Panhandle Renewable Energy Zone (PREZ) Study
Preliminary Results

Shun-Hsien (Fred) Huang
ERCOT System Planning

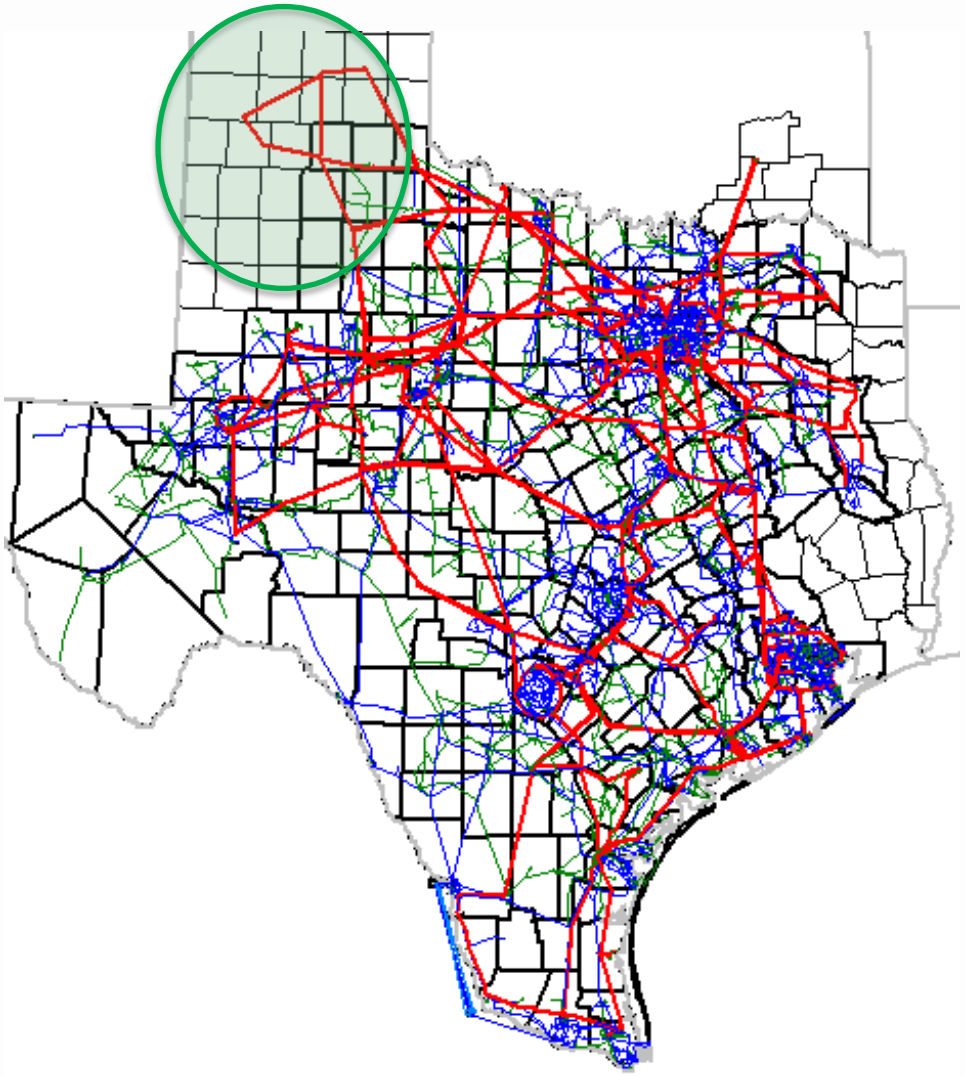
ERCOT Regional Planning Group (RPG) Meeting
12-17-2013

Outlines

- CREZ Implementation in Panhandle
- PREZ Needs and Study Objective
- Preliminary Results and Key Findings
- Summary and Conclusion
- Future Work

CREZ Implementation in Panhandle

- Original CREZ plan called for ~5.5 GW of capacity in Panhandle, but reactive support equipment initially installed for ~2.4 GW
- Panhandle transmission remote from ERCOT load and synchronous generation
- Stability constrained
  - Most of the activity is at the edge of the Panhandle system which exacerbates the stability constraints



Standard Generation Interconnection Agreements in Panhandle (12/12/2013)

GINR	ProjectName	County	IA Capacity (MW)	FC Capacity (MW)	IA Signed Date	Projected COD
13INR0048	Spinning Spur Wind Two	Oldham	161	161	2/27/2013	6/1/2014
14INR0012a	Miami Wind 1 Project	Gray	289	289	3/1/2013	7/31/2014
14INR0030a2	Panhandle Wind	Carson	218	218	12/19/2012	8/1/2014
11INR0050	Moore Wind 1	Crosby	149	0	7/12/2012	8/8/2014
14INR0030b	Panhandle Wind (Ph2)	Carson	198	0	10/2/2013	9/1/2014
13INR0059a	Hereford Wind	Castro	200	200	6/10/2013	9/4/2014
13INR0010a	Mariah Wind	Parmer	200	0	1/31/2013	10/30/2014
13INR0005	Conway Windfarm	Carson	600	600	10/24/2012	12/1/2014
14INR0023	Longhorn Energy Center	Briscoe	361	0	12/10/2012	12/1/2014
14INR0032a	Route66 Wind	Randall	150	0	10/31/2013	12/1/2014
13INR0059b	Hereford Wind	Castro	300	0	6/10/2013	4/15/2015
14INR0012b	Miami Wind 1 Project	Gray	112	0	3/1/2013	8/15/2015
13INR0010b	Mariah Wind	Parmer	200	0	1/31/2013	12/31/2015
13INR0010c	Mariah Wind	Parmer	200	0	1/31/2013	12/31/2016
12INR0029	Comanche Run Wind	Swisher	500	0	7/24/2013	12/31/2016
12INR0018	Pampa Wind Project	Gray	500	0	11/12/2013	3/31/2017
			4,338	1,468		

IA: Interconnection Agreement
FC: Financial Commitment
COD: Commercial Operating Day

Needs of PREZ Study

- 2012 Long Term System Assessment
  - Significant expansion of wind resources in the Panhandle under a range of future outcomes.
  - If the northwestern-most portion of the Panhandle CREZ system becomes over-subscribed, voltage stability limits will constrain wind power delivery to the rest of the ERCOT system.

- Generation projects will exceed the CREZ design capacity for the Panhandle area (based on the CREZ Reactive Study “Initial Build” recommendations).

- No near-term Panhandle transmission projects being developed post CREZ 2013.

Purpose of PREZ Study

- To identify system constraints and upgrades to accommodate future wind generation projects.

- To provide a project roadmap for both ERCOT and TSPs to accommodate additional generation resources in the study area.
  - List of potential system upgrade projects.
  - Triggers for when those projects will be recommended.

Disclaimer

- PREZ study focuses on the upgrade needs to increase Panhandle export capability. Other ERCOT regions may require further studies for potential thermal and stability challenges.

- The identified upgrades may be revised based on the actual implementation of wind projects in Panhandle.

- The upgrades identified in this study are “NOT” approved projects. The identified projects may still require RPG review.

Study Process

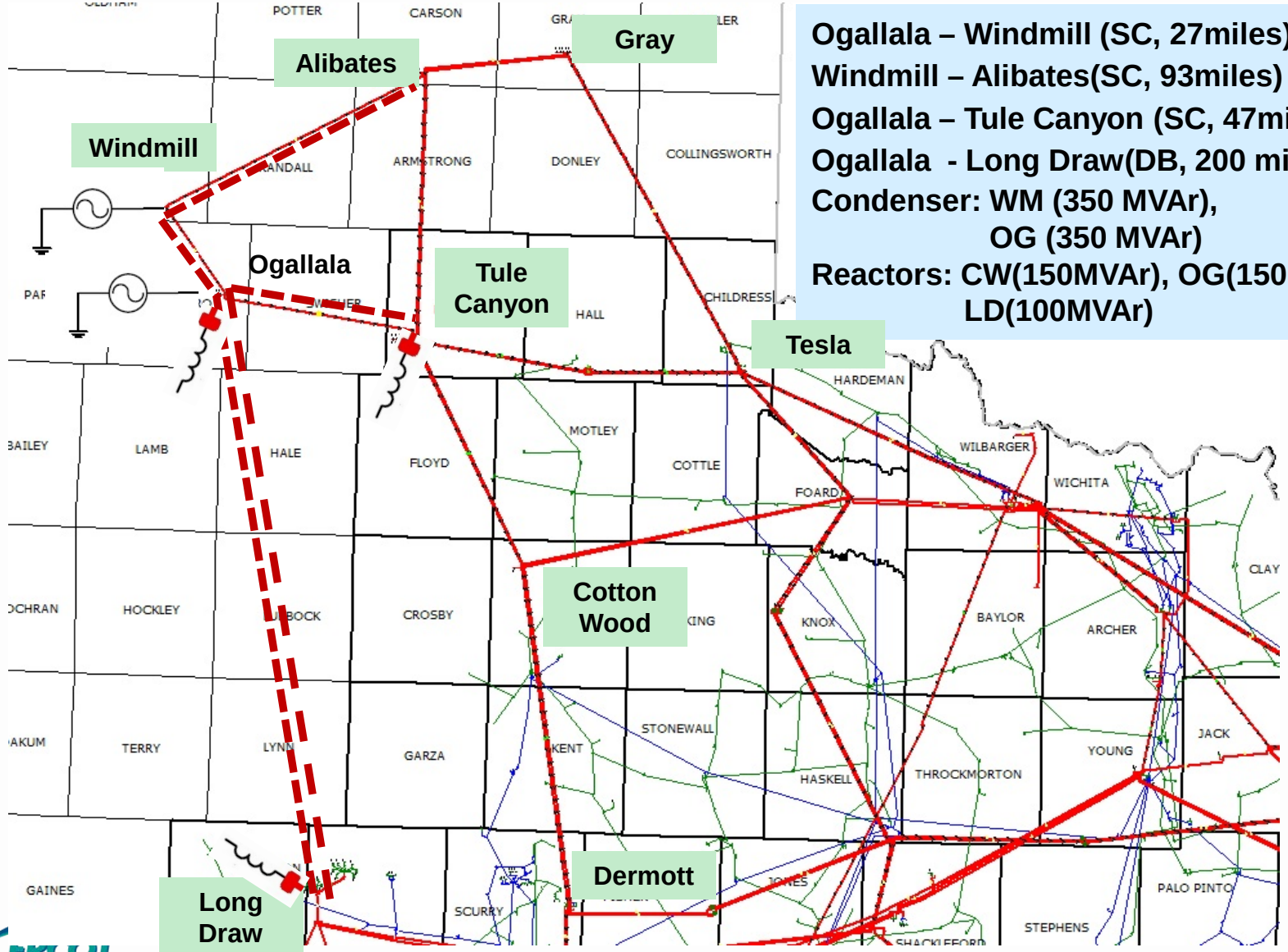
- Study Base Case
  - Reliability Analysis: 2016 HWLL DWG (8,946 MW wind output / 36.5 GW load, 24.5% wind penetration)
  - Economic Cost Analysis: 2017 UPLAN case from 2012 Five-Year Transmission Plan

- Study Tasks
  - Scenario 1:
    - Add 5,043 MW of Panhandle wind at 95% output
    - Wind penetration: ~35% (13.7GW wind output)
  - Scenario 2:
    - Add 7,845 MW of Panhandle wind at 95% output
    - Wind penetration: ~45% (16.4GW wind output)
  - Roadmap and triggering point for upgrades

Study Progress

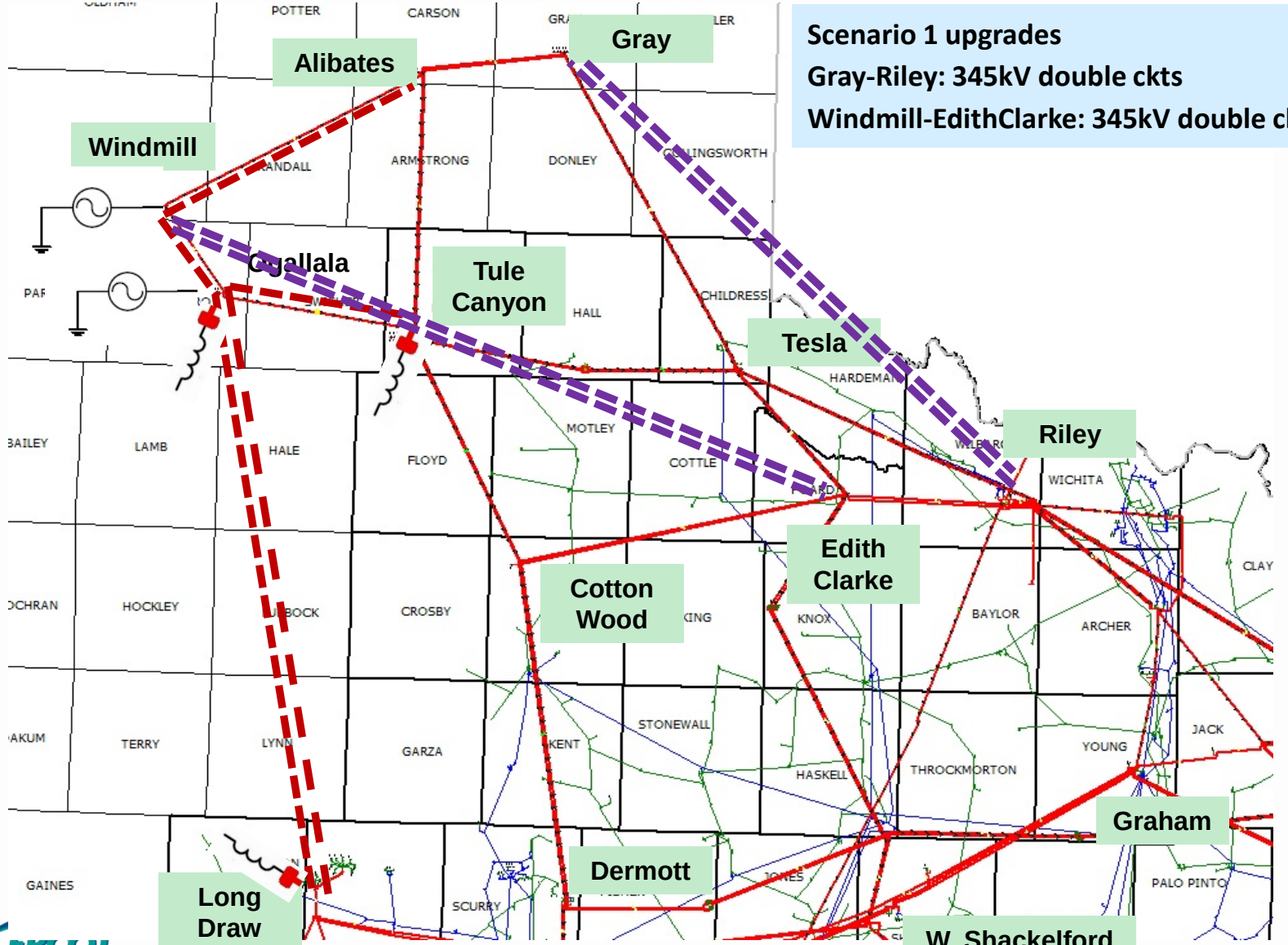
Mar-13	Present PREZ study scope in RPG
May-13	Complete Steady State Voltage Stability Analysis
	Complete Dynamic Flat Start Cases
Jun-13	Complete Scenario 1 (5GW Wind Gen in Panhandle)
	Identify High Voltage Ride Through (HVRT) Needs
Aug-13	Propose HVRT requirement (NOGRR 124)
	Complete Scenario 2 (7.5GW Wind Gen in Panhandle) and observe system constraint in other ERCOT region
Oct-13	Complete Roadmap Upgrade 1 (Panhandle export limit: 3.5 GW)
	Propose SCR criteria and identification for system strength enhancement
Nov-13	RPG synchronous condenser presentation (3 vendors and 1 utility)
	Complete Roadmap Upgrade 2 (Panhandle export limit: 5.2 GW)
Dec-13	Complete PREZ study
Jan-14	Complete PREZ report

Scenario 1: System Upgrade Option

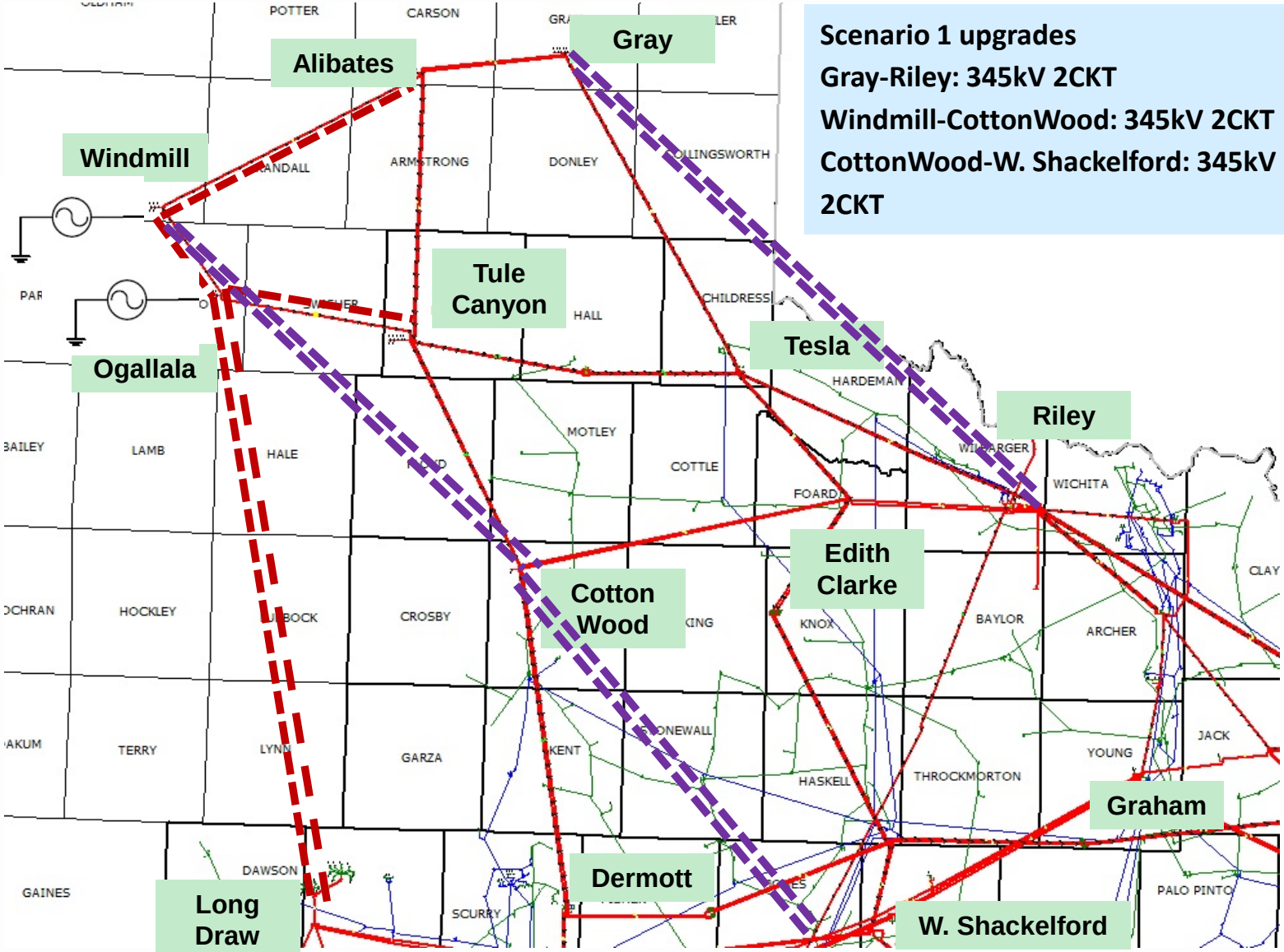


Ogallala – Windmill (SC, 27miles)
Windmill – Alibates(SC, 93miles)
Ogallala – Tule Canyon (SC, 47miles)
Ogallala - Long Draw(DB, 200 miles)
Condenser: WM (350 MVAr), OG (350 MVAr)
Reactors: CW(150MVAr), OG(150MVAr), LD(100MVAr)

Scenario 2: System Upgrade Option A



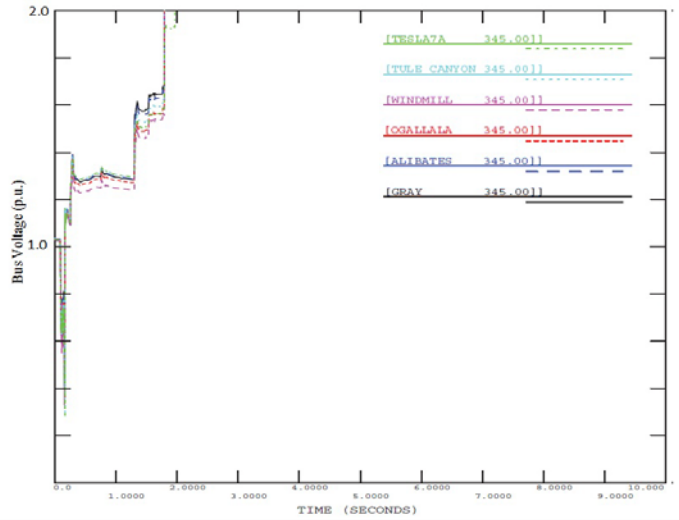
Scenario 2: System Upgrade Option B

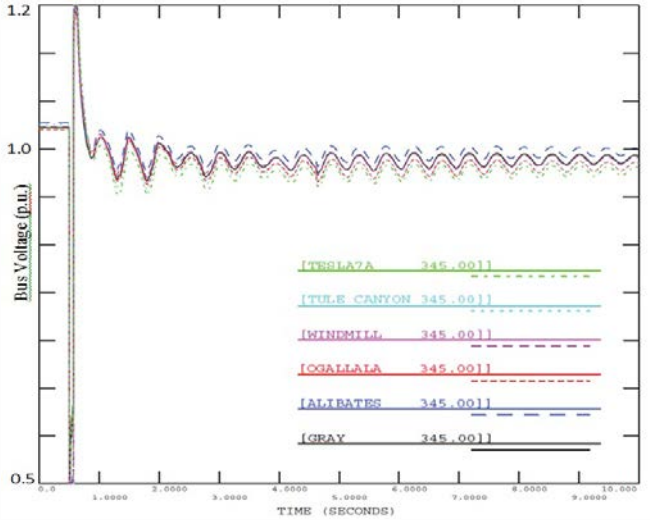


Scenario 1 upgrades
Gray-Riley: 345kV 2CKT
Windmill-CottonWood: 345kV 2CKT
CottonWood-W. Shackelford: 345kV 2CKT

Key Findings – Upgrade Needs

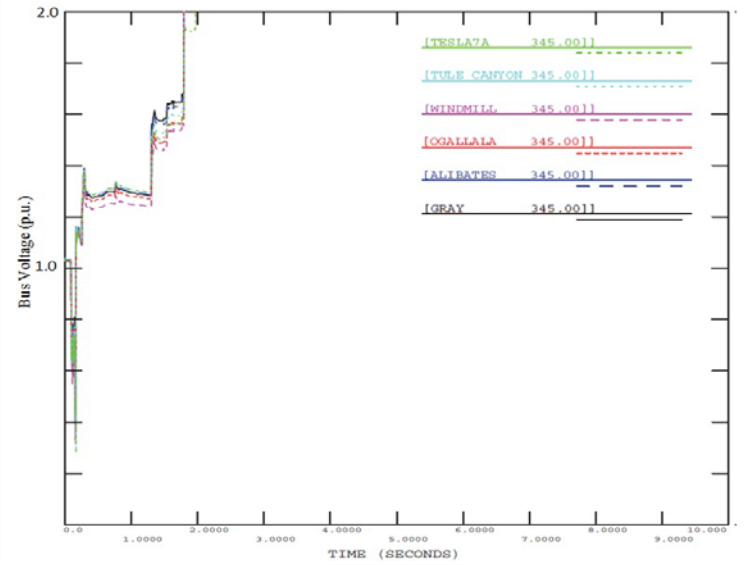
- Panhandle Upgrade Needs
  - Voltage Stability
  - System Strength (Short Circuit Ratio)
- Constraints in other region may limit the Panhandle export capability when Panhandle generation exceeds 6.5 GW. Other ERCOT regions may require further studies for potential thermal and stability challenges.



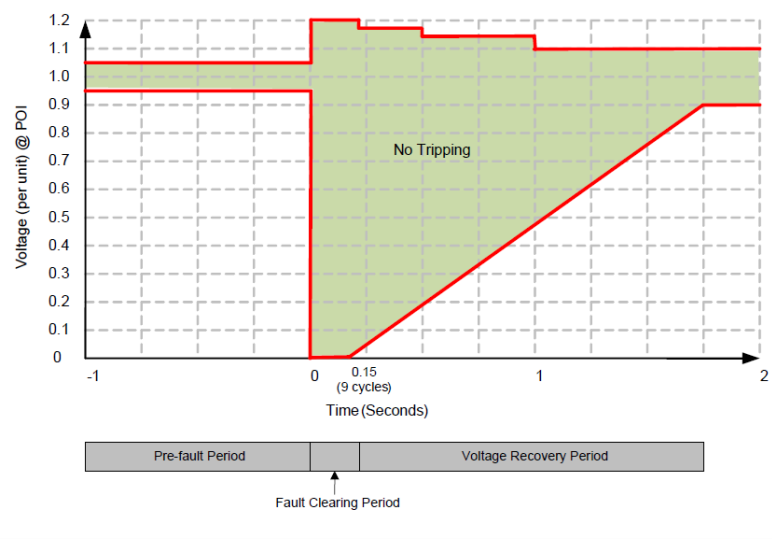


Key Findings – Overvoltage Cascading

- High Voltage Ride Through Capability in the proposed NOGRR 124 is needed to accommodate more wind generation in Panhandle

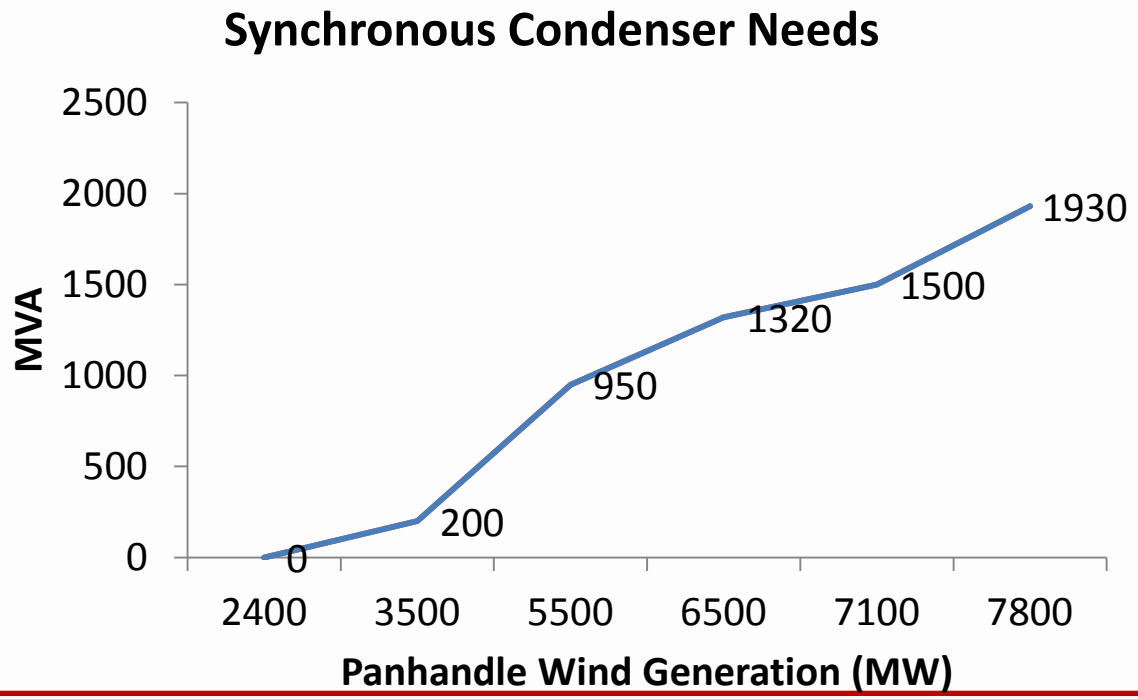


Potential overvoltage cascading



Proposed HVRT: NOGRR 124

System Strength Needs: Synchronous Condenser as an example

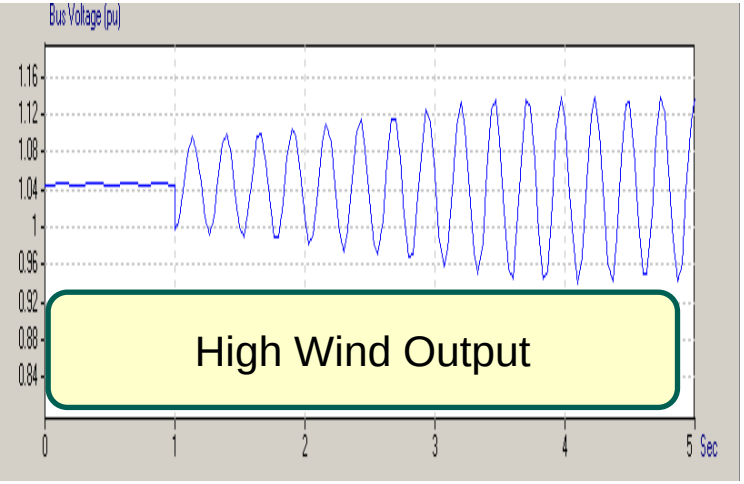


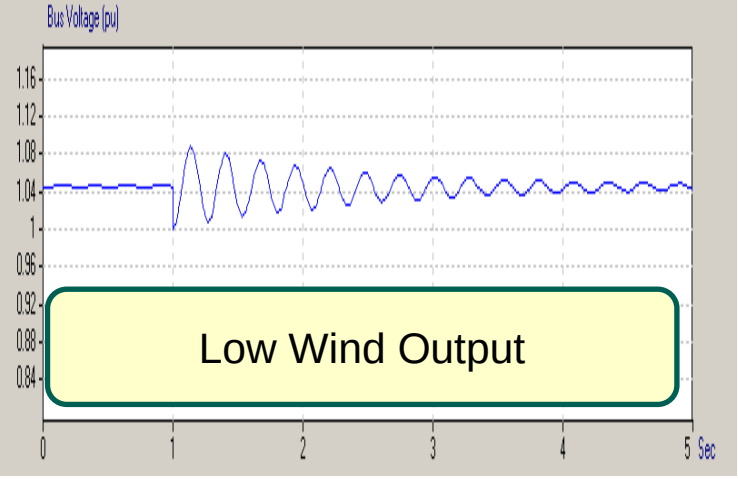
- Panhandle SCR target = 1.5
- Actual synchronous condenser needs will vary based on transmission line upgrades and wind generation projects.

- Is the need based on wind generation capacity or output?

Key Findings – System Strength Enhancement

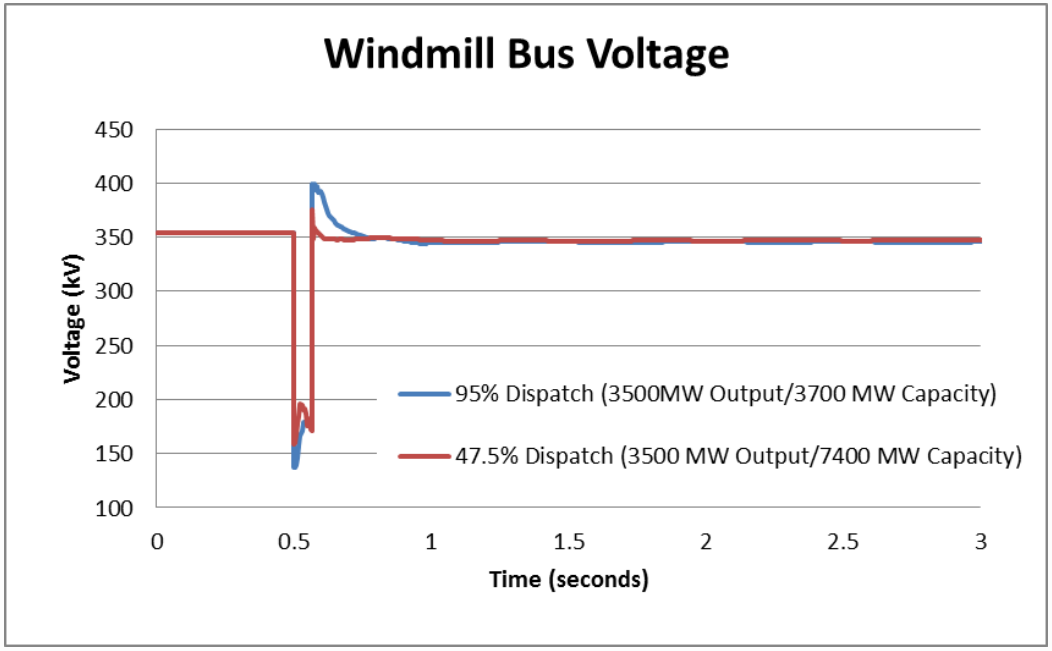
- The need of system strength enhancement in Panhandle is based on **wind generation output**.
- ERCOT and TSPs observed unstable responses from an existing WGR under a weak connection. A mitigation was developed to constraint the wind generation output to provide a stable operation of the WGR.





Key Findings – System Strength Enhancement

- PREZ Sensitivity Test:
  - Base case: 3,500MW output from 3,700MW capacity, SCR ~1.5
  - Test case: 3,500MW output from 7,400MW capacity, same system condition in the base case
- PREZ study results confirm the system strength enhancement is based on wind generation output.

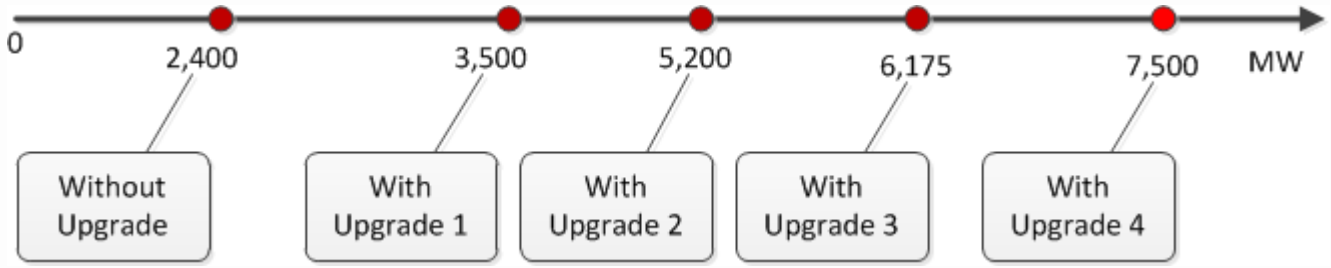


Roadmap

- Upgrades identified in scenario 1 and 2 are the reference for roadmap.
- The upgrade stage in the roadmap is identified to provide most reliability Panhandle export increase at a least upgrade cost.
- Perform economic cost analysis to find the triggers of upgrades
  - in terms of wind project capacity in Panhandle
  - Protocol 3.11.2 (5)

    …., the levelized ERCOT-wide annual production cost savings over the period for which the simulation is feasible is calculated and compared to the first year annual revenue requirement of the transmission project.….

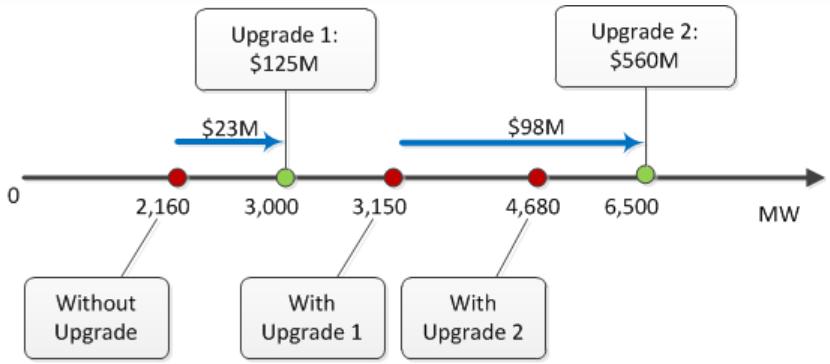
Roadmap – Panhandle Export Limit



- Each upgrade also requires synchronous condensers and reactors
- Upgrade 1: add second circuit on the existing single circuit in Panhandle
- Upgrade 2: add new 345kV double circuits from Ogallala to Long Draw
- Upgrade 3: include one option from upgrade list below
- Upgrade 4: include one additional option from upgrade list below
- The final upgrade should include Gray-Riley option
- Upgrade list
  - Gray-Riley 345kV double circuits
  - Windmill—Edith Clarke 345kV double circuits
  - Windmill—Cottonwood—W.Shackelford 345kV double circuits

- Upgrades, project trigger points, and export limits may vary based on the assumed location of wind generation projects

Roadmap – Consider Operation Practice



Legend

- 90% of Panhandle Export Limit (Output)
- Project Trigger Point (Capacity)
- Annual Production Cost Difference

Upgrades

Element	Description	Circuit #	Upgrade	Length/Size	Note	Estimated Cost ($M)	Total Cost ($M)
345kV Line	Alibates-Windmill	1	1	93 miles	On the existing tower		
345kV Line	Windmill-Ogallala	1	1	27 miles	On the existing tower	63	
345kV Line	Ogallala-Tule Canyon	1	1	47 miles	On the existing tower		
Synchronous Condenser	Windmill	--	1	200 MVA		43	115
Reactor	Alibates	--	1	50 MVAr		2.75	
Reactor	Ogallala	--	1	100 MVAr		5.5	
345kV Line	Ogallala-Long Draw	2	2	190 miles	New line	380	
Synchronous Condenser	Windmill	--	2	400 MVA		86	
Synchronous Condenser	Alibates	--	2	200 MVA		43	
Synchronous Condenser	Gray	--	2	150 MVA		32.25	560
Reactor	Windmill	--	2	50 MVAr		2.75	
Reactor	Ogallala	--	2	150 MVAr		8.25	
Reactor	Long Draw	--	2	150 MVAr		8.25	

- Upgrades, project trigger points, and export limits may vary based on the assumed location of wind generation projects

Summary -- Roadmap

Panhandle Grid	Panhandle Export Limit	Trigger for Upgrade (Panhandle Wind Capacity)	Upgrade Element	Estimated Upgrade Cost ($M)
Existing Grid	2,400 MW	-	-	-
Upgrade 1	3,500 MW	3,000 MW	• Add second circuits on the exisitng Panhandle grid • 200MVA synchronous condenser • 150MVAr reactors	115
Upgrade 2	5,200 MW	6,500MW	• Add one new 345kV double circuits -- (Ogallala-Long Draw) • 750MVA synchronous condenser • 350MVAr reactors	560
Upgrade 3	6,175 MW	-	• Add one new 345kV double circuits -- (Gray-Riley or Windmill-Edith Clarke or Windmill-Cottonwood-W.Shackelford) • 350MVA synchronous condenser • 300MVAr reactors	442
Upgrade 4	7,500 MW	-	• Add one additional new 345kV double circuits -- (Gray-Riley or Windmill-Edith Clarke or Windmill-Cottonwood-W.Shackelford) • 350MVA synchronous condenser • 450MVAr reactors	500

Conclusion

- ERCOT initiated study in early 2013 to determine roadmap for transmission improvements necessary to accommodate Panhandle wind development beyond initial 2.4 GW capacity
- Preliminary results show some near-term improvements may be able to be put in place to increase capacity relatively quickly but improvements for higher capacity may include longer lead time transmission lines

- Upgrades, project trigger points, and export limits may vary based on the assumed location of wind generation projects

Future Work

- Continue to work with TSPs for other alternative upgrade options proposed by TSPs and/or stakeholders

- Monitor the generation interconnection status for actual implementation of wind projects in Panhandle
  - The identified upgrades may be revised based on the actual implementation of wind projects in Panhandle
  - The impact of the proposed DC-tie connect to Panhandle may require further investigation