FAR WEST TEXAS PROJECT

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Plans are subject to change due to factors including, but not limited to, load, generation, engineering, system protection and system topology.



WE DELIVER.



WEST TEXAS PLAN KEY ELEMENTS

Convert 69 kV system to 138 kV

- Rebuild 69 kV Lines with double-circuit 138 kV construction, one circuit at 69 kV
- Gradually migrate loads from 69 kV to 138 kV service

Add New and Upgrade 138 kV transmission lines

- Create 138 kV loops to enable clearances and improve system reliability
- Work closely with oil & gas customers to provide expedited service to large single point loads

Upgrade and add switching stations

- Increase capacity, modern configurations facilitate greater clearance availability
- Improved system protection and communications
- Provisions for future expansion and physical security requirements (CIP)

Upgrade and add autotransformers with Load Tap Changing (LTCs)

• Increase capacity and voltage support; operational flexibility for clearances

Upgrade and add substations with LTCs and Dynamic Reactive

- Increase load serving substation capacity to meet growth plans
- Increase distribution voltage control capability

345 kV Infrastructure

- Provide backbone support
- Reach out to areas where there is extreme load and generation growth, but there is a lack of adequate transmission grid infrastructure



FAR WEST TEXAS PROJECT unocai 345 kV LINE Tarzan SW Dollarhide South Curtis To Dollarhide **345 kV AUTO** CULBERSON LOVING Midland Goldsmit/ WINKLER Cheyenne Grandview Midland Air p Goldsmith South Odessa Basin Keystone **RIVERTON** Black_River Screwbear Keystone **ODESSA EHV** Anderson Ranch POI MOSS Kermit #2 Salt Greekd Southwest Wink Gulf POI Culberson Loving Pegasus Wink Vest Forms S. Pegasus WARD Edwards Operating UPTON at 22kV Wickett Gulf Sand Laketar Note: Future Yucca Drive - Culberson Yucca Dr Barstow N.W: Elcor 138 kV Line shown. CCN granted in Sandhills 20 Ward Cochise 2015. Barstow Ward Sw. Arco McElroy LCRA Crane & Pyote Royalty Eas-Barnsley Reeves County Worsham Exxon Cordona KING MOUNTAIN Trans-Pecos Faulkner Materials △ WEST Coyanosa Cherry Flat North Creek Wolfcamp Sun REÉVES cCamey Valley LYNX Pecos Valley AEP/WTU Saragosa ₹ Gomez JEFF DAVIS Northern **BAKERSFIELD** Natural Woodward Mountain ∆MESA NWP **SOLSTICE** Comanche Creek 16th St. Junction Stocktor Serrbino Mesa Now Sw.



FAR WEST TEXAS PROJECT SUMMARY

LINES

- Odessa EHV to Moss to Wolf to Riverton 345 kV Line (Oncor)
- Riverton to Sand Lake (Oncor) to Solstice (AEP) 345 kV Line
- Solstice to Fort Stockton Plant to Lynx 345 kV Line (AEP)
- Lynx to Bakersfield 345 kV Line (AEP)

345/138 kV AUTOTRANSFORMERS

- Riverton Sw. Sta.
- Solstice Sw. Sta.
- Lynx Sw. Sta.

• ESTIMATED COST - \$423 MILLION

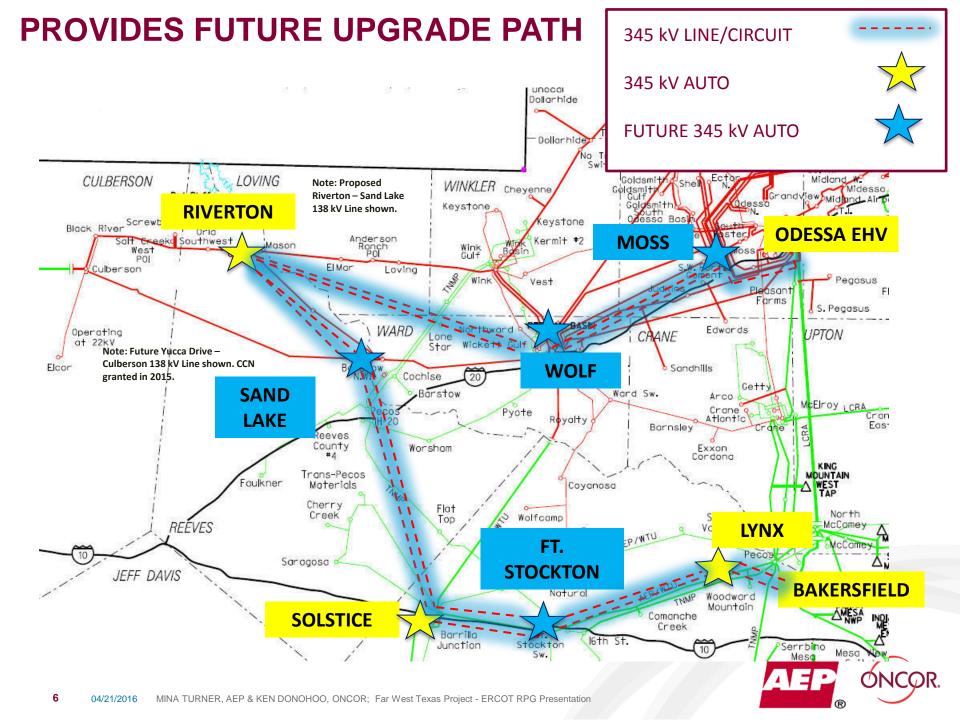
- AEP
 - Station \$43 million
 - Line \$146 million
- Oncor
 - Station \$17 million
 - Line \$217 million



FAR WEST TEXAS PROJECT NEEDED TO

- Provide reliable service to current and future load
- Relieve planning criteria violations including overloading and voltage collapse with loss of load
- Support continuing oil/natural gas load growth
- Provide export capability for new and existing generation interconnections
- Provide injection sources to aid short circuit strength limitations and meet system protection requirements
- Increase transmission operational flexibility under various normal and contingency conditions
- Provide a path for long-term upgrades to the region





PROVIDES FUTURE UPGRADE PATH

LINE – ADD SECOND CIRCUIT(S)

- Odessa EHV to Moss to Wolf to Riverton 345 kV Line (Oncor)
- Riverton to Sand Lake (Oncor) to Solstice (AEP) 345 kV Line
- Solstice to Lynx 345 kV Line (AEP)
- Lynx to Bakersfield 345 kV Line (AEP)
- Bakersfield to North McCamey to Odessa

345/138 kV AUTOTRANSFORMERS

- Sand Lake Sw. Sta.
- Moss Sw. Sta.
- Wolf Sw. Sta.
- Fort Stockton Plant



FAR WEST TEXAS PROJECT KEY ELEMENTS

SECURITY

 Strengthen system voltage and provide 345 kV source too address potential voltage collapse

RELIABILITY

- Resolve thermal and steady state voltage issues
- Maximize operational flexibility to adequately serve customers under all scenarios

TRANSFER CAPABILITY

- Interconnect new generation resources
- Ensure adequate capacity and utilization for generation to reach load

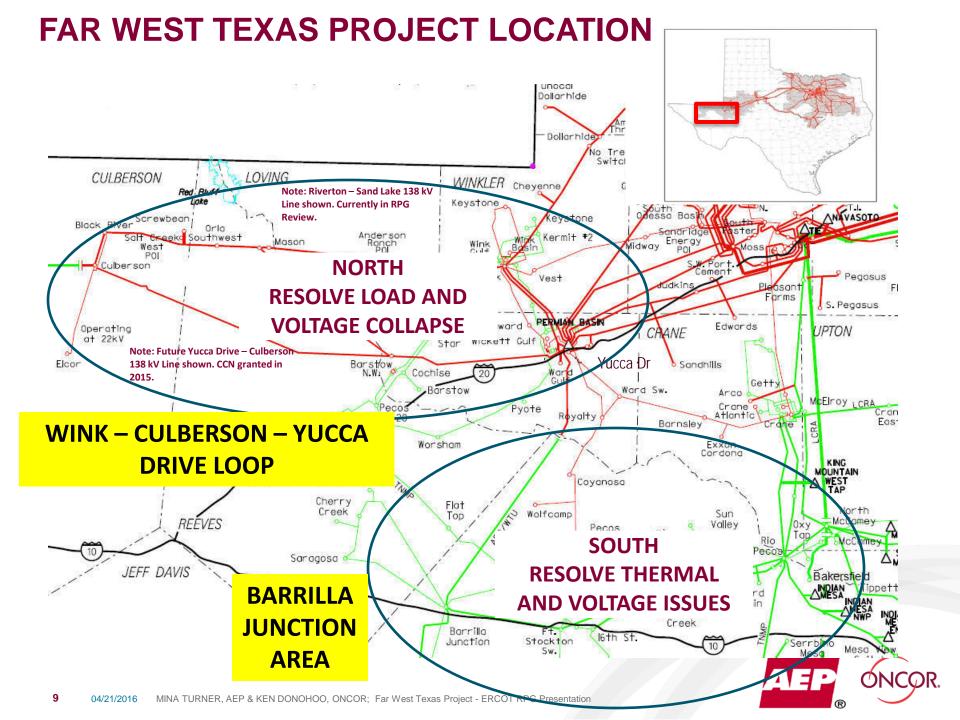
SHORT CIRCUIT STRENGTH

 Increase system fault duty in a weak area, particularly when conventional gen is not running

RESILIENCY & FLEXIBILITY

 Provide a long-term solution with upgrade paths to meet future load and generation growth





GENERATION INTERCONNECTIONS

GENERATORS WITH INTERCONNECT AGREEMENTS

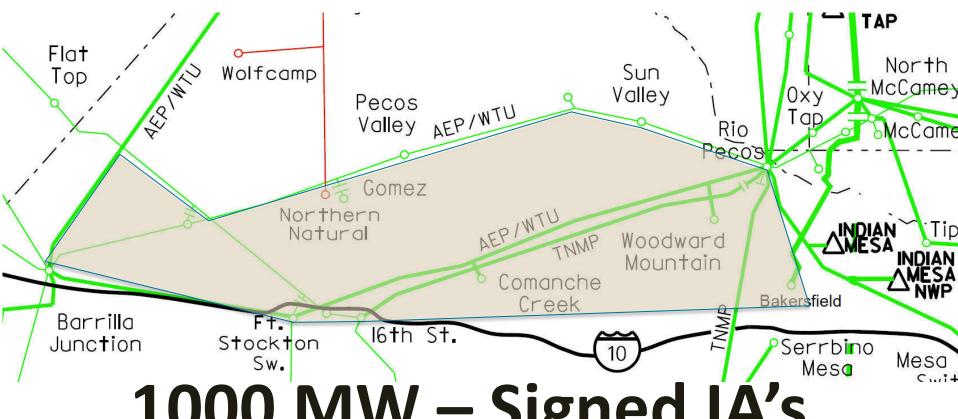
- Barrilla Solar (50 MW) connecting at Barrilla Junction/Solstice 138 kV station
- Rose Rock Solar (150 MW) connecting at Barrilla Junction/Solstice 138 kV station
- Oak Solar (150 MW) connecting at Ft. Stockton Plant 138 kV
- Solaire Holman (50 MW) connecting on the Ft. Stockton Plant Alpine 69 kV line
- East Pecos Solar (120 MW) connecting at Bakersfield 345 kV station
- Maplewood Solar (500 MW) connecting at Bakersfield 345 kV station

GENERATORS WITH STUDY AGREEMENTS

- Barrilla Area Thirteen Generators totaling about 1,100 MW
- Many More in Other West Texas locations totaling more than 7,000 MW



BARRILLA JUNCTION AREA GENERATION

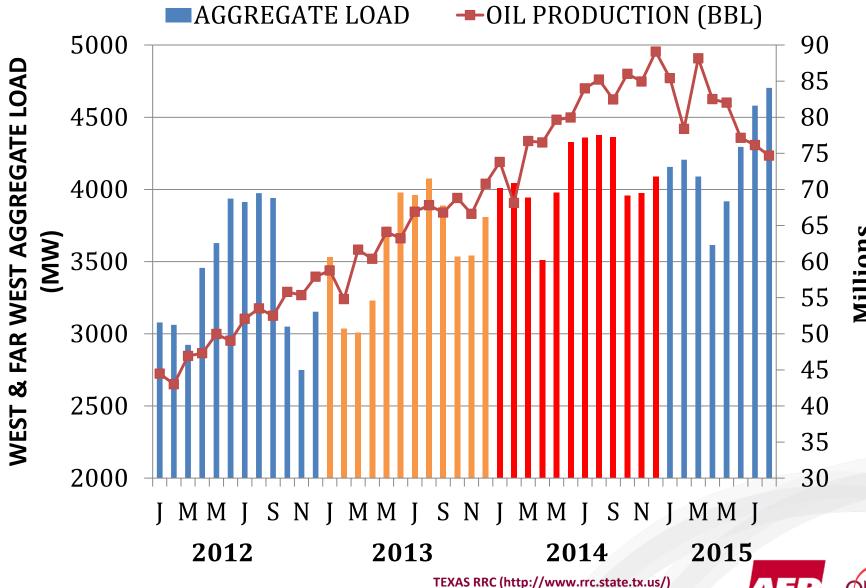


1000 MW – Signed lA's 1100 MW – Under Study





WEST & FAR WEST WEATHER ZONES AGGREGATE LOAD COMPARED TO OIL PRODUCTION



OIL PRODUCTION

WINK - CULBERSON - YUCCA DRIVE LOOP



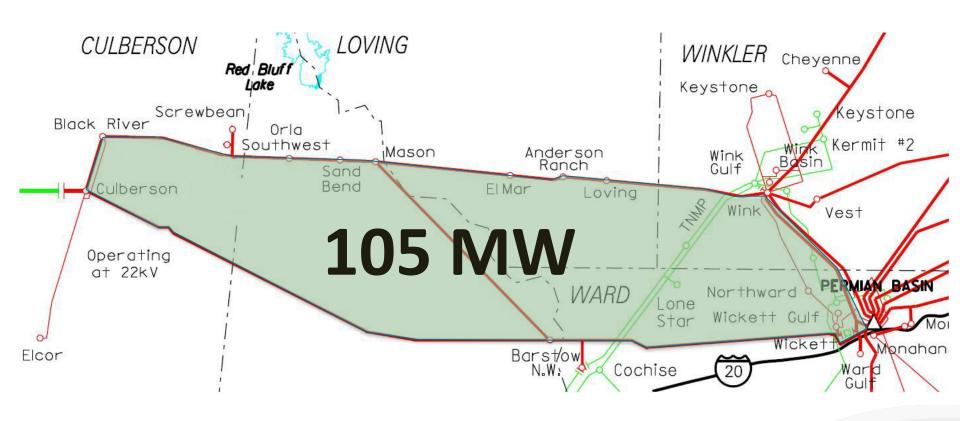
	Historical Load						Projected Load					
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total (MW)	22.4	21.6	33.4	53.2	89.7	105.4	231	304	343	391	411	426

Projections only include confirmed load increases from normal load forecasting and signed customer agreements.





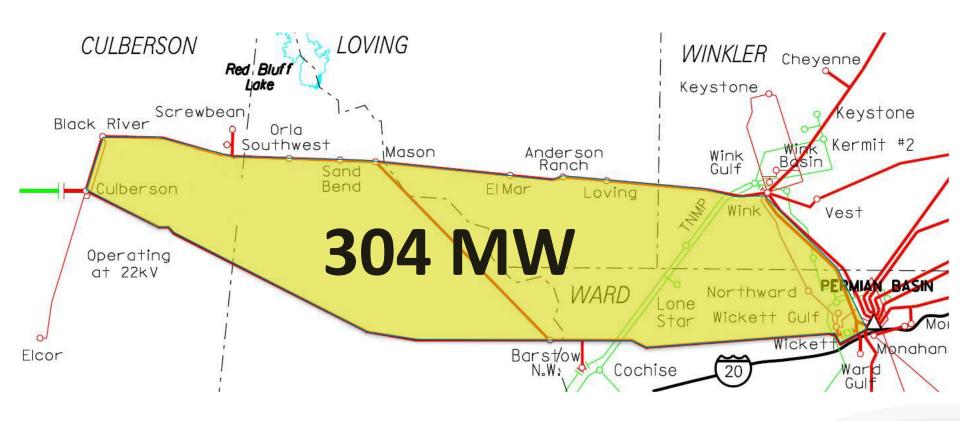
2015 WINK-CULBERSON-YUCCA DRIVE LOAD







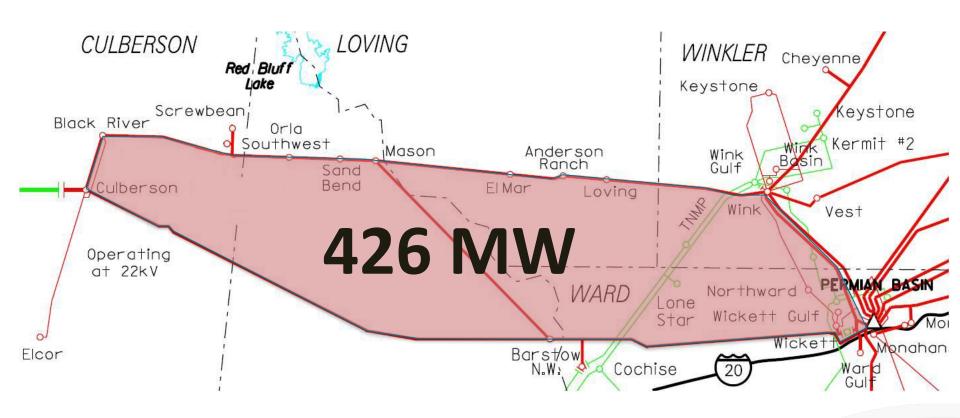
2017 WINK-CULBERSON-YUCCA DRIVE LOAD







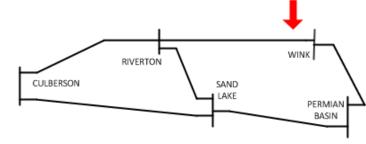
2021 WINK-CULBERSON-YUCCA DRIVE LOAD



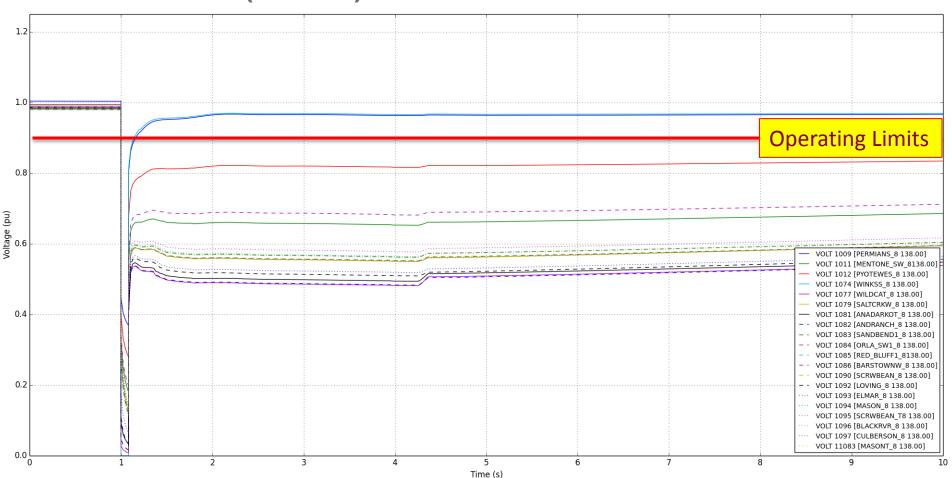




N-1 Double Circuit Worst Case Voltage Response



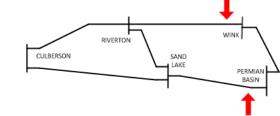
Double Circuit (Branch) Wink - Riverton

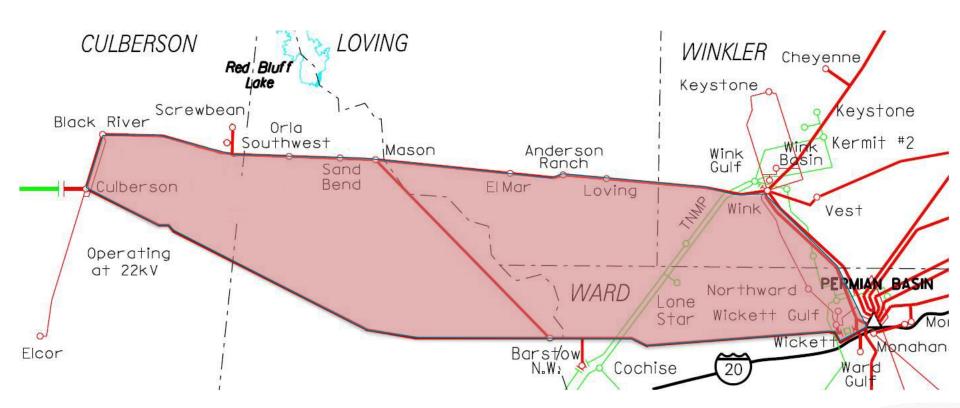






SIGNIFICANT CONSEQUENCES

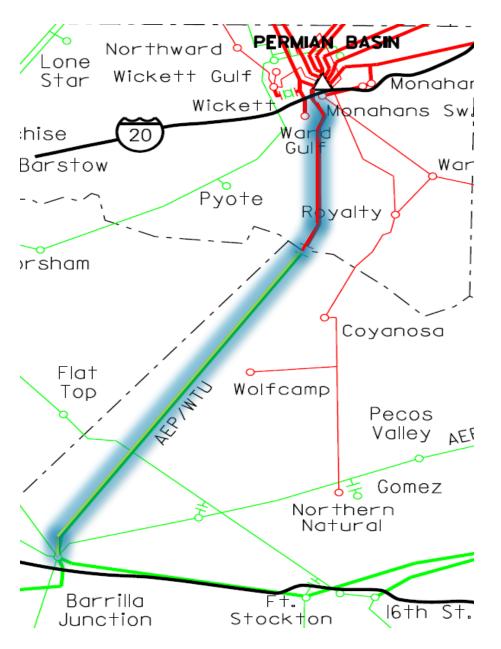




Over 300+ MW Load Loss



2020 PERMIAN – BARRILLA JUNCTION LOADS



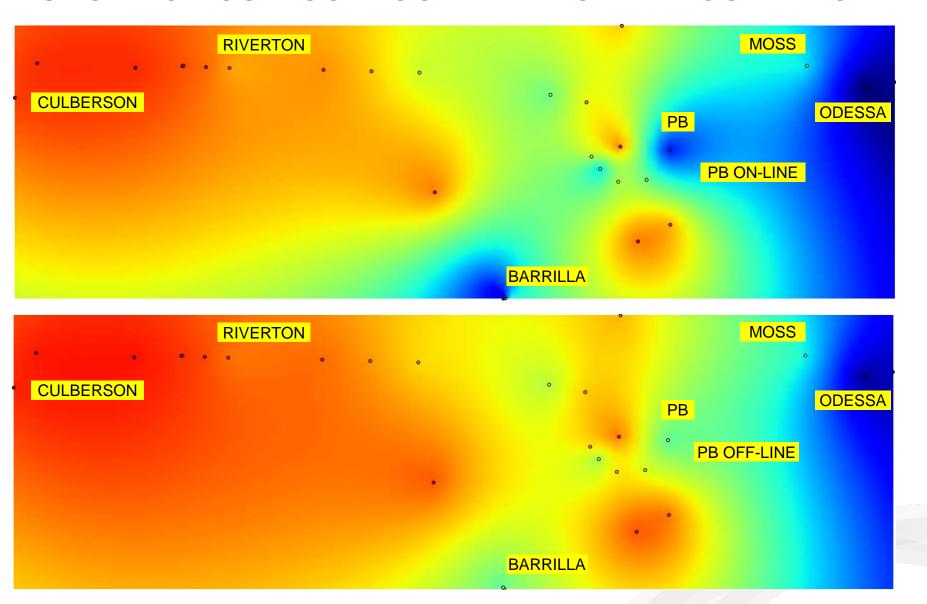
150 MW





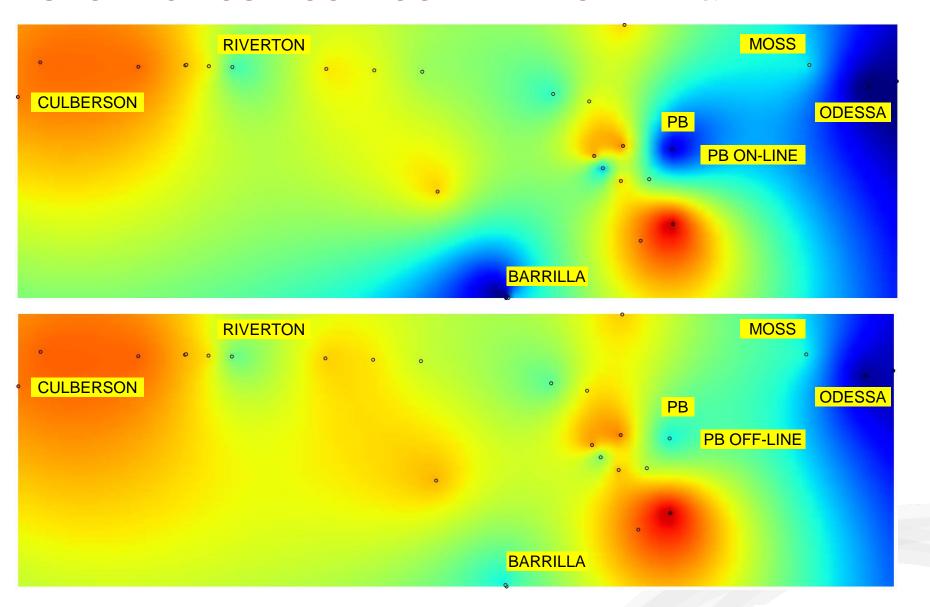
SHORT CIRCUIT STRENGTH unocai Dollarhide Dollarhide No T **CULBERSON** LOVING WINKLER Cheyenne Red Bluff Keystone Black River Screwbean Keystone Anderson Ranch POI Kermit #2 Salt Greeka Southwest Mason Wink Gulf West ElMar Culberson Loving Pegasus Vest S. Pegasus WARD Northward Edwards Operating UPTON at 22kV Wickett Gulf Star Barstow N.W: Elcor Sandhills 20 Cochise Ward Gulf Getty Barstow Ward Sw. Arco McElroy LCRA Crane Pecos Pyote Royalty Atlantic Eas-Barnsley Reeves County Worsham Exxon Cordona KING MOUNTAIN Trans-Pecos Faulkner Materials Coyanosa Cherry Flat Creek North Wolfcamp Sun Top REÉVES McCamey Valley Pecos Valley AEP/WTU Tap Rio Saragosa 5 Gomez JEFF DAVIS Bakersfield Northern Tippett Natural Woodward Mountain Creek Barrilla Stockton Junction Serrbino 10 Sw. 20 04/21/2016 MINA TURNER, AEP & KEN DONOHOO, ONCOR; Far West Texas Project - ERCOT RPG Presentation

SHORT CIRCUIT CONTOUR MAP NORMAL CONDITION



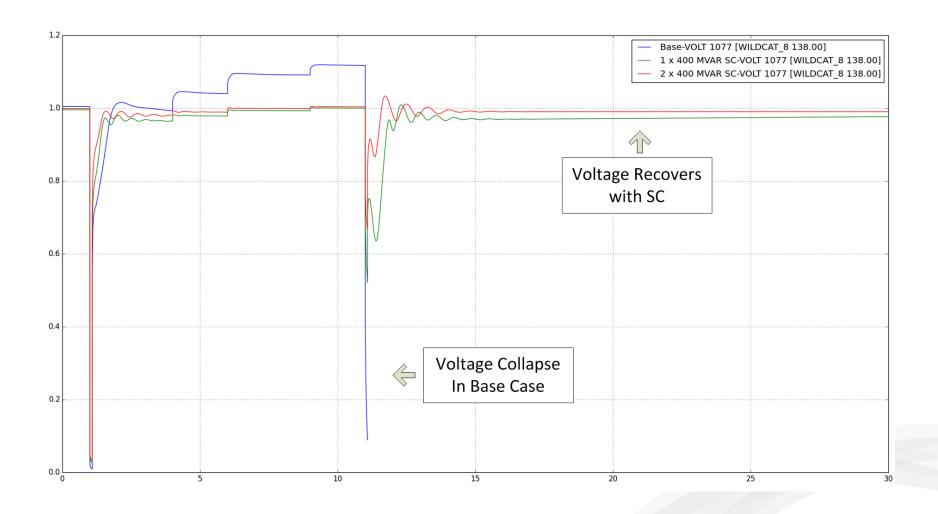


SHORT CIRCUIT CONTOUR MAP NORMAL & FWTP



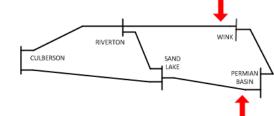


SVC AND STATCOM FAILS TO RESOLVE ALL ISSUES



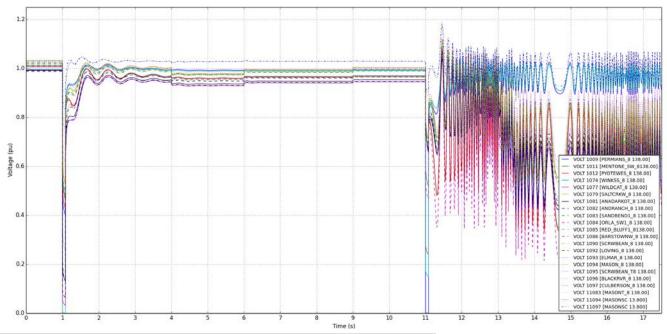


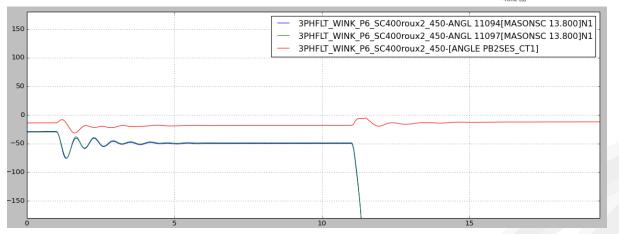
Synchronous Condenser (SC) performance gets poorer as load grows



450 MW

Solution diverges after SCs go unstable





Angular Instability of SCs

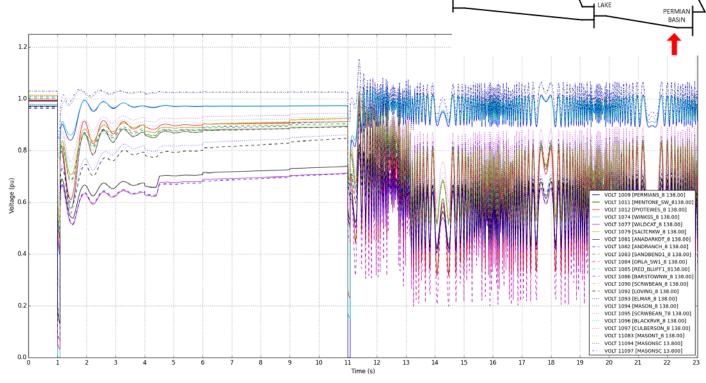


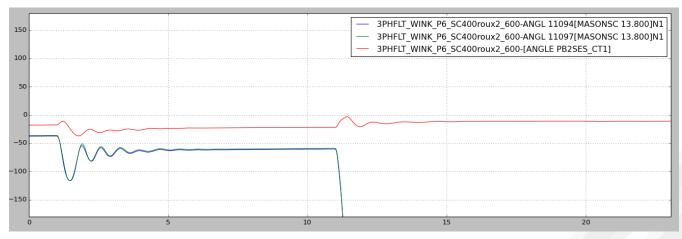


And worse...

600 MW

Solution diverges after SCs go unstable





Angular Instability of SCs

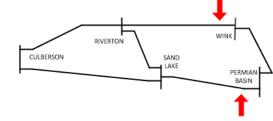


RIVERTON

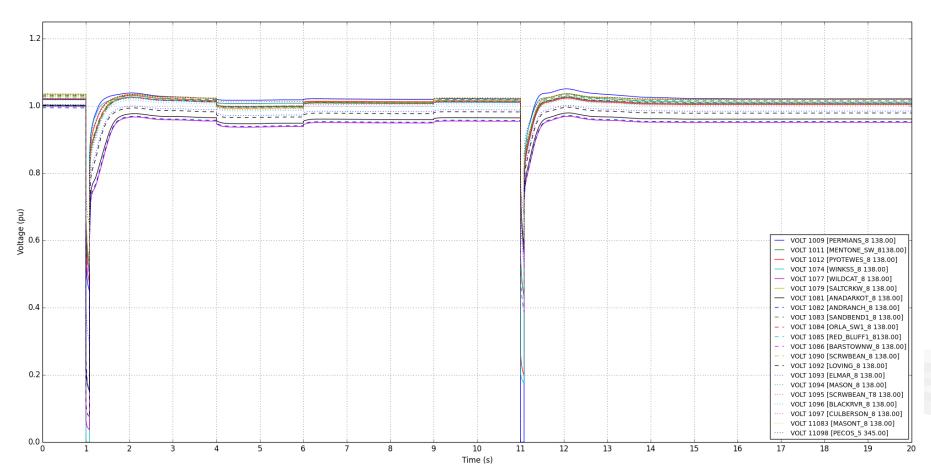
CULBERSON



345 KV IS A LONG TERM RESILIENT SOULTION



600 MW







FAR WEST TEXAS PROJECT

- PROVIDES SECURITY
- PROVIDES RELIABILITY & OPERATIONAL FLEXIBILITY
- INCREASES NEW GENERATION INTERCONNECTS & TRANSFER CAPABILITY
- INCREASES SYSTEM STRENGTH
- PROVIDES RESILIENCY & UPGRADE PATH



QUESTIONS/DISCUSSION



