



West Texas Export Capability Assessment Results

System Planning and Operations

October 21, 2014

ERCOT Regional Planning Group Meeting



Assessment Purpose

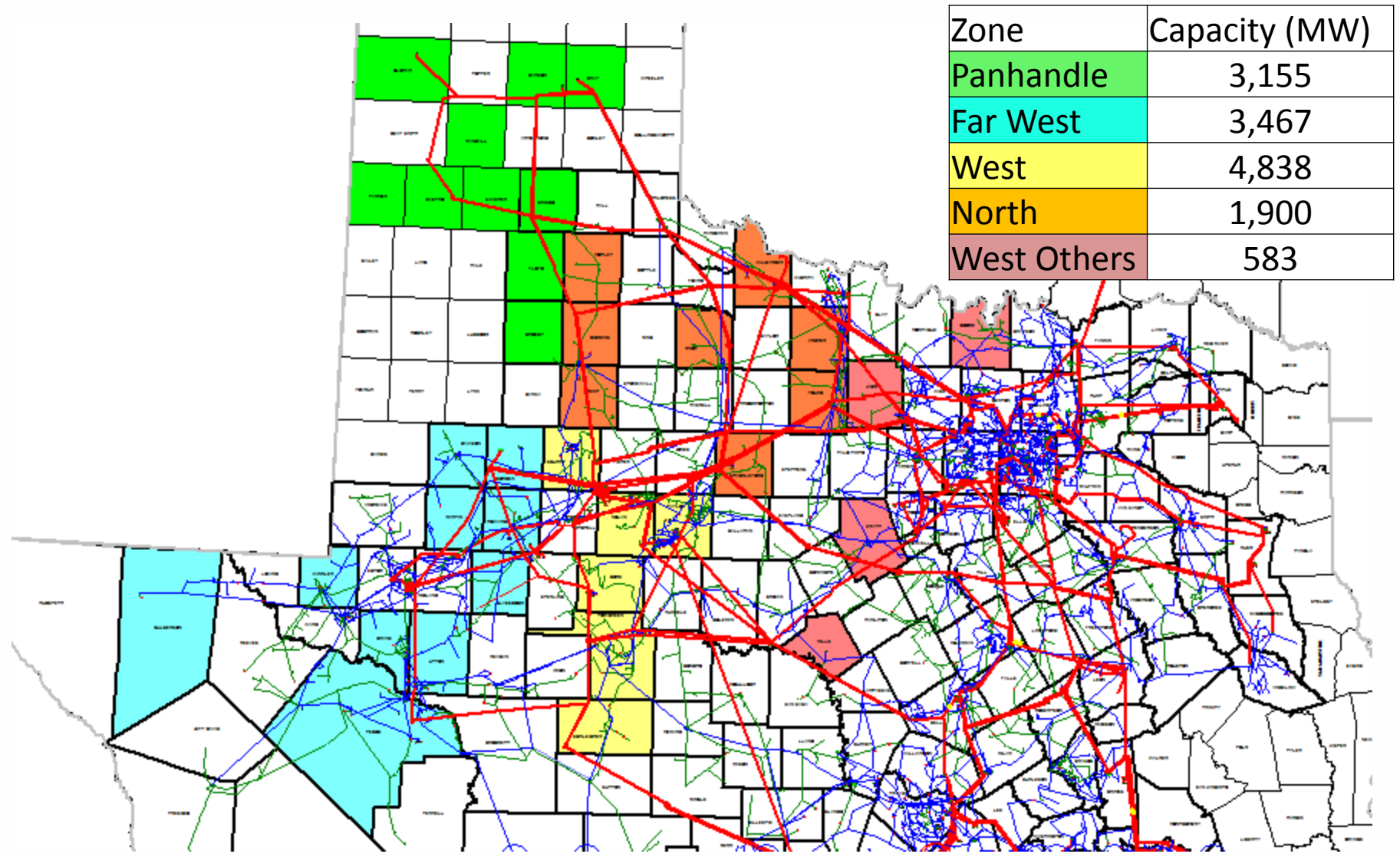
- I. To assess the impact of series capacitors on the West Texas export capability

- II. To revise the existing West-North Interconnection Reliability Operating Limit (IROL)

I. Series Capacitor Impact

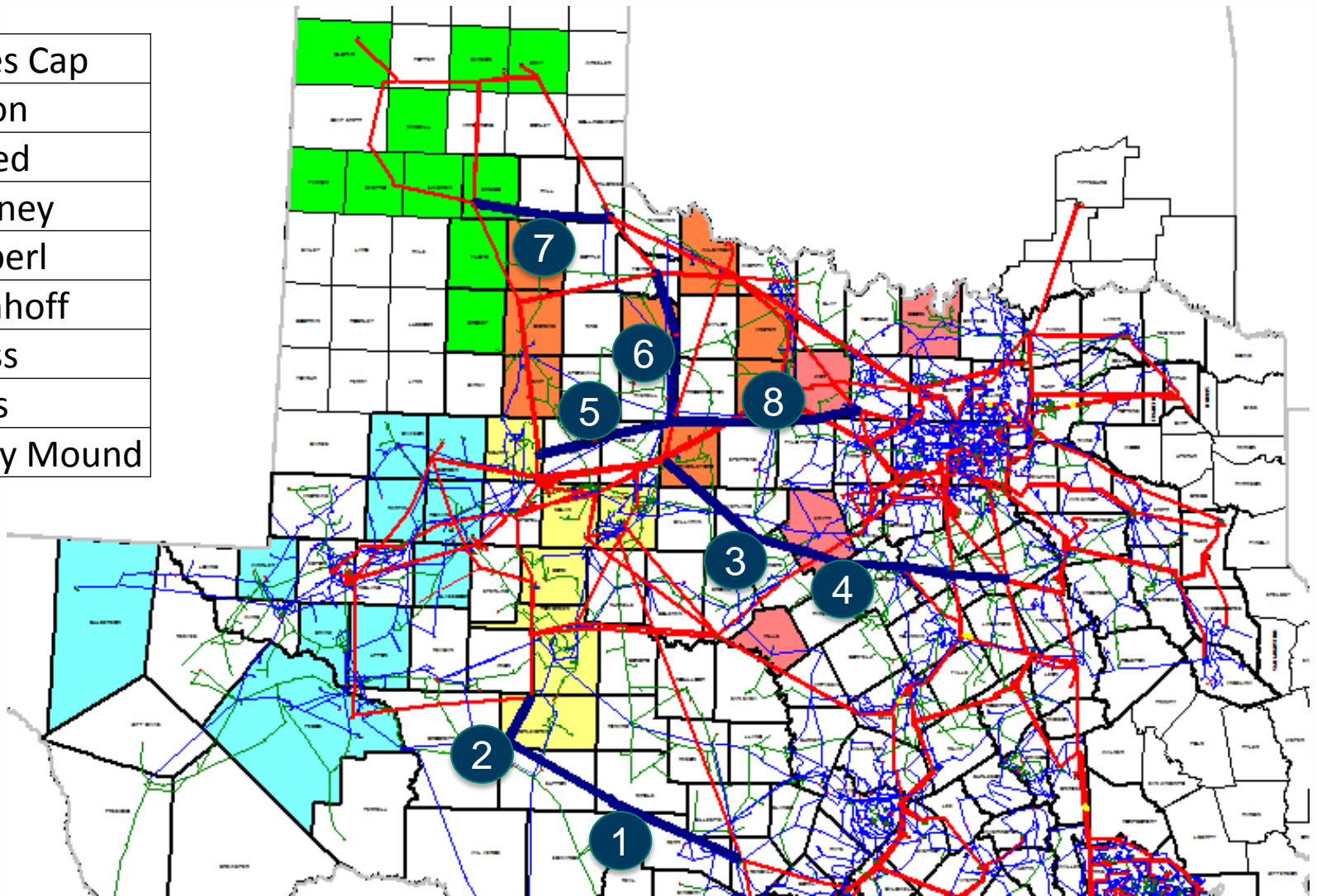
- 2016 HWLL + wind generation projects meet Planning Guide
 - System load: 36.5 GW
 - Total wind generation capacity is 15,850 MW, dispatched output is 12,714 MW
 - Wind generation in the West Texas is 13,943 MW, dispatched output is 11,461 MW

West Texas Wind Generation



West Texas Series Capacitors

#	Series Cap
1	Edison
2	Orsted
3	Romney
4	Kopperl
5	Kirchhoff
6	Gauss
7	Cross
8	Rocky Mound



Assessment

- Steady State Voltage Stability (PV) Analysis
- System Strength Impact on the Panhandle Region
- Dynamic Stability Analysis
- Economic Cost Analysis – Congestion Impact

PV Analysis

Series Capacitors	Contingency Category	Constraint	Secure Total West Wind (MW)	Wind Output (%)
All In	SSWG_B	Max Gen	13,861	99.43%
All Out	SSWG_B	Max Gen	13,861	99.43%
All In	SSWG_C	Max Gen	13,861	99.43%
All Out	SSWG_C	Voltage Collapse	13,661	97.99%
Edison, Orsted In	SSWG_C	Voltage Collapse	13,761	98.71%
Edison, Orsted In Romney, Kopperl In	SSWG_C	Voltage Collapse	13,861	99.43%
All In	SSWG_D	Voltage Collapse	12,361	88.67%
All Out	SSWG_D	Voltage Collapse	12,361	88.67%

Total wind generation capacity in west Texas: 13,943 MW

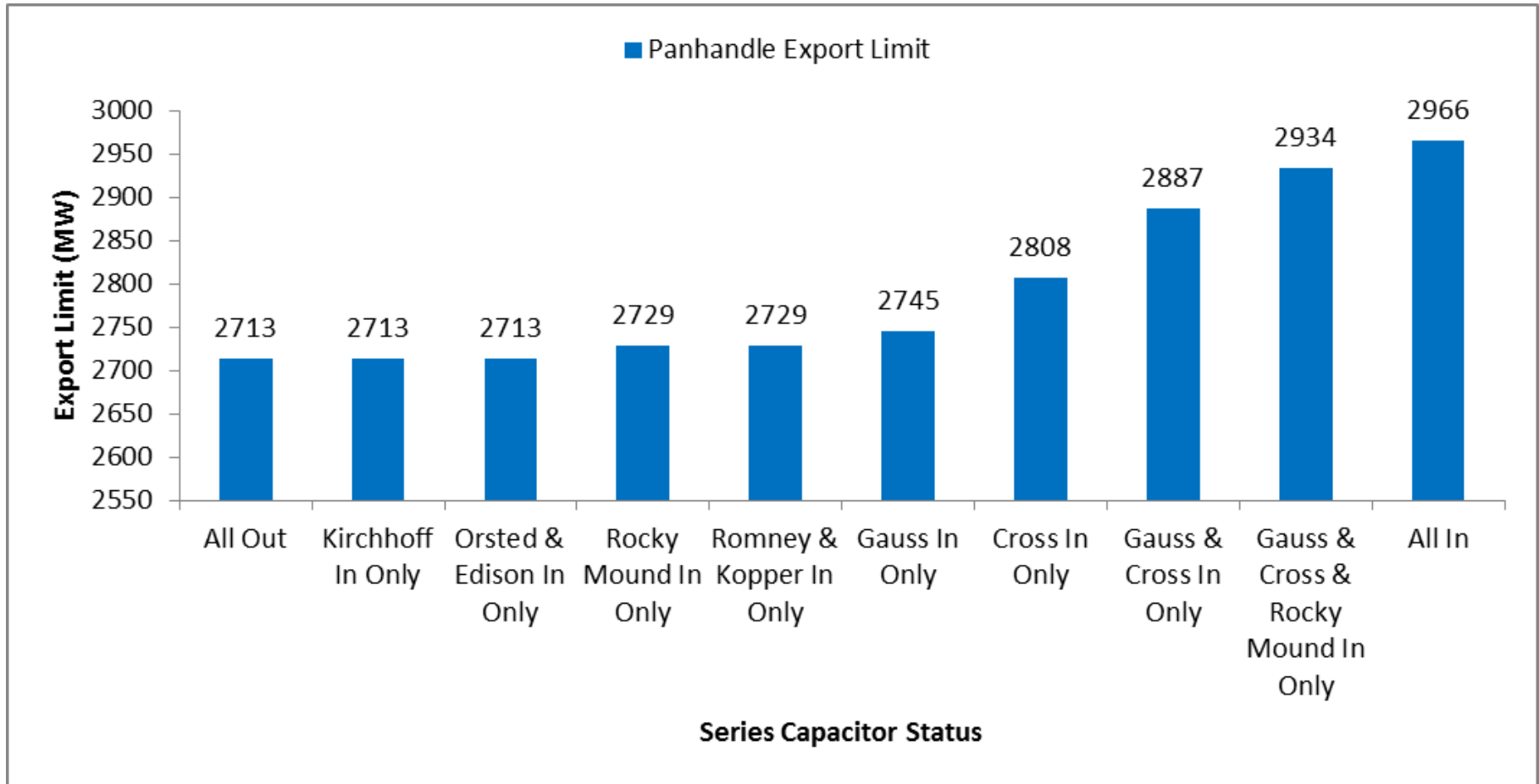
PV Results Summary

- NERC B:
 - No export limit identified (reach maximum west Texas wind generation) with/without series capacitors in west Texas
- NERC D:
 - Constraints were identified in the Panhandle region. No impact of series capacitors.
- NERC C:
 - 200 MW (1.4%) export capability reduction if bypassing all series capacitors in west Texas.
 - Sensitivity analysis indicated the series capacitors that cause the export capability reduction are
 - Edison and Orsted on the BIG HILL – KENDALL double circuits
 - Romney and Kipperl on the W. Schackelford – NAVARO/SAM Switch double circuits

System Strength Impact on Panhandle

- System strength is one key constraint for the Panhandle export capability.
- Weighted Short Circuit Ratio (WSCR) of 1.5 is proposed as the minimum system strength for the Panhandle region.
- WSCR is dependent on the electrical distance between WGRs and rest of ERCOT main grid.

Impact on Panhandle System Strength



Note:

1. Total Panhandle Wind Generation Capacity is 3,155 MW
2. Export limit is determined based on WSCR of 1.5

Panhandle System Strength Summary

- Panhandle export capability is reduced by 250 MW if bypassing all series capacitors in west Texas.
- Series capacitors that help to increase the Panhandle export capability are (in order)
 - CROSS on the Tule Canyon – Tesla double circuits
 - GAUSS on the Clear Crossing – Edith Clarke double circuits
 - Rocky Mound on the Clear Crossing – Willow Creek double circuits
- Other series capacitors have limited or no impact on Panhandle export capability.

Economic Analysis – Congestion Impact

- Economic cost analysis is performed to calculate the annual production cost to capture the impact of series capacitors in west Texas.
- 90% of the identified Panhandle export limit based on system strength criteria is used as the Panhandle interface limit in the production cost simulation.

Scenario	Series Capacitor	Panhandle Interface Limit (MW)	Incremental Cost (M\$)
1	All In	2,669	--
2	All Out	2,669*	+ 1.10
3	All Out	2,441	+ 7.97

* Assuming no impact on the Panhandle system strength

Dynamic Stability Simulations

- 2016 HWLL
 - Wind projects that meet Planning Guide 6.9 added
- Total System Generation: 38,357 MW
- Total Wind Generation: 15,037 MW
 - South Wind: 1253 MW (65.6% of 1,911 MW capacity)
 - Panhandle Wind: 2997 MW (95% of 3,155 MW capacity)
 - Other Wind: 10,787 MW (100% of 10,787 MW capacity)
- 39.2% Wind Penetration Level
- ~8,300 MW of Non-wind Spinning Reserves

Dynamic Simulation Tests

- 144 Total Contingencies
 - Panhandle & CREZ System
 - Single Circuit/3-Phase Fault
 - Double Circuit/3-Phase Fault
 - Breaker Failure Event/1-Phase Fault
- Monitor System Response
 - Amount of Wind Trip
 - Voltage Response - West Texas 345 kV Buses
- Evaluate with CREZ series capacitors in service and bypassed

Dynamic Simulations Results

- Acceptable Response Observed for 144 Contingencies
 - Post-disturbance voltage settles between 0.9 and 1.1 pu
 - Higher wind trip amounts observed when series capacitors bypassed

# of Contingencies with:	CREZ Series Capacitor Status	
	In Service	Bypassed
Acceptable Response	144	144
>1400 MW Wind Trip	1	9

- Better performance for Panhandle when adding Gauss and Cross series capacitors.

Series Capacitors -- Conclusion

#	Series Cap	Increase Panhandle Export	Improve Voltage Stability	Reduce Congestion Cost	Improve Dynamic Stability
1	Edison		marginal		
2	Orsted		marginal		
3	Romney		marginal		
4	Kipperl		marginal		
5	Kirchhoff				
6	Gauss	High		High	High
7	Cross	High		High	High
8	Rocky Mound	Medium		marginal	marginal

II. W-N IROL Study

- Study to assess whether the W-N stability limit is an IROL
- CREZ transmission fully online
- Determine the limit under various outage scenarios, particularly around the W-N Interface
 - Use Operations cases for various conditions
 - Only include wind capacity in the Operations case
 - Planned wind generation not included
- Tool used for study: TSAT, VSAT

Study Case and Assumption

- Five real-time operational cases were assessed.
- System Wind Generation Capacity ~ 11,000 MW

Scenario	System Load (MW)	West Texas Wind (MW)	W-N Transfer (MW)
High Wind, Low Load	28,655	7,175	3,856
High Wind, Medium Load	36,450	6,760	4,121
High W-N Transfer	45,400	7,100	4,850
No Conventional Generation online in West Texas	38,900	7,100	3,466
All conventional generation in West Texas online	58,000	3,244	2,540

W-N Transfer: Flow on the sixteen 345 kV lines between West Texas and the rest of ERCOT

Study Case and Criteria

- By-pass all the series capacitors in West Texas.
- All available TSAT wind models were included.
- Load was adjusted in both North Central and South Central weather zones in the transfer analysis.
- Horse Hollow wind farm was assumed to be interconnected in West Texas to increase available generation for transfer study.
- SOL Methodology

Study Results

- No loss of load in the Cascading or voltage collapse
- No trigger of under-frequency load shed at 59.3 Hz
- No inter-area oscillation with damping ratio less than 3%
- No issues found for all tested scenarios taking up to six outages on the W-N Interface
- Observe local voltage stability in regions of West Texas when more than six 345 kV circuits out on the W-N Interface

WN-IROL Conclusion

- Propose retirement of the W-N-IROL/GTL
 - following the criteria in the SOL Methodology, no stability limit for the tested planning and operation scenarios.
- Post-retirement: Only allow up to 6 circuits on outage on the W-N interface