

Optimizing Bulk Power Reserves

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Hawaiian Electric

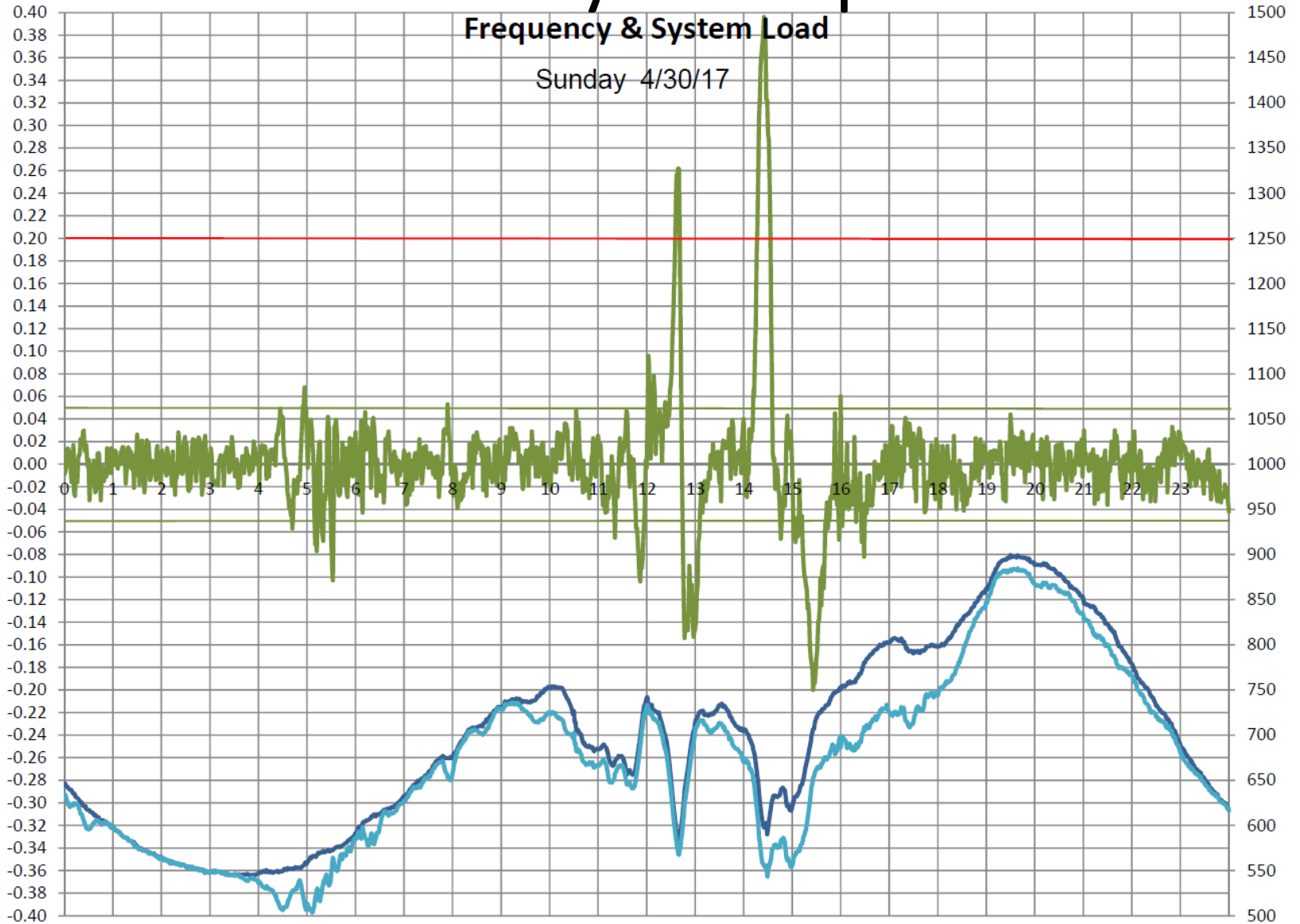


Hawaiian Electric
Maui Electric
Hawai'i Electric Light

- **Hawaiian Electric**
 - Island of Oahu, 300,000 customers
 - System Peak ~ 1225 MW
 - Renewable Generation (2019) – 740 MW
 - Grid-scale Wind 100 MW
 - Grid-scale PV 190 MW
 - Distributed PV 450 MW (2018 end)
- **Variable Generation: Wind & PV are the predominant renewable generation technologies today.**
 - Operating issues
 - Uncertainty
 - Variability

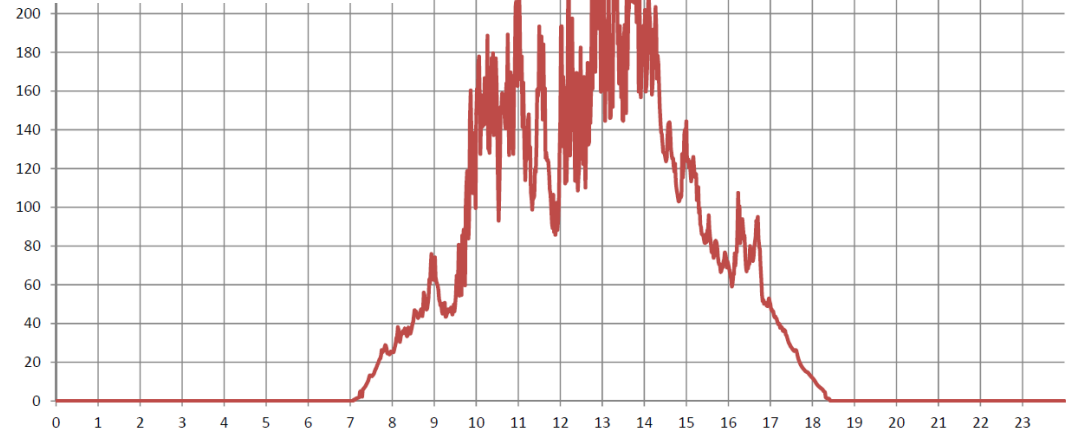
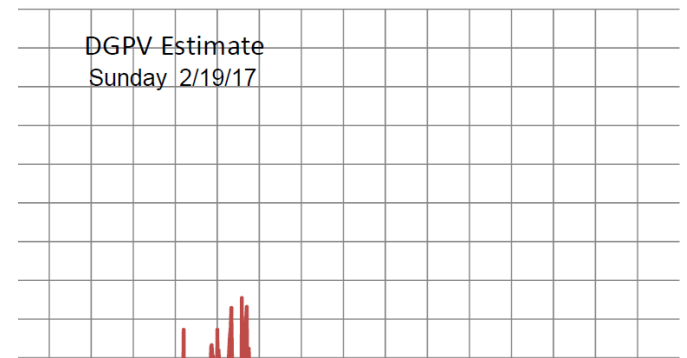
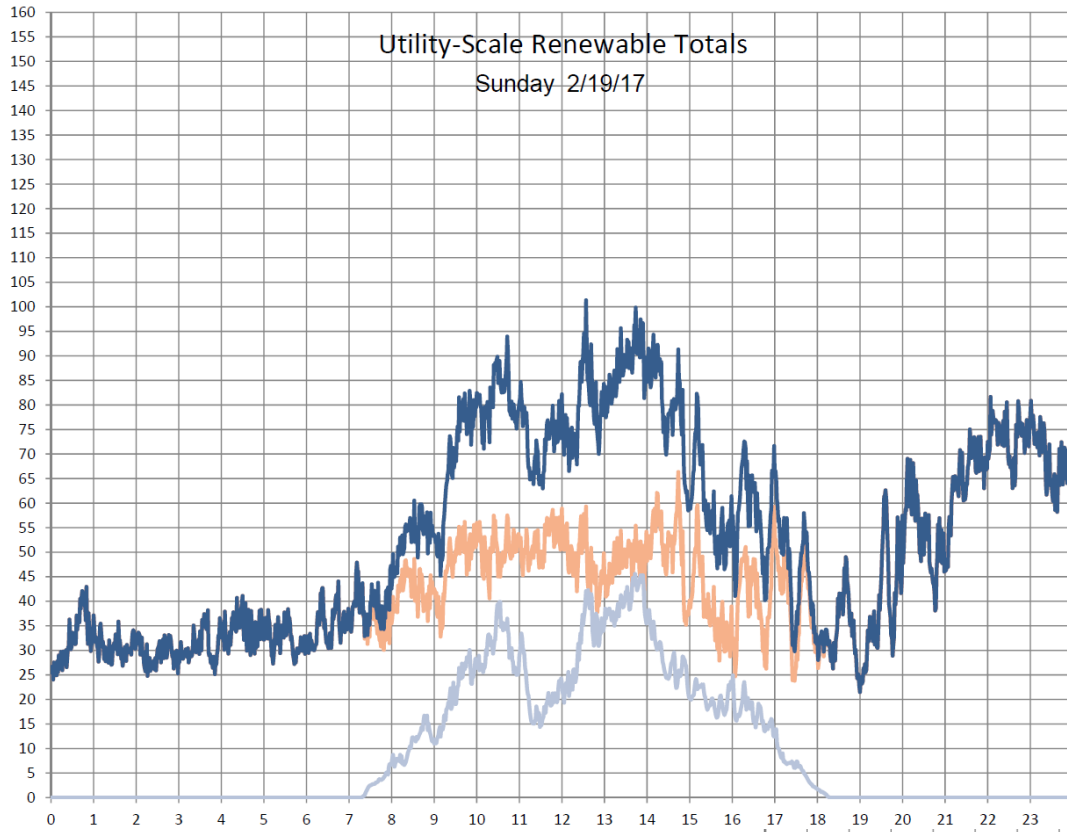


Uncertainty - Ramp Event



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Variability



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- Operating Reserves =
Contingency Reserves + Regulating Reserves
- Regulating Reserves Determination
 - Past
 - Deterministic methods based on worst case variability.
 - Future
 - Dynamic and stochastic methods based on forecast, i.e. right-sizing reserves.
 - EPRI Method
 - OPTSUN
 - Stochastic optimization between contingency and regulating reserves?

