



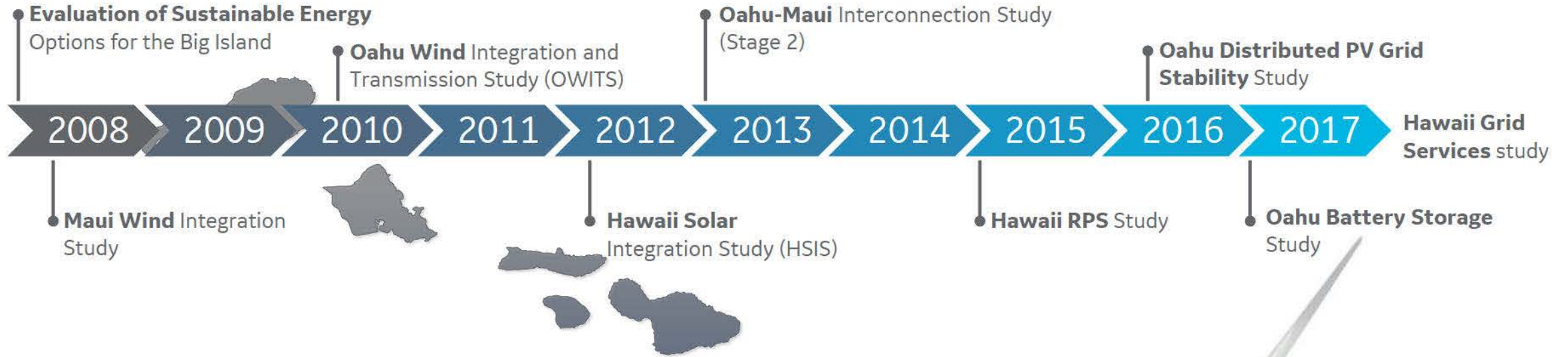
# Integrated Grid Planning Symposium

## State of IGP Technology

16 November 2017

Derek Stenclik, GE Energy Consulting

# GE's Hawaii Grid Planning Experience



For more information and recent reports:  
<http://www.hnei.hawaii.edu/projects#GI>

Special thanks to:



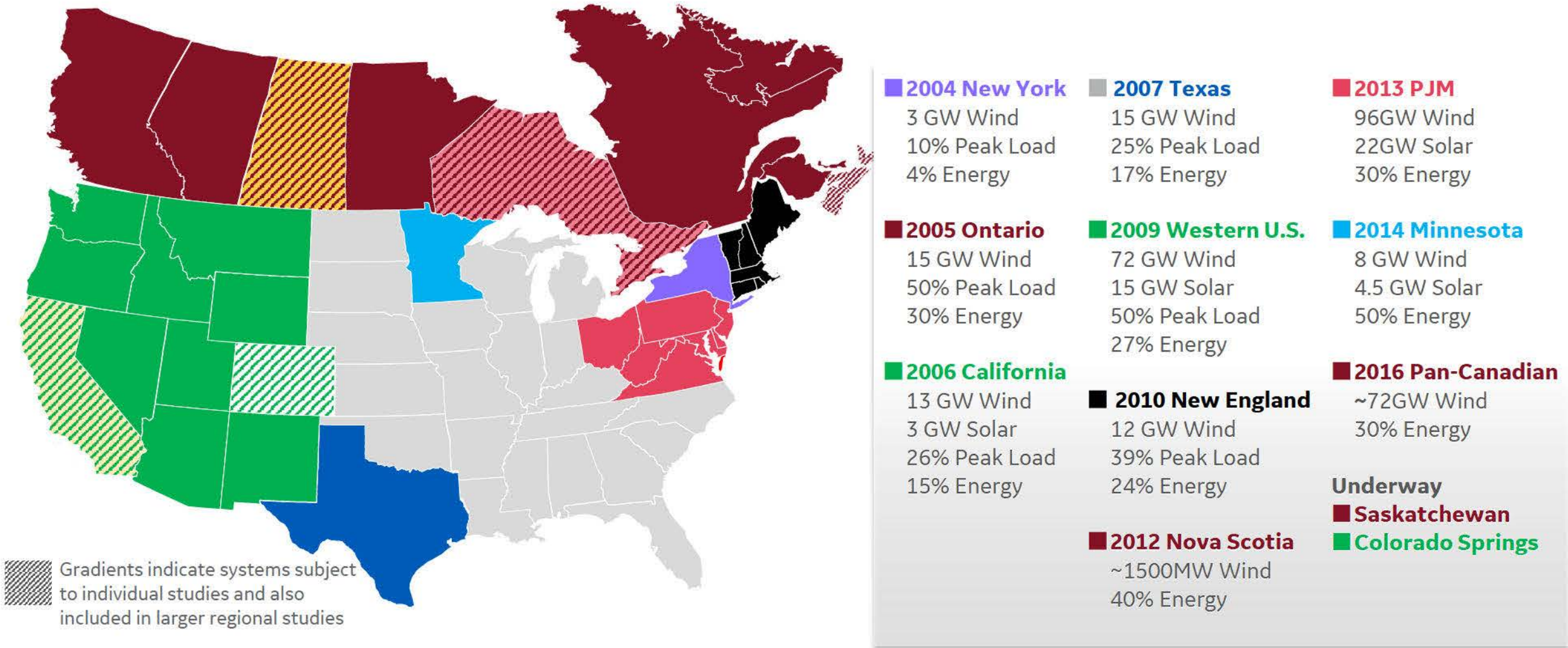
**HNEI**

**Hawai'i Natural Energy Institute**

School of Ocean and Earth Science and Technology  
University of Hawai'i at Mānoa



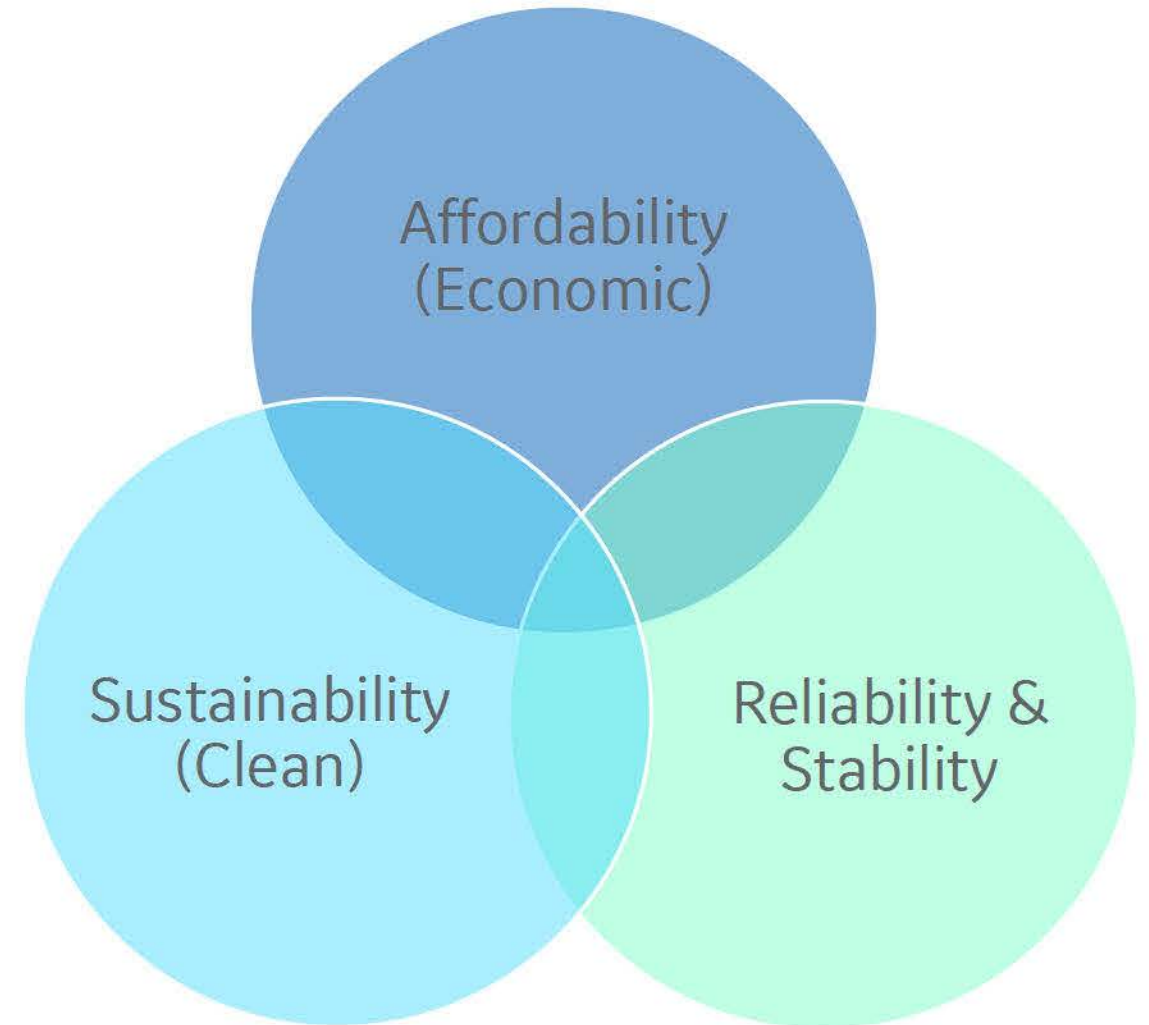
# Sharing Best Practices from across the Industry



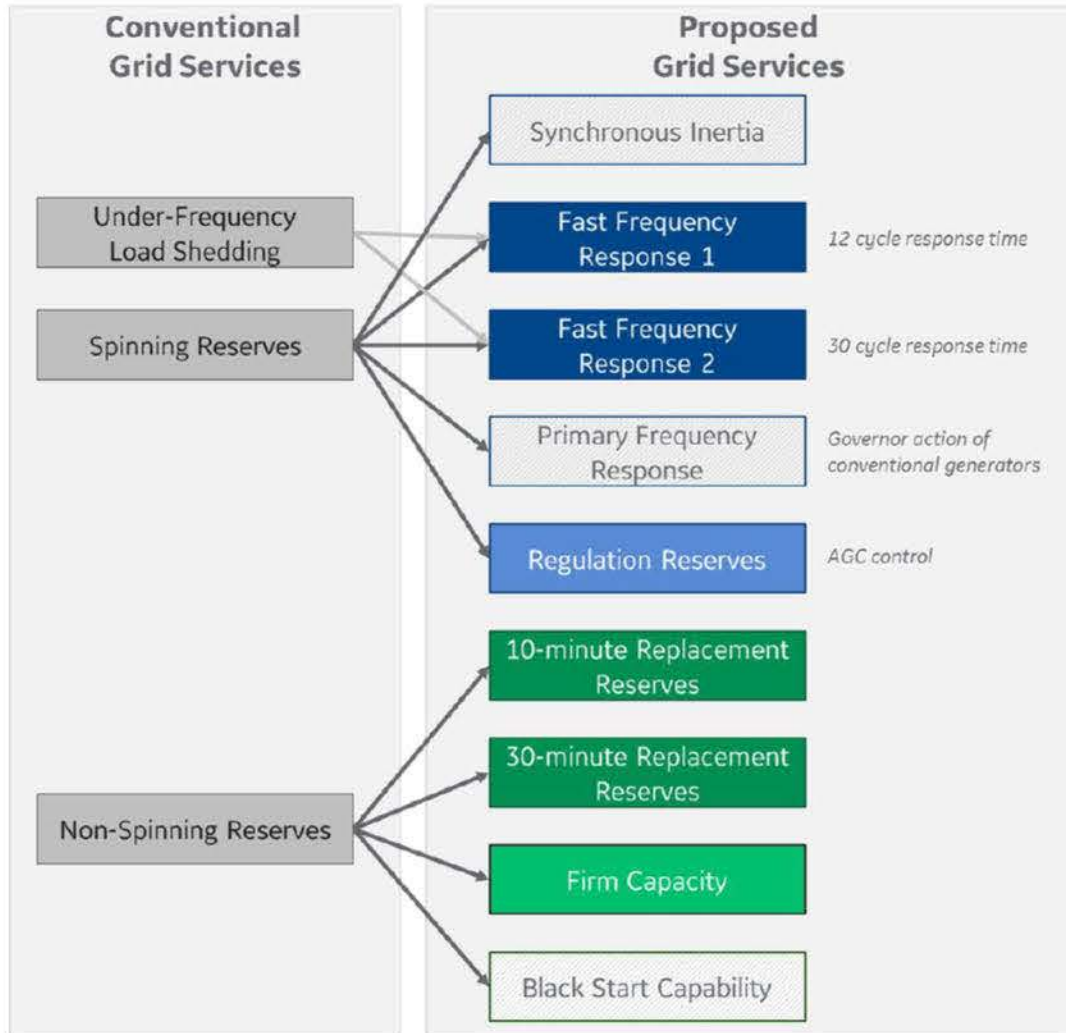
# Three Pillars of Power System Planning & Operations

Don't take reliability and stability for granted!

- Customers want their electricity to be affordable, clean, and reliable ... all are important
- Part of a comprehensive analysis for power system planning
- Responds to emergency (contingency) events, not normal operations
- Important at different time scales of system operation; seconds to minutes



# Grid Services are Evolving Across the Industry



Short Duration



Speed of Response



Long Duration

“Grid Services” also known as *Ancillary Services* or *Essential Reliability Services*

General trend away from “ancillary” ... now a primary rationale for system operator decisions (commitment and dispatch of generators),

Especially relevant for Hawaii and other island systems

**Other grid services, not evaluated in this analysis:**

- Short Circuit Strength and/or Voltage Support
- Synchronous Inertia
- Primary Frequency Response
- Ramping Reserves
- Black Start Capability

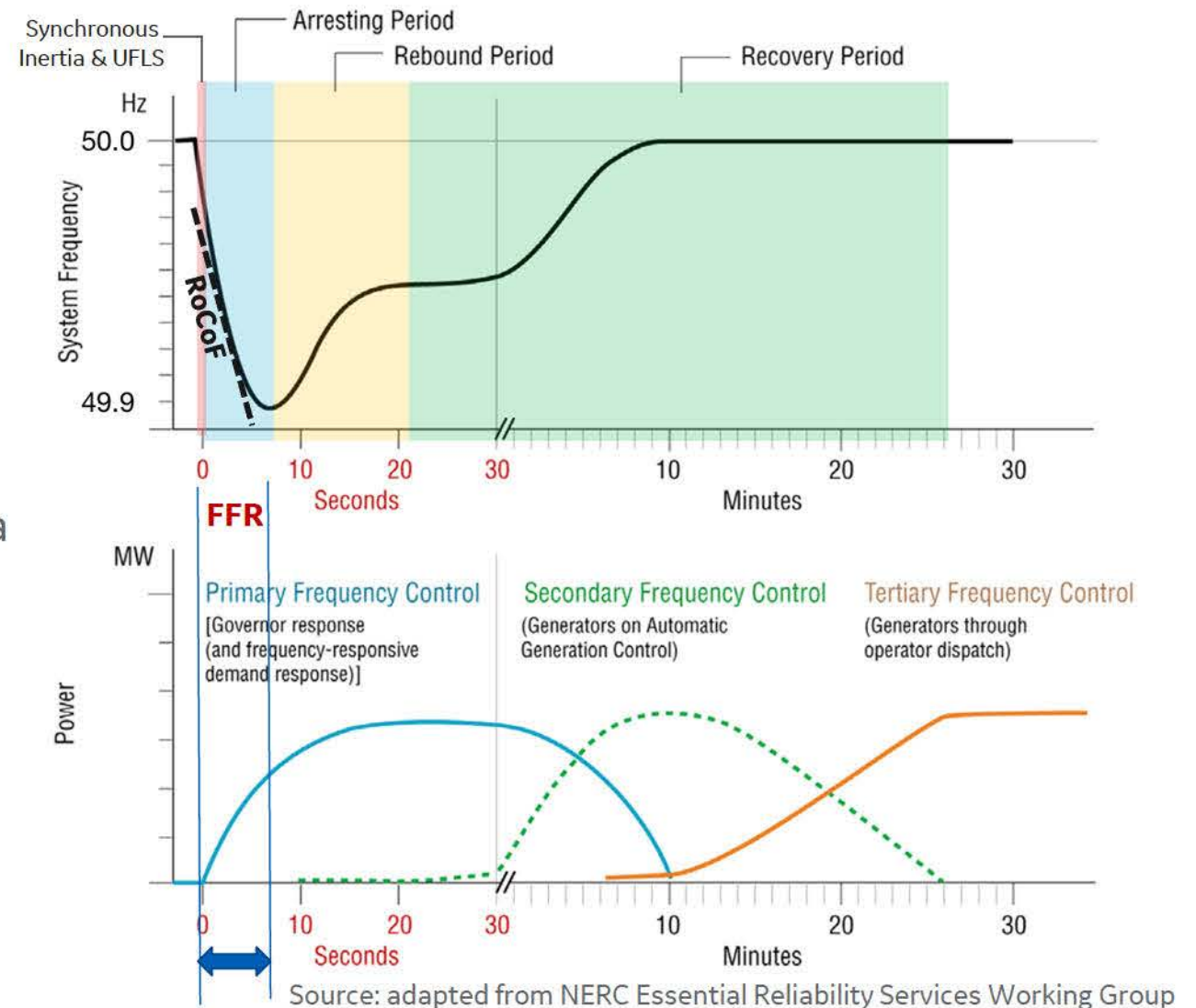
□ Essential Reliability Services not proposed by HECO, but anticipated to be provided by conventional generators  
 Source: Adapted from ERCOT, *Cost-Benefit Analysis of ERCOT's Future Ancillary Services (FAS) Proposal*



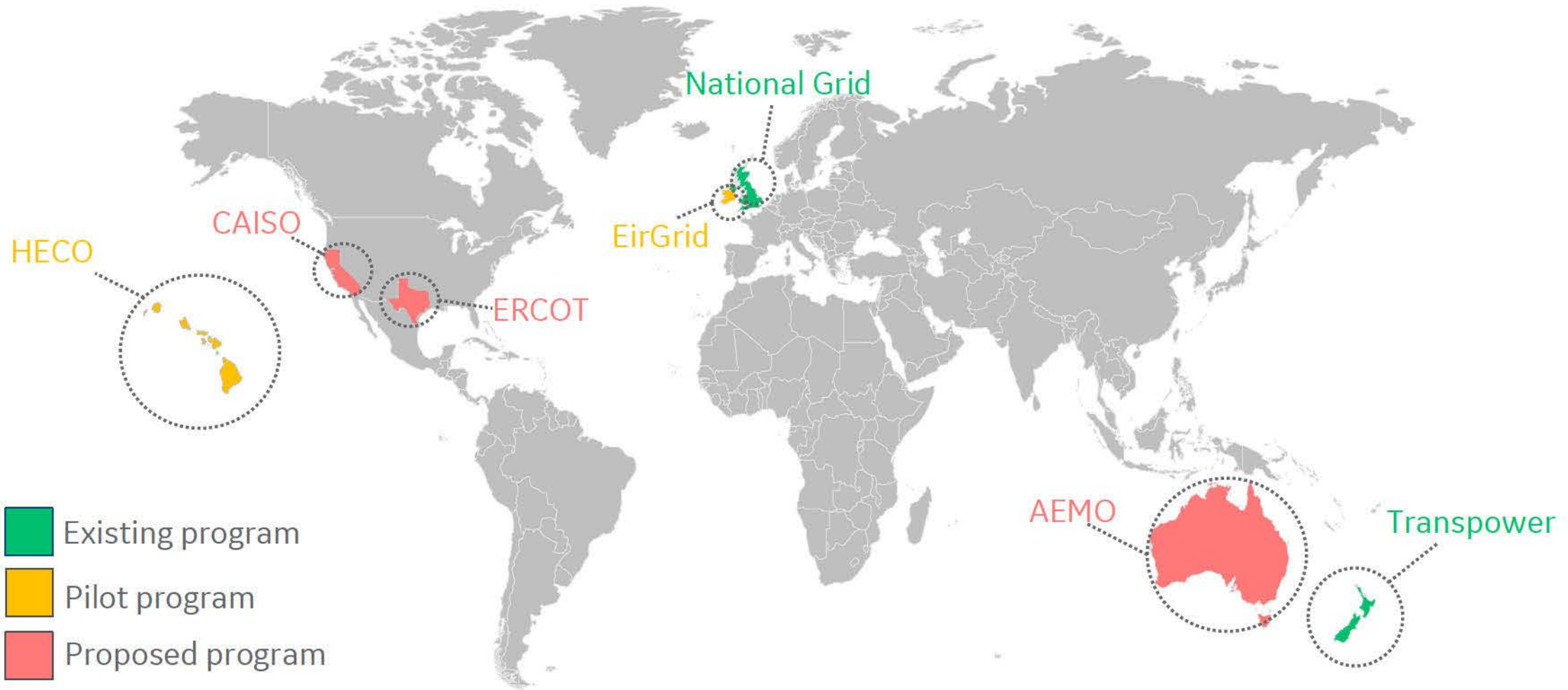
# Maintaining grid stability requires actions within seconds cycles

- Grid must be prepared for and respond to emergency (contingency) events
- Important at different time scales of system operation; sub-seconds to minutes
- During a contingency, system frequency will change quickly (high RoCoF\*)
- Conventional response is from system inertia (kinetic energy in synchronous generator)
- As renewables increase, system inertia decreases, leading to faster changes

\*RoCoF = rate of change of frequency =  $df/dt$

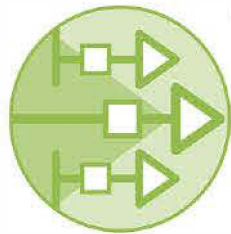


# Where are FFR programs taking shape?



# Modeling Tools for all Timescales of Power Systems

## No one tool does it all...



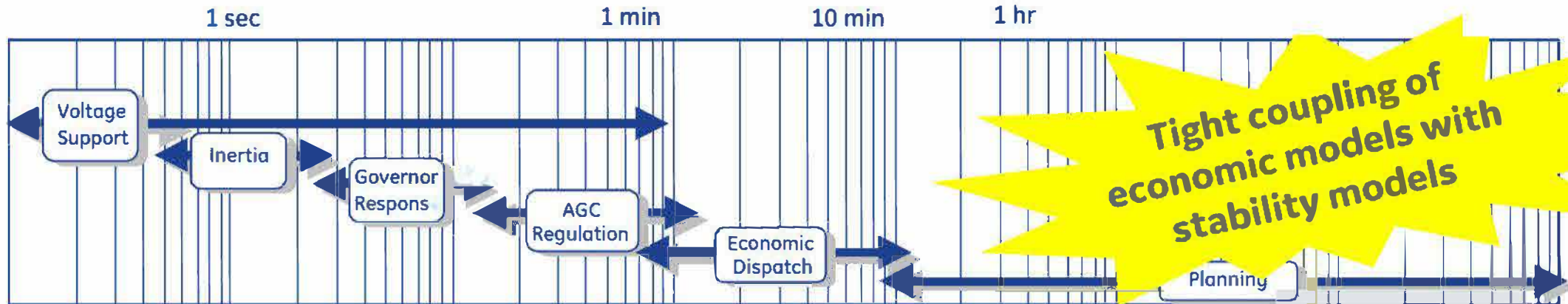
### GE PSLF Grid Simulations

- Voltage & stability performance
- Frequency response
- Contingency analysis



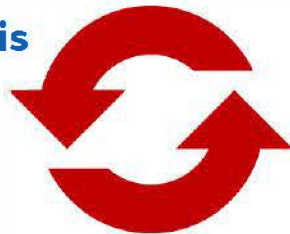
### GE MAPS or PLEXOS Production Cost Simulations

- Sub-hourly chronological dispatch model
- System operations and economics with increasing levels of W&S integration



### STATISTICAL Variability Analysis

- Characterize wind and solar variability
- 2 sec data to 60 min
- Develop operating reserve profiles



### GE MARS Reliability LOLE Simulations

- System reliability model
- Calculates loss of load expectation (LOLE), resource adequacy, and capacity value of wind and solar

# Next Steps & Ongoing Analysis

- How should FFR be designed & calibrated?
- What is the capacity value of storage and demand response?
- What is the value of resource diversity?
- What mitigations can reduce curtailment and save money?



**What do you  
think we need  
to evaluate?**



# Thank You!

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