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Optimization-Based Fast-Frequency Estimation and Control of Low-Inertia Microgrids

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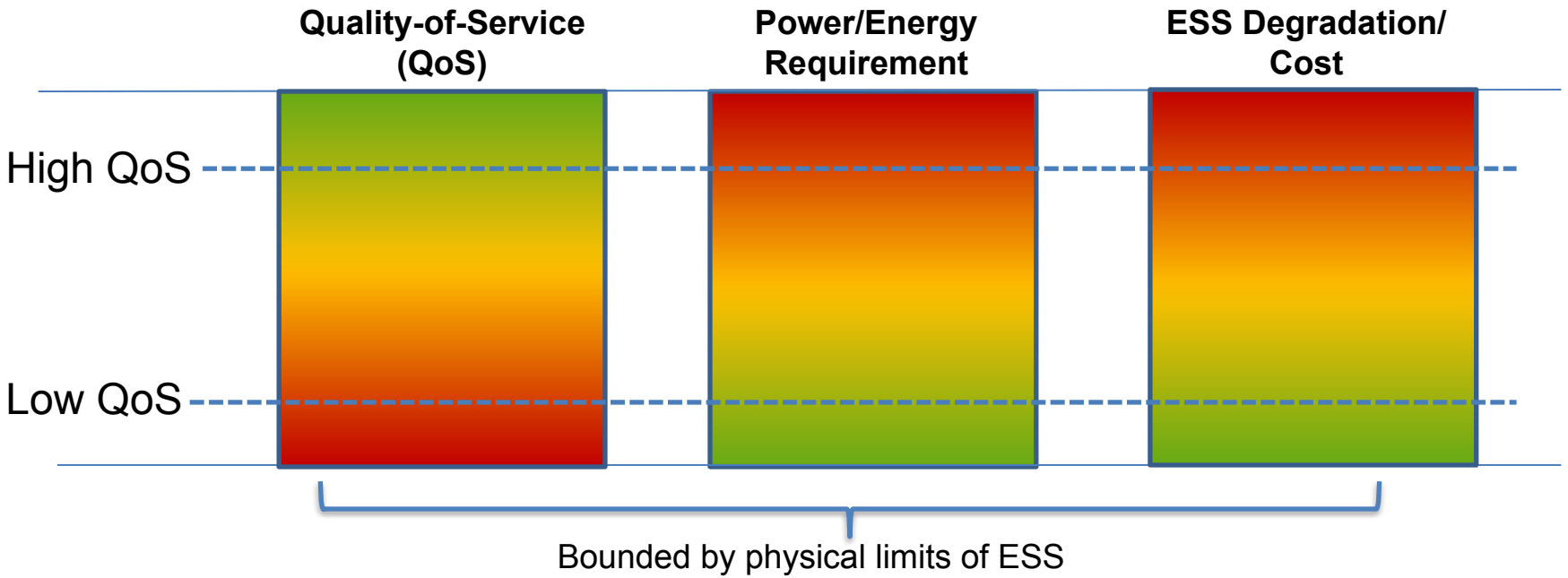
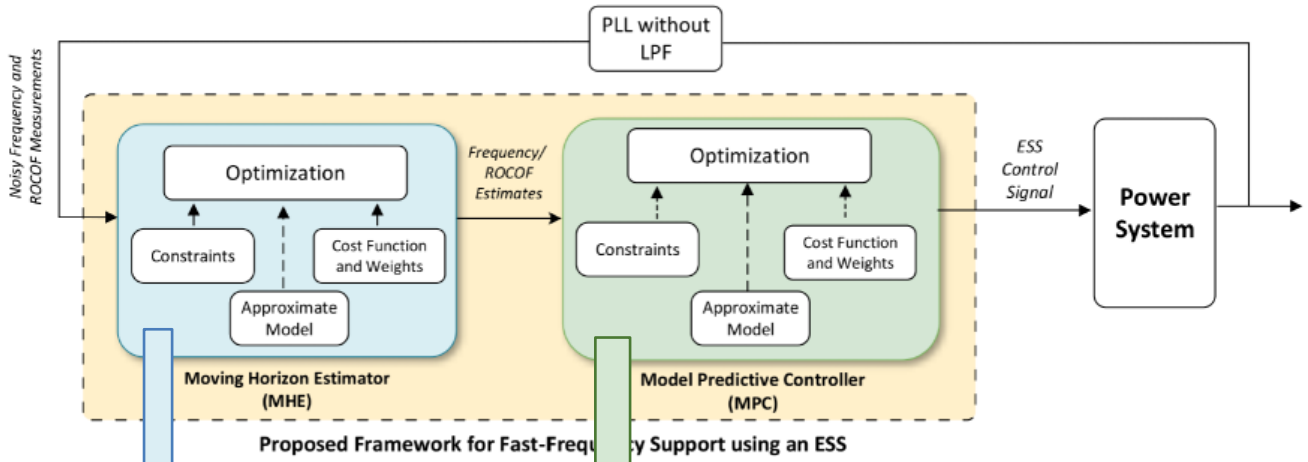
Background

- **Framework to provide fast frequency support using energy storage systems (ESSs)**
  - Combined approach based on Moving Horizon Estimator (MHE) and Model Predictive Controller (MPC)
  - MHE improves stability while MPC provides a flexible framework

QoS → Reduction in frequency deviation and ROCOF



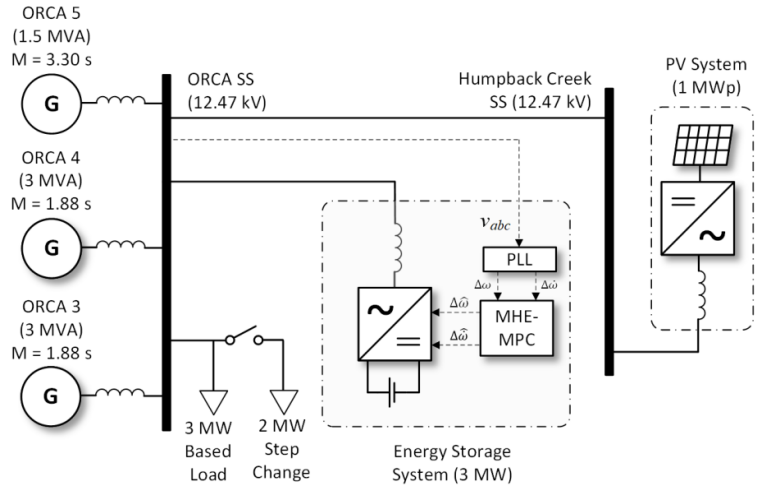
Combined MHE-MPC Framework for Fast Frequency Support



Frequency measurements without delays of a LPF

Provides fast frequency support

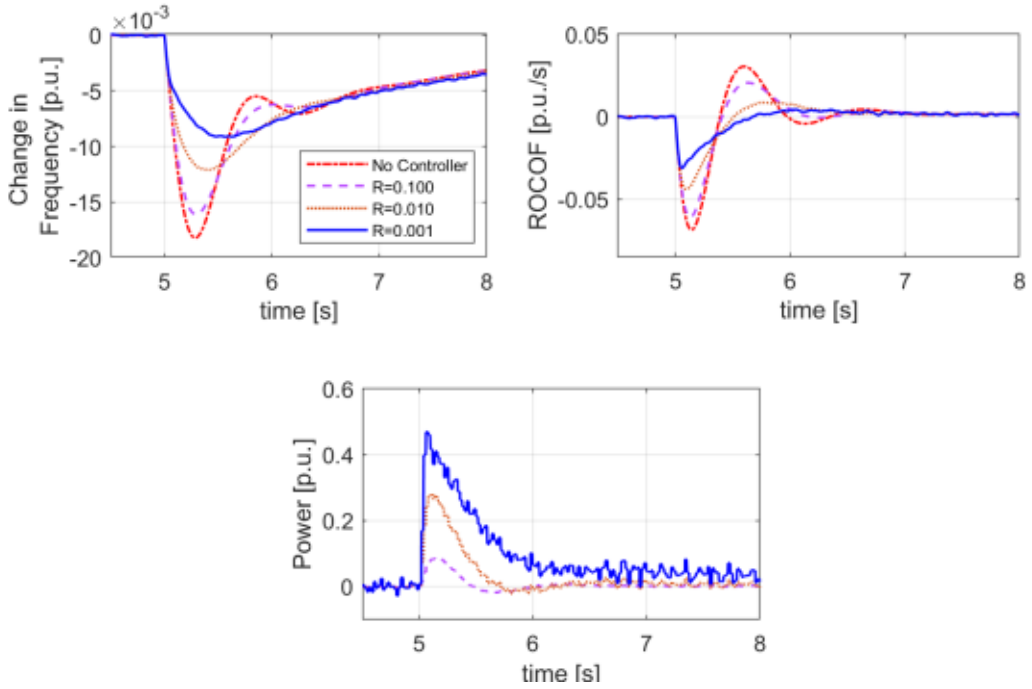
- Incorporates ESS physical constraint
- Weight selection allows flexibility in frequency support (Matrices Q and R)



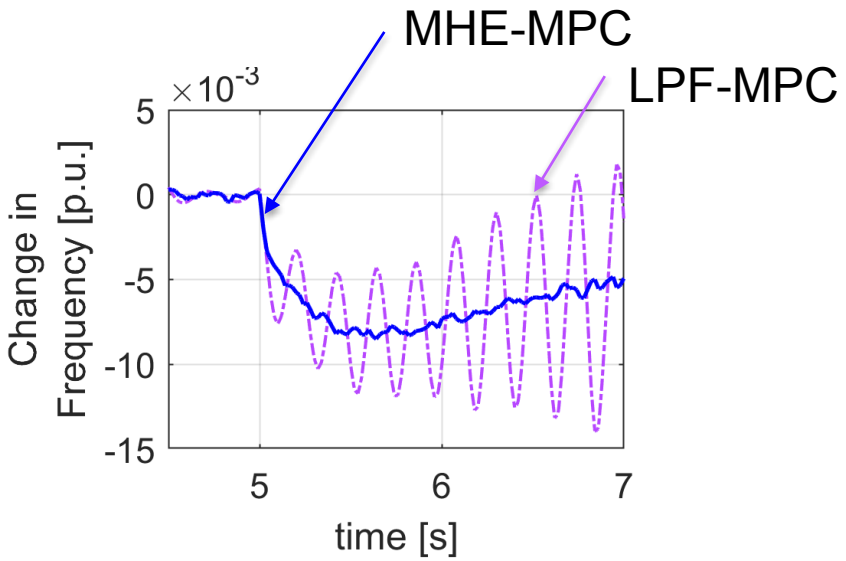
Simulation Setup
Modified Test System from Cordova, Alaska

- Thee diesel-gensets, 1 MW PV
  - PV reduces system inertia
  - 3 MW ESS
- Combined MHE-MPC framework implemented in the 3 MW ESS
- 2 MW step changes used to analyze performance

Performance of Fast Frequency Support Framework



- Selection of R dictates power response of ESS
- Appropriate weight selection changes QoS



- Using MHE instead of LPF avoids delays and improves stability

Conclusions/Recommendations

- Proposed framework can provide frequency support
  - Flexible operation based in resource availability and desired QoS
  - Physical constraints of ESS can be incorporated
  - Avoiding delays improves stability

- What further research is required?
  - Verify applicability of real-time implementation
  - Parameter estimation