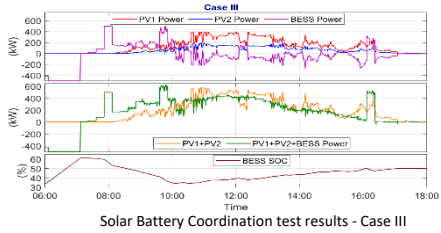
- The proposed model for solar PV and BESS coordination implemented in microgrid controller incorporates:
- **Multi-time scale model:** The proposed model is a 15-minute model for 24 hours while also considering the minute-by-minute variation of PV unit outputs for the first two hours. This is important since PV unit outputs may change rapidly within any time period.
- **Robust model:** The proposed model can accommodate all possible scenarios of the actual PV unit outputs. This is important since the PV unit outputs cannot be forecasted very accurately, and the forecasting error could be high (e.g., 20%).
- **Constant 15-minute aggregated solar-storage output:** The aggregated output of the solar-storage system in the proposed model will remain unchanged on 15-minute basis even if the PV unit outputs deviate from the forecasted values. This is important if:
  - there is no thermal unit in a microgrid;
  - thermal units in a microgrid are not fast enough to track the rapid change of PV unit outputs; or
  - the microgrid is in the islanded mode and does not have utility grid support.

Experimental Setup & Test Results

- A comprehensive Hardware in the loop test setup was built at ComEd's Grid Integration and Technology lab to test the microgrid controller
- It includes several strategically selected control hardware devices representing the actual system equipment such as distribution automation (DA) devices, protection relays, capacitor bank controllers, and DER site controllers RTAC. RTDS simulates the microgrid dynamic characteristics
- The site controller for PV, BESS and gas generator implemented in separate RTAC devices interact with the real-time model simulated in RTDS via ethernet based Modbus protocol



Day ahead PV forecast and actual PV profiles for Cases I, II and III



Solar Battery Coordination test results - Case III

Discussion and Conclusion

- The SBC algorithm was tested with multiple scenarios that simulates different level of forecasting uncertainties resulting in mismatch between forecasted solar PV output and actual PV output
- The multi-time scale robust unit commitment model for mitigating variability and intermittency of solar PV and uncertaintieis in forecasting was tested for BCM and the results show that the algorithm dispatches BESS and PV as a combined unit that is predictable and dispatchable. This is critical for enabling higher solar PV integration.