Texas Synchrophasor Network Observations for ERCOT during
Prof. Mack Grady and PhD Student Andrew Mattei, Baylor University, Waco, TX

A total of twenty-six events are shown. The first eleven are significant unit trips.

Event 2. Sept. 21, 2019. 08:00 UTC. 2-Minute Window.
Unit trip, 461 MW. Load = 40.5 GW.
Unit trip, 696 MW. Load = 60.0 GW.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Unit trip, 576 MW. Load = 49.4 GW.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Unit trip, 846 MW, Load = 44.2 GW
Unit trip, 451 MW. Load = 38.9 GW

Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX
**Severe** Unit trip, Freq. dropped to **59.74** Hz. 1205 MW. Load = 40.0 GW
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Unit Trip, 774 MW. Load = 38.9 GW.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Unit trip, 541 MW. Load = 43.9 GW.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Unit trip, 663 MW. Load = 41.4 GW.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Events 12 – 14 represent other types of common events

Sequence of transmission line switching, most likely near Waco.
No indication of faults. Power flow is increasing from West Texas to South Texas.
Event 13. Oct. 06, 2019. 19:50 UTC. 2-Minute Window. Unit trip with unusually fast recovery, followed by one small unit trip, and two larger unit trips.
Event 14. Nov. 29, 2019. 08:08 UTC. 1-Minute Window. Classic transmission line fault near Waco, breaker opens the line, then successfully recloses 10 seconds later.
Events 15 – 26 are most likely due to solar power plant controllers and inverters in Far West Texas (represented by McDonald Observatory). All occurred during daytime.

Before showing the latest events, take a look at high-frequency events shown in this presentation:

Portions of

“The Impact on Power Quality Associated with the Integration of Wind and Solar”
Presented at the
Electricity Consumers Resource Council (ELCON) Fall Workshop on
“Preserving Reliability in a Period of Constant Transition”
Washington DC
November 28, 2018
by
Dr. Mack Grady, Professor, Dept. of ECE,
Baylor University since 2012, and U.T. Austin (Emeritus)
Rich in Oil, Wind, and Solar

Pecos County

100 Mile Long Arrow

Fort Stockton

McDonald Observatory

Pecos County

One Solar Area

100 Mile Long Arrow

“No Country for Old Men” movie?
3.5 Mile Arrow

Zoom-In of the Solar Area Outlined in the Previous Slide

The panels track the sun
We First Noticed Oscillations Like This at McDonald Observatory in Fall 2016 (100+ miles away from solar farms)

1-Minute Zoom-In

10-Second Zoom-In

5.8 Hz (Characteristic of PV Inverters)

Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX
10,000+ Synchrophasor Event Triggers During the Five Months Shown Below are Convincing Evidence that the Oscillations Above 5 Hz are Solar Farm Related. All Information Shown Here Comes From Two Synchrophasor PMUs - the Remote PMU is at McDonald Observatory, and the Reference PMU is at Austin.

- Only 34 of the 10,000+ Texas Synchrophasor Network triggers were below 5.0 Hz.
- While the ringing is clearly due to PV installations, the role that nearby wind generation plays is not yet known.
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Event 16. Sept. 11, 2019, 8-Minutes Later. 3-Minute Window.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Event 17, continued. Sept. 22, 2019. 5-Minute Zoom-In.

Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

0.13 Hz Ringing
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Texas Synchrophasor Network Observations for ERCOT during Sept. 01, 2019, through Jan. 22, 2020. Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX


Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX
Texas Synchrophasor Network Observations for ERCOT during
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

2.0 Hz Ringing in Far West Texas
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

2.0 Hz Ringing in Far West Texas

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PMU Waveform Analyzer, Prof. Mack Grady, Baylor University. Sponsored by Schweitzer Engineering Labs and ERCOT

2.0 Hz Ringing

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Voltage Phasor Diagram (First and Last Seconds)
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Event 23. Oct. 17, 2019. 23:45 UTC. 3-Minute Window. (5:45 pm CST)
2.0 Hz Ringing
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX


Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX
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Strong 0.9 Hz Switching in Far West Texas
Strong 1.8 Hz Switching in Far West Texas Begins After a Unit Trip.

Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX
Event 26, continued. Dec. 19, 2019. 1-Minute, Starting After the Last Slide. 1.8 Hz Switching.
Prof. Mack Grady and Mr. Andrew Mattei, Baylor University, Waco, TX

Event 26, continued. Dec. 19, 2019. 1-Minute Window at the End (10-Minutes Later.) 1.8 Hz Switching.