FAR WEST TEXAS PROJECT

Presentation to ERCOT Regional Planning Group at April 21, 2016 Meeting Austin, TX – MET Center

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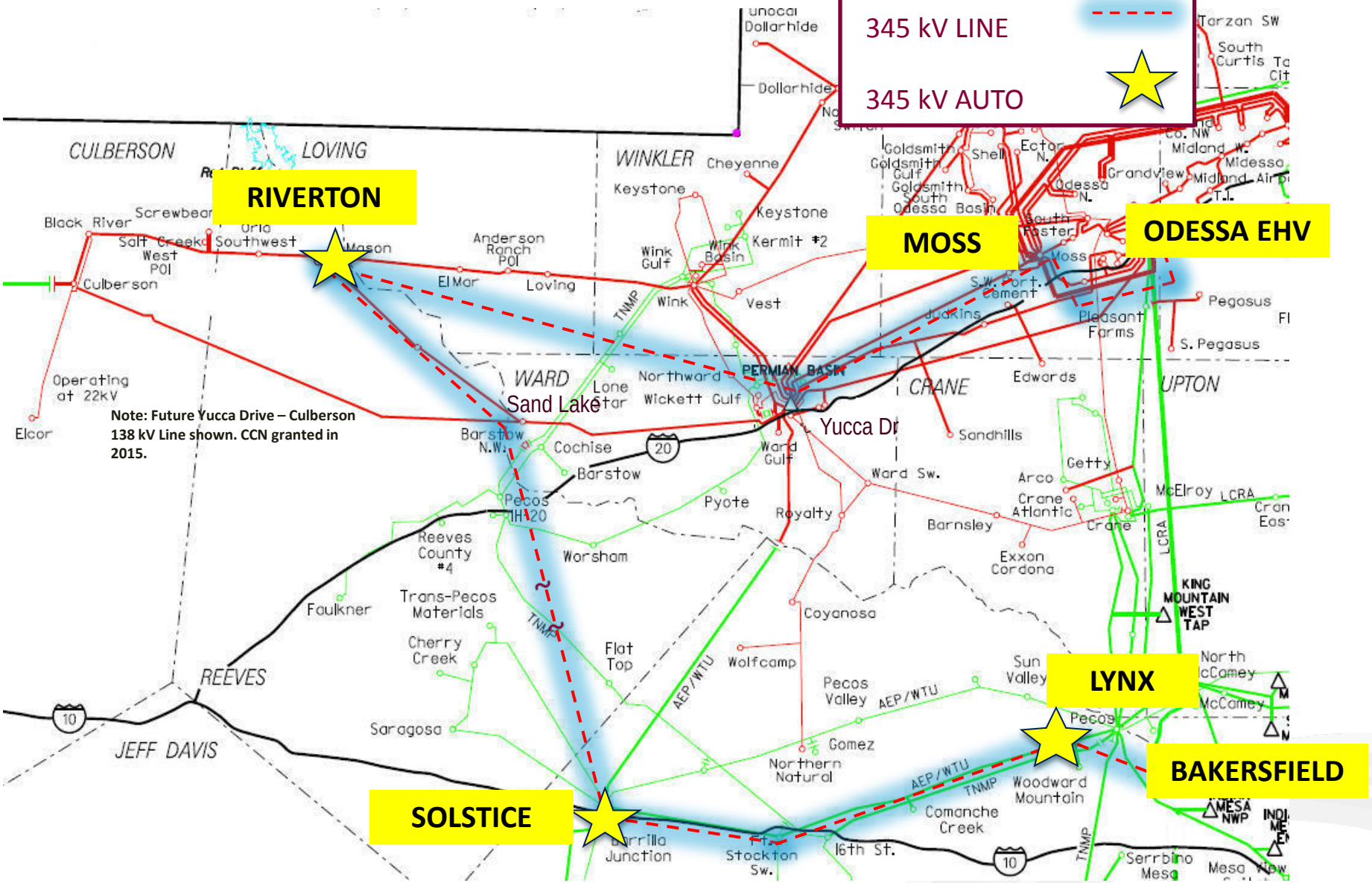
Plans are subject to change due to factors including, but not limited to, load, generation, engineering, system protection and system topology.

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



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)

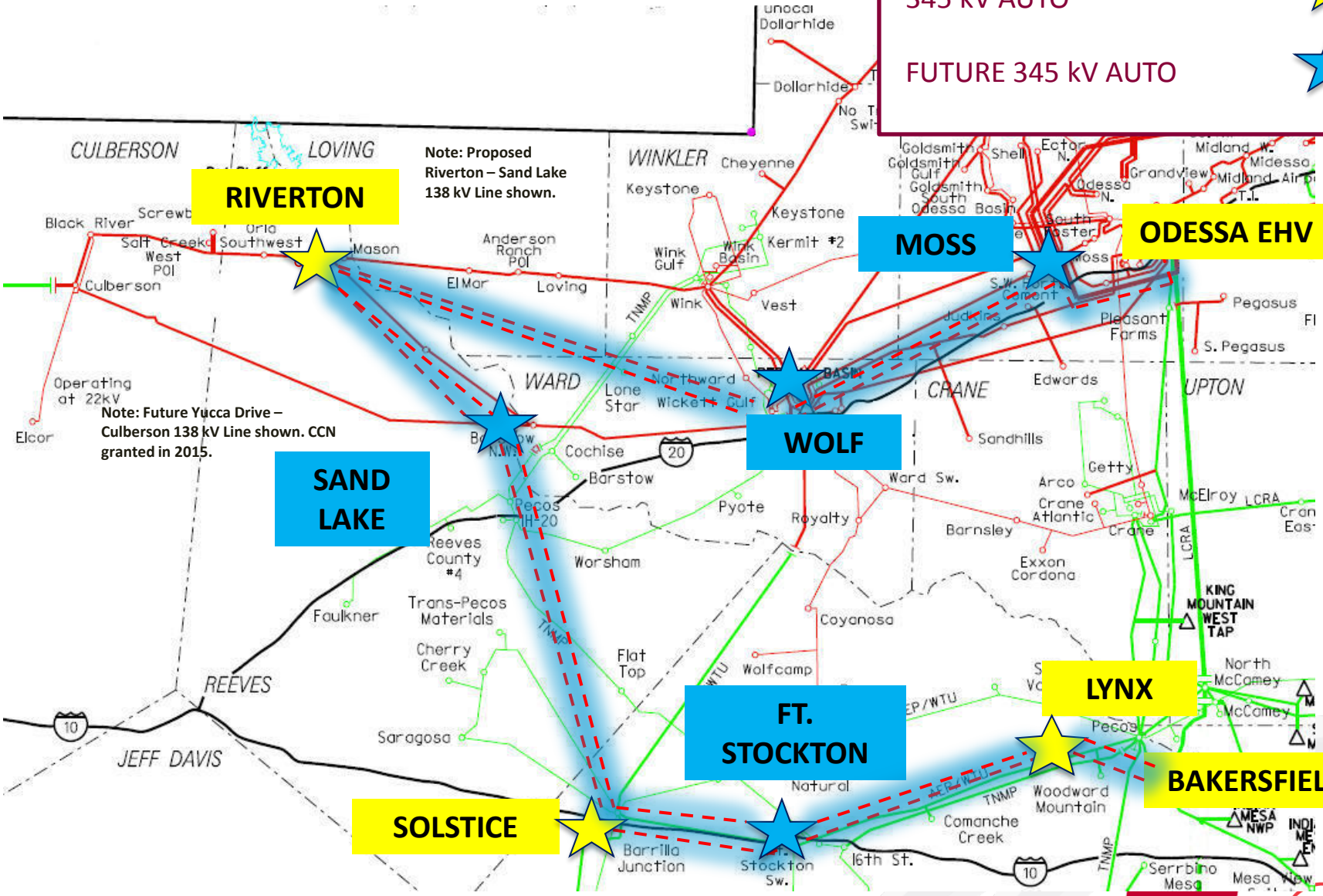
- **345/138 kV AUTOTRANSFORMERS**
  - Riverton Sw. Sta.
  - Solstice Sw. Sta.
  - Lynx Sw. Sta.

- **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



PROVIDES FUTURE UPGRADE PATH

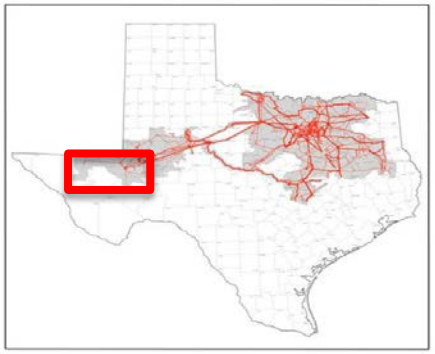
- **LINE – ADD SECOND CIRCUIT(S)**
  - Odessa EHV to Moss to Wolf to Riverton 345 kV Line (Oncor)
  - Riverton to Sand Lake (Oncor) to Solstice (AEP) 345 kV Line
  - Solstice to Lynx 345 kV Line (AEP)
  - Lynx to Bakersfield 345 kV Line (AEP)
  - Bakersfield to North McCamey to Odessa

- **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

FAR WEST TEXAS PROJECT LOCATION

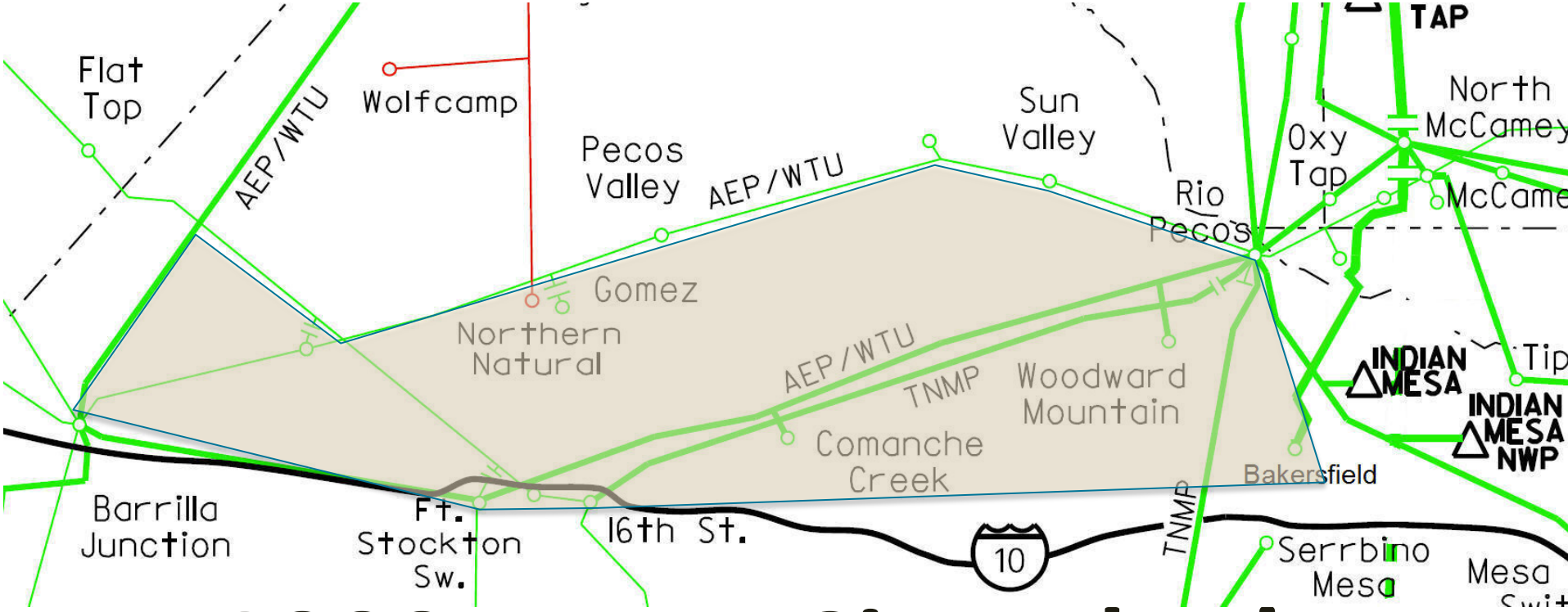


GENERATION INTERCONNECTIONS

- **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

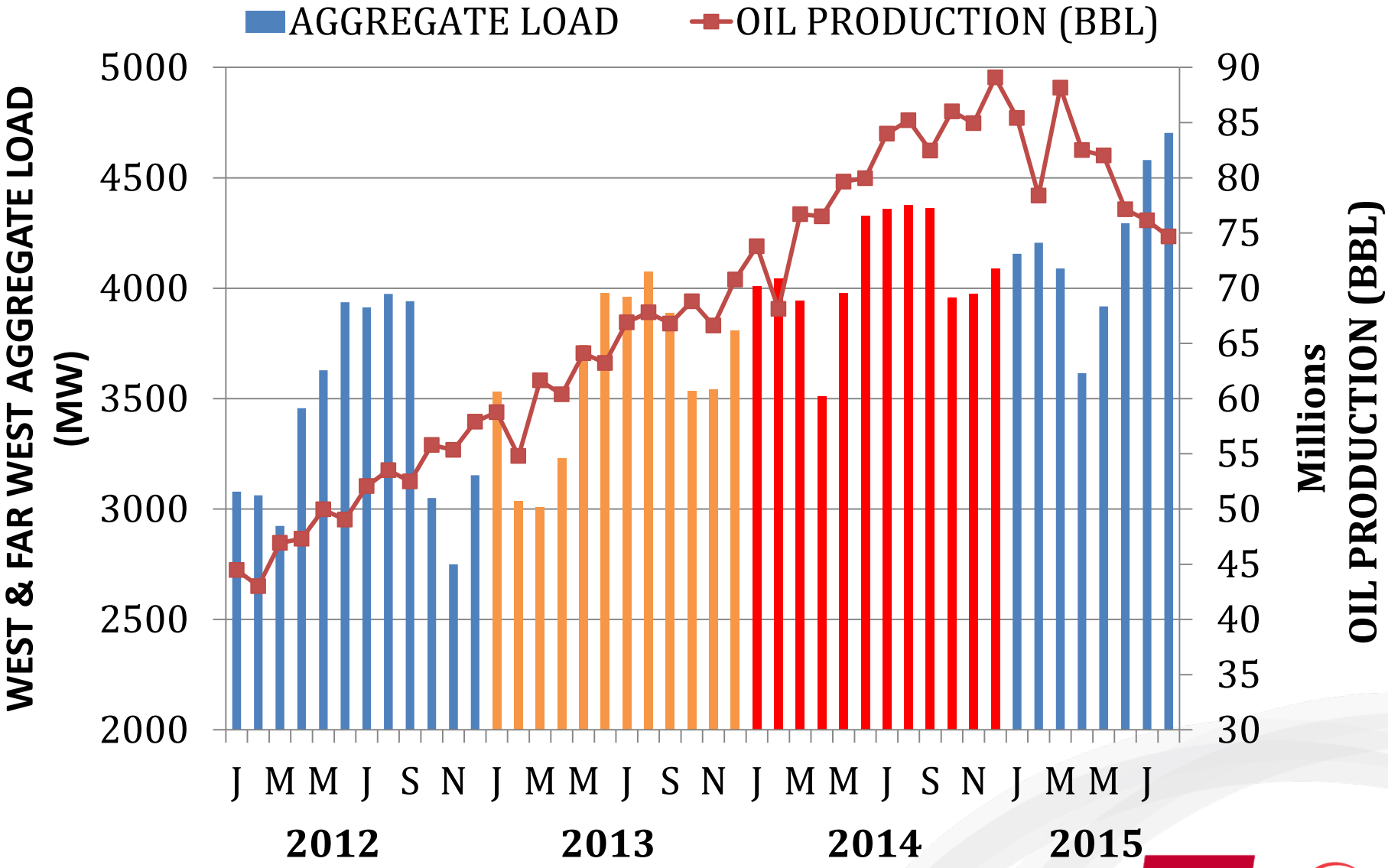
BARRILLA JUNCTION AREA GENERATION



1000 MW – Signed IA's

1100 MW – Under Study

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



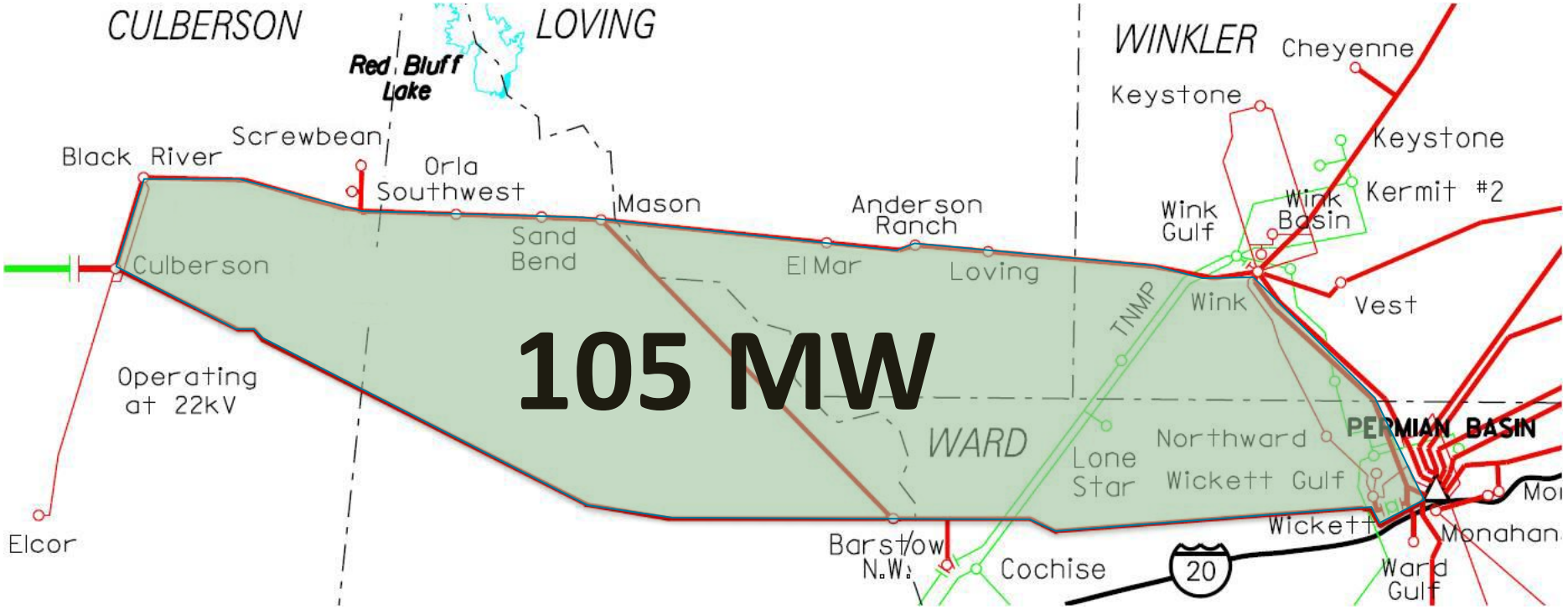
TEXAS RRC (http://www.rrc.state.tx.us/)

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

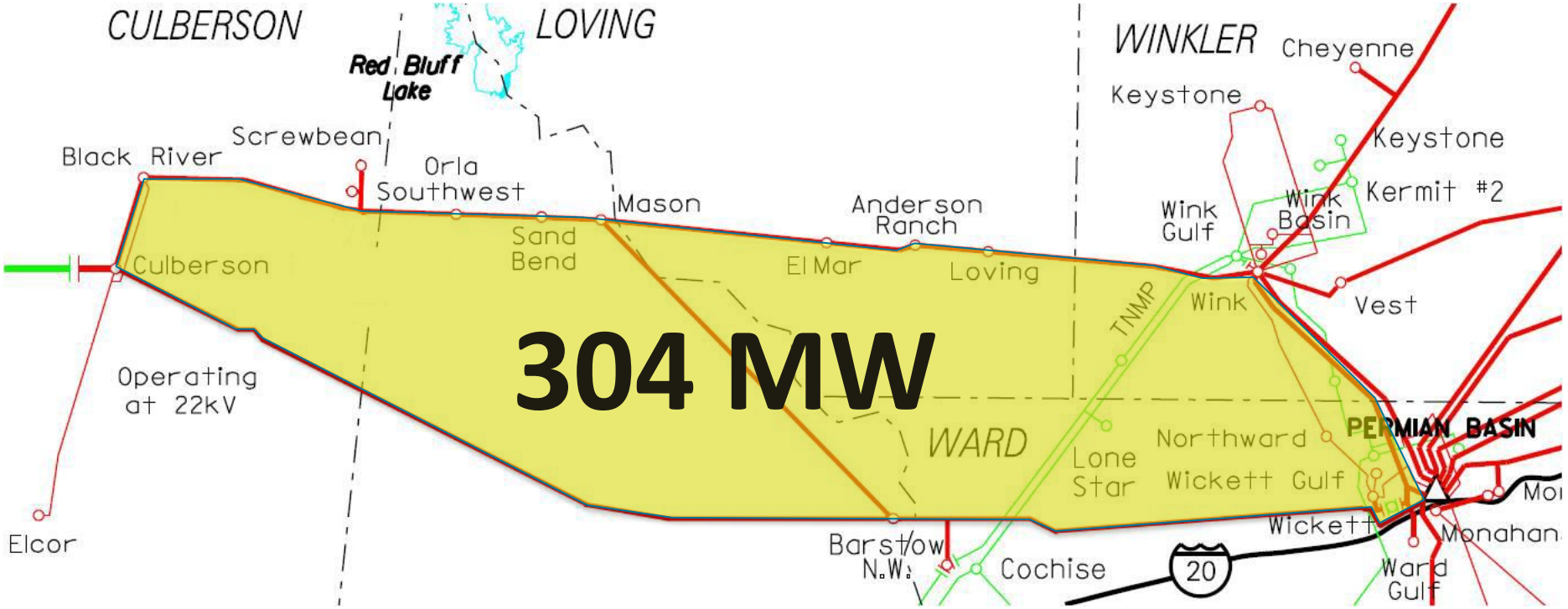
Projections only include confirmed load increases from normal load forecasting and signed customer agreements.

2015 WINK–CULBERSON–YUCCA DRIVE LOAD



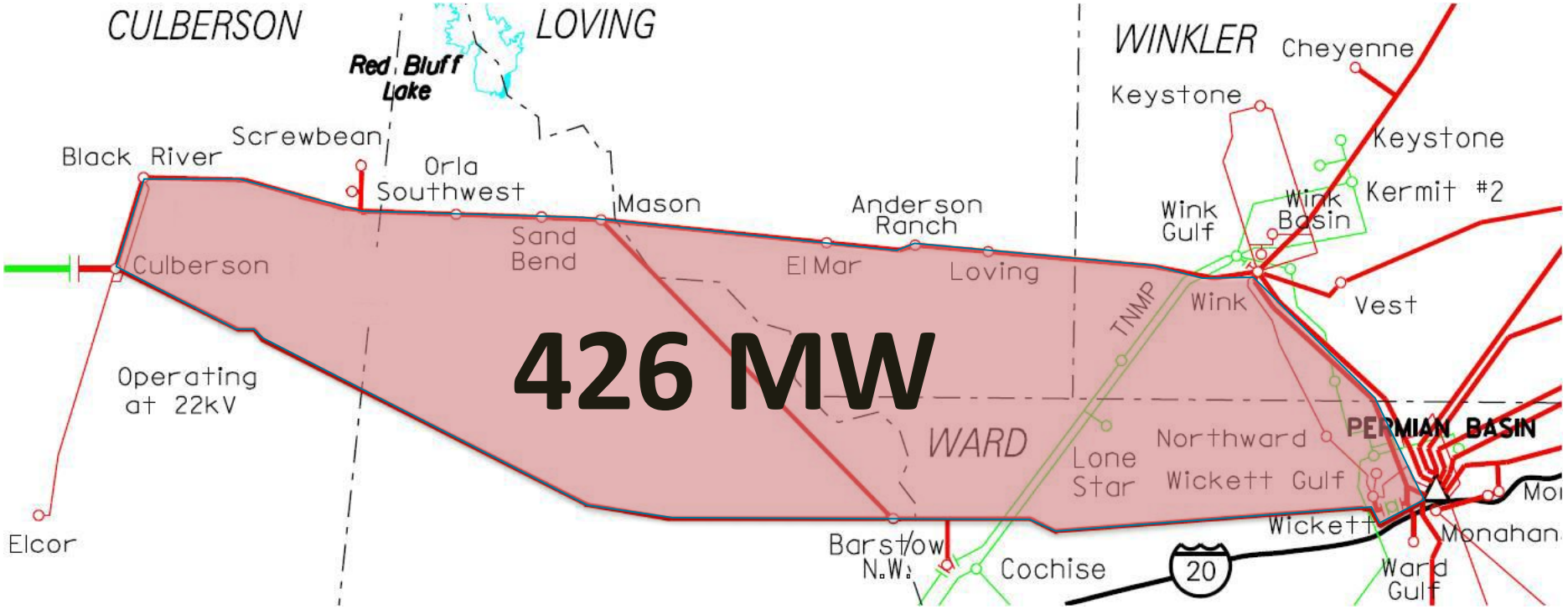
2015

2017 WINK–CULBERSON–YUCCA DRIVE LOAD



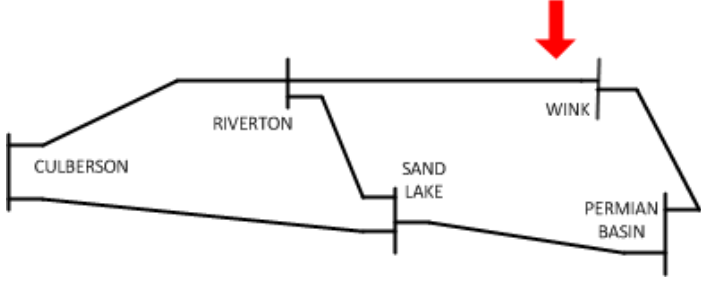
2017

2021 WINK–CULBERSON–YUCCA DRIVE LOAD

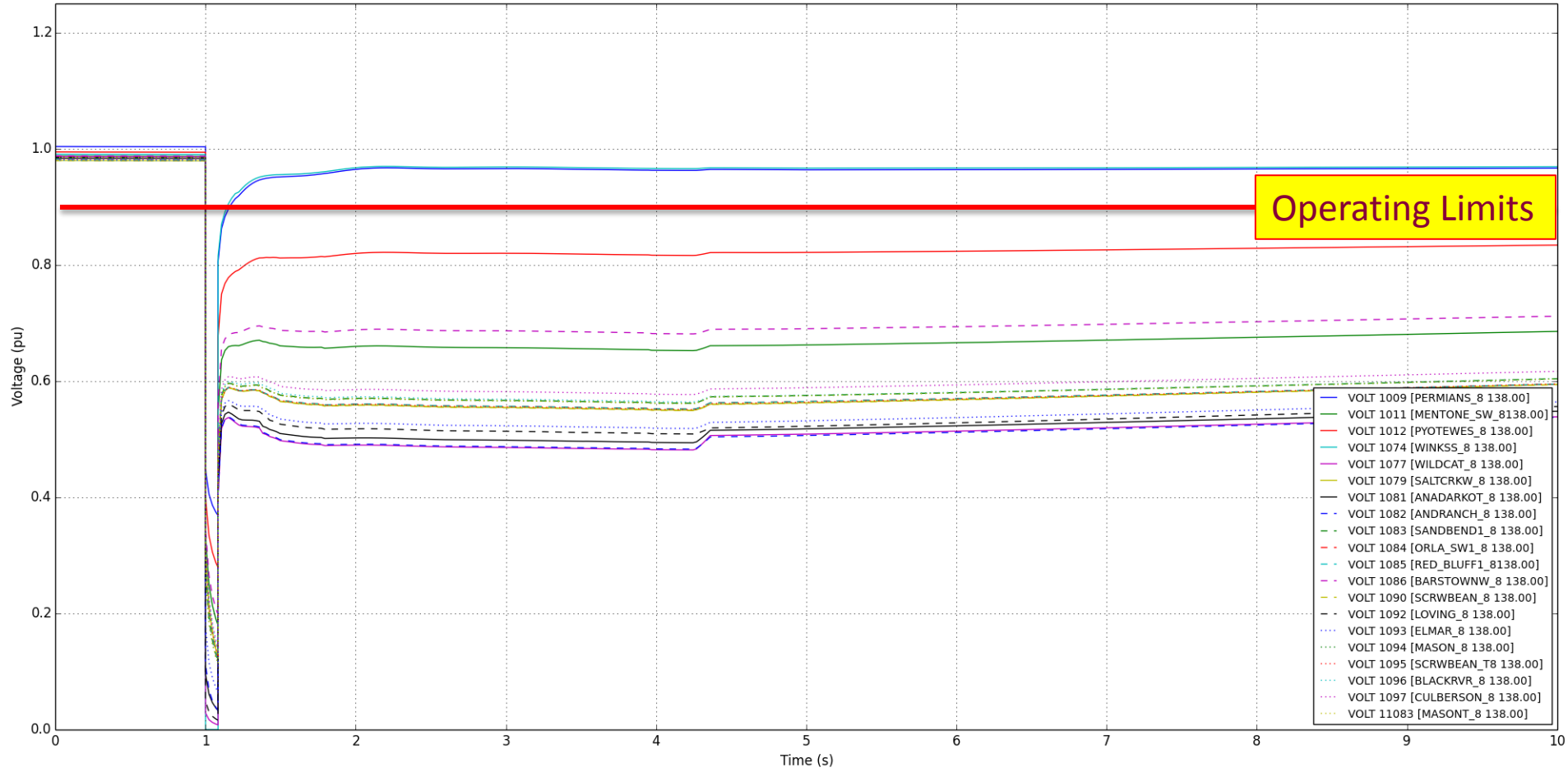


2021

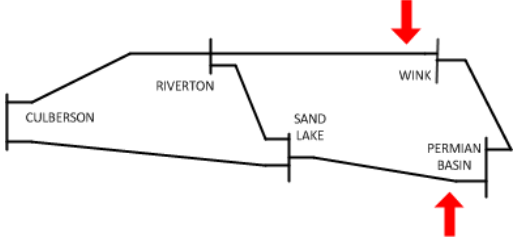
N-1 Double Circuit
Worst Case Voltage Response

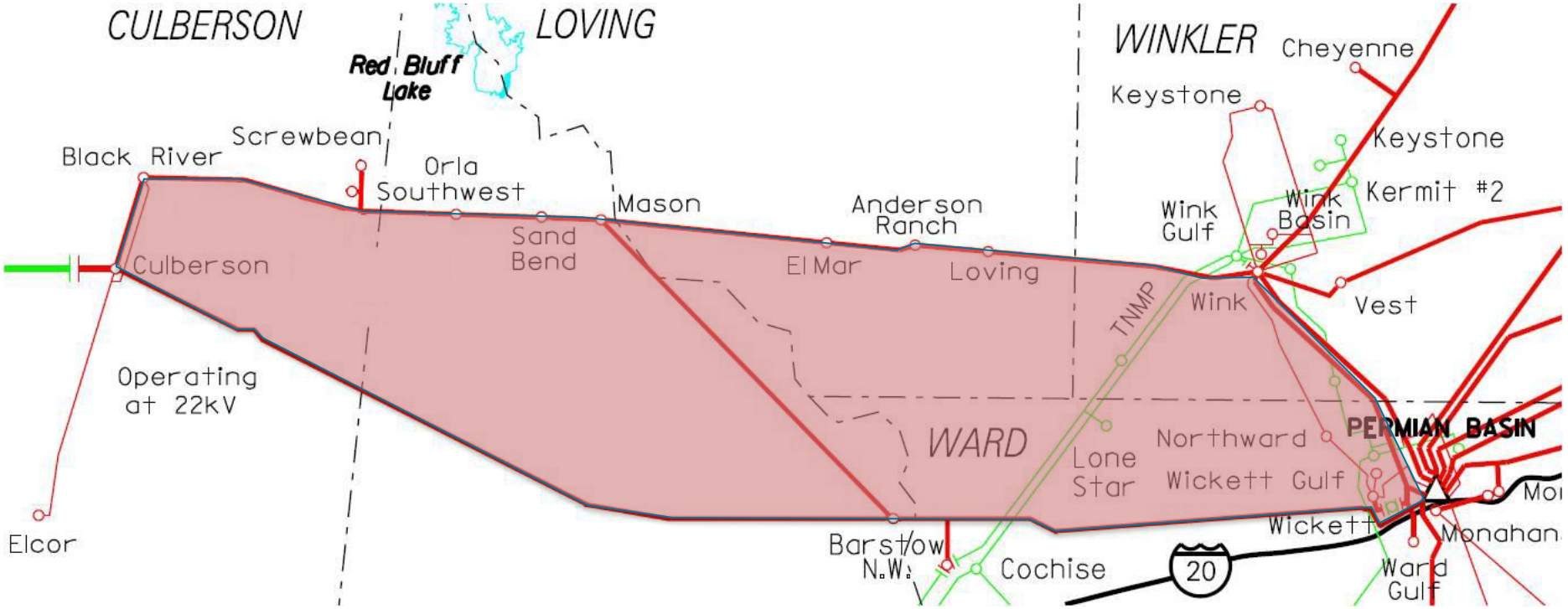


Double Circuit (Branch) Wink - Riverton



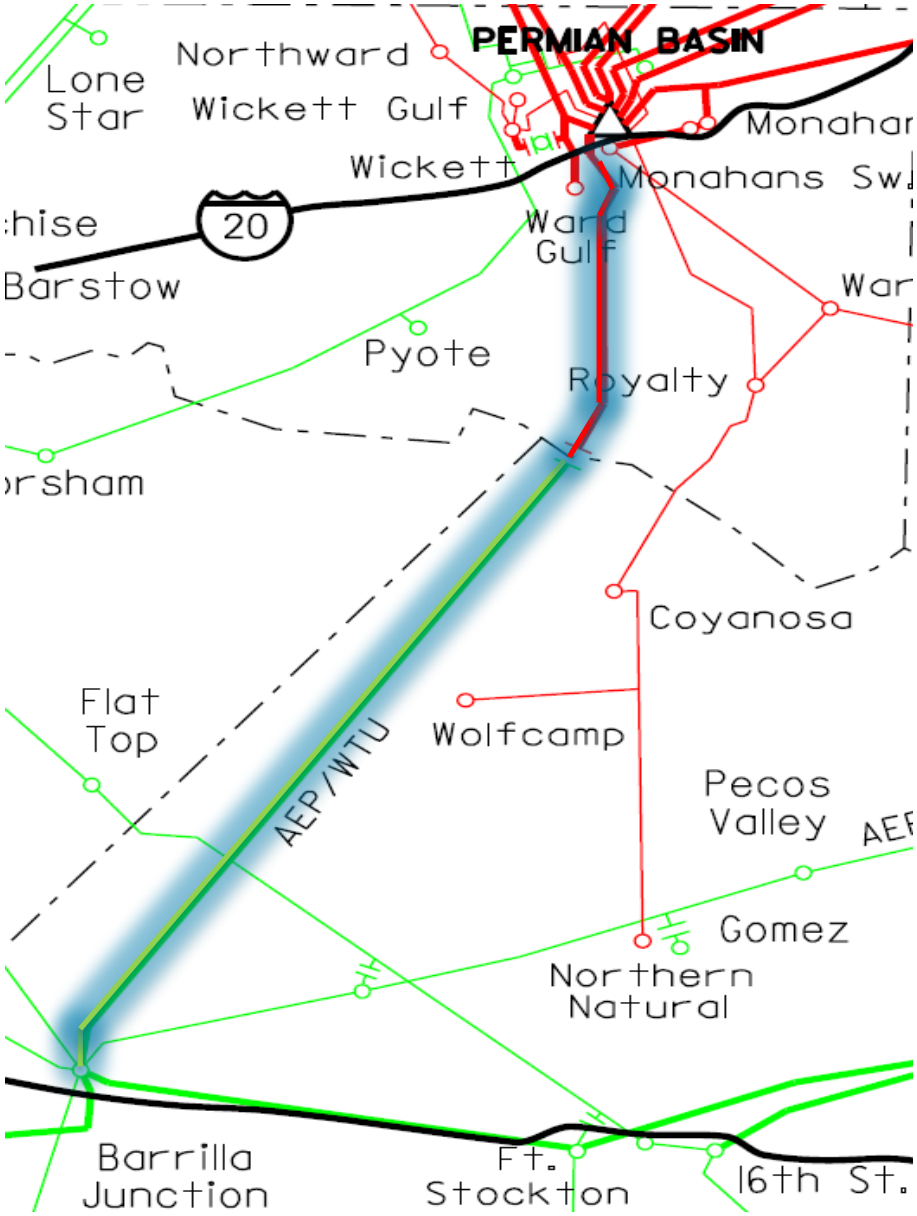
SIGNIFICANT CONSEQUENCES





Over 300+ MW Load Loss

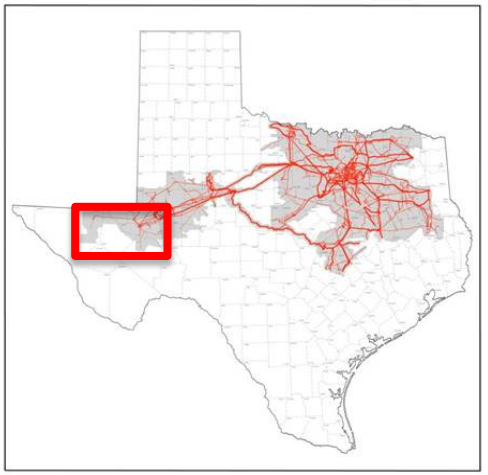
2020 PERMIAN – BARRILLA JUNCTION LOADS



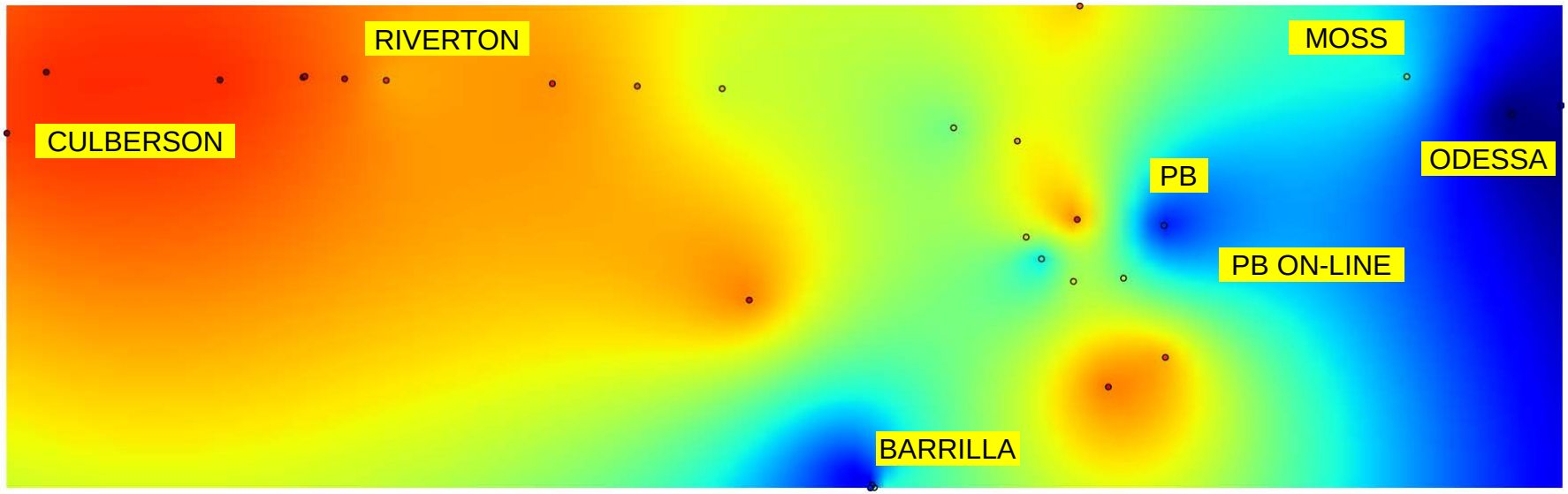
150 MW

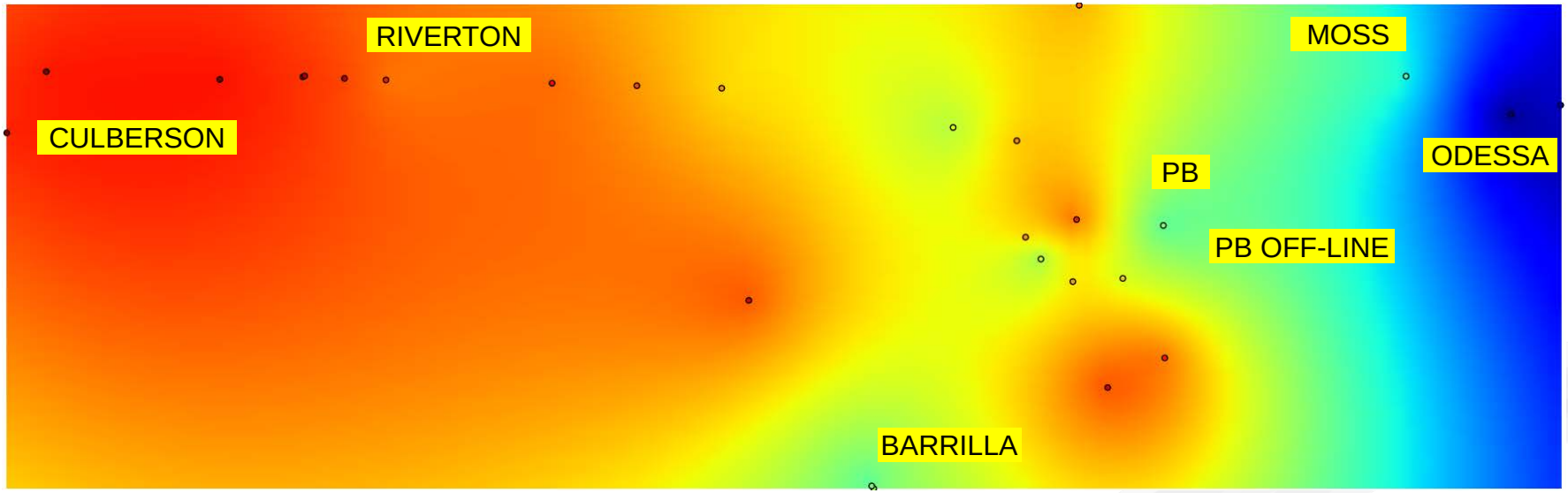
2020

SHORT CIRCUIT STRENGTH

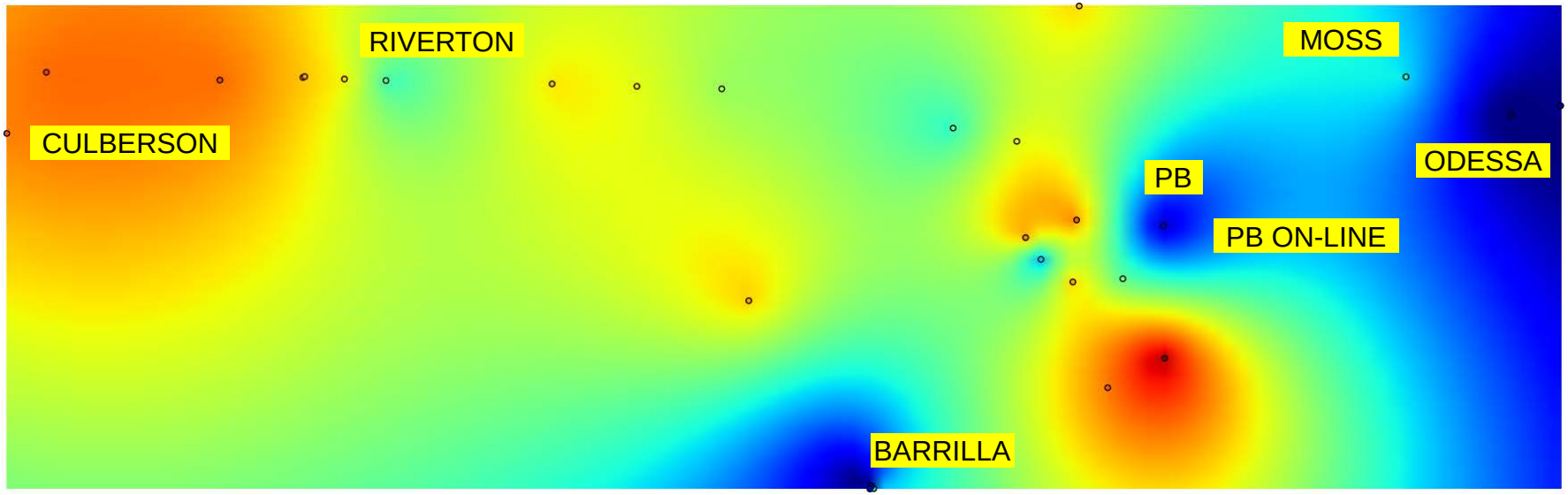


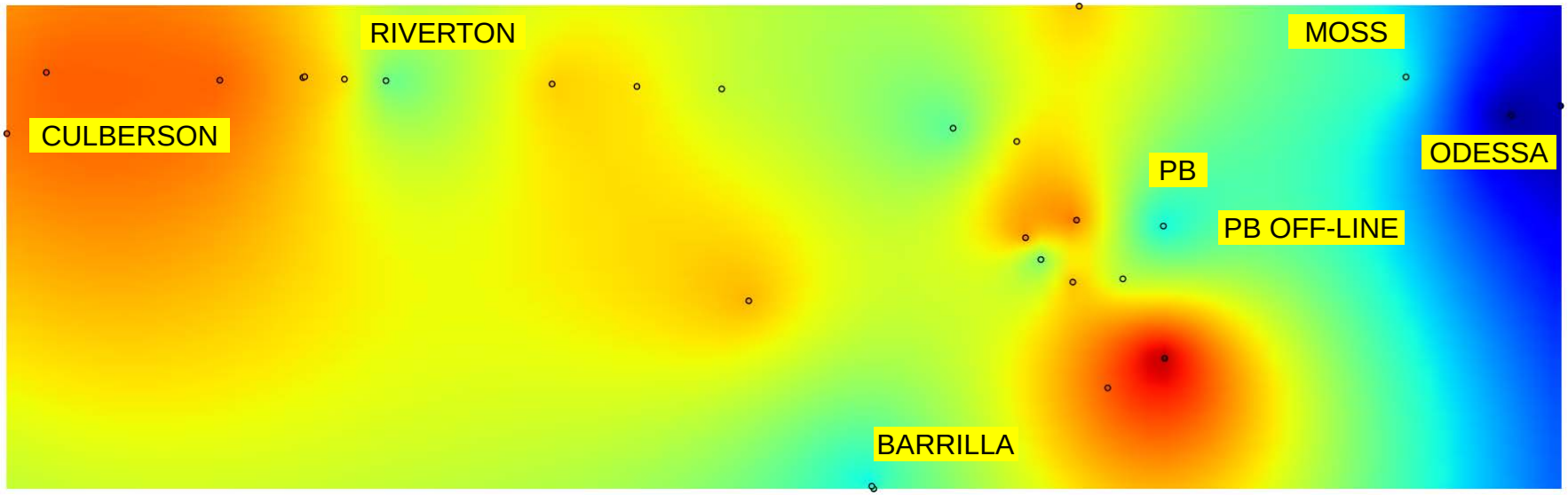
SHORT CIRCUIT CONTOUR MAP NORMAL CONDITION



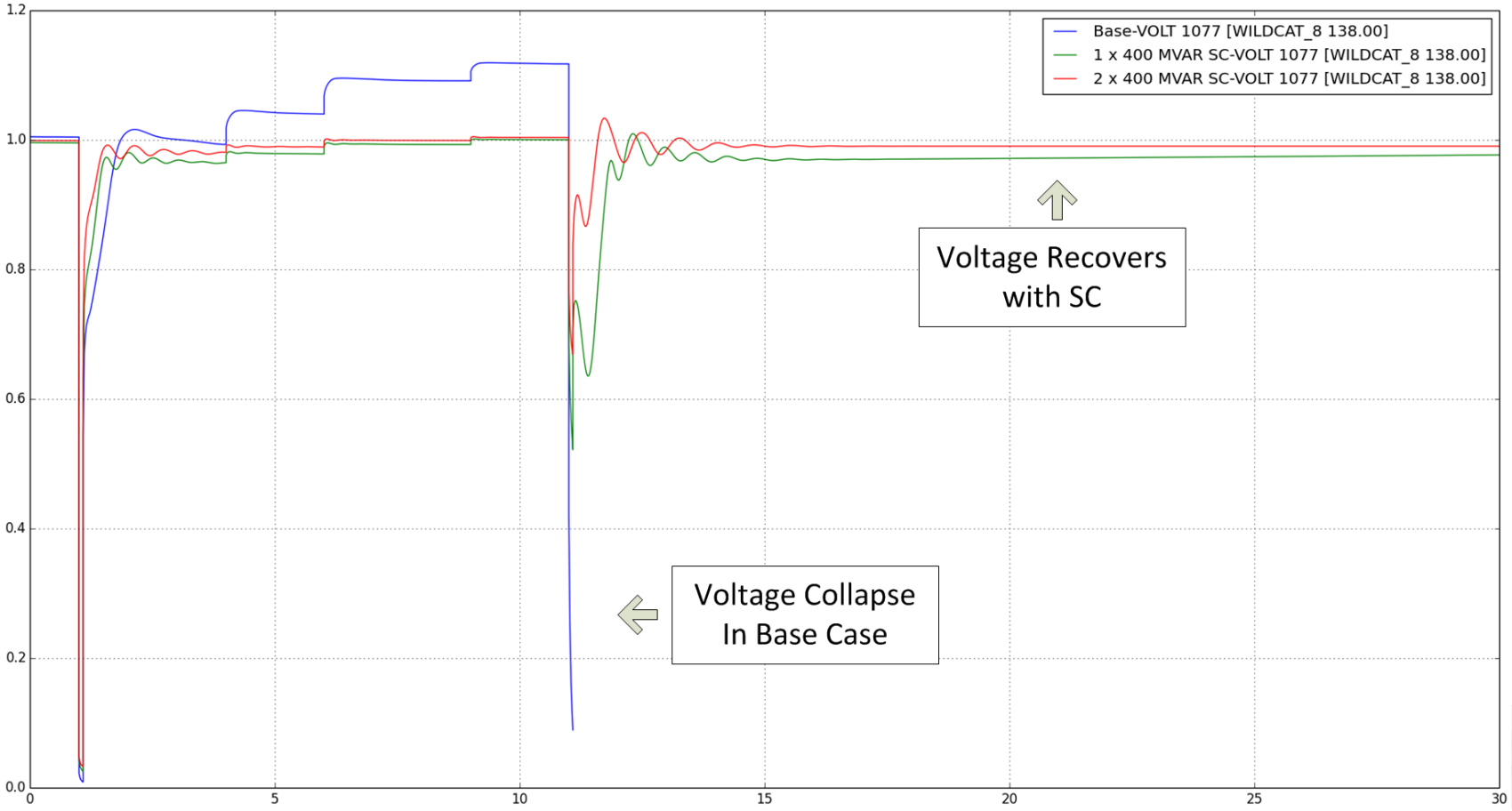


SHORT CIRCUIT CONTOUR MAP NORMAL & FWTP

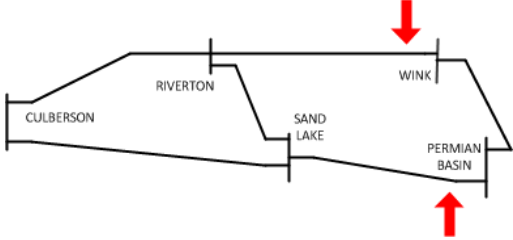




SVC AND STATCOM FAILS TO RESOLVE ALL ISSUES

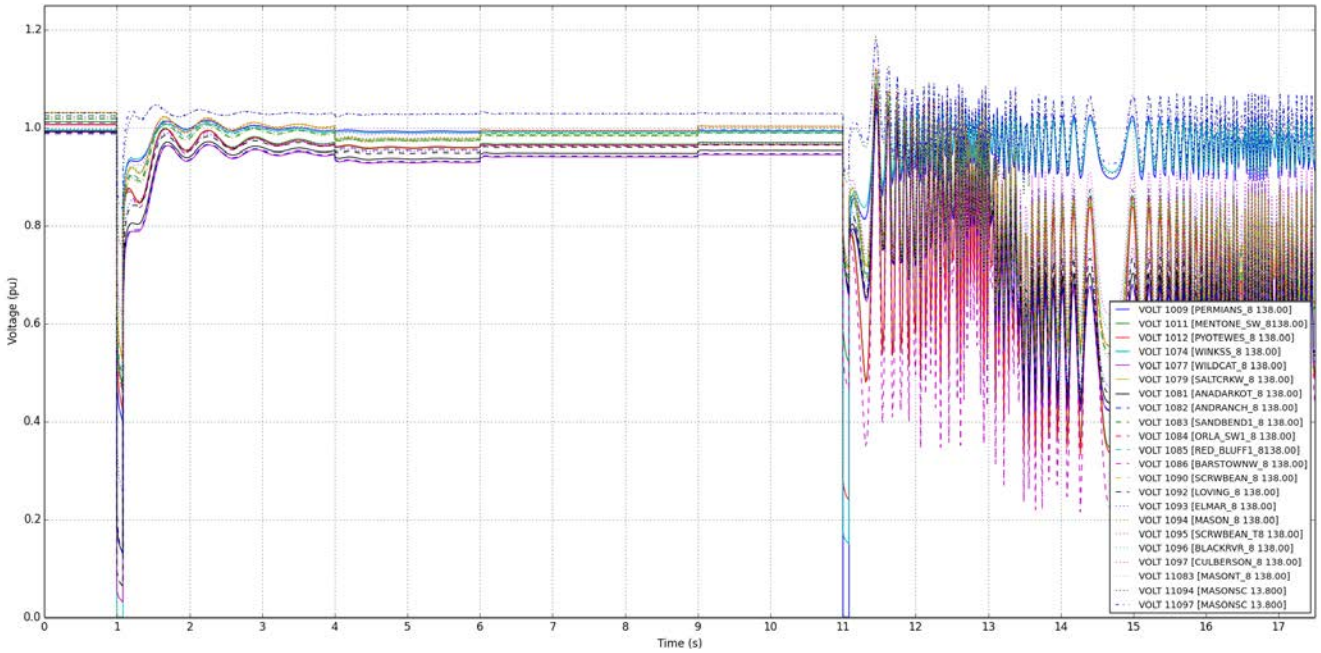


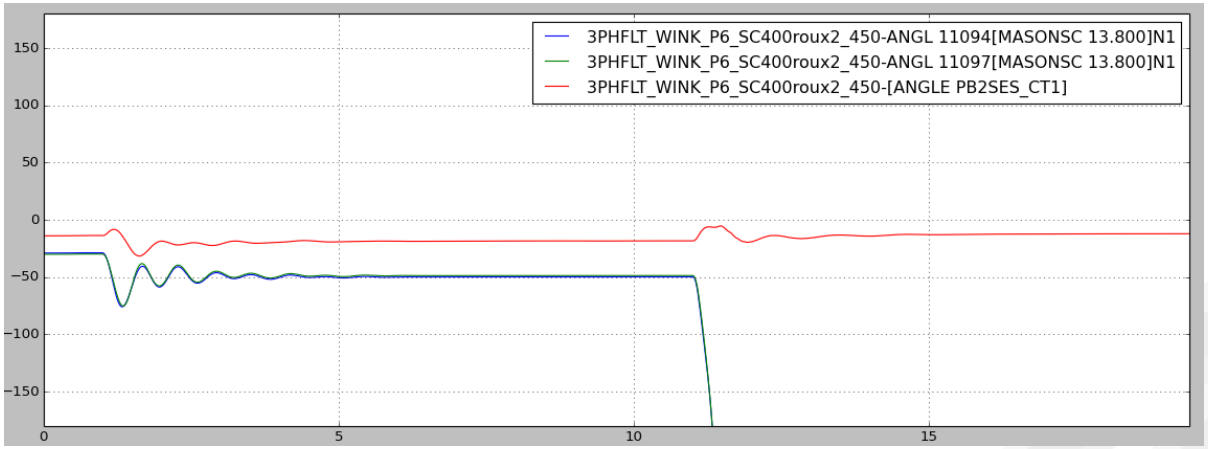
Synchronous Condenser (SC) performance gets poorer as load grows



450 MW

Solution diverges after SCs go unstable

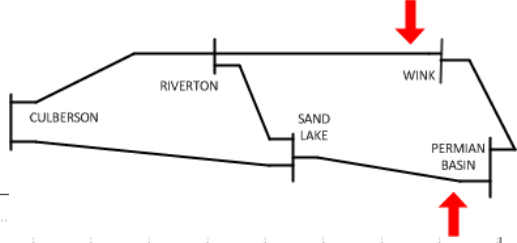




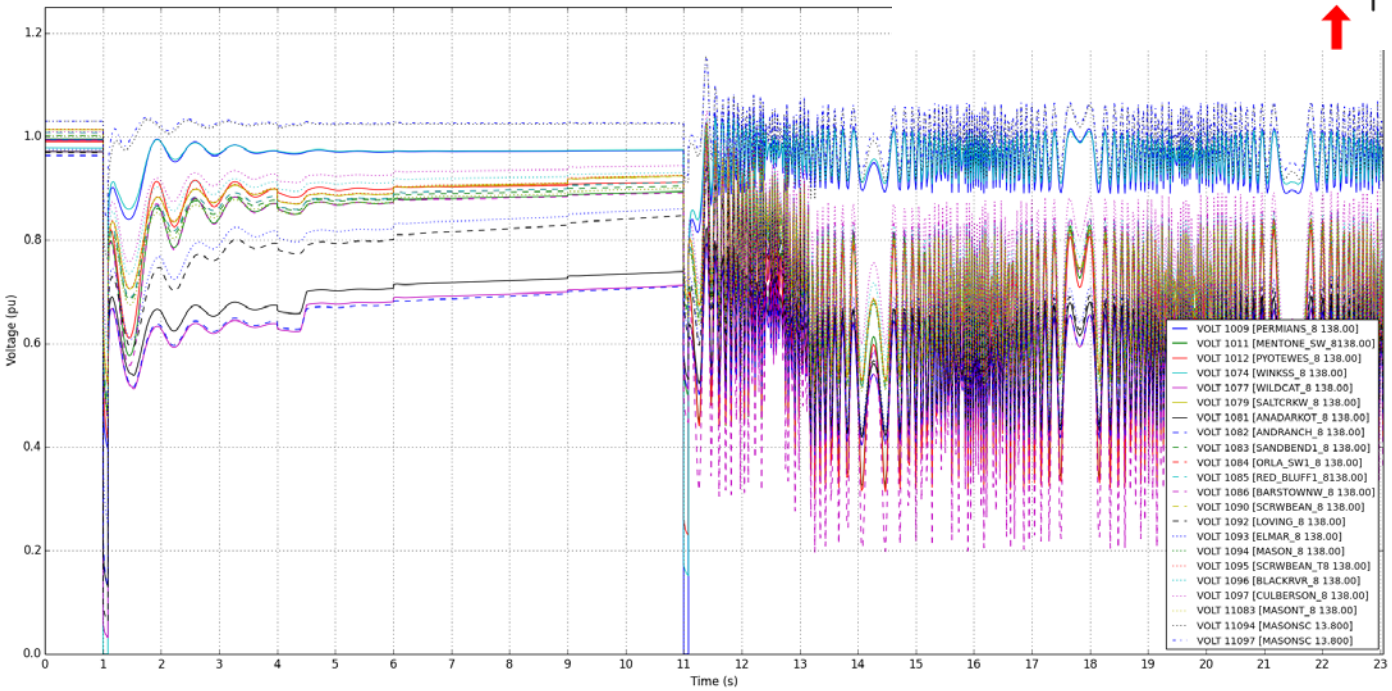
Angular Instability of SCs

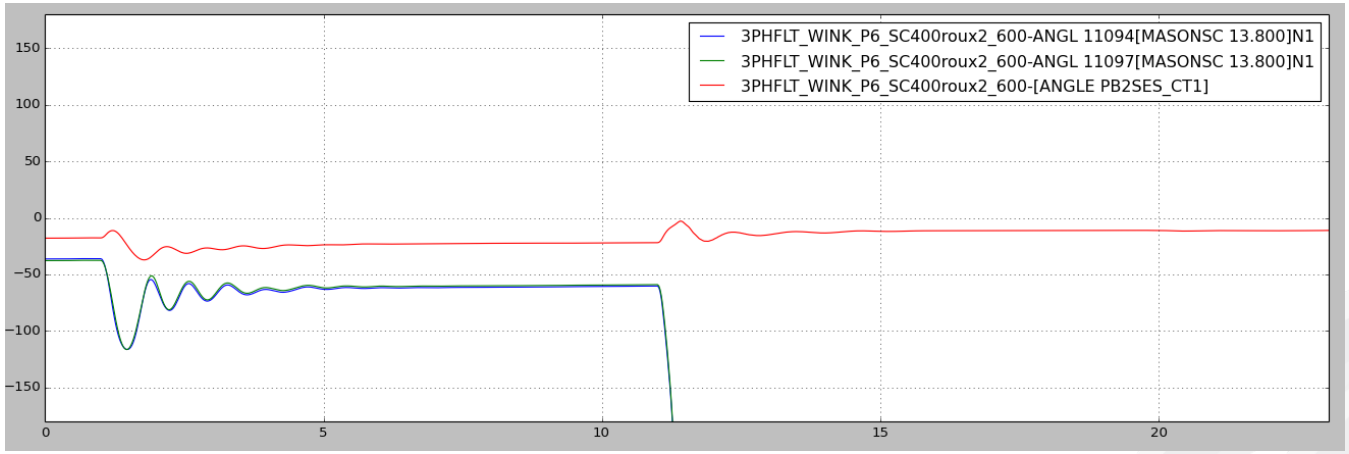
And worse…

600 MW



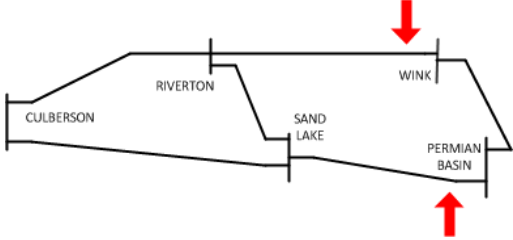
Solution diverges after SCs go unstable



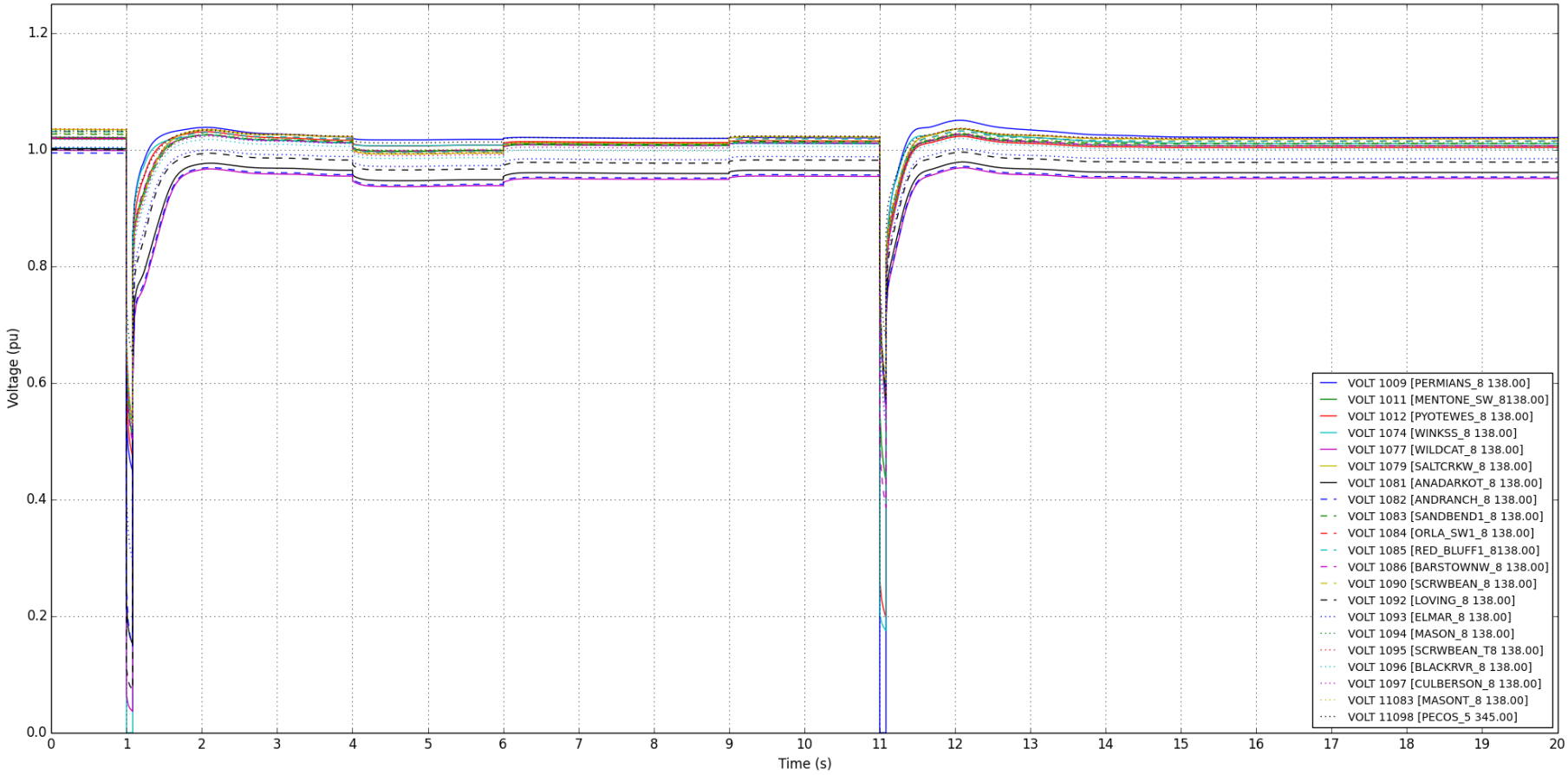


Angular Instability of SCs

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