



Far West Texas Transmission Project - ERCOT Independent Review

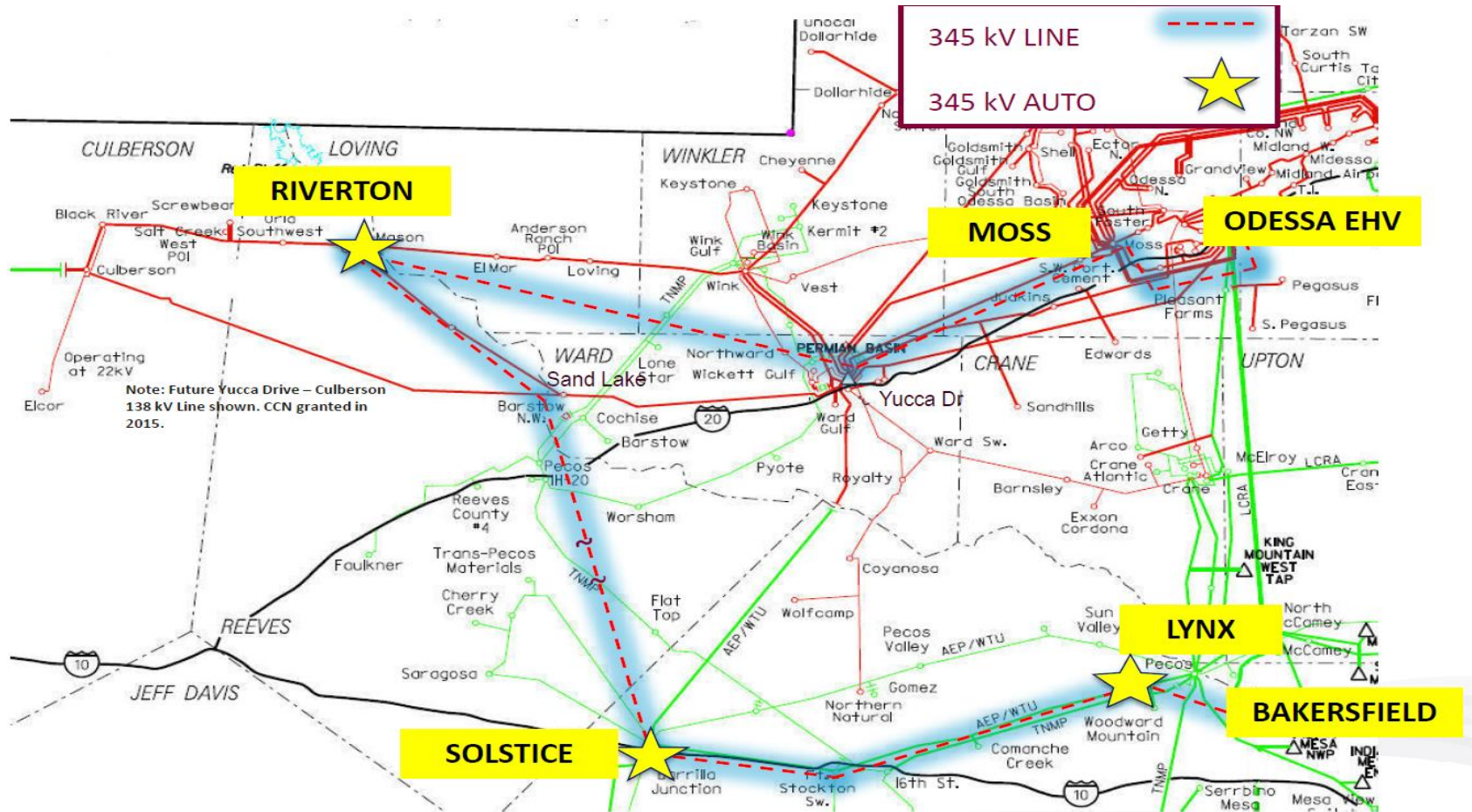
May 16, 2017

Overview

AEPSC and Oncor jointly submitted Far West Texas Project (FWTP) for Regional Planning Group review. The original AEP and Oncor proposal is a Tier 1 project that was estimated to cost \$ 423 million.

- Proposed for 2021 to 2022 timeframe
- Addresses oil and gas related load forecasts
- Reliability Issues
 - Voltage Collapse
 - Loss of Load
 - Short-Circuit Strength & System Protection
- Provide Operational Flexibility
- Provides future upgrade path for Far West Region

Far West Texas Project Proposal



Source: AEP/ONCOR RPG submittal on 21-Apr-2016
(<http://www.ercot.com/calendar/2016/4/21/81733-RPG>)

Study Case Assumptions

Steady State - Study Case

- Start Case from 16RTP reliability case 16RTP_2021_SUM_WFW
- Study Region consists of Far-West and West Weather Zones
- Generator additions that meet Planning Guide Section 6.9 criteria in study region were added to the case (2016 October GIS report).
- Transmission Projects expected to be in-service within the study region by 2021 were added to the case
- 2021 oil and gas related load forecasts
 - Culberson loop: 533 MW
 - Barilla Junction Area : ~511 MW

Dynamics- Study Case

- Start Case from LT-2022 DWG case
- The Dynamic Study case was updated to reflect the 2021 load forecasts in the Culberson loop and Barilla Junction Area

Study Scenarios

Scenarios evaluated in the study:

- 1) Study Case
- 2) No Solar Case
 - 0 MW Solar dispatched in study region
 - Load in Far-West reduced by 6% to reflect no solar peak period (*around 9 PM; Real-Time data used to calculate load reduction percentage*)
- 3) Potential Load Case
 - Higher Load on Culberson Loop and AEP region
 - Culberson loop: ~834 MW
 - Barilla Junction Area : ~568 MW

Sensitivities based on PG 3.1.3 (4)(a) – PGRR 042

- Generator additions with Signed Interconnection Agreements but that DO NOT meet Planning Guide Section 6.9 criteria in study region were added to the Study case (2017 Mar GIS report)

Study Criteria

P1, P2-1 and P7 contingencies were applied to filter base case violations

- Post Contingency thermal violation
Monitor all transmission lines and transformers in study region (excl. GSU)
 - Use Rate A for Normal Conditions
 - Use Rate B for Emergency Conditions

- Voltage Stability Analysis
 - PV calculations for load transfer (Culberson loop)

- Post Contingency voltage deviations
 - > 8% on non-radial load buses

- Post Contingency voltage violation criteria
Monitor all buses 100 kV and above
 - $0.95 < V_{pu} < 1.05$ Normal
 - $0.90 < V_{pu} < 1.05$ Emergency

Base Case - Steady State & Dynamics Results

Steady State	Study Case	No Solar Case
Unsolvable Contingencies	One (in Culberson loop)	One (in Culberson loop)
Thermal Violations	One 138 kV line (32 miles; Rio Pecos, TNMP 16TH St. region)	Four 138 kV lines (total 52 miles; Rio Pecos, TNMP 16TH St. region)
Voltage Violations	18 – 138 kV buses in Culberson	11 – 138 kV buses in Culberson
Voltage Deviations	None	10 – 138 kV buses

Transient Stability	Study Case	No Solar Case
Voltage Recovery Issues	P6, P7	P4, P6, P7

Initial Project Options

Nearly 40 project alternatives were studied

- Initial options included subset of transmission elements from the Oncor & AEP proposal with some of the following considerations:

345 kV construction operating at 138 kV with single circuit

345 kV construction operating at 138 kV with single & double combination circuits

345 kV construction operating at 138 kV with double

345 kV single circuit

345 kV double circuit

- Several options also considered adding dynamic reactive devices (Syn. Condensers)

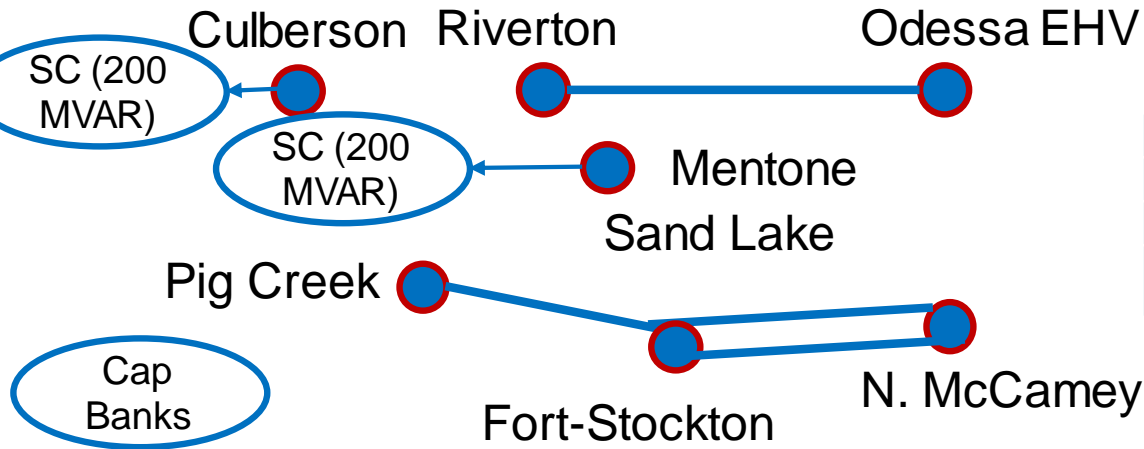
Initial Project Options - Evaluation

- Initial Options were screened and shortlisted based on:
 - i. Steady State Analysis
 - ii. Voltage Stability Analysis (PV results)
 - iii. Load Serving Capability including ability to meet future load growth
 - iv. Project Cost estimate
 - v. ROW impact
 - vi. Cost of upgrading existing lines to relieve overloads
- Based on the initial options screening, four options were selected for detailed analysis

Final Study Options – Evaluation/Results

- The four selected options were further evaluated included the following:
 - i. Steady State analysis (NERC P1 through P7, ERCOT X-1+N-1)
 - ii. Voltage Stability Analysis (PV results)
 - iii. Economic Analysis (UPLAN)
 - iv. N-1-1 Analysis

Option 1 – Results



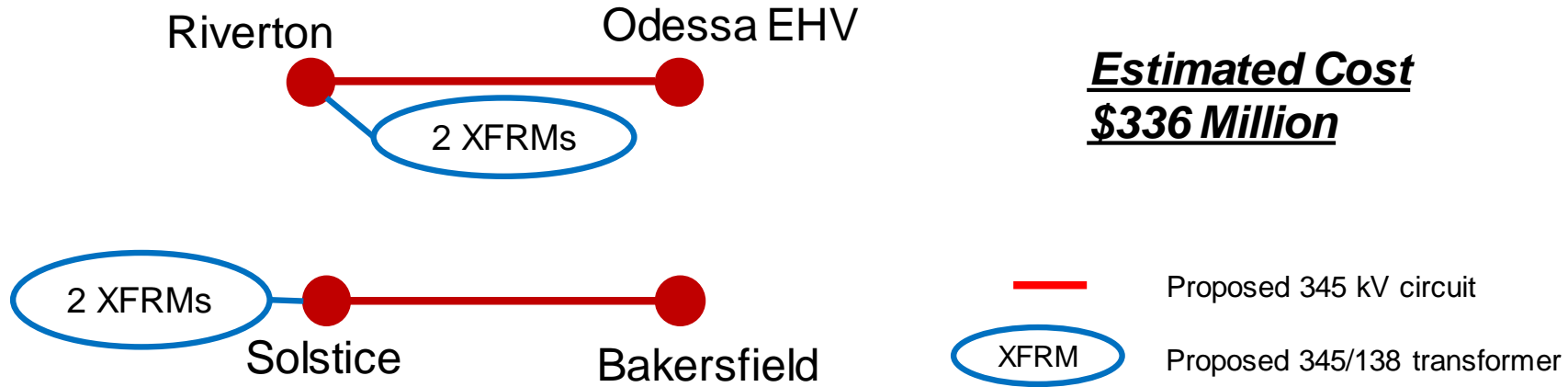
Estimated Cost \$464 Million

Cap bank at Mentone and SaltCreek	36 MVARs each
Cap bank at Orla and Elmar, Loving	18 MVARs each
Cap bank at ALMC	18 MVARs
Cap bank at ESPY, SHAF, TSAND	3.6, 10.8, and 7.2 MVARs

- SC Proposed synchronous condenser
- 345 kV construction operating at 138 kV

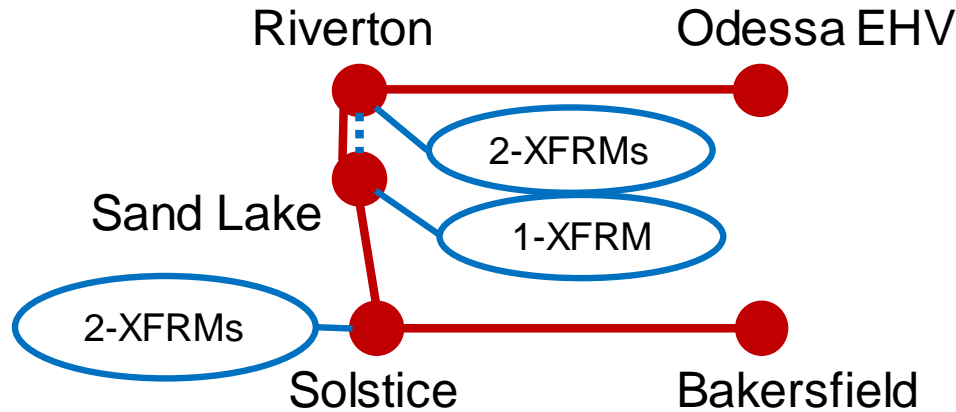
Reliability Assessment	Study Case	Potential Load
PV (Culberson Load)	917 (P6) 927 MW (P7)	
Thermal	Study Case : No Violations No Solar Case : No Violations	Study Case : Violations No Solar Case : Violations
Voltage Violation	Study Case : No Violations No Solar Case : No Violations	Study Case : No Violations No Solar Case : No Violations

Option 2 - Results



Reliability Assessment	Study Case	Potential Load
PV (Culberson Load)	717 MW (P7) 767 MW (P1, ERCOT X-1+N-1)	
Thermal	Study Case : No Violations No Solar Case : No Violations	Study Case : Violations No Solar Case : Violations
Voltage Violation	Study Case : No Violations No Solar Case : No Violations	Study Case : Violations No Solar Case : Violations

Option 3 - Results



Estimated Cost
\$446 Million

..... RPG approved 345 kV line operated @ 138 kV

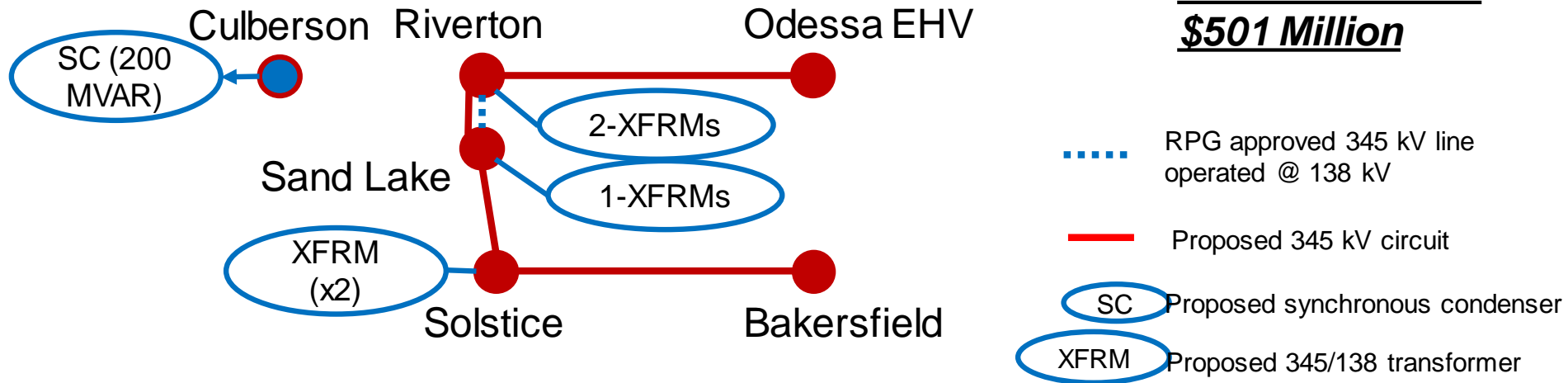
— Proposed 345 kV circuit

XFRM Proposed 345/138 transformer

Reliability Assessment	Study Case	Potential Load
PV (Culberson Load)	917 MW (ERCOT X-1+N-1) 967 MW (P7)	
Thermal	Study Case : No Violations No Solar Case: No Violations	Study Case : No Violations No Solar Case: No Violations
Voltage Violation	Study Case : No Violations No Solar Case: No Violations	Study Case : No Violations No Solar Case: No Violations

Option 4 - Results

Estimated Cost:
\$501 Million



Reliability Assessment	Study Case	Potential Load
PV (Culberson Load)	1037 MW (P6, ERCOT X-1+N-1) 1137 MW (P7)	
Thermal	Study Case : No Violations No Solar Case: No Violations	Study Case : No Violations No Solar Case: No Violations
Voltage Violation	Study Case : No Violations No Solar Case: No Violations	Study Case : No Violations No Solar Case: No Violations

Economic Analysis - Results

OPTIONS	Relative Annual Production Cost Savings \$ (base Option 1)
Option 1	-
Option 2	\$ 6.2 Million
Option 3	\$ 6.6 Million
Option 4	\$ 6.6 Million

Sensitivity Analysis – PG Section 3.1.3 (4)

PG Section 6.9 Units without any Options

Violation Type	Study Case	No Solar Case
Unsolvable Contingencies	One	One
Thermal Violations	One 138 kV line	Four 138 kV lines
Voltage Violations	18 – 138 kV buses	11 – 138 kV buses
Voltage Deviations	None	10 – 138 kV buses

Units with signed IA that did not meet PG6.9 without any Options

Violation Type	Study Case	No Solar Case
Unsolvable Contingencies	One	One
Thermal Violations	None	Three 138 kV lines
Voltage Violations	15 – 138 kV buses	8 – 138 kV buses
Voltage Deviations	None	3 – 138 kV buses

Sensitivity Analysis – PG Section 3.1.3 (4)

- ERCOT concludes that the generation sensitivity analysis as described in PG Section 3.1.3 (4)(a) does not have an impact on the project need and any of the four project options
- A review of the Power Transfer Distribution Factors (PTDFs) of overloaded elements with respect to the load transfer for each weather zone (excluding Far West) concluded that the load scaling as described in PG Section 3.1.3 (4)(b) does not have impact on the project need and any of the four project options

Overall Comparison

Description	Option 1	Option 2	Option 3	Option 4
System Performance – Study Case	Met criteria	Met criteria	Met criteria	Met criteria
System Performance – Potential Load Case	Criteria not Met	Criteria not Met	Met criteria	Met criteria
Capital cost (\$ Million)	464	336	446	501
PV Results Culberson Load Served	917	717	917	1037
Relative Production Cost Savings (\$ Million)	-	6.2	6.6	6.6
Total System Loss Reduction (MW)	10.4	31.2	34.4	34.4
New Right of Way Required	187 mi	169 mi	235 mi	235 mi

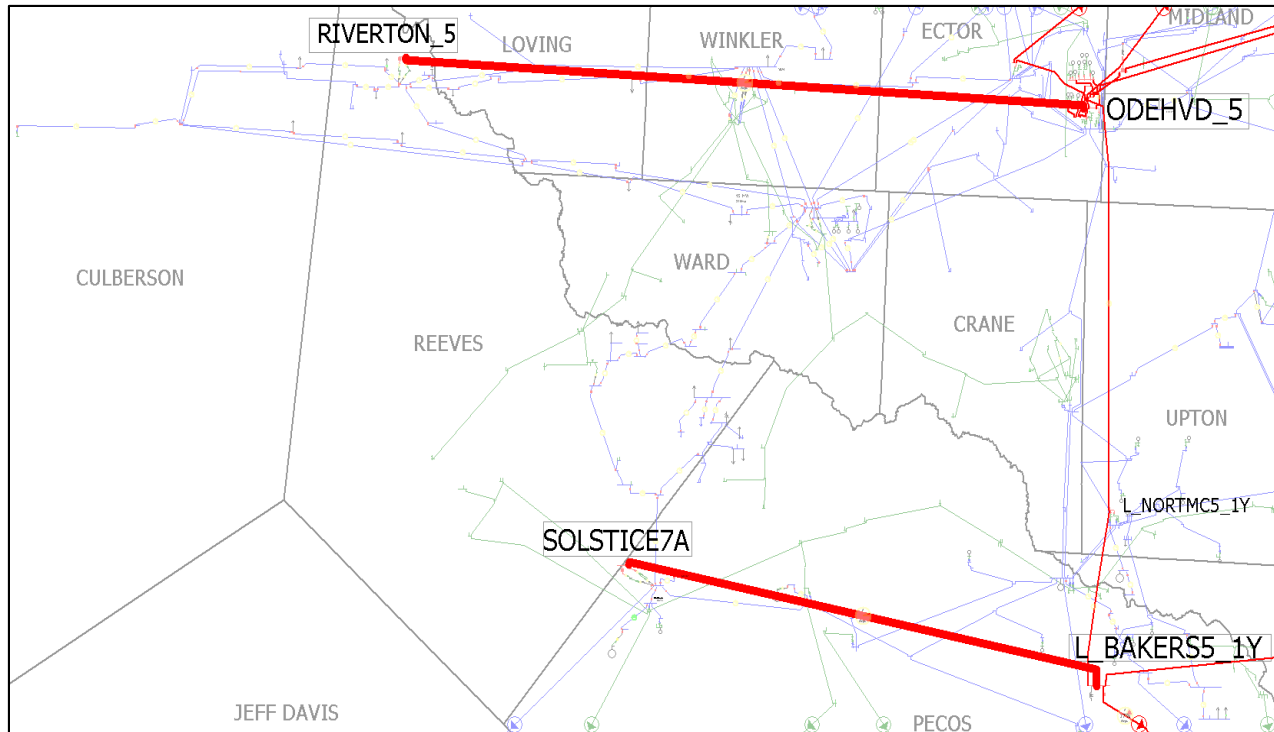
Dynamic Analysis

- Study Case with Option 2 upgrade option was tested in dynamic stability analysis that also included dynamic load model for the heavy motor load in Culberson loop area
- Met reliability criteria for NERC and ERCOT dynamic events
- Option 3 and 4 are assumed to have equal or better results since Option 2 is a subset of Option 3 and 4

ERCOT Recommendation

- Based on the review, ERCOT will recommend the Board endorse Option 2 to address the reliability need in the study region:
 - Expand the Riverton Sw. Sta. to install a 345 kV ring-bus arrangement with two 600 MVA, 345/138 kV autotransformer
 - Construct a new approximately 85-mile 345 kV line on double-circuit structures with one circuit in place, between Moss and Riverton Sw. Sta. Add a second circuit to the existing 16-mile Moss Sw. Sta. – Odessa EHV 345 kV double-circuit structures. Install 345 kV circuit breaker(s) at Odessa EHV. Connect the new circuit from Riverton Sw. Sta. and terminate at Odessa EHV to create the new Odessa EHV – Moss - Riverton 345 kV Line
 - Expand the Solstice Sw. Sta. to install a 345 kV ring-bus arrangement with two 600 MVA, 345/138 kV autotransformer
 - Construct a new approximately 68-mile 345 kV line from Solstice Sw. Sta. to Bakersfield station on double-circuit structures with one circuit in place
- Estimated Capital Cost: \$336 million

ERCOT Recommendation – Option 2



Future Load Growth Consideration

- At the conclusion of the ERCOT independent review, Oncor has confirmed that the committed load forecast in the Culberson area has reached to 596 MW by 2022
- The recommended Option 2 will be able to meet the 2022 Culberson area load projections
- Further improvements may be needed if the net load in the Culberson Loop area continues to grow beyond existing forecasts. Option 2 has several expansion alternatives that will allow it to meet a higher load demand including: addition of the 2nd circuit to the 345 kV towers, addition of a dynamic reactive device, and/or connecting Riverton to Solstice via a 345 kV line (closing the loop)

Next Steps

- ERCOT will finalize the Independent Review Report.
- ERCOT will present the project recommendation to TAC on May 25th and to ERCOT Board of Directors on June 13th.

