

Impact Assessment of Cyberattacks in Inverter-Based Microgrids

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Introduction

- **Distributed Energy Resource (DER)** integration is rising
- **Microgrids (MG)** improve grid reliability
- **Hardware-in-the-Loop (HIL)** enables advanced testing

Methods

1. **Solar-based MG** integration to the IEEE 39-bus system
2. **Faults** with varied DER penetrations
3. **Cyberattacks** via Raspberry Pi commands
4. **Real-time** impact analysis

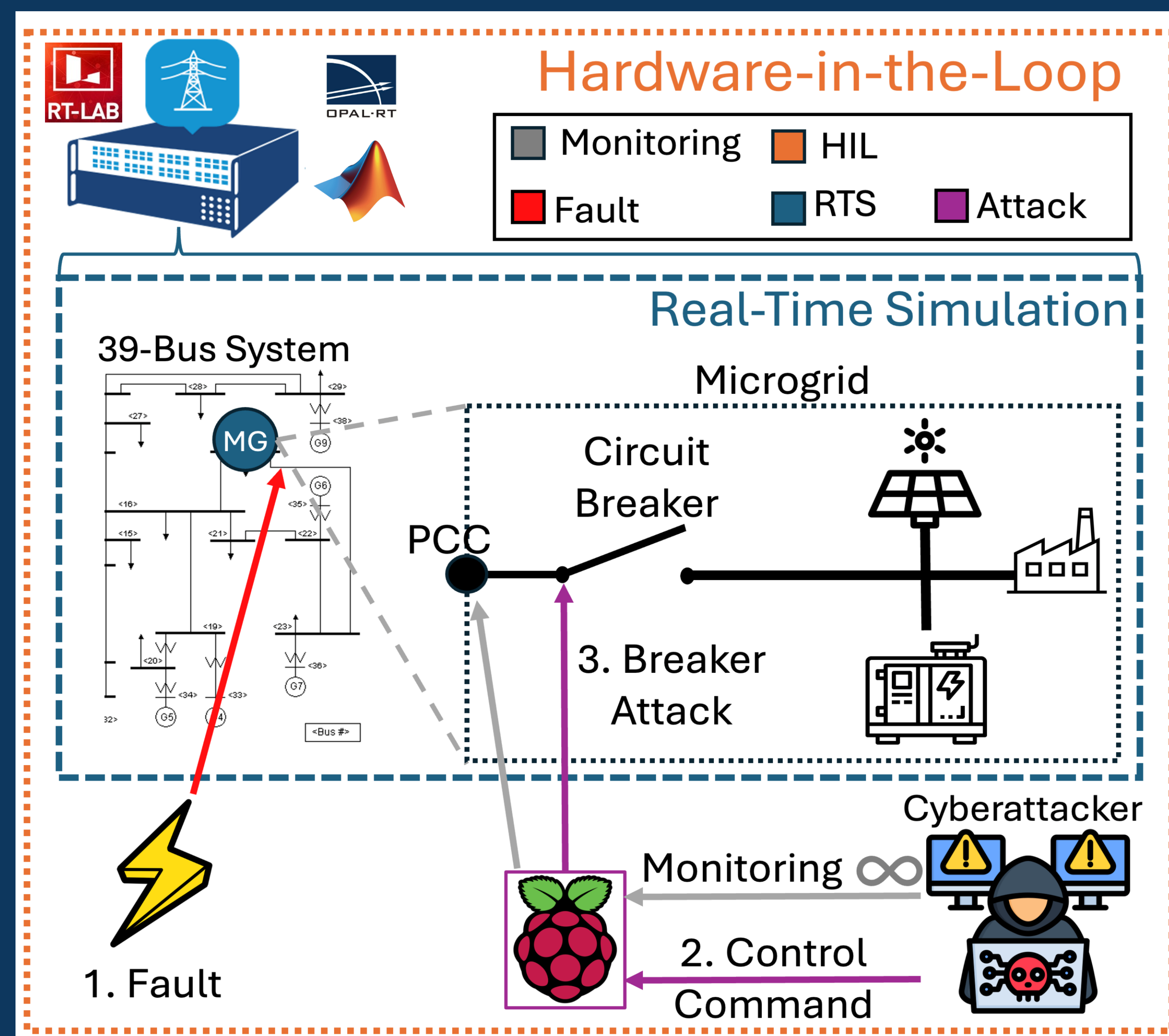
Results and Discussion

- **Cyberattacks** caused frequency and voltage fluctuations
- Higher **Photovoltaic (PV)** levels increased instability
- Repeated **switching** degraded grid performance over time
- MG stayed within **operating limits** throughout all attacks

Are more renewables beneficial for the grid?

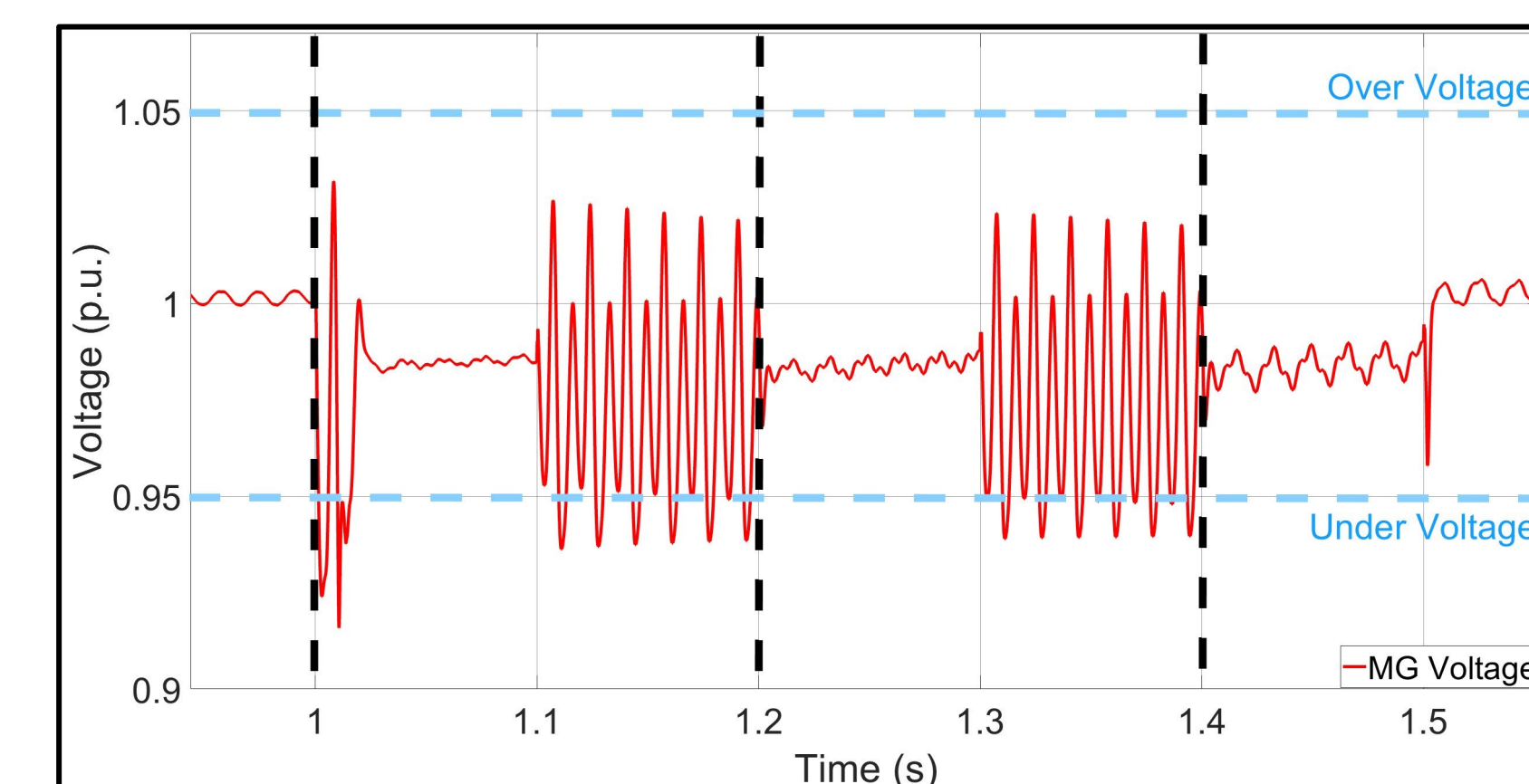
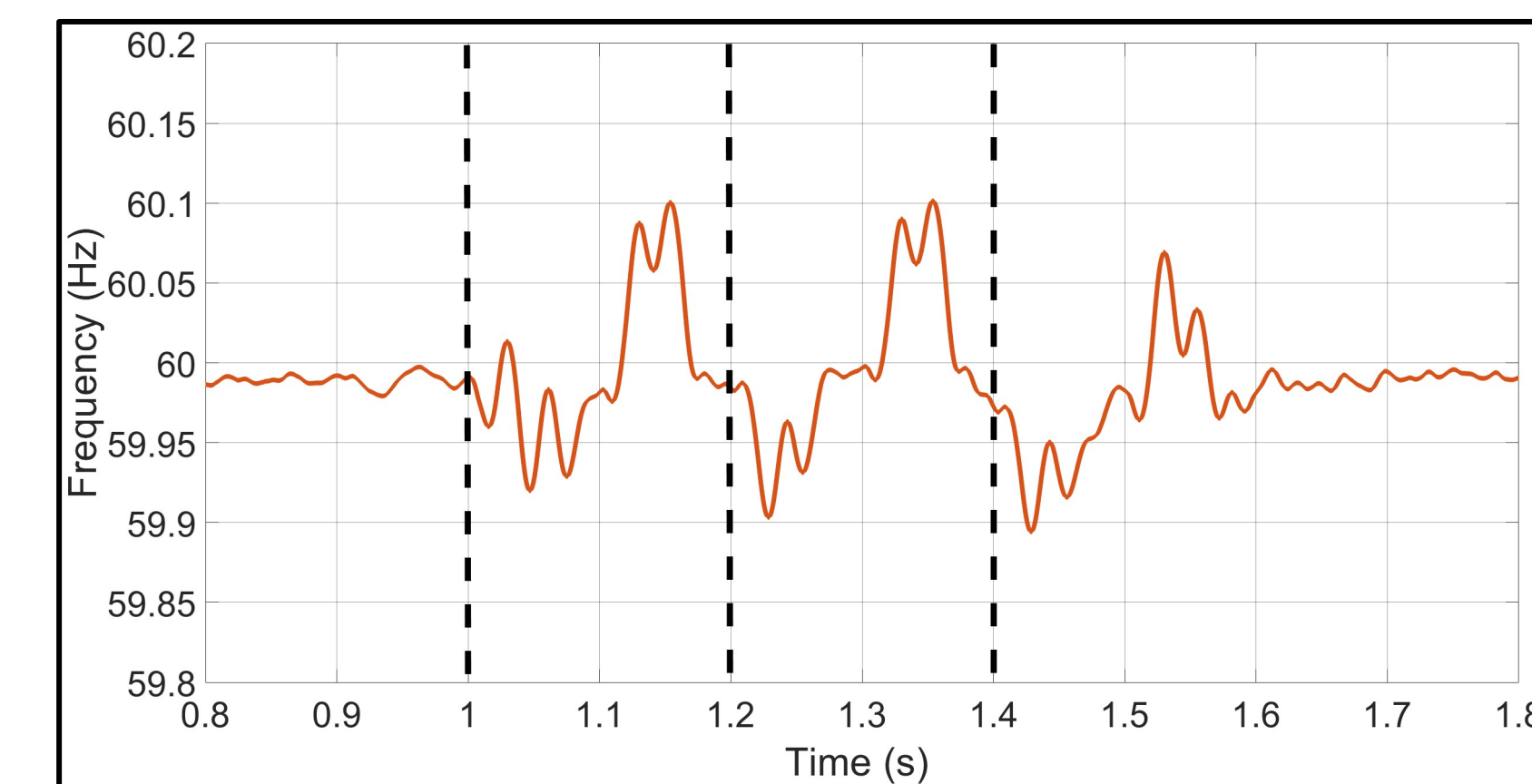
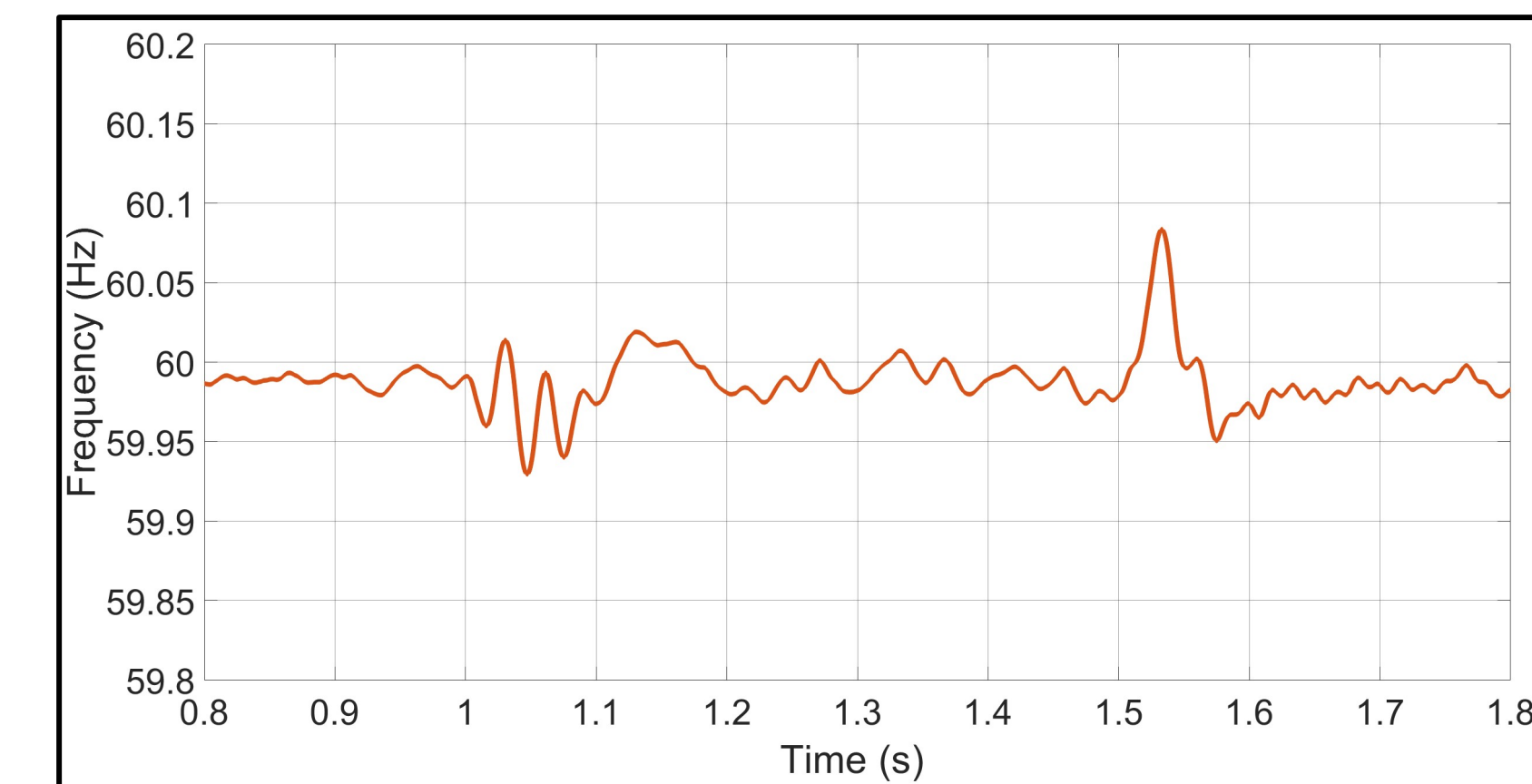


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Real-Time Results

System I: 50% PV



System II: 70% PV

