Benefits of Low-Energy Interruption and Low-Energy Testing Technology applied at Transmission Circuits with Falling Inertia

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Presented by

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Outline

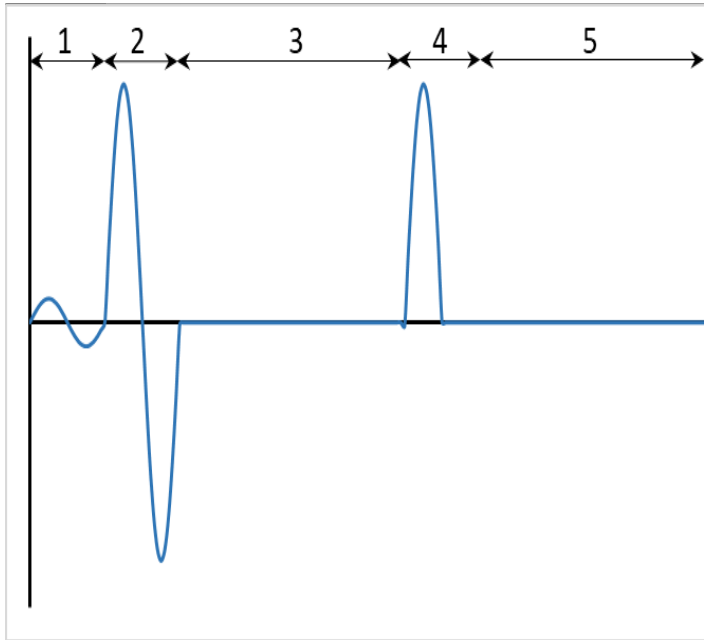
- Falling Inertia Challenges
- Low Energy Interruption and Testing
- Model Description and Contingency Selection
- Simulation Results
- Role of Protection
- Summary

Falling Inertia Challenges

- More and more system operators, and market participants of all kinds, continue to make carbon neutral pledges.
- ERCOT captured the time constraint very effectively in [3]: as inertia falls, and wind penetration increases, load reserves have less and less time to respond.
- Synthetic inertia requires generators to operate below capacity, ramping up quickly to compensate for generation losses. Reducing security margins exposes consumers to greater likelihood of curtailment.

Low Energy Interruption and Testing

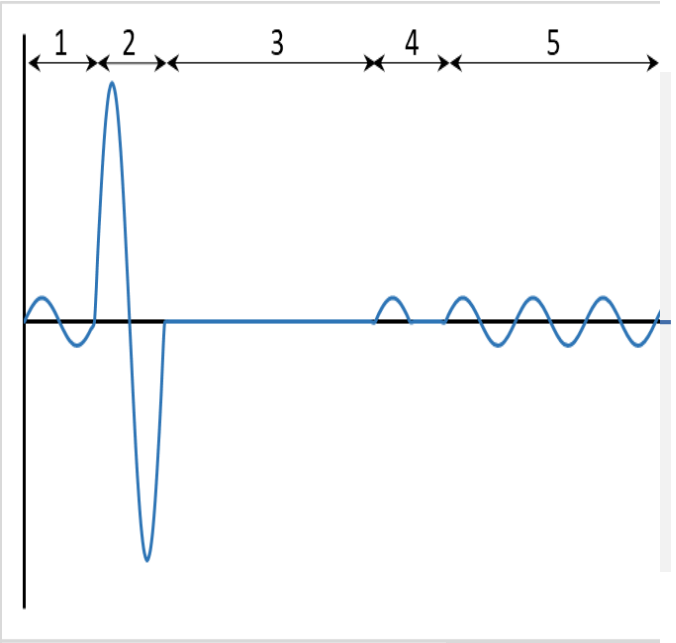
- Permanent Fault:



1. Normal load current
2. Fault current starts. Fault is detected and interrupted
3. User-configured delay before initiating circuit testing
4. Low-Energy Test is applied and analyzed.
5. Since fault is still detected, interrupting device is locked out.

Low Energy Interruption and Testing

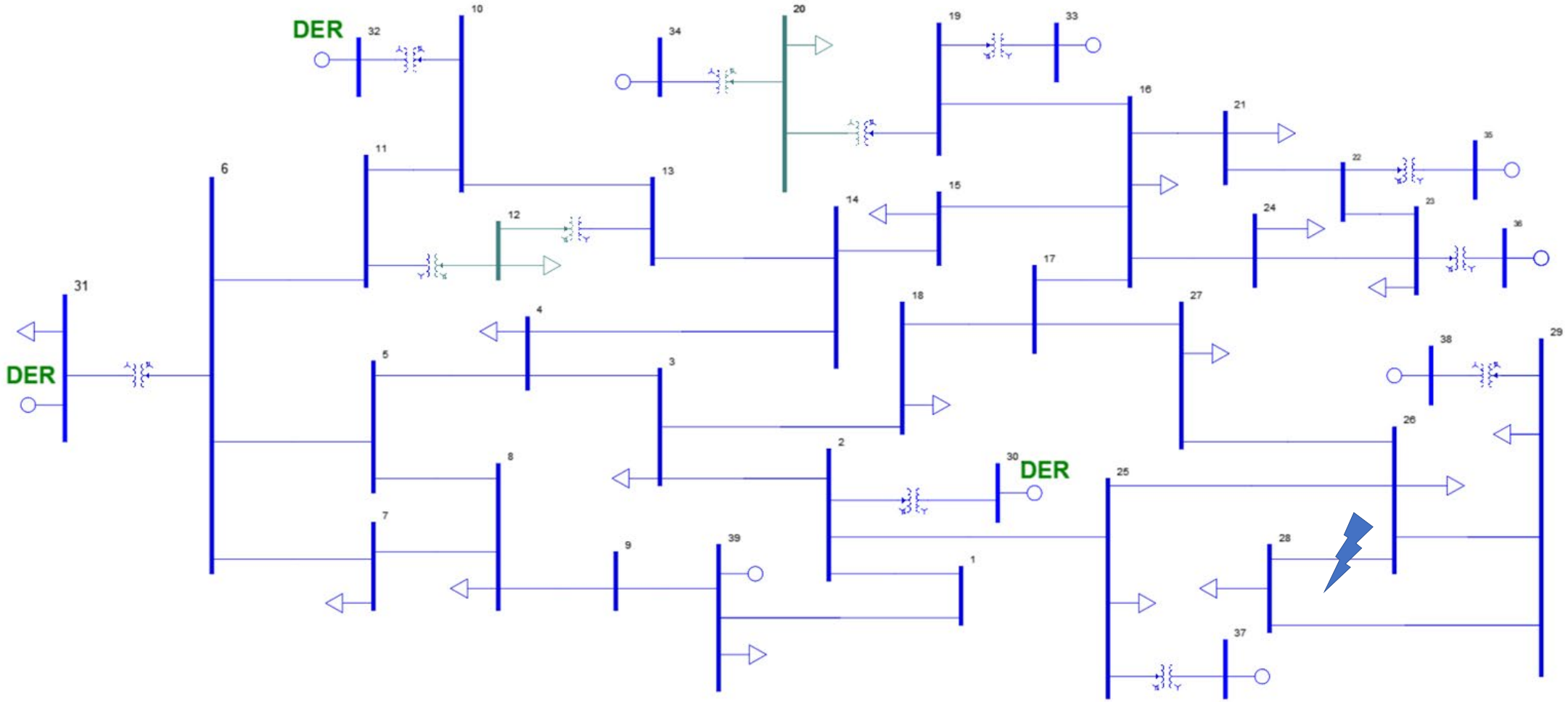
- Temporary Fault:



1. Normal load current
2. Fault current starts. Fault is detected and interrupted
3. User-configured delay before initiating circuit testing
4. Low-Energy Test is applied and analyzed
5. Since no fault current was detected, breaker recloses and re-energizes loads

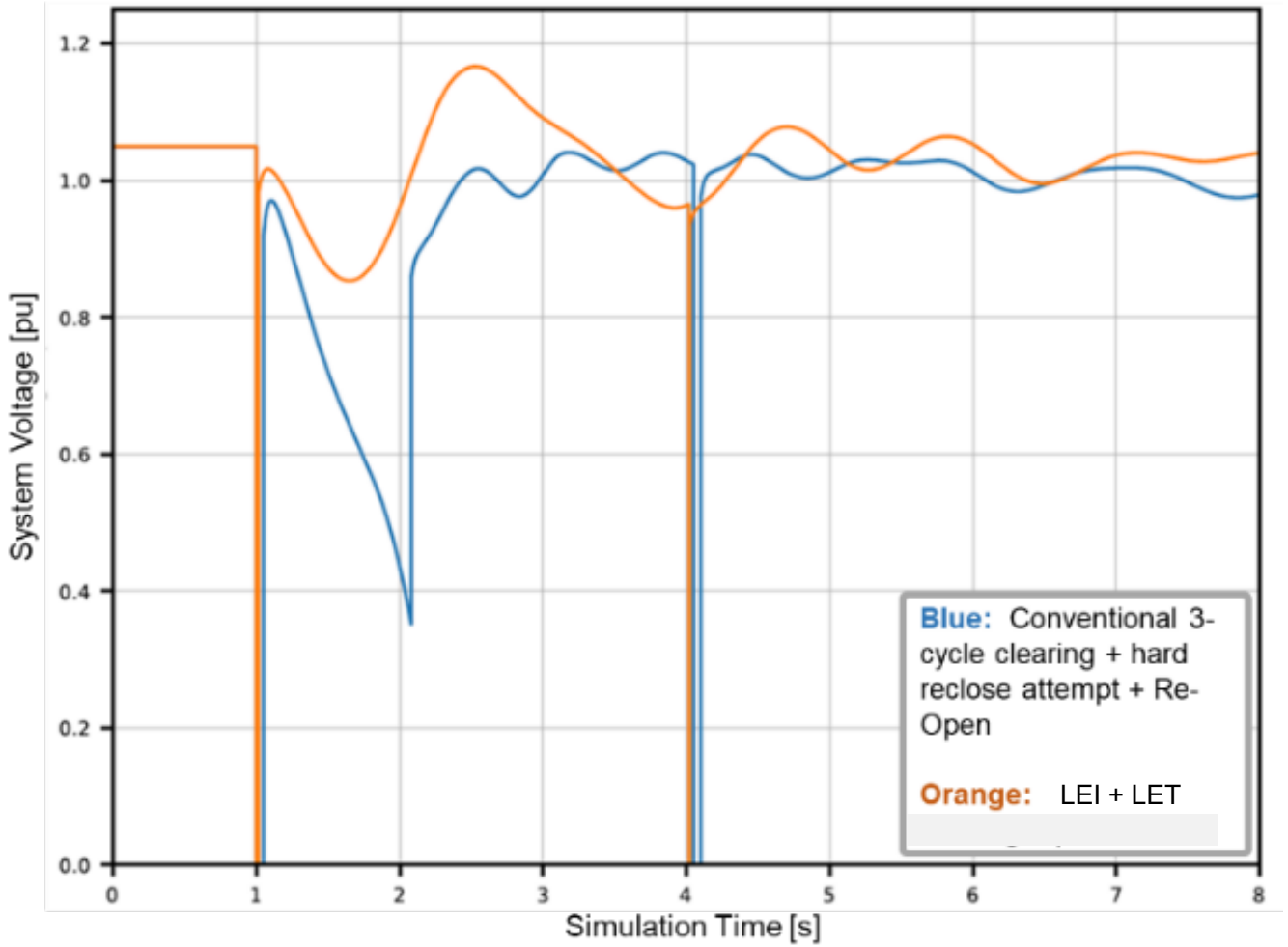
Model Description and Contingency Selection

- Modified IEEE 39-Bus System Model (also Known as “New England” Test System) with 20% Renewable Penetration.



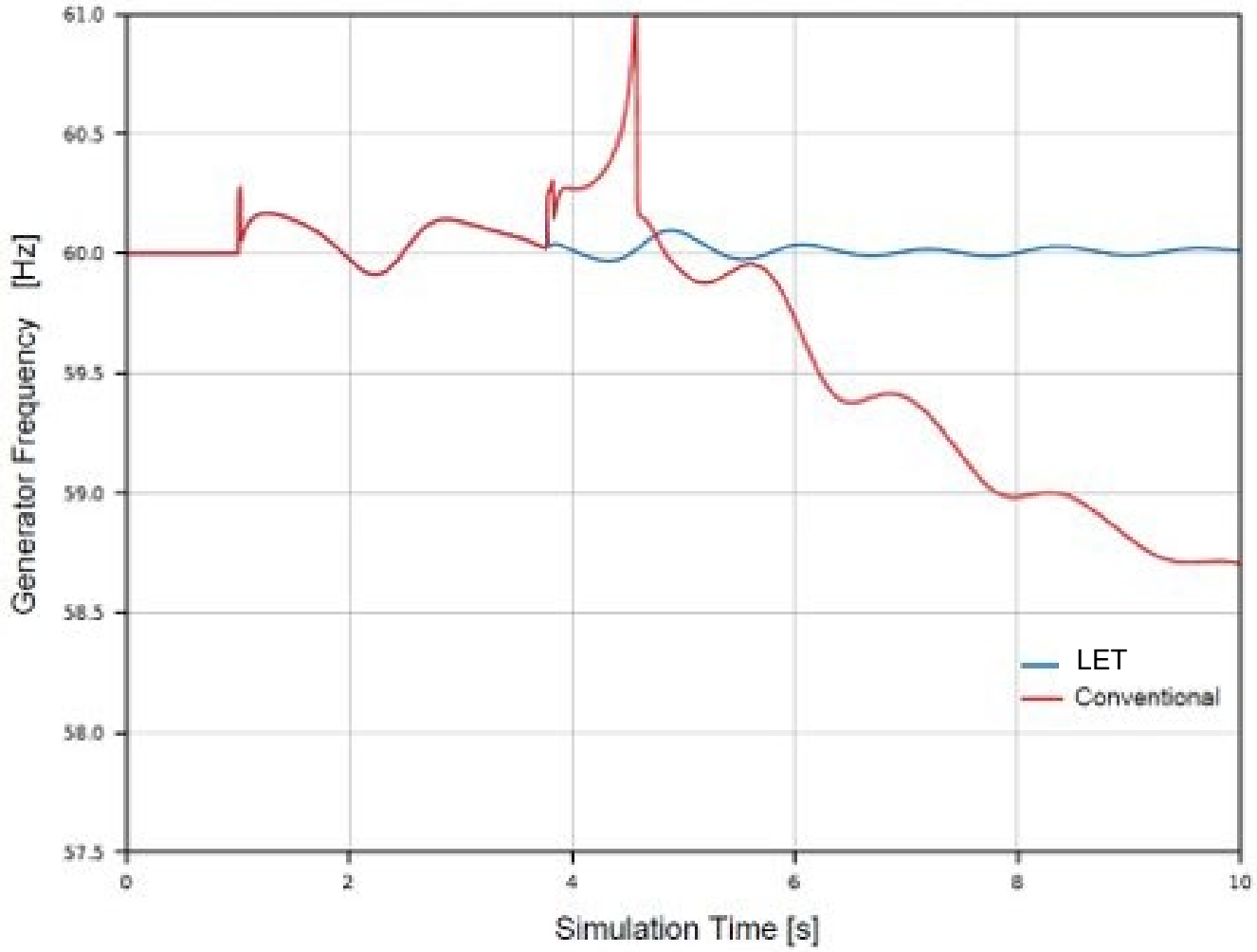
Generator Stability - LEI vs. Conventional Clearing

- System Voltage Response



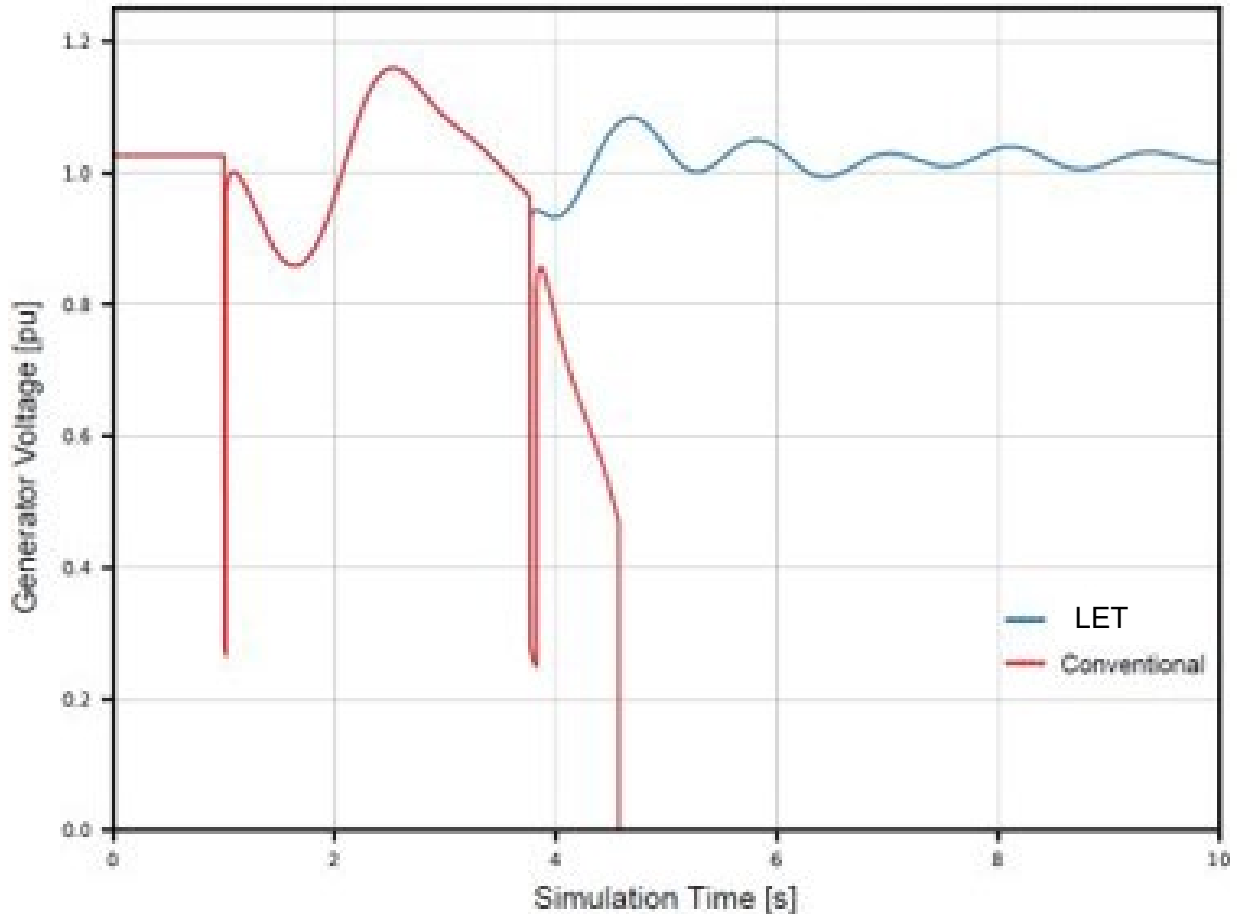
Generator Stability - LEI vs. Conventional Clearing

- Generator Frequency Response



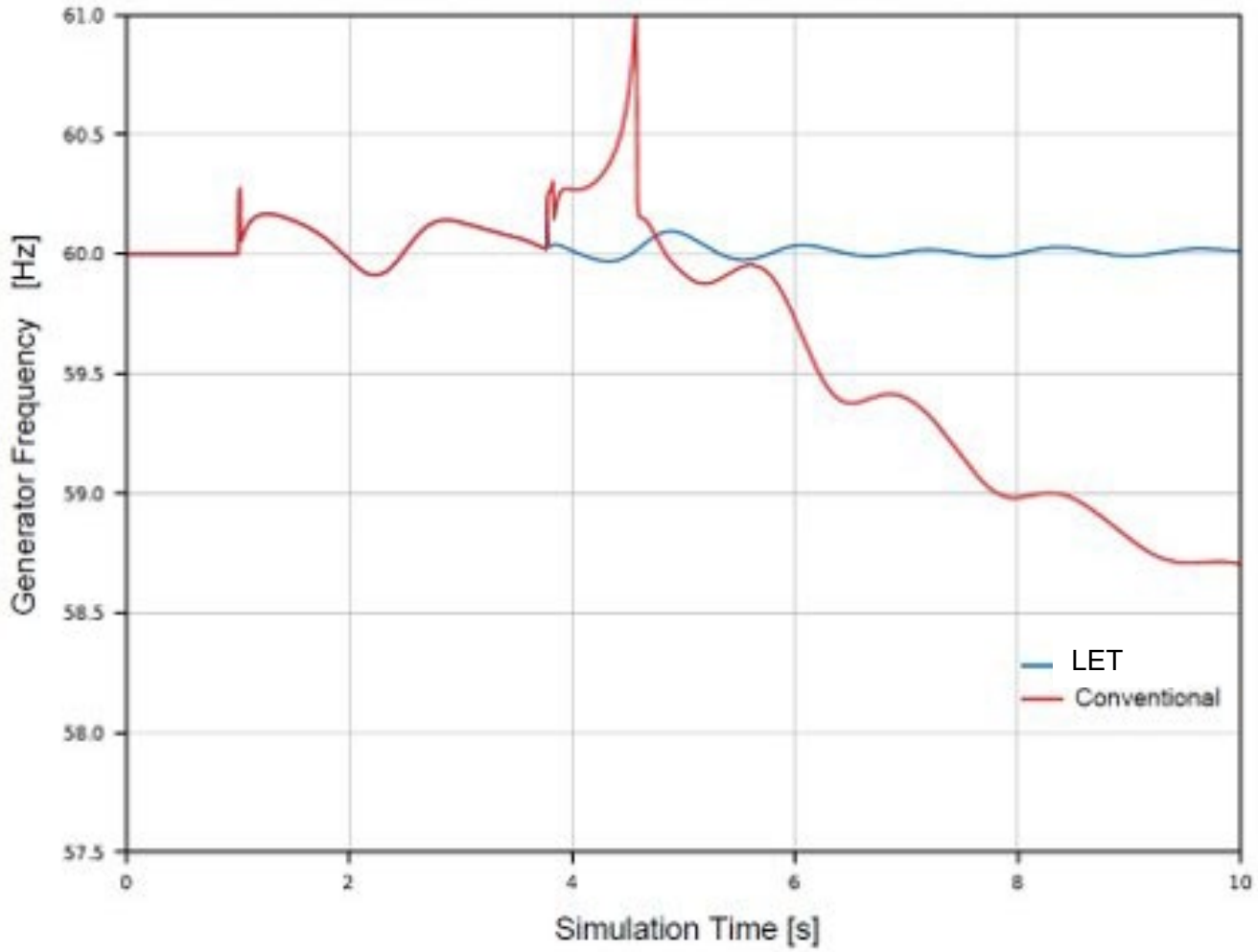
Generator Stability - LET vs. Conventional Reclosing

- Generator Voltage Response



Generator Stability - LET vs. Conventional Reclosing

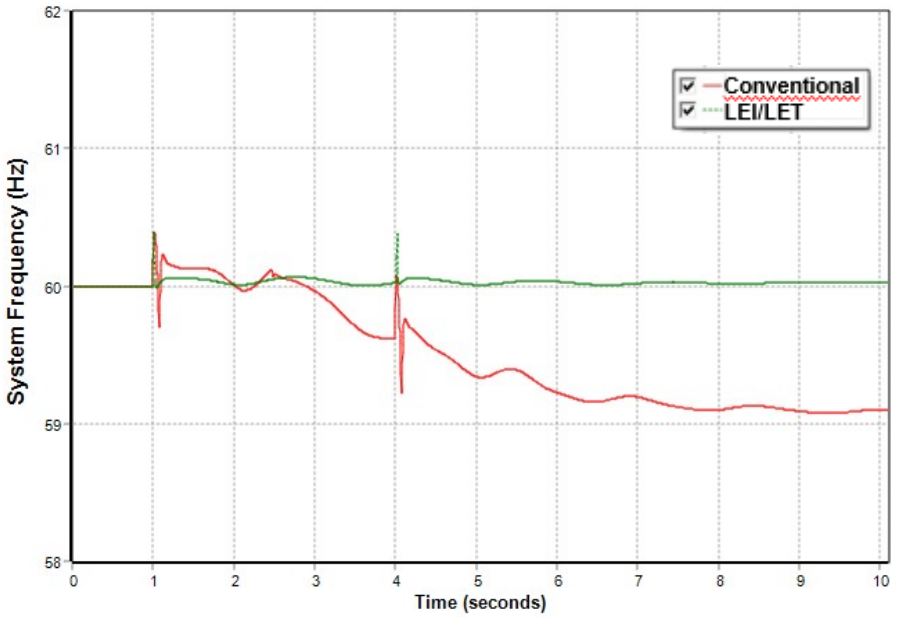
- Generator Frequency Response

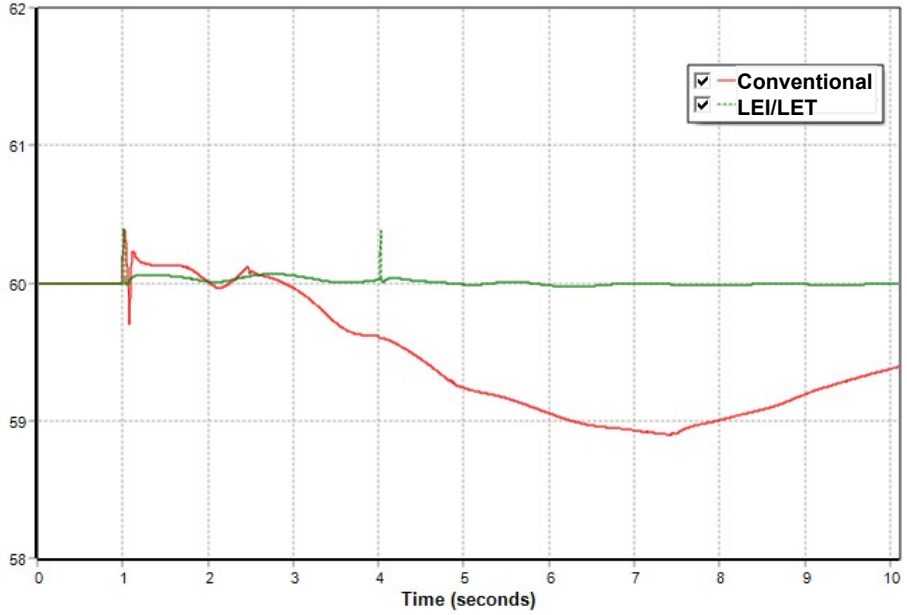


Simulation Results – Load Rejection

- LEI/LET Technology vs Conventional Clearing and Reclosing

Frequency Response (Permanent Fault vs. Temporary Fault)





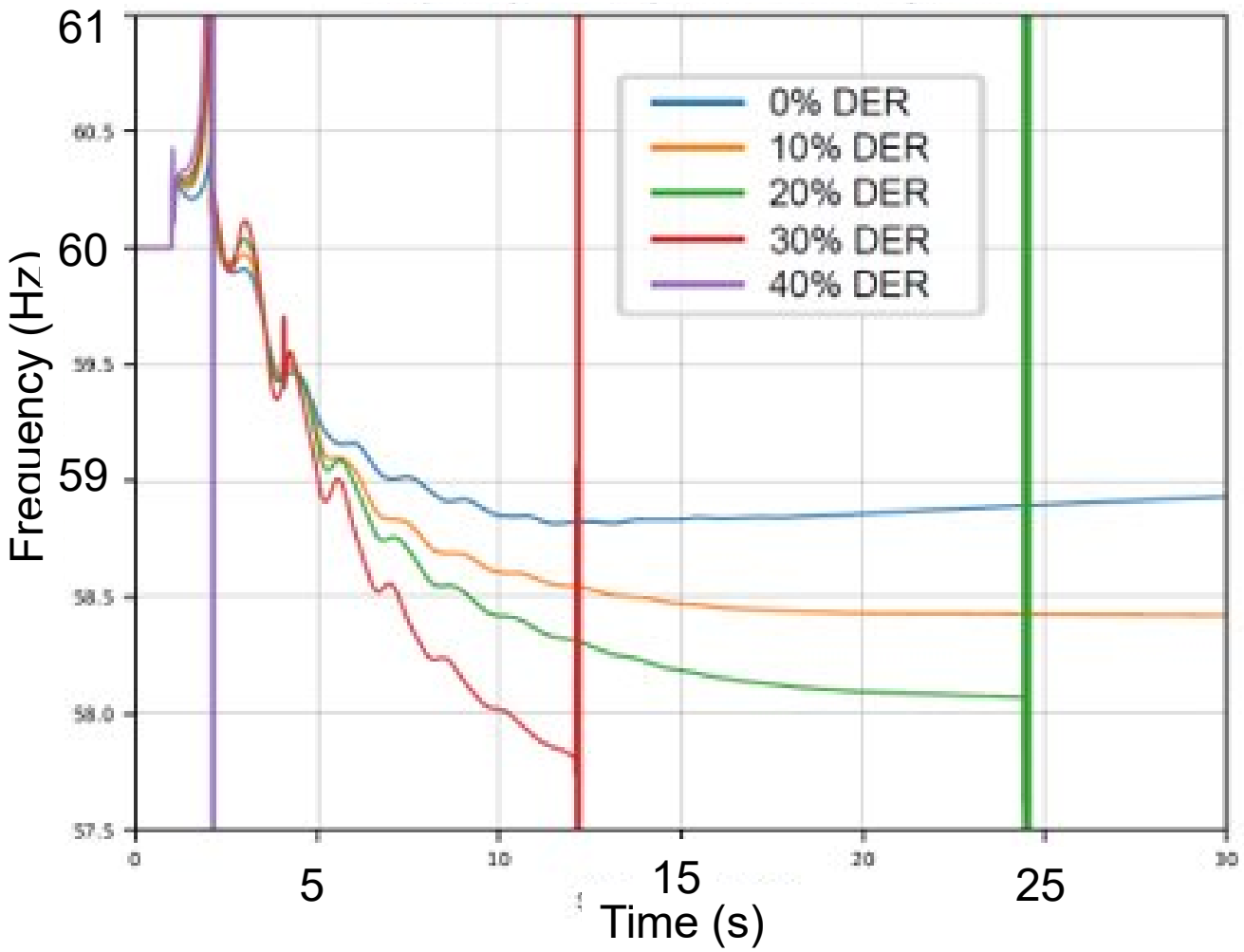
Simulation Results – Summary

LEI/LET Feature / Transmission Benefit	Fault	LEI	LET
Preserves generation	PF	✓	✓
Prevents load-shedding/load-loss	PTF	✓	
Prevents even more load-shedding	PTF	✓	✓

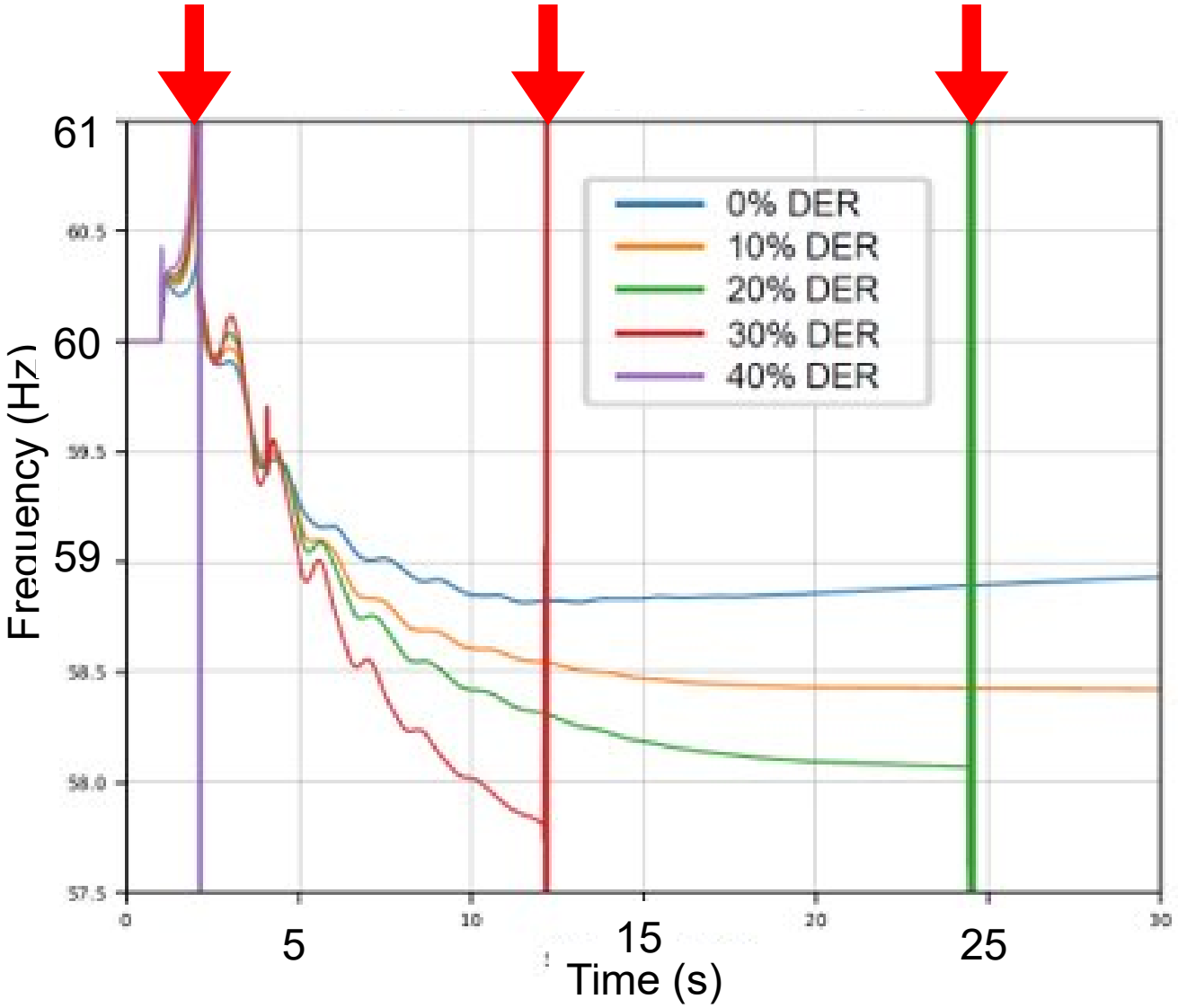
PF = Permanent Faults

PTF = Permanent and Temporary Faults

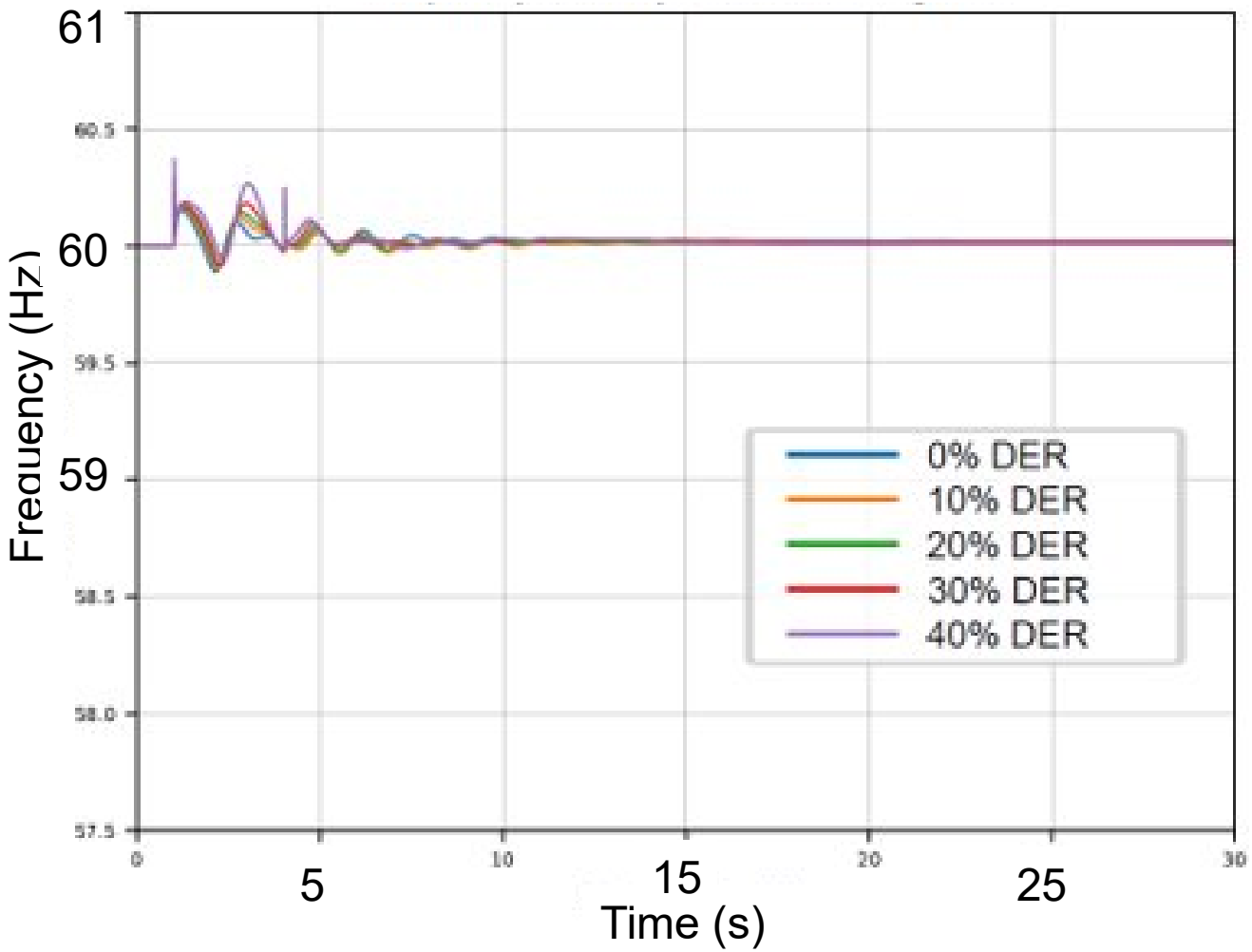
Role of Protection on Stability
Faults Perturb the System…



Role of Protection on Stability
Which Trips Protection…



Role of Protection on Stability
Protection Operations Lead to Discontinuities



Summary

- Faster fault clearing enables renewables
- Mitigates the system's transient response by mitigating the magnitude of the perturbation
- Supports low inertia, high-DER expansion
- Permits reclosing where previously reclosing was not possible

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