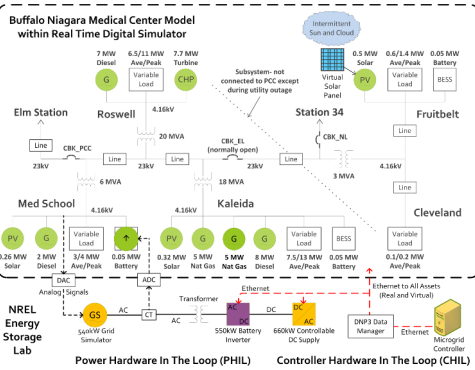


- This project was funded under the DE-FOA-0000997, which supports the development and testing of advanced, commercial-grade microgrid controllers that can manage aggregated generation capacity from 1–10 MW.
- This paper describes a controller hardware-in-the-loop (CHIL) and power hardware-in-the-loop (PHIL) microgrid controller test bed that was designed and constructed to evaluate the capabilities of a microgrid controller for a proposed campus microgrid.
- This paper also presents a test methodology to evaluate the microgrid controller and the controller assessment through the application of different test scenarios.



Use Case A: Grid-connected

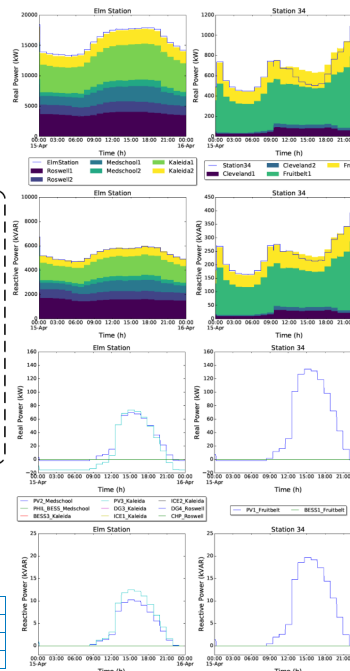
Use Case B: Disconnect

Use Case C: Islanded

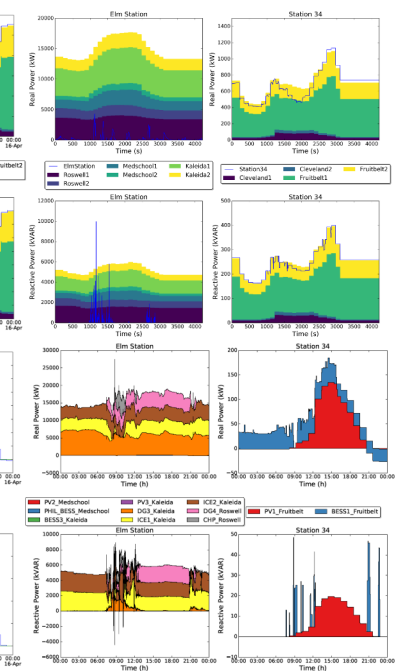
Use Case D: Reconnect

	C1 Disconnect	C2 Reconnect	C3 Steady-state	C4 Protection	C5 Dispatch
Use Case A: Grid-connected	X				X
Use Case B: Disconnect				X	
Use Case C: Islanded			X	X	X
Use Case D: Reconnect		X			

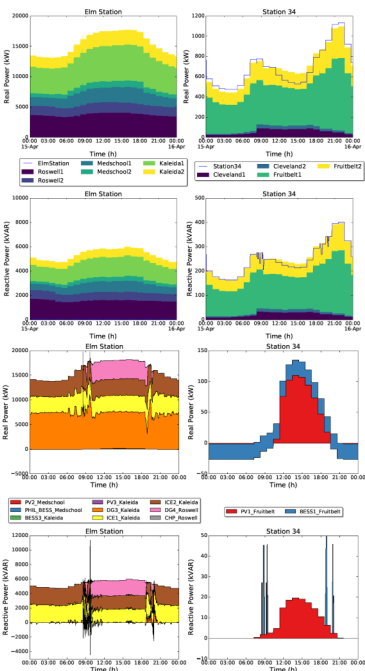
Test Case A1: Normal Grid-Connected Operation with No Dispatch (Baseline)



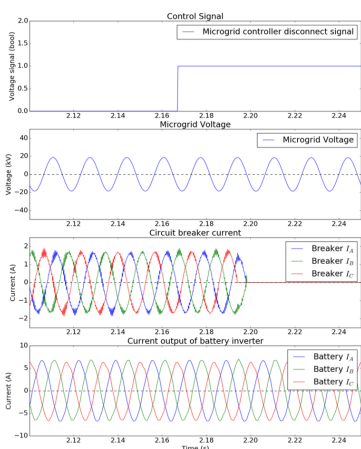
Test Case A2: Normal Grid-Connected Operation with Dispatch



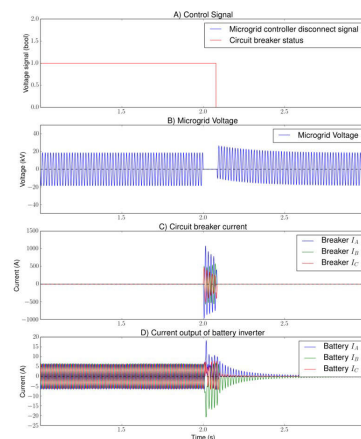
Test Case C1: Normal Islanded Operation



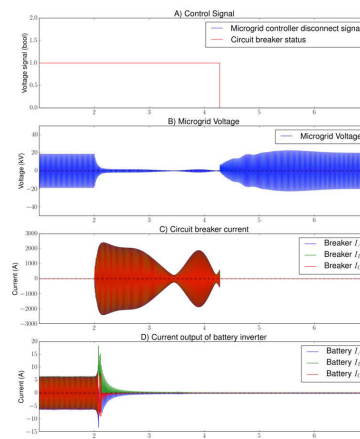
Test Case B1: Planned Separation



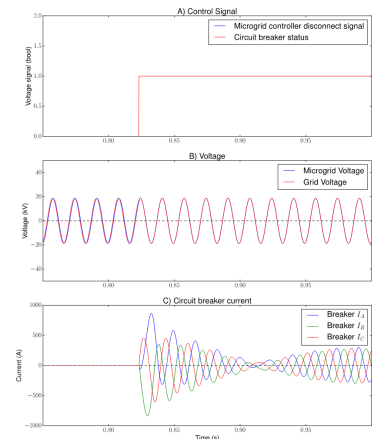
Test Case B2: Unplanned Separation Due to an External Fault



Test Case B3: Unplanned Separation Due to Loss of Utility



Test Case D1: Reconnection



Conclusions:

- This paper presented the development of a test bed for evaluating the functional capabilities of a microgrid controller.
- The test bed incorporates both CHIL and PHIL elements in the experimental setup. A campus microgrid was modeled in a digital real-time simulator, and communications were enabled among the microgrid controller hardware and the simulated assets, circuit breakers, and loads as well as with the battery inverter hardware via a PHIL interface.

3. This paper also presents a test methodology to evaluate the microgrid controller through the application of different test scenarios. Hardware-in-the-loop simulation results provide insight into the test bed's capabilities and the types of evaluations that could be performed by using it. Such a test bed is valuable to help microgrid controller providers, microgrid developers, and owners evaluate performance prior to field deployment.

