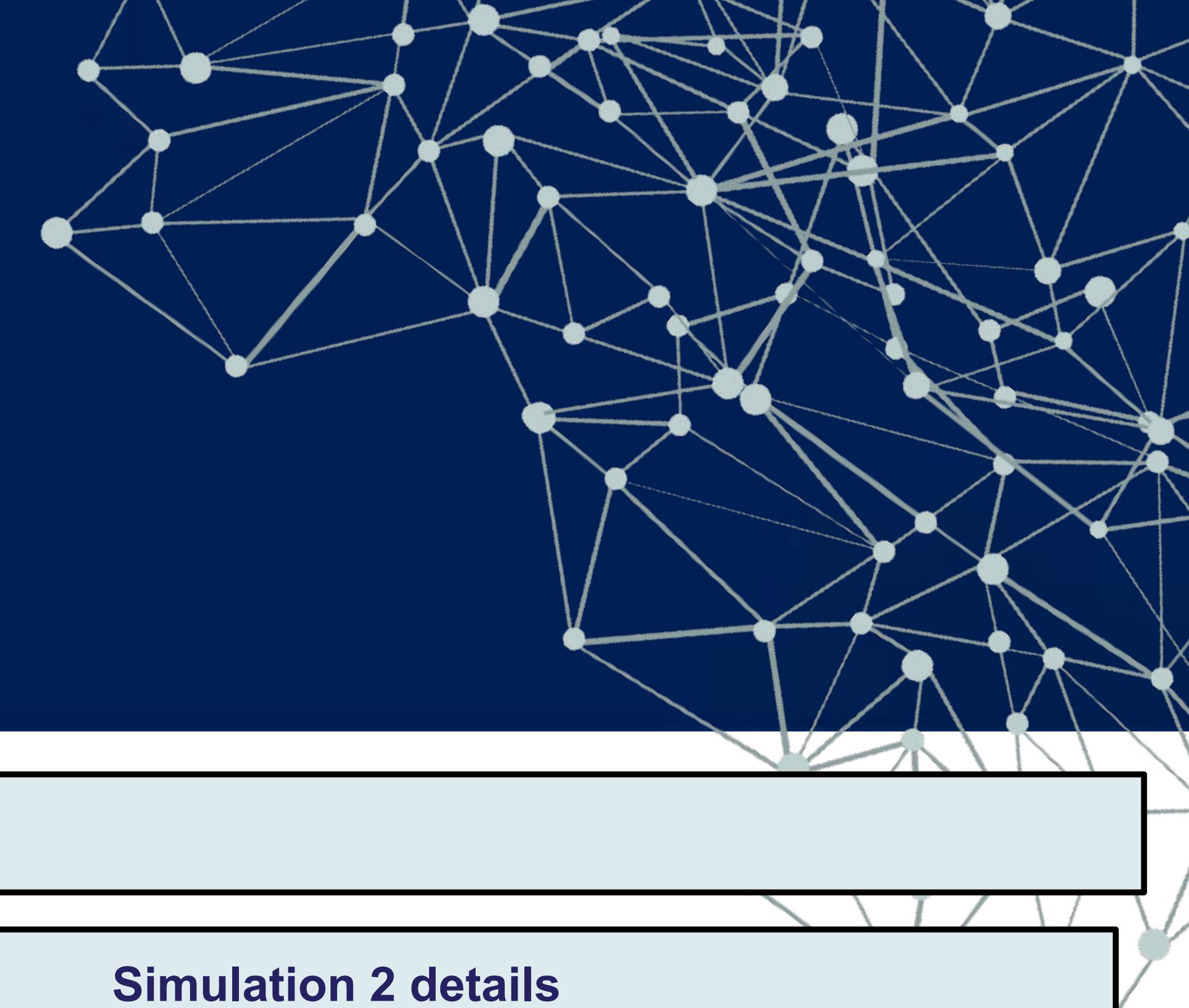


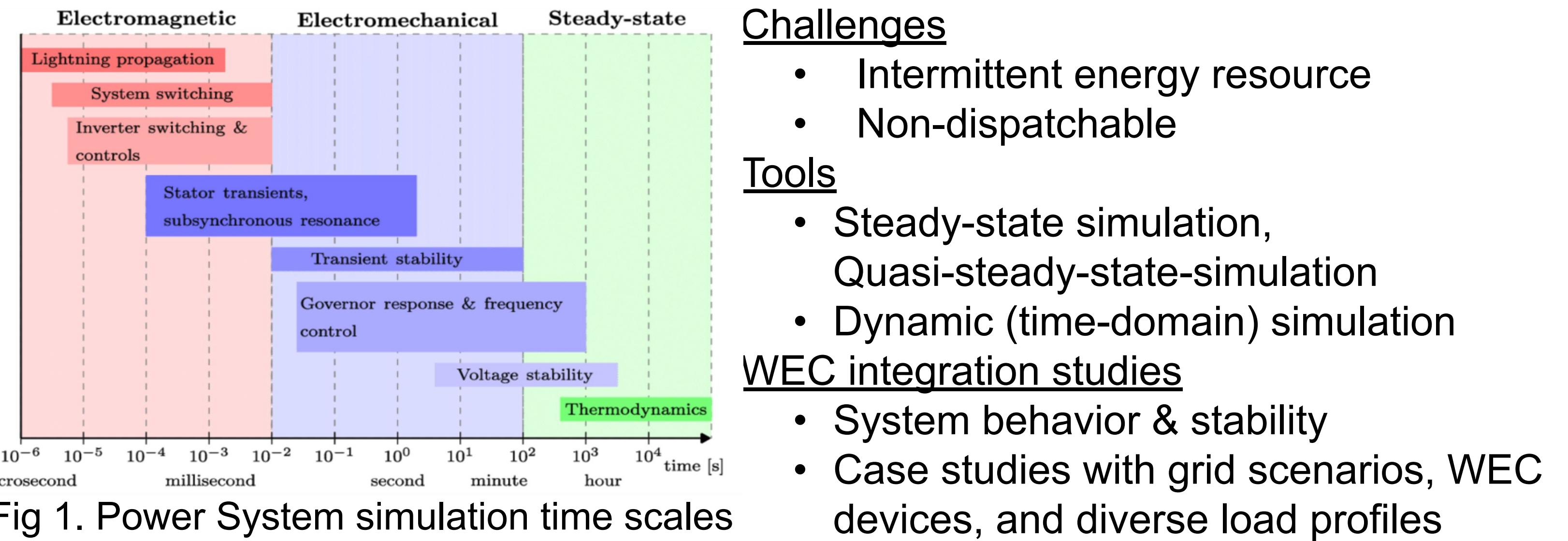
Integration and Demonstration of Marine Energy Models in Dynamic Stability Simulations

Alexander Barajas-Ritchie^{1,2}, Eduardo Cotilla-Sanchez¹, Saptarshi Bhattacharya²

1. School of Electrical Engineering and Computer Science, Oregon State University, 2. Pacific Northwest National Lab



Wave Energy & Dynamics Grid Simulations



Challenges

- Intermittent energy resource
- Non-dispatchable

Tools

- Steady-state simulation, Quasi-steady-state-simulation
- Dynamic (time-domain) simulation

WEC integration studies

- System behavior & stability
- Case studies with grid scenarios, WEC devices, and diverse load profiles

Model Runs & Technical Contribution

Model runs

- Modified IEEE-14 bus test case to include Wave E Power Take-Off (PTO) located at bus 8.
- Regular wave time-series input to PTO during sim
- Simulation with line outages, faults, and power pe

Contributions

- Linear PTO Model module in PowerDynamics.jl.
- Extension of PowerDynamics.jl support time-series
- Full WEC PTO integration time-domain simulation

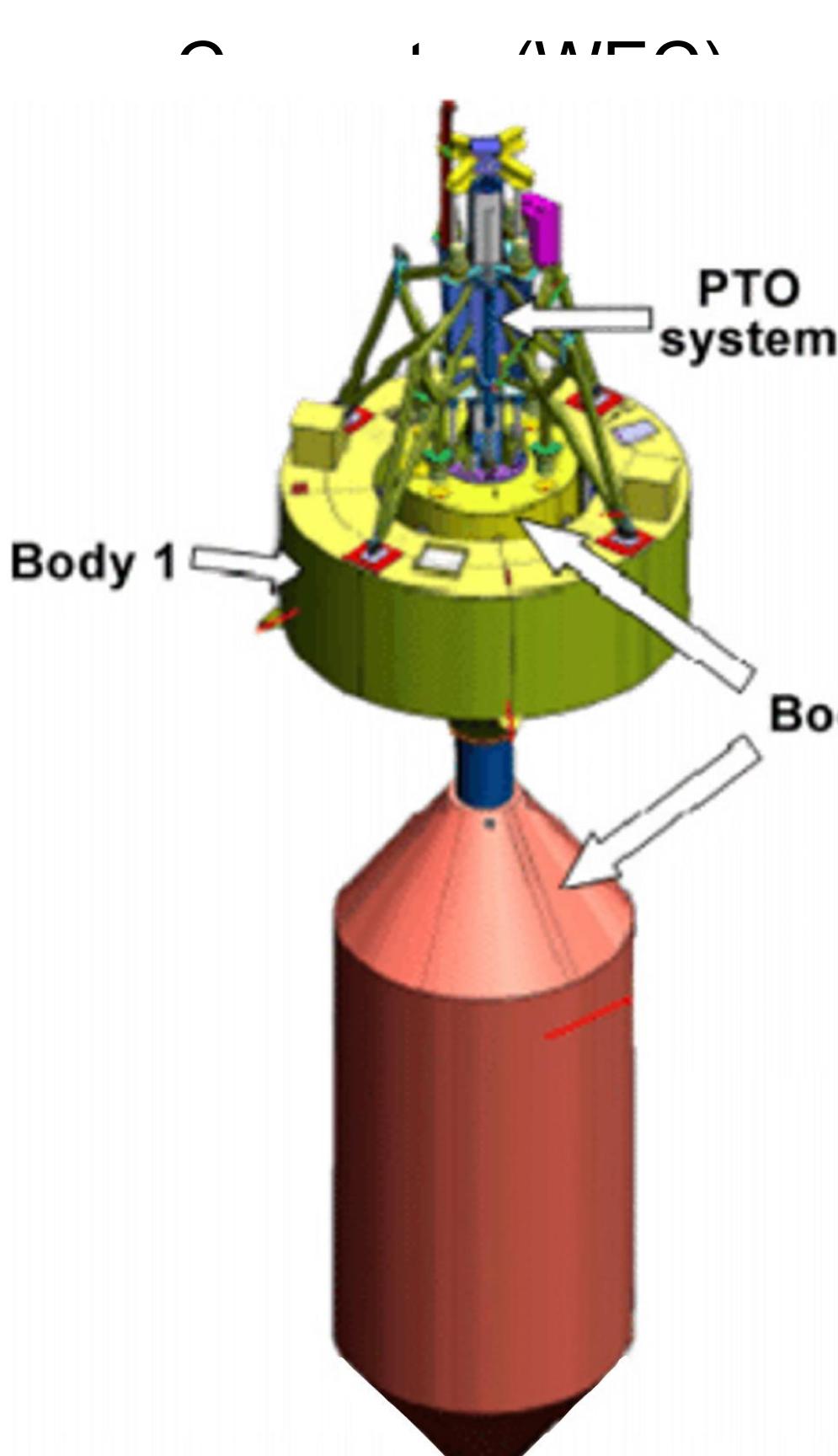


Fig 2. WEC adapted IEEE 14 test grid network

Fig 3. Two-body wave energy converter with PTO system

Key Insights & Future Work

- Stable grid conditions with various faults and line outages using PTO.
- Investigate non-converging test cases.
- Scaled simulations to include a WEC farm on a larger system.
- Irregular wave test.
- WEC-SIM integration.

Results

Simulation 1 details

- 30-second dynamic simulation with a variable step size.
- At $t = 5$ line outage between bus 1 and bus 2.
- Line reconnecting at $t = 10$.

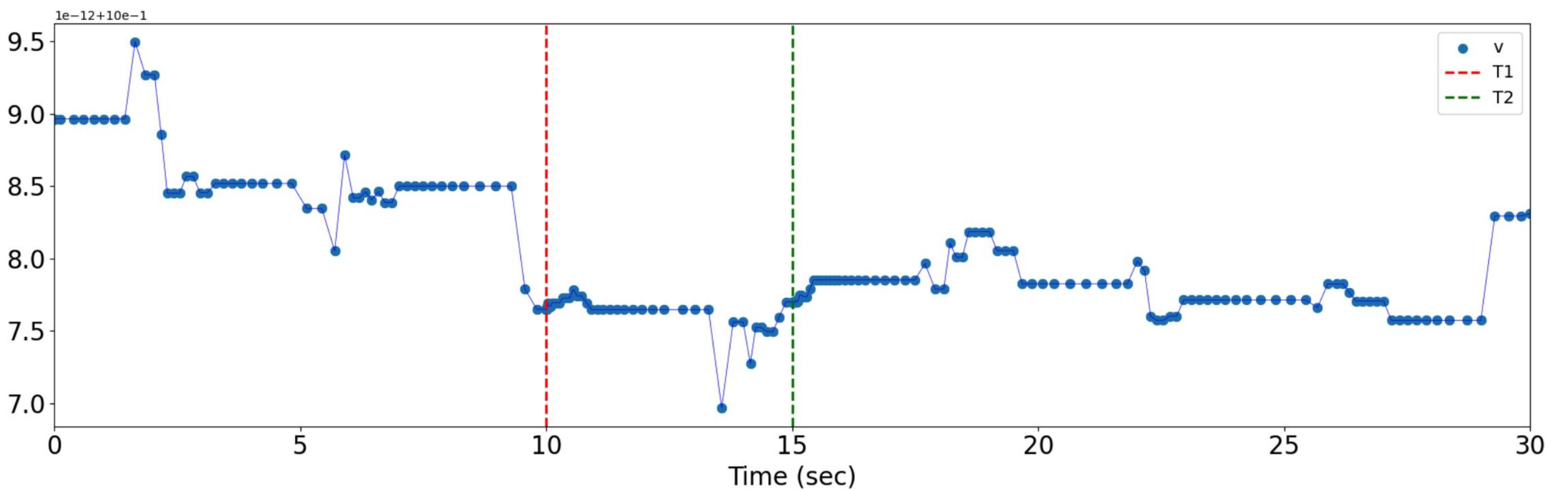


Fig 4. Bus 8 voltage with line failure

Simulation 2 details

- 30-second dynamic simulation with a variable step size.
- Active power at bus 3 is set to 1.0 from $t = 5.0 - 10.0$.
- Line reconnecting at $t = 10$.

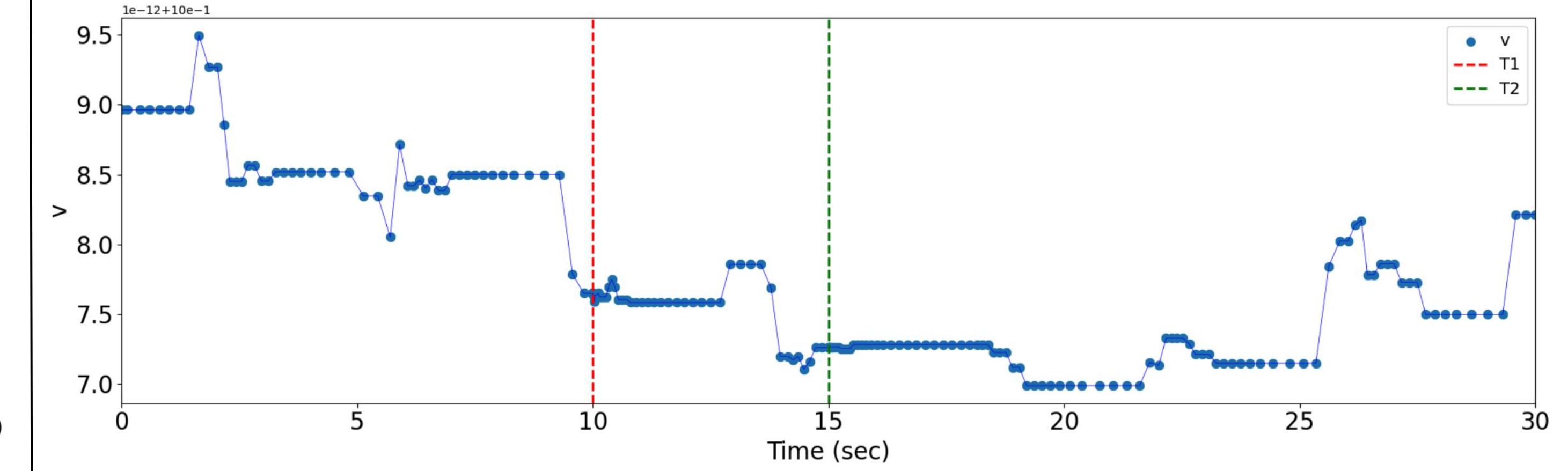


Fig 7. Bus 8 voltage with active power disruption

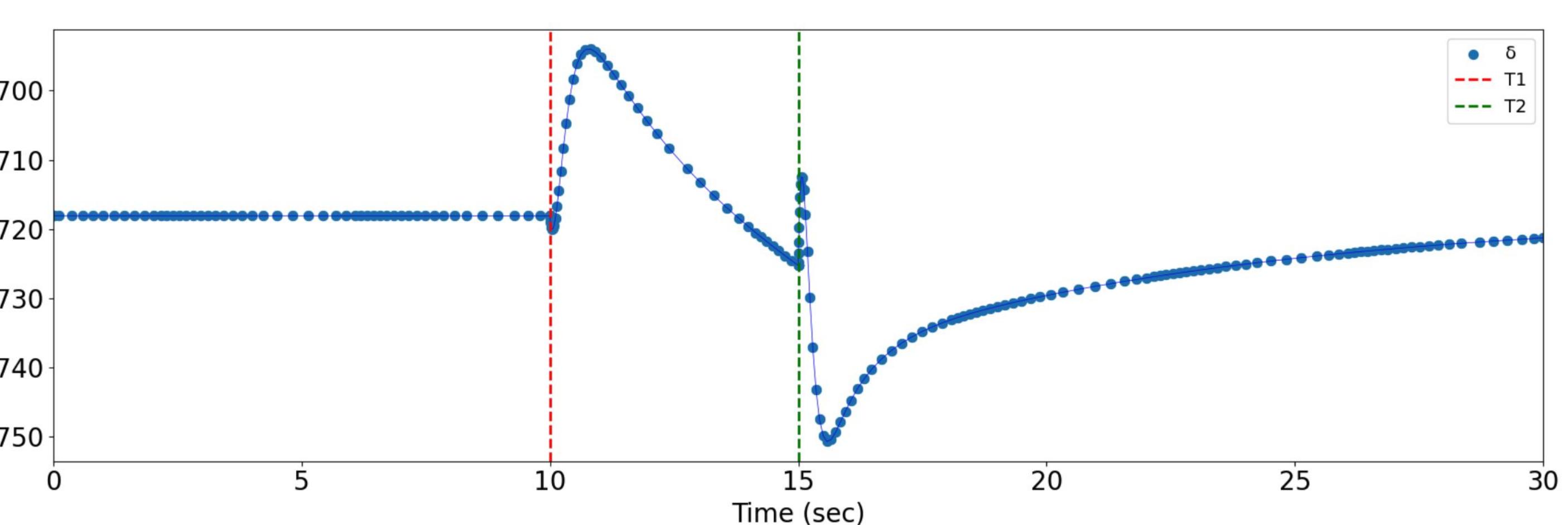


Fig 5. Bus 8 δ with line failure

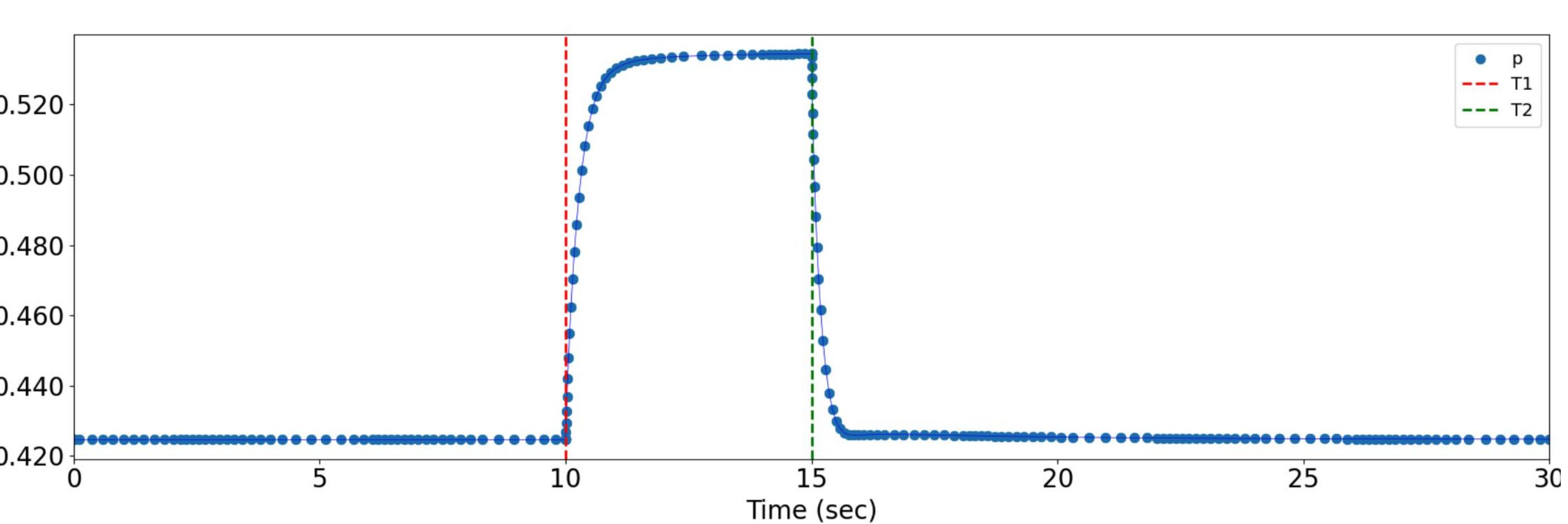


Fig 6. Bus 8 active power with line failure

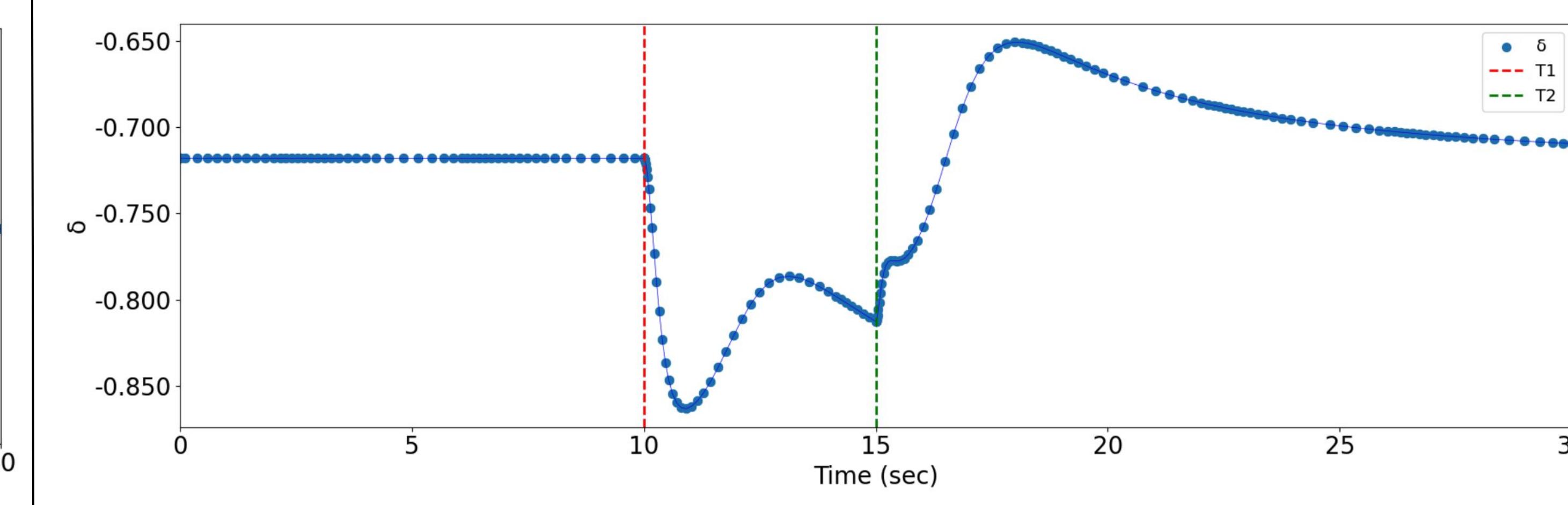


Fig 8. Bus 8 δ with active power disruption

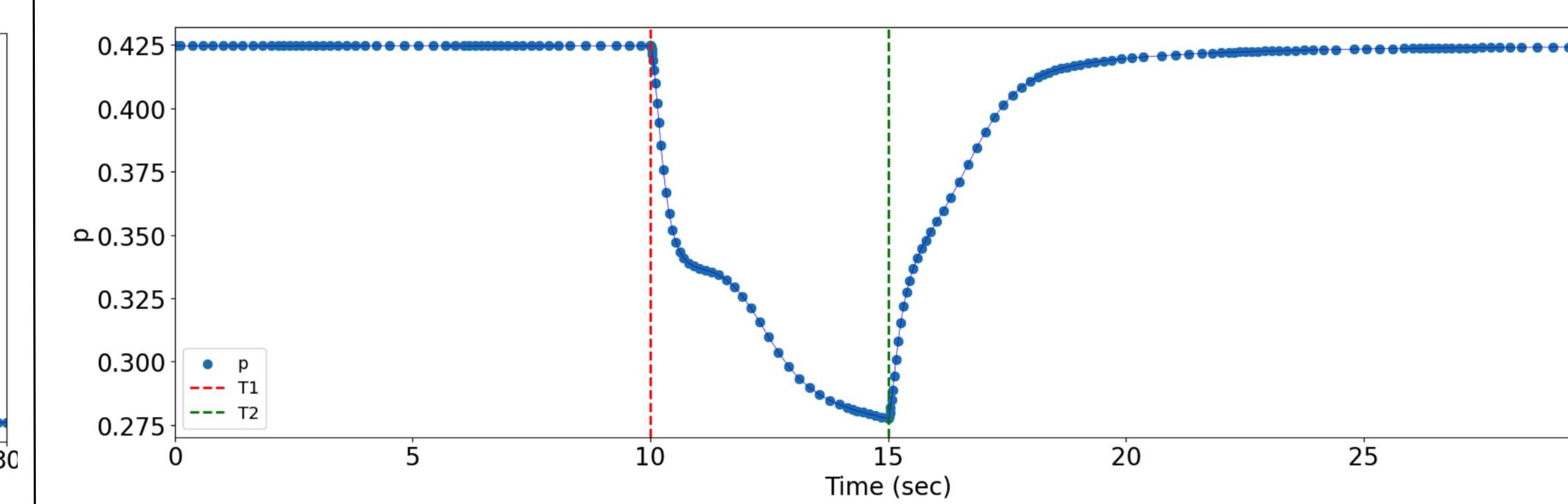


Fig 9. Bus 8 active power with active power disruption