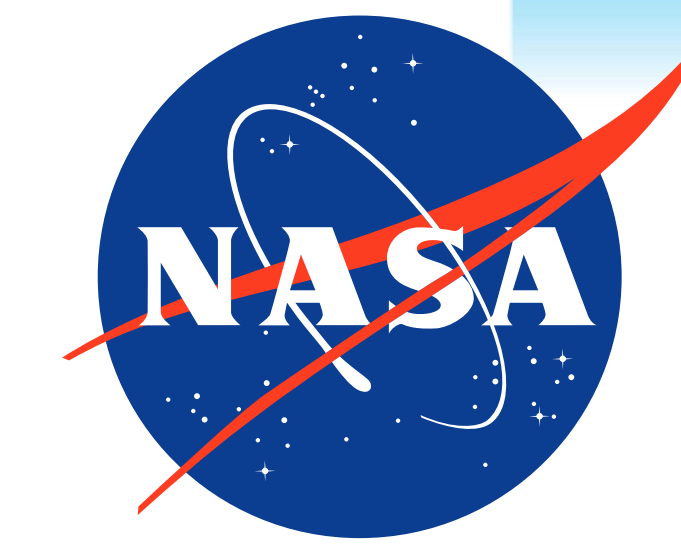




50TH ANNIVERSARY

Development of an Adaptive Droop Control Method for Interconnected Lunar DC Microgrids Using Power Hardware-in-the-Loop

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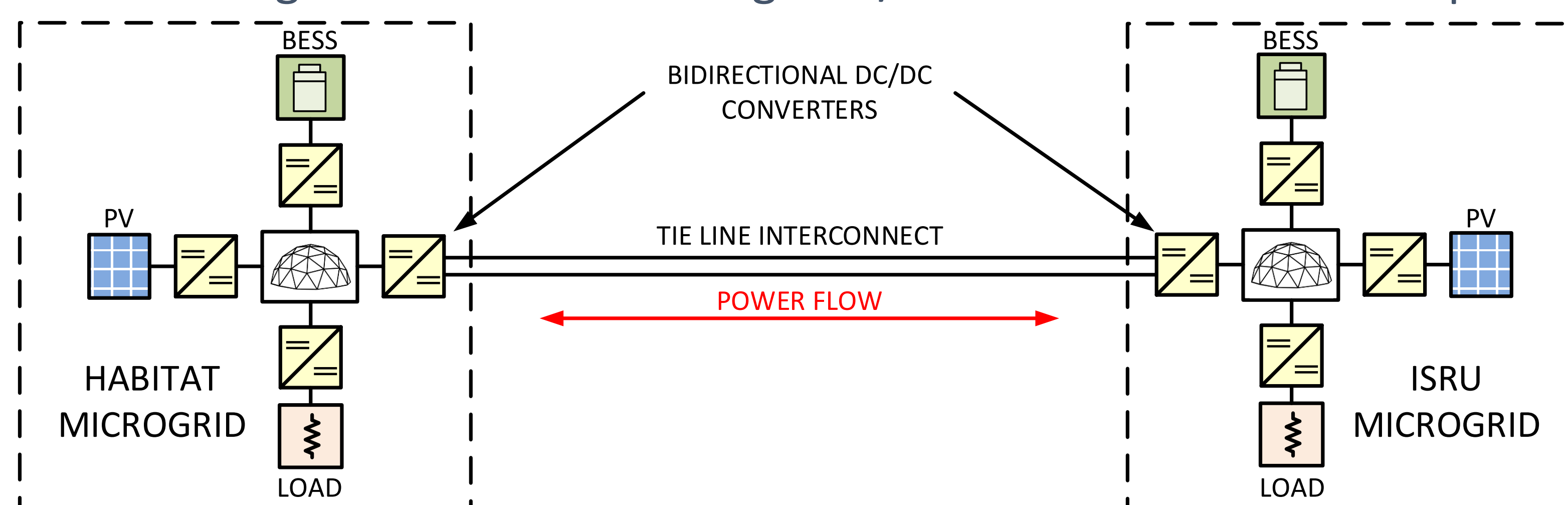
Introduction

An adaptive droop control method is developed for two interconnected DC microgrids via hierarchical control as part of NASA's Artemis program to establish human presence on the Earth's moon.

- Microgrids modeled using Simulink Simscape and state-space average DC/DC converter models.
- Adaptive droop control allows microgrid power sharing and system-controlled power set points.
- Validated using Power Hardware-in-the-Loop to further study the effects of environmental events (loss of PV, load changes, energy storage charge/discharge) on actual power hardware.

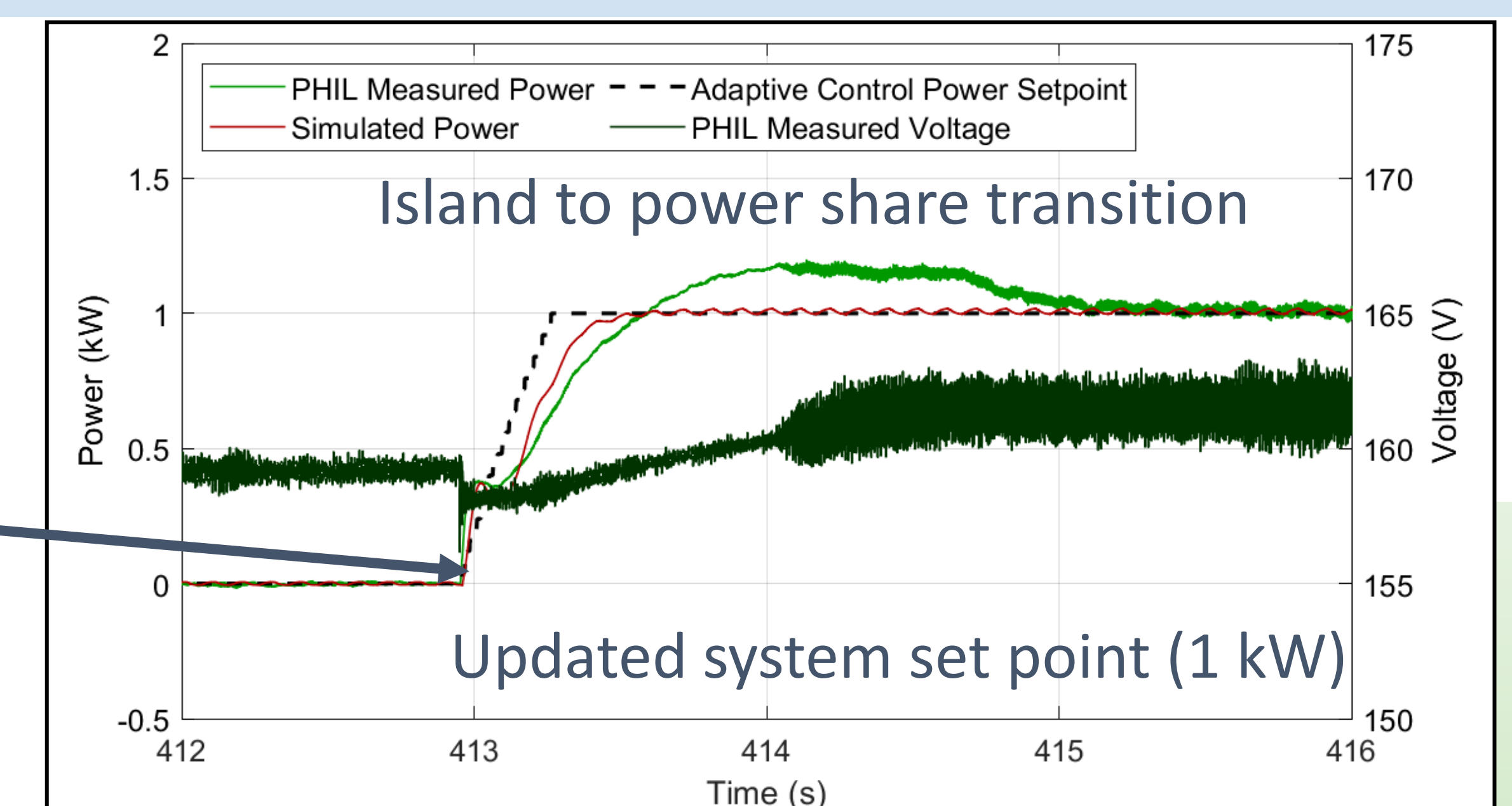
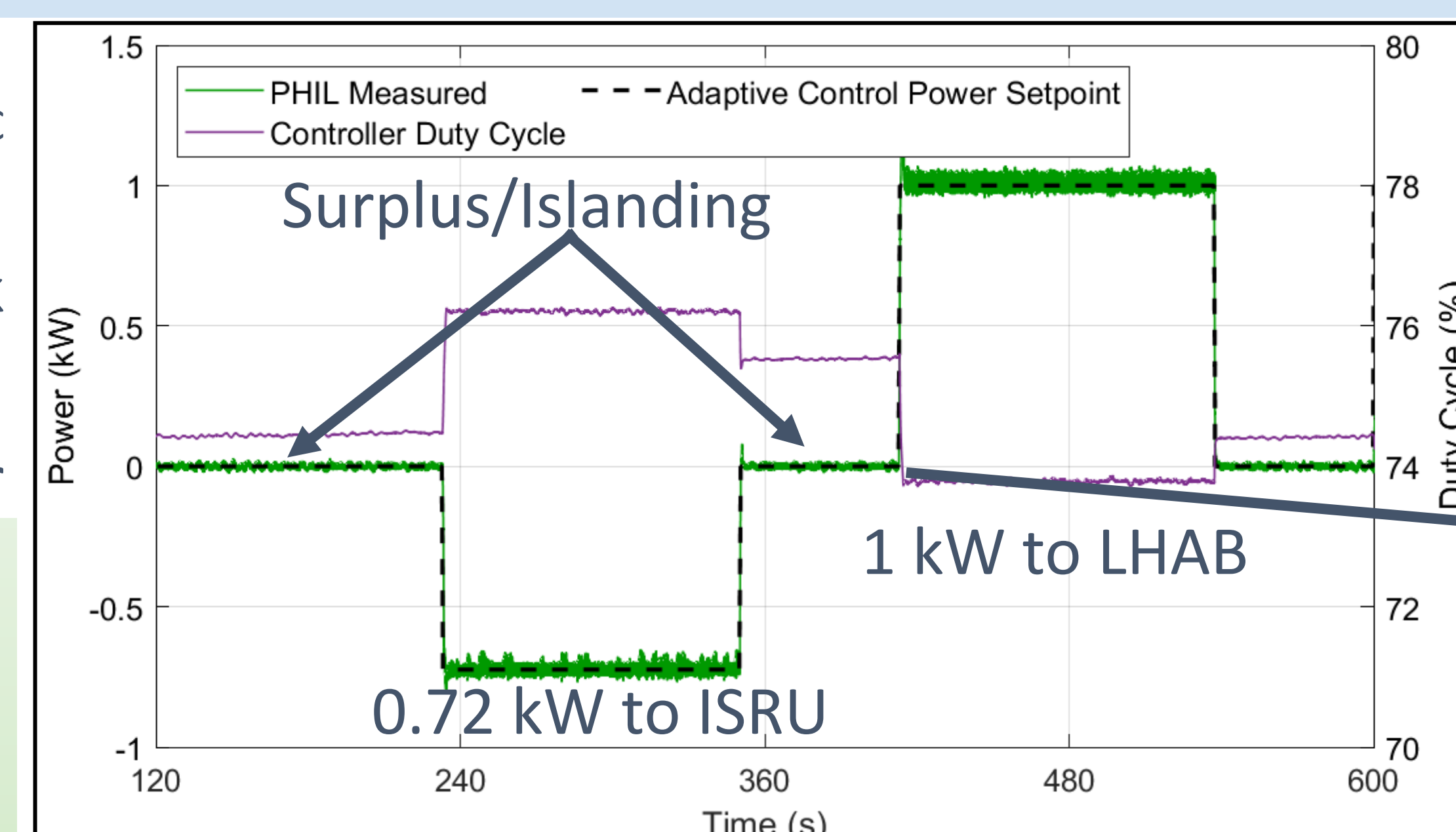
Lunar Habitat Microgrid Model

- Two independent microgrids connected through DC/DC converters for shared power flow.

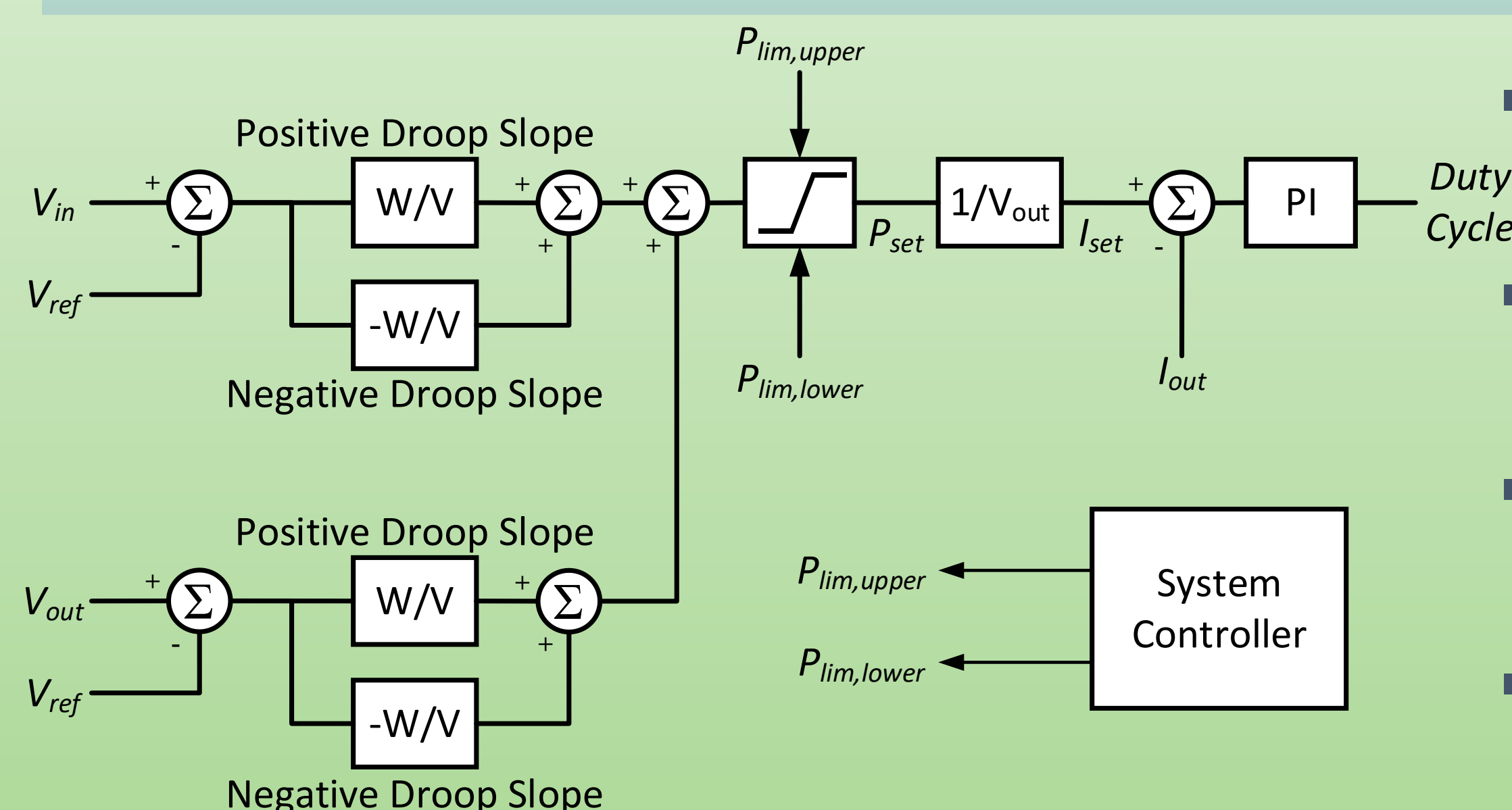


Experimental Test Results

- Tie line converter provides 120 V_{DC} to 160 V_{DC} voltage conversion and bidirectional power flow.
- Measured hardware power found to track hierarchical-issued control set points.
- Power share seamlessly moves from island to power sharing modes during environmental events.
- Bus voltages maintain regulation via droop control method throughout set point changes.



Adaptive Droop Control Method



- Converter input and output voltages compared to nominal reference values.
- Power targets calculated based on droop curve with saturation limits applied.
- PI controls PWM duty cycle based on current set point and measured output.
- System controller providing updated saturation limits to control power share.

Conclusions

- Adaptive control method allows power sharing between two independent DC microgrid models through hierarchical-issued control set points.
- PHIL platform captures hardware DC/DC performance for voltage regulation and bidirectional power flow between microgrids via tie line interconnect.
- Environmental events create power surpluses and deficits in real-time simulation. Events trigger system control changes that interact with power hardware controller to increase interconnected microgrid resiliency.