Policies and Regulations for Energy Storage

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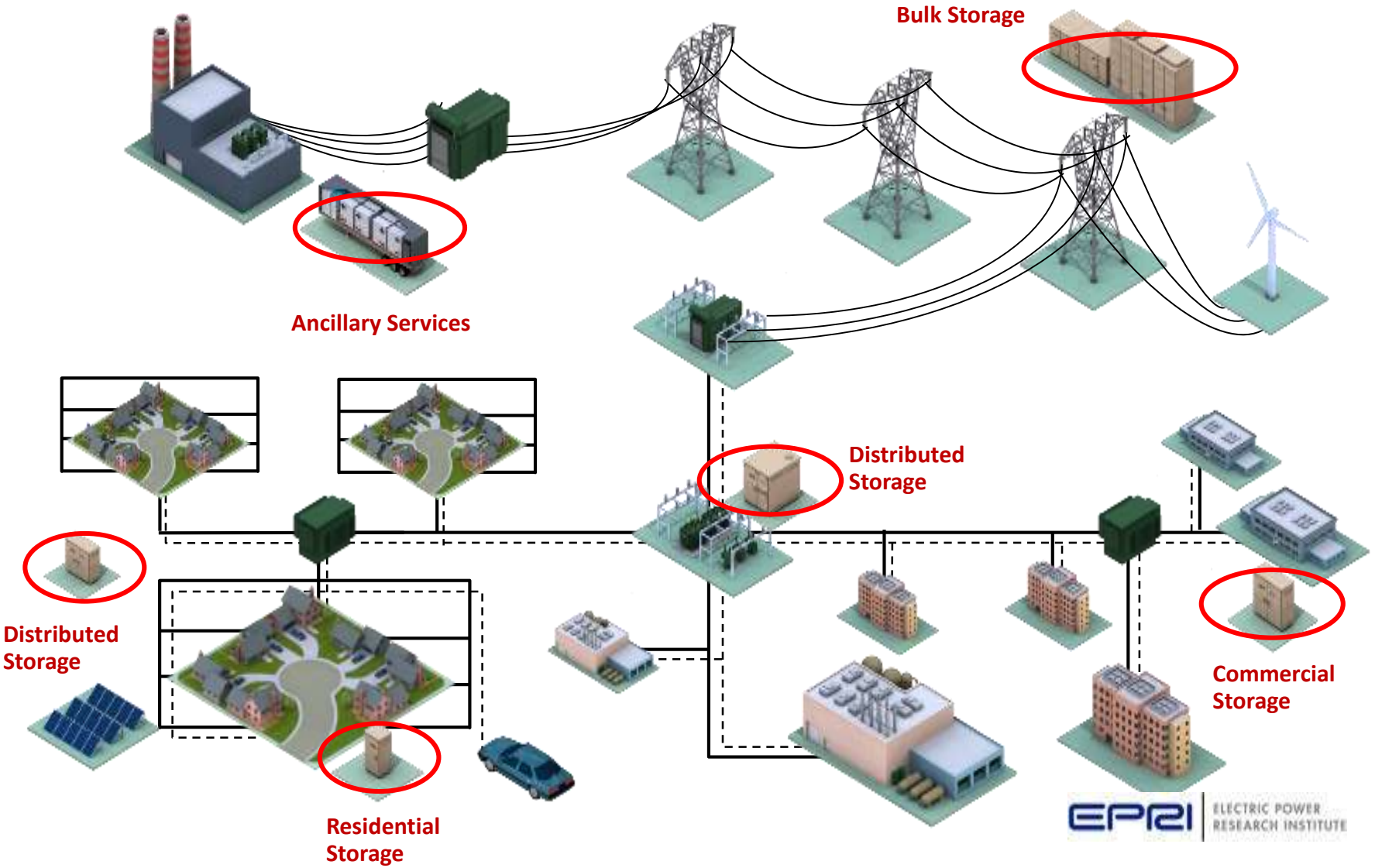
Diversity & Modularity: Storage Can Provide Flexibility to Support Insertion of Other Emerging Technologies



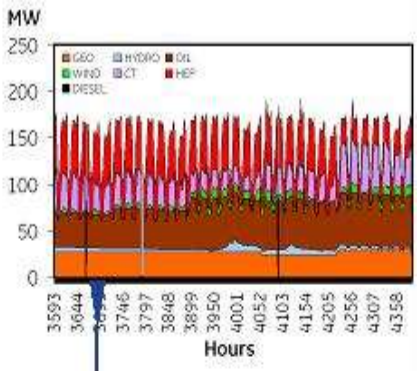
EPRI ELECTRIC POWER RESEARCH INSTITUTE

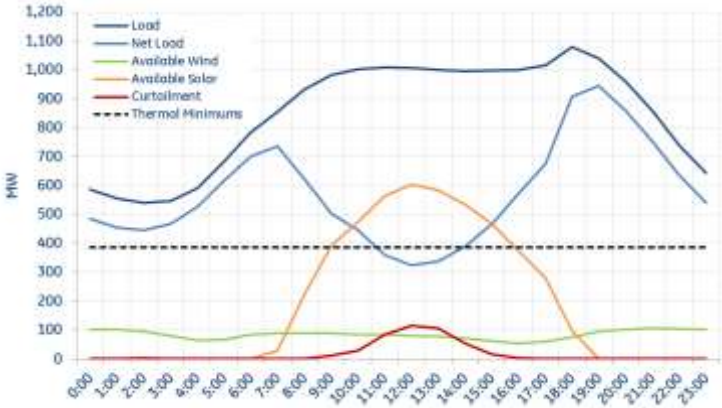
HNEI Hawai'i Natural Energy Institute

What Problem Are We Trying to Solve?

"Hours/Days"

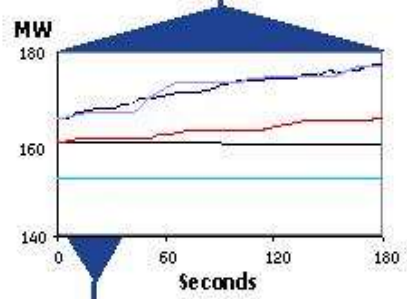
Spinning reserve, day-ahead scheduling, energy arbitrage





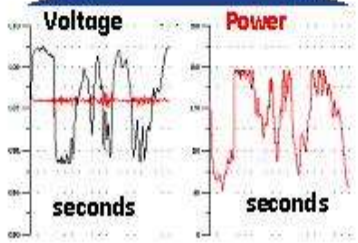
"Minutes/Hours

Load-following



"Seconds"

Faster than AGC



Possible Program

- Quantify current and future grid operations
- Identify and quantify performance of mitigation technologies, including energy storage, in each timescale
- Explore partnerships to demonstrate performance of proposed grid solutions including but not limited to storage

Grid Scale BESS Projects (HNEI)

Develop operating strategies to optimize battery energy storage for high value grid applications

photos courtesy of Altairnano

Upolu Point, Hawaii Island (1MW, 250kWh)

- Frequency regulation and wind smoothing
- 3.3 GWh over 3yrs, > 6000 full cycles

Molokai Secure Renewable Microgrid (2MW, 375kWh)

- Operating reserves (fault management), frequency regulation,
- Fast response decision and control (<50ms response)

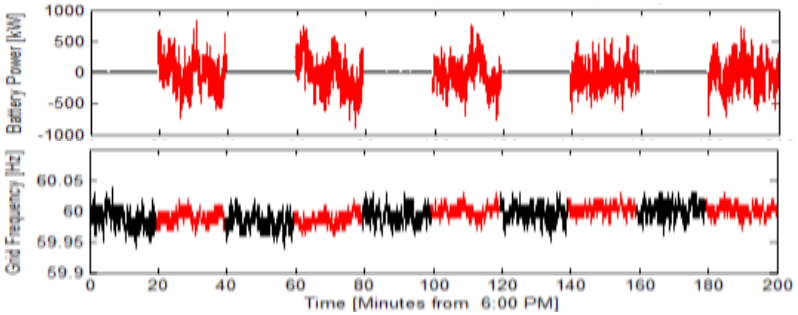
Campbell Park feeder with high PV penetration (1MW, 250kWh)

- Power smoothing, voltage and VAr support, and frequency regulation

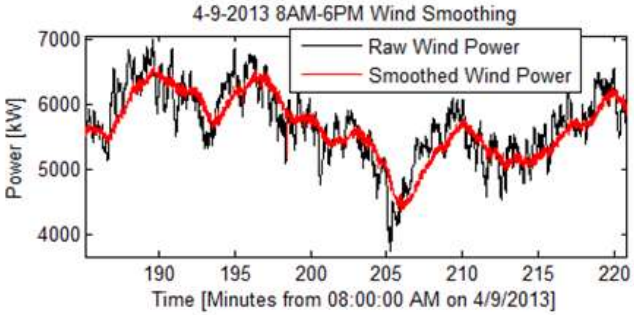
Laboratory testing of single cells to assess performance and lifetime

- Novel technique to characterize state-of-health of battery
- Performance models to better predict lifetime of grid scale BESS

Selects Results: Grid Scale BESS Projects

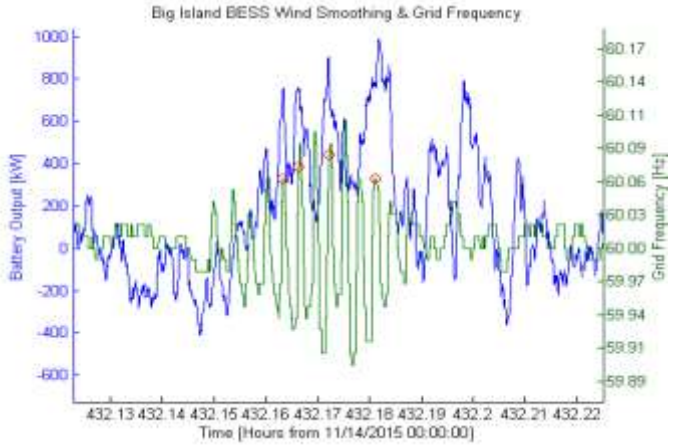


Reduce Big Island frequency variability up to 40%



Wind smoothing: Significant reduction short duration ramp rates

Wind smoothing can lead to response opposite to desired frequency response (up to 750kW)



- Optimize lifetime vs grid benefit
- Control temperature excursions to extends lifetime

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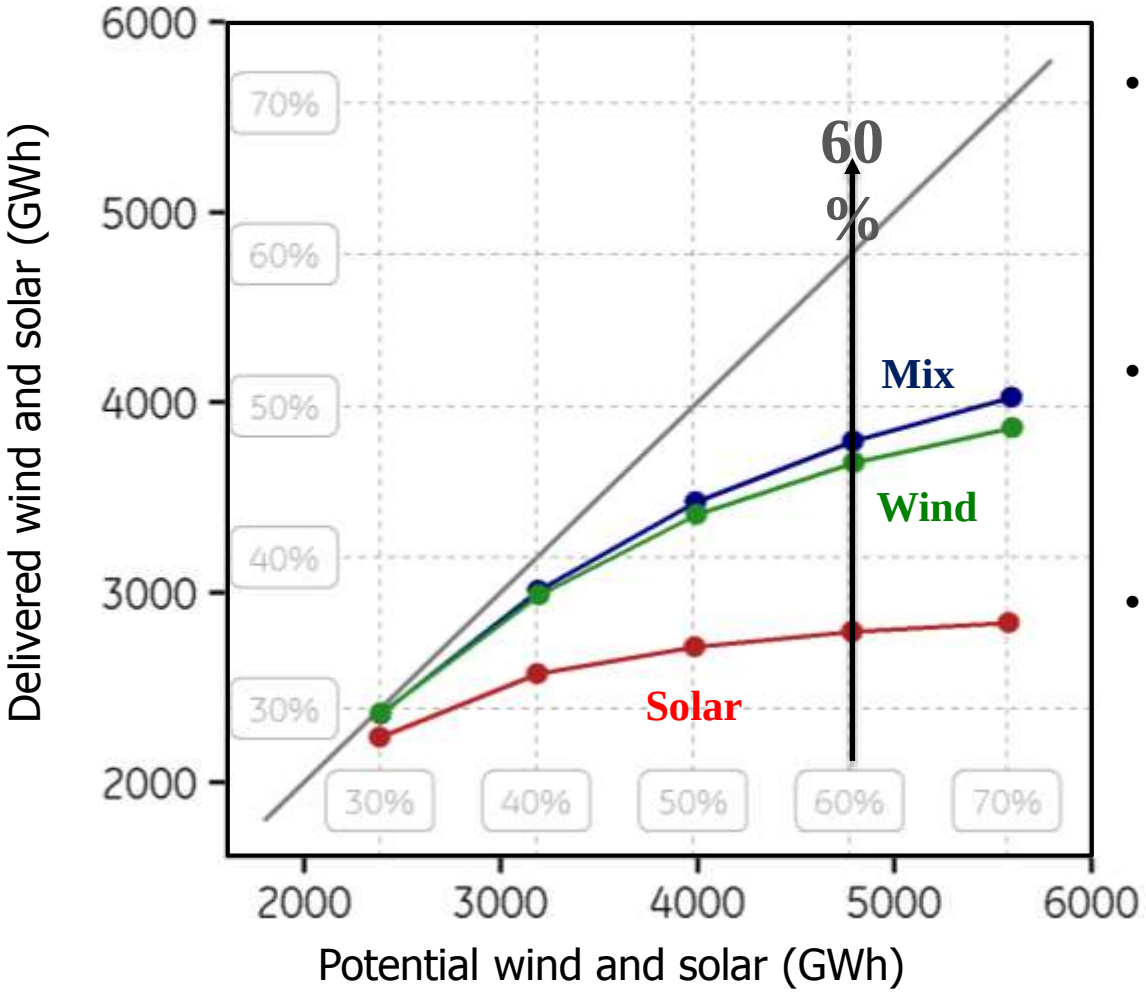
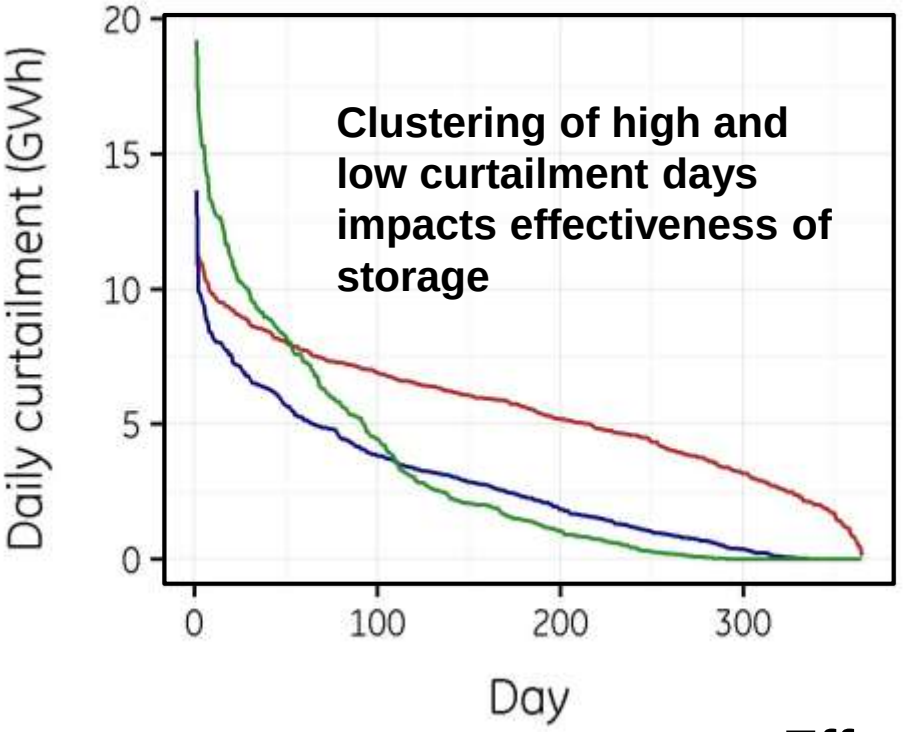
Curtailment at High Penetrations wo Storage (Oahu)

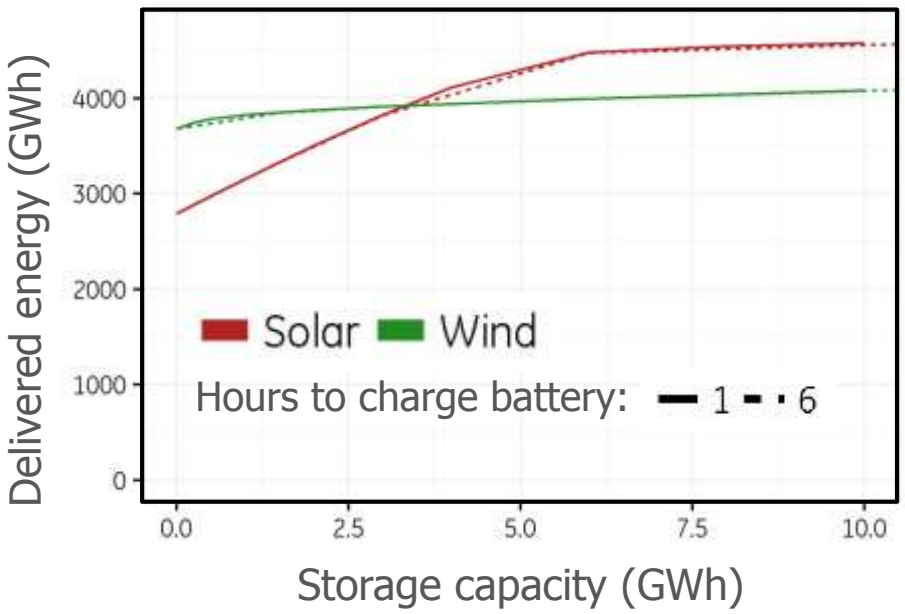


- **Curtailment depends on generation technology and site specific resource variability**
- **Incremental curtailment increases as penetration increases**
- **Wind curtailment, generally less than solar for same energy generation**

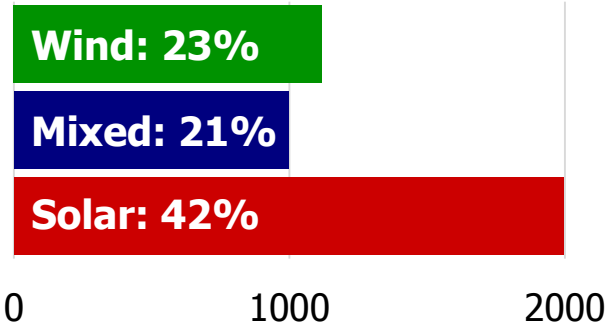
Storage Effectiveness

Advanced grid, 60% W&S penetration





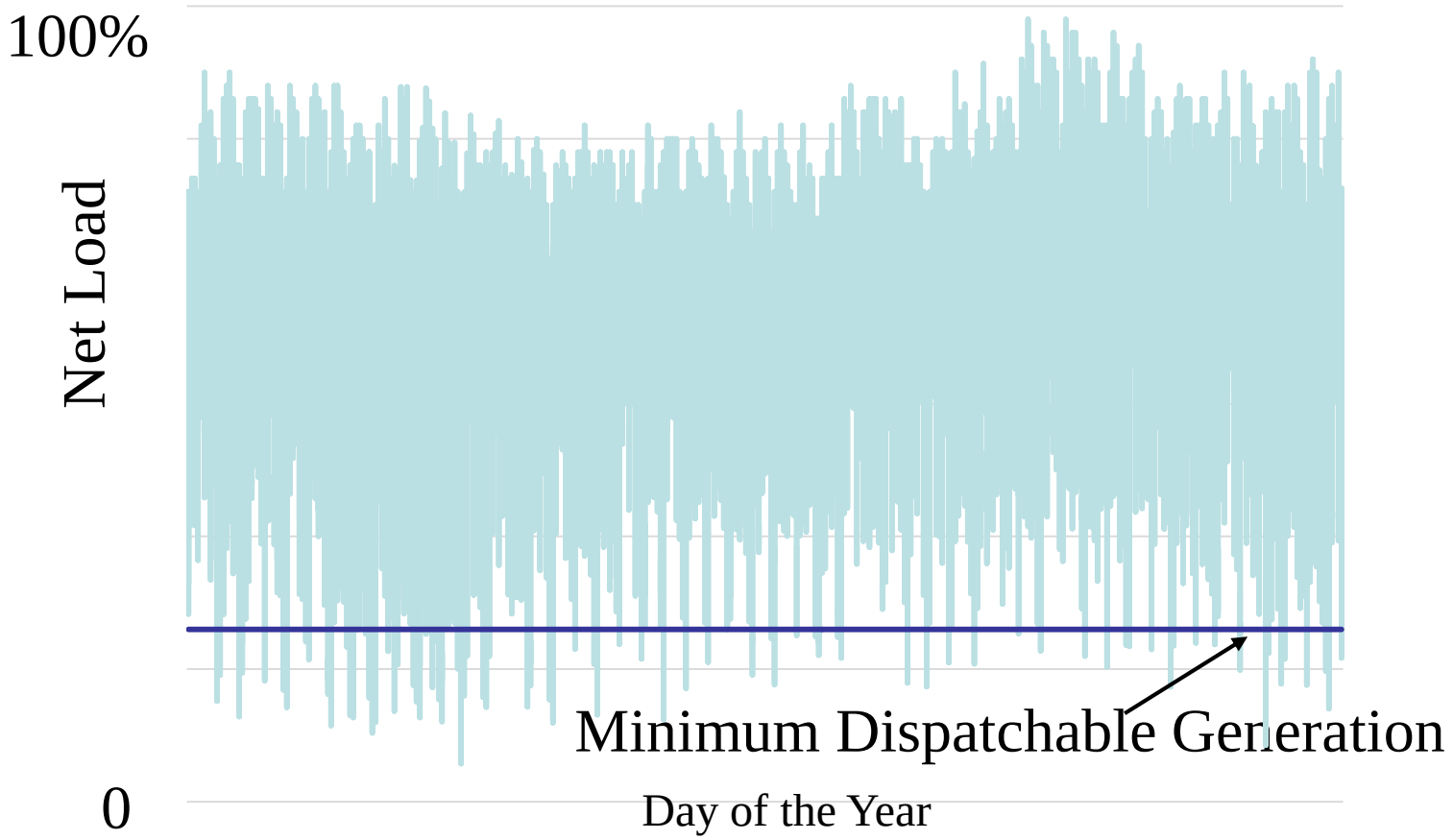
Annual Curtailment (GWh):



- **Effectiveness (and cost) of storage depends on generation technology and local resource variability energy**
- **Storage more effective for solar - at least in Hawaii**
- **Do storage mandates eliminate other technology options?**

Solar “Saturation” plus 50%

Curtailment: 1% (204 hours)



At 2x “solar capacity”, 6% curtailment, 840 hours,

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