Panhandle Stability Study – Status Update and Preliminary Results

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ERCOT ROS Meeting
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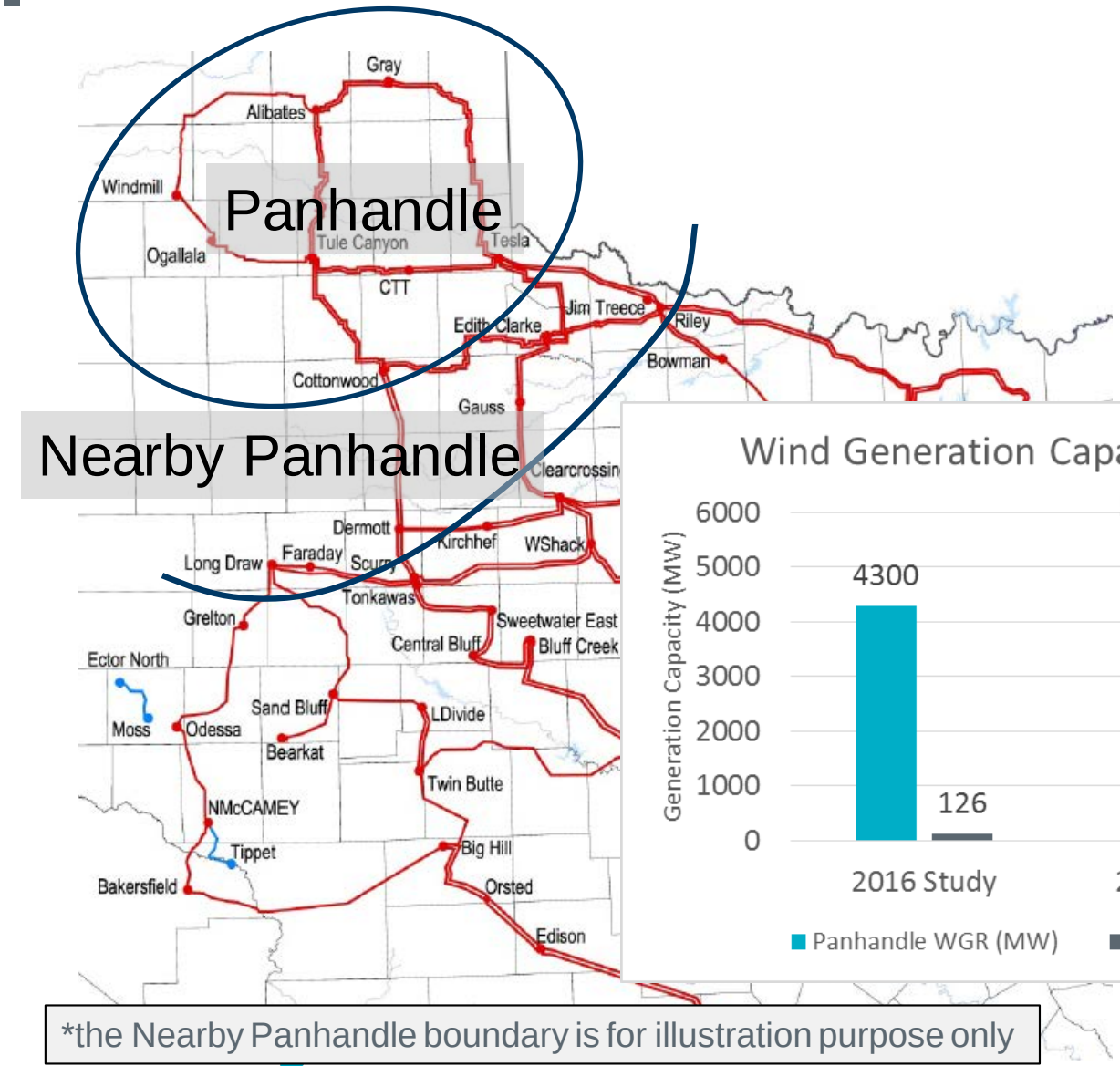
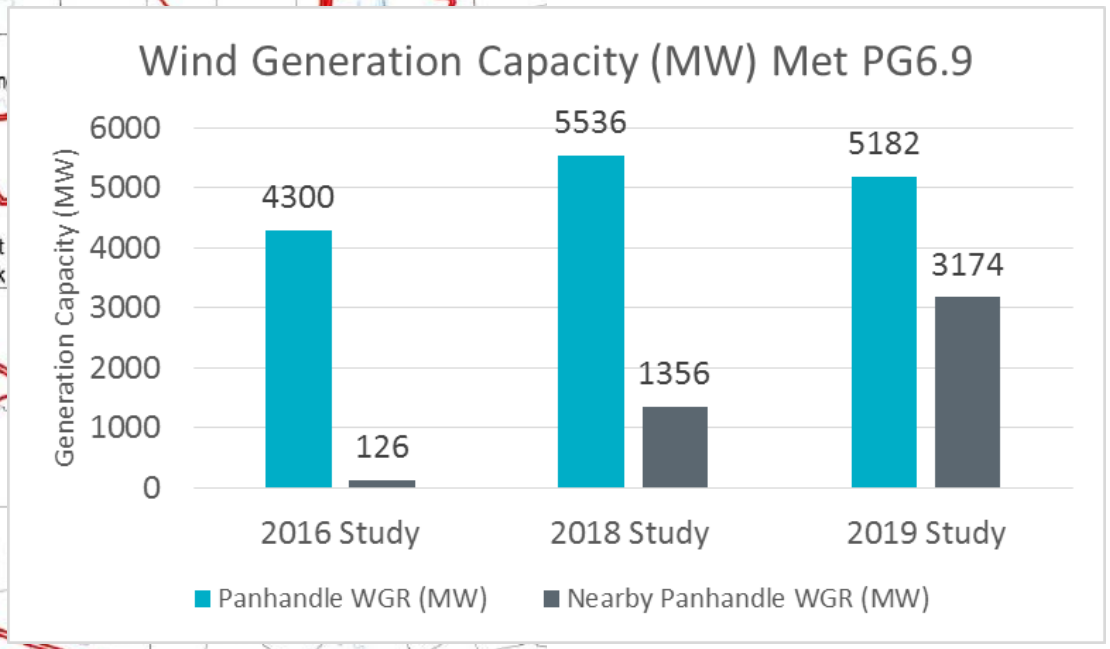
Outline

- Generation Overview in the Panhandle Region
- Recap of Previous Studies
- Preliminary Observations and Next Steps

Generation Overview in the Panhandle Region

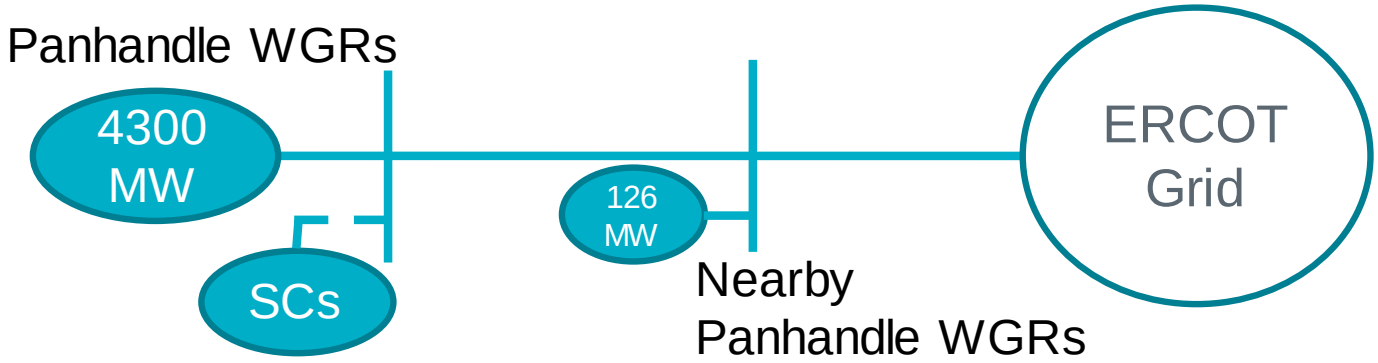




*the Nearby Panhandle boundary is for illustration purpose only

Previous Panhandle Stability Studies:

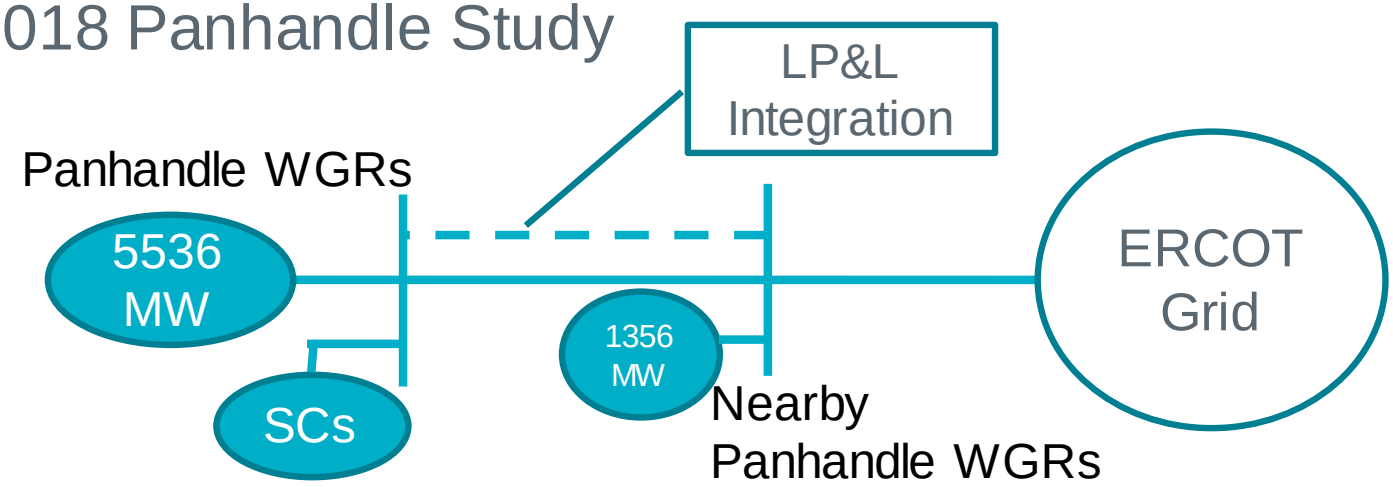
- 2016 Panhandle Study



- Stability issues and system needs in Panhandle
  - System strength in normal operation (no planning outage)
  - Voltage stability under outage condition (N-1 planned outage)
- Key takeaways:
  - Synchronous condensers were proposed to provide system strength and voltage support in Panhandle
  - PSCAD modeling improvement was required

Previous Panhandle Stability Studies:

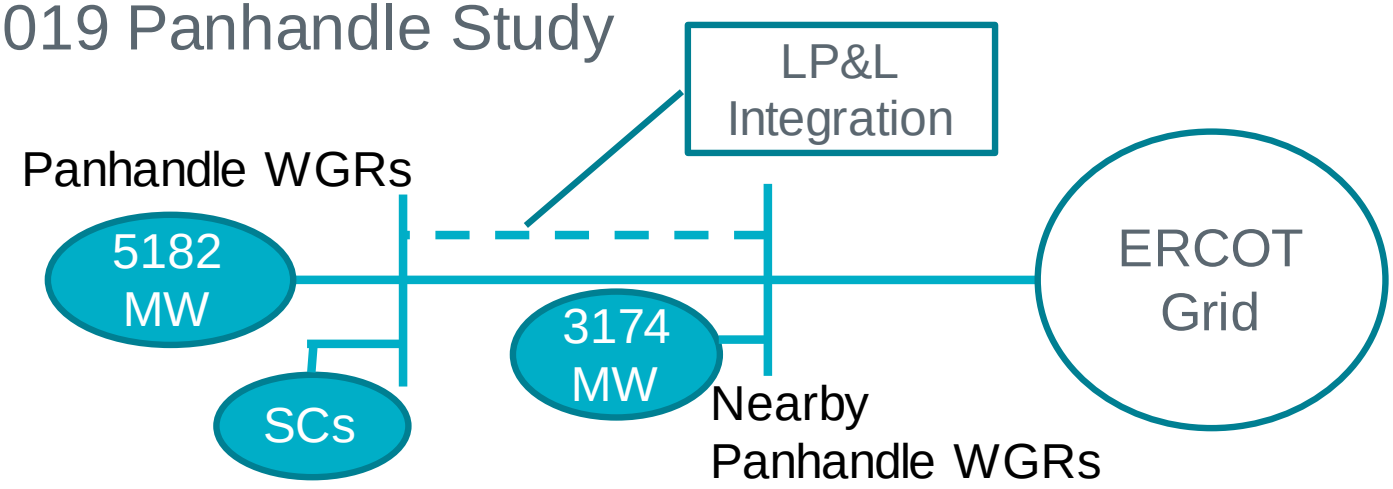
- 2018 Panhandle Study



- Stability issues and system needs in Panhandle
  - System strength for normal operation
  - Voltage stability under outage condition
- Key takeaways:
  - System strength improvement was observed with and without LP&L
  - The impact of nearby Panhandle generation should be further assessed
  - PSCAD modeling improvement and guideline was recommended

2019 Panhandle Stability Studies

- 2019 Panhandle Study



- Include all the WGRs that either are in service or have met PG6.9.
  - All the committed WGRs are projected to be in service by 2020
  - Significant increase of nearby Panhandle WGRs
- Stability Issues to be identified and addressed
  - Sufficient system strength for inverter operation
  - Sufficient reactive support for long distance and large power transfer
  - Sufficient damping for angular stability

Study Approach

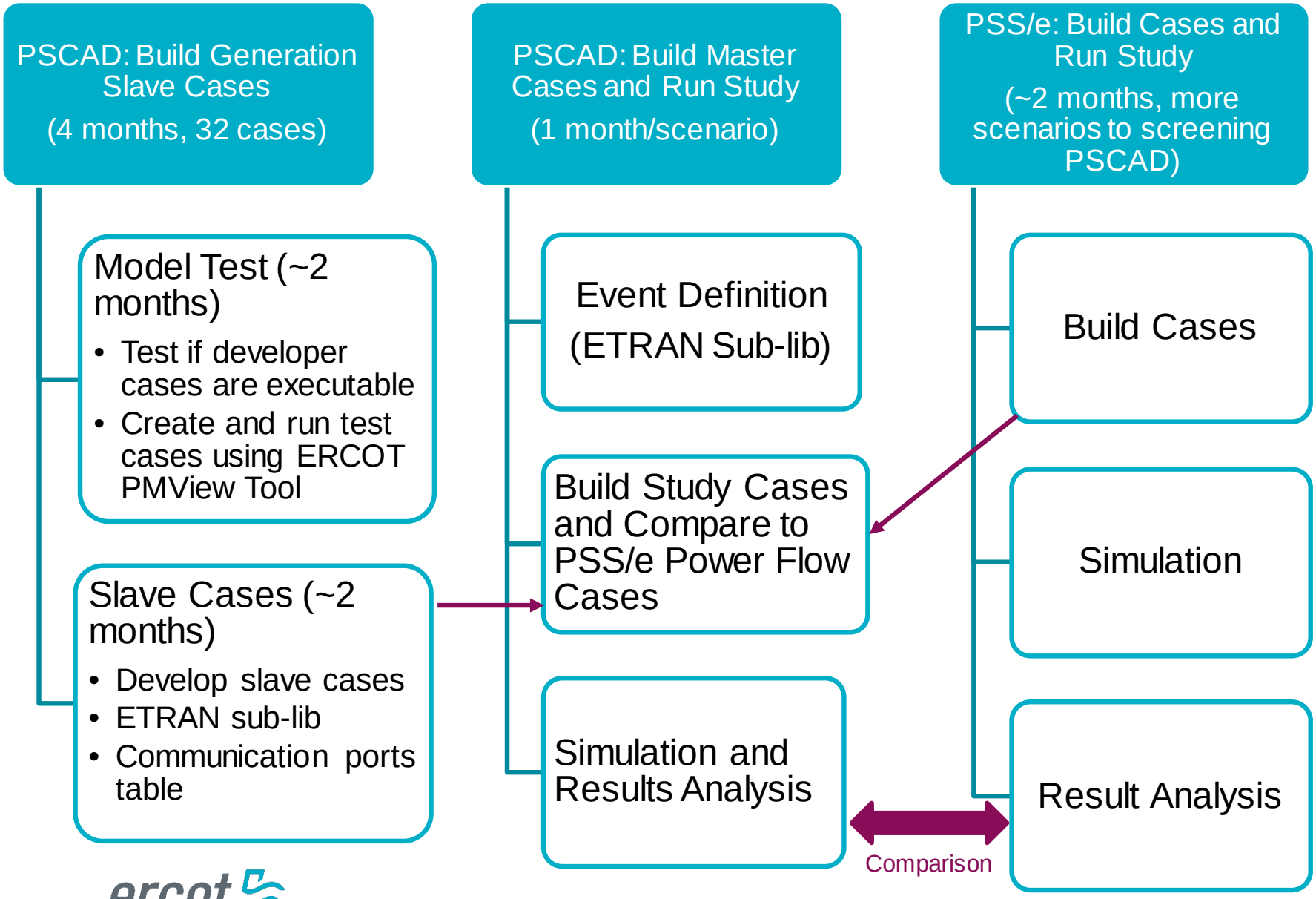
PSS/e (Positive Sequence)

- Modeling the entire ERCOT system
- Assess voltage stability and interaction between Panhandle and the rest of ERCOT
- Identify the scenarios and contingencies for PSCAD study

PSCAD (Three Phase Detail Model)

- Only include detailed PSCAD models for the Panhandle and nearby Panhandle region – the rest of ERCOT represented with a passive equivalent
- Focus on the system strength assessment

Panhandle Study Overview



PSCAD Modeling Overview

- Total of 40 WGRs in the Panhandle and nearby Panhandle

- Five months were required for PSCAD model submittal and update
  - Numerous discussions among ERCOT, REs/developers, and vendors

Acceptable with PPC*	33 WGRs
Acceptable without PPC	5 WGRs
No Submittals	2 WGRs

*power plant controller for voltage support

- Overall, PSCAD model quality is better but lack of certain usability/efficiency features listed in the PSCAD modeling guideline

Simulation Setup

PSCAD Study

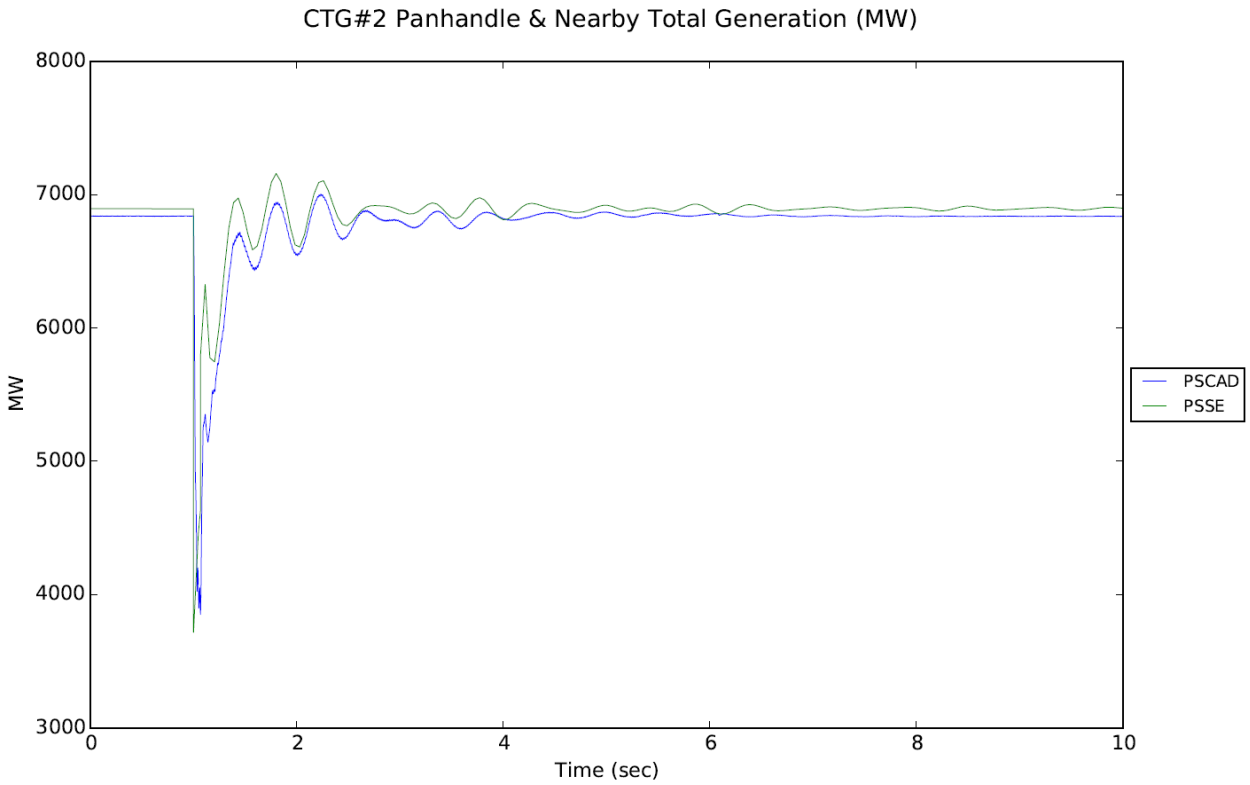
- 1 Master Case for transmission system with SVCs and synchronous condensers
  - More than 400 buses modeled in PSCAD
  - Model nearby Panhandle region in PSCAD
- 32 Slave Cases for 40 WGRs
- 34 CPU cores utilized for PSCAD simulation using ETRAN PLUS parallel processing
- It took 1.5 hours to run one contingency simulation. Two days for one scenario (if the model did not crash during the run).
- Each scenario created 60 GB simulation files with 26 contingencies.

PSS/e Analysis

- Increasing numerical issues were observed.
- Increasing occurrences of instantaneous tripping due to overvoltage and frequency protections.

Prior to LP&L Integration Under Normal Condition: Observations

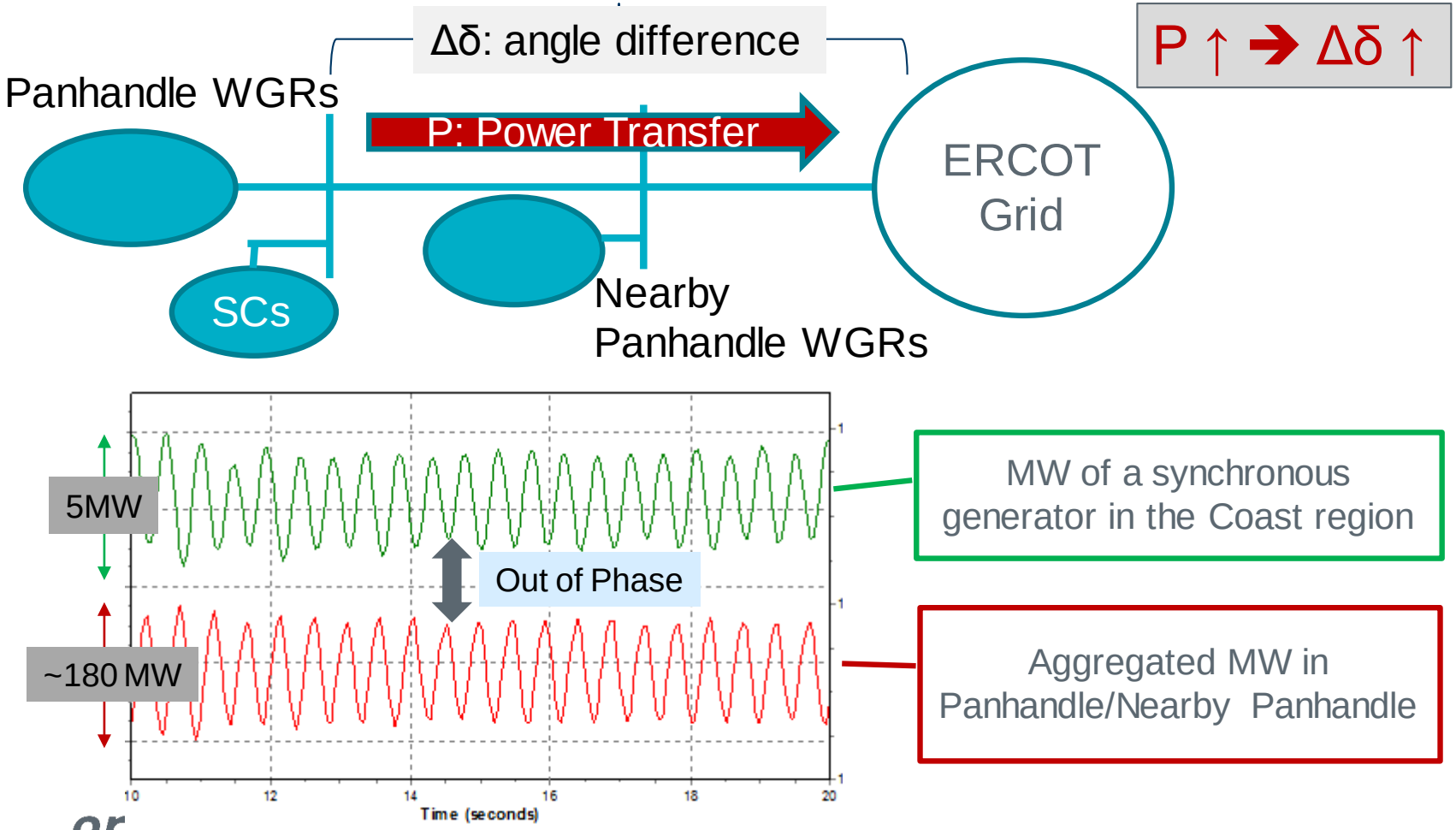
1. System strength
   - Generally, PSS/e and PSCAD results are consistent
   - Acceptable response at a lower system strength, WSCR < 1.5



Prior to LP&L Integration: Observations

2. Angular stability

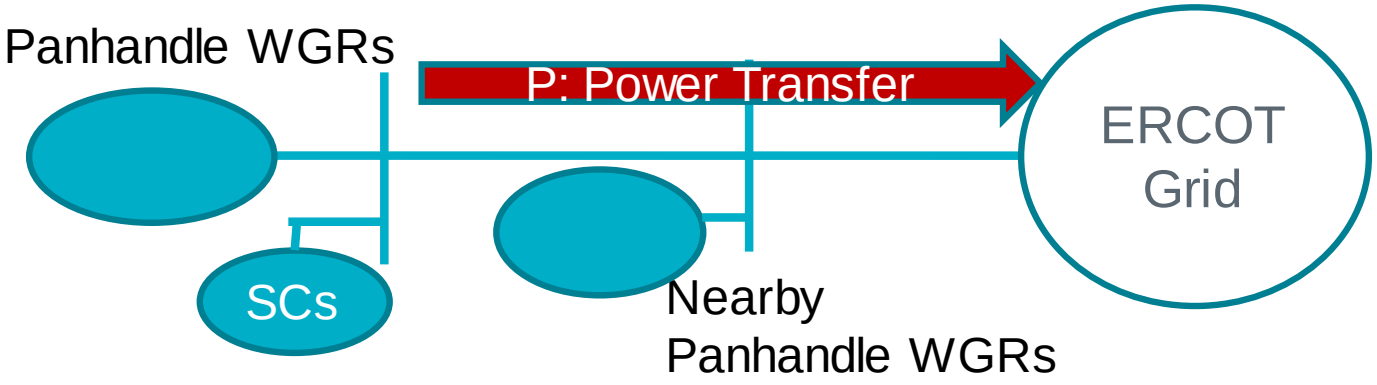
- Oscillatory responses are observed at high power transfer



Prior to LP&L Integration: Observations

3. Voltage stability
   - Limited dynamic voltage support on the transfer path
   - Further stressed voltage challenges under a planned outage condition. Voltage collapse at 0.95 pu or above in Panhandle

P ↑ ➔ Qloss ↑ ➔ Outage ➔ impedance ↑ ➔ Qloss ↑ ↑ ➔ V↓ ➔$Q_{(shunt)}$ ↓ ↓ ➔V ↓ ↓ ➔voltage instability



Preliminary Summary (include WGRs by 2020)

- Increasing nearby Panhandle WGRs helps on the responses at a lower system strength (similar to the 2018 study findings)
- Angular instability **(new constraint)**
- Voltage instability (**new constraint**)

Panhandle Export Limit (Full Capacity: 5182 MW)		
System Constraints	Normal Condition	Planned Outage
System Strength	WSCR < 1.45	TBD
Angular Stability	Most Limiting Constraint, 3886 MW	TBD
Voltage Stability	More than 3886 MW	Most Limiting Constraint

Preliminary Summary (include WGRs by 2020)

- Existing Panhandle interface is adequate and effective to maintain the transfer under all identified stability constraints
  - Test results indicate that to increase Panhandle interface limit by 1 MW, the nearby Panhandle WGRs need to be reduced by 3~6 MW.

- Next steps:
  - Further studies for the existing conditions (normal and planned outages; tentative schedule: June/July, 2019)
  - Work with TSPs to investigate the feasibility of damping support from synchronous condensers and dynamic reactive devices in Panhandle to improve the angular stability

Post-LP&L Integration

Panhandle Dispatch (%, MW)	Nearby Panhandle Dispatch (%, MW)	Lubbock Load (%, MW)
100% (5182 MW)	100% (3174 MW)	35% (171 MW)

- Although improved system response with LP&L integration is expected, unacceptable results for 100% Panhandle dispatch were observed.
  - LP&L Integration helps on the responses at a lower system strength (similar to the 2018 study findings)
  - Angular instability
  - Voltage instability

- Further analysis with LP&L Integration (tentative schedule: Q3, 2019)

Appendix

Panhandle WGR

Station	WGR Capacity (MW)
Gray 345kV	463
Railhead 345kV	658
Alibates 345kV	562
Tule Canyon 345kV	350
AJ Swope 345kV	355
Windmill 345kV	1046
Ogallala 345kV	303
White River 345kV	980
Cotton Wood 345kV	257
CB_TAP 345kV	210
Total	5182

Nearby Panhandle WGR

Station	WGR Capacity (MW)
Dermott 345kV	496
Edith Clark 345kV	350
Grsland 345kV	300
Jim Treece 345kV	235
Long Draw 345kV	587
Riley 345kV	414
Smoky Hill 345kV	480
Dermott 138kV	313
Total	3174