



ERCOT Independent Review AEPSC Lower Rio Grande Valley (LRGV) Project and CPS Energy and Sharyland LRGV Import Project

Document Revisions

Date	Version	Description	Author(s)
05/19/2016	1.0	Final	Ehsan Ur Rehman
		Reviewed by	Shun-Hsien (Fred) Huang, Prabhu Gnanam, Jeff Billo

Table of Contents

1. Executive Summary	1
2. Introduction	3
3. Criteria, Study Assumption and Methodology	6
3.1. Study Region and Criteria	6
3.2. Study Assumption and Methodology	6
3.2.1. Study Base Cases and Modification	6
3.2.2. Study Assumptions	7
3.2.3. Study Methodology	7
3.2.4. Study Tools	8
4. Analysis Results	8
5. Sensitivity Analyses	11
5.1. LNG Load	11
5.2. New Generation Project	11
6. Conclusion and Recommendation	12
7. Designated Provider of Transmission Facilities	12
8. Appendix	14
8.1. Simulation Results	14
8.2. LRGV Topology and Upgrade Options	15

1. Executive Summary

AEPSC and Sharyland Utilities, L. P. & CPS Energy have submitted Regional Planning Group (RPG) projects for the Lower Rio Grande Valley (LRGV) area. For the two RPG proposals submitted, ERCOT has conducted one combined independent review to identify transmission upgrades that will satisfy the NERC and ERCOT planning criteria by year 2021.

Based on the result of independent review, ERCOT deems the following Option 1 upgrades as necessary to meet reliability criteria:

- Install a 300-MVAR Static Var Compensator (SVC) at LaPalma 138 kV substation
- Install a 300-MVAR Static Var Compensator (SVC) at AEP Pharr 138 kV substation

The estimated cost for Option 1 upgrades is approximately \$91 million. The estimate may vary as the designated providers of the new transmission reinforcement perform more detailed cost analysis. ERCOT recommends that the designated provider for the transmission upgrades consult with ERCOT if different specifications of the dynamic reactive devices are considered for implementation. For example, a dynamic reactive device with a nominal rating less than 300 MVAR but with a short-term duty rating of at least 300 MVAR may achieve acceptable performance.

Currently, there are six proposed Liquefied Natural Gas (LNG) plants that could potentially be constructed in the LRGV at the Port of Brownsville¹. These plants could add up to potentially 2,400 MW of load in the LRGV. None of the proposed plant developers had provided financial commitment with a notice to proceed with the construction of the interconnection facilities to their respective Transmission Service Provider (TSP) at the time of this review. ERCOT performed sensitivity analysis with an assumed 700 MW LNG load (a portion of the proposed LNG facilities). The analysis showed that if this amount of load were to be added without new generation located within the LRGV, additional transmission facilities would be required beyond Option 1, potentially including the addition of a new 345 kV import line.

ERCOT also performed a sensitivity analysis to identify the impact of potential new generation that might be constructed in the LRGV area. There are currently two large natural gas combined cycle facilities proposed to be constructed in the LRGV that have a signed Standard Generation Interconnection Agreement (SGIA). It should be noted that neither of these facilities met the Planning Guide Section 6.9 requirements for inclusion in the planning models at the time of this notice because neither developer had provided the required financial security with notice to proceed with construction of the interconnection facilities to their respective interconnecting TSP. ERCOT performed this sensitivity analysis by testing the ability of the system to meet reliability criteria without any additional system upgrades if one of the potential new generation facilities were to be constructed. For this test ERCOT modeled one of the proposed new generators (La Paloma – 780 MW), though the results are expected to be similar if the other proposed facility were to be constructed.

The results of this sensitivity analysis showed that NERC and ERCOT reliability criteria could be met without any additional import facilities at this time, including those recommended in Option 1. It should be noted that the addition of either or both of these generation facilities would require transmission upgrades to facilitate the generator interconnection.

¹ See ERCOT 2015 Report on Existing and Potential Electric System Constraints and Needs at page 21; <http://www.ercot.com/content/news/presentations/2016/2015ERCOTConstraintsAndNeedsReport.pdf>

ERCOT's analysis showed that forecasted load growth beyond the year 2021 may require additional upgrades to meet ERCOT and NERC reliability criteria for the LRGV. However, due to the uncertainties surrounding the potential addition of LNG load or potential new generation being constructed in the LRGV ERCOT is proposing a "least-regrets" approach at this time. Option 1 represents the best option to meet the near-term reliability needs and all of the short-listed options needed beyond 2021 included the facilities listed in Option 1.

The other short-listed options also include facilities to meet the perceived longer-term needs of the LRGV, but which longer-term option is optimal may be influenced by whether or not LNG load materializes in the Port of Brownsville. Furthermore, if one of the proposed new combined cycle generation facilities constructs without the interconnection of LNG load addition then no additional upgrades will be needed to support LRGV imports.

However, if none of the proposed LNG load or generation projects move forward additional transmission upgrades may need to be recommended within the next one to two years.

2. Introduction

The Lower Rio Grande Valley (LRGV) area is located in the southernmost part of the ERCOT Region. The load in the LRGV area has experienced significant load growth. The summer and winter peak demand, as shown in figure 2.1, is forecasted to reach 2727 MW and 2984 MW², respectively, by the year 2021.

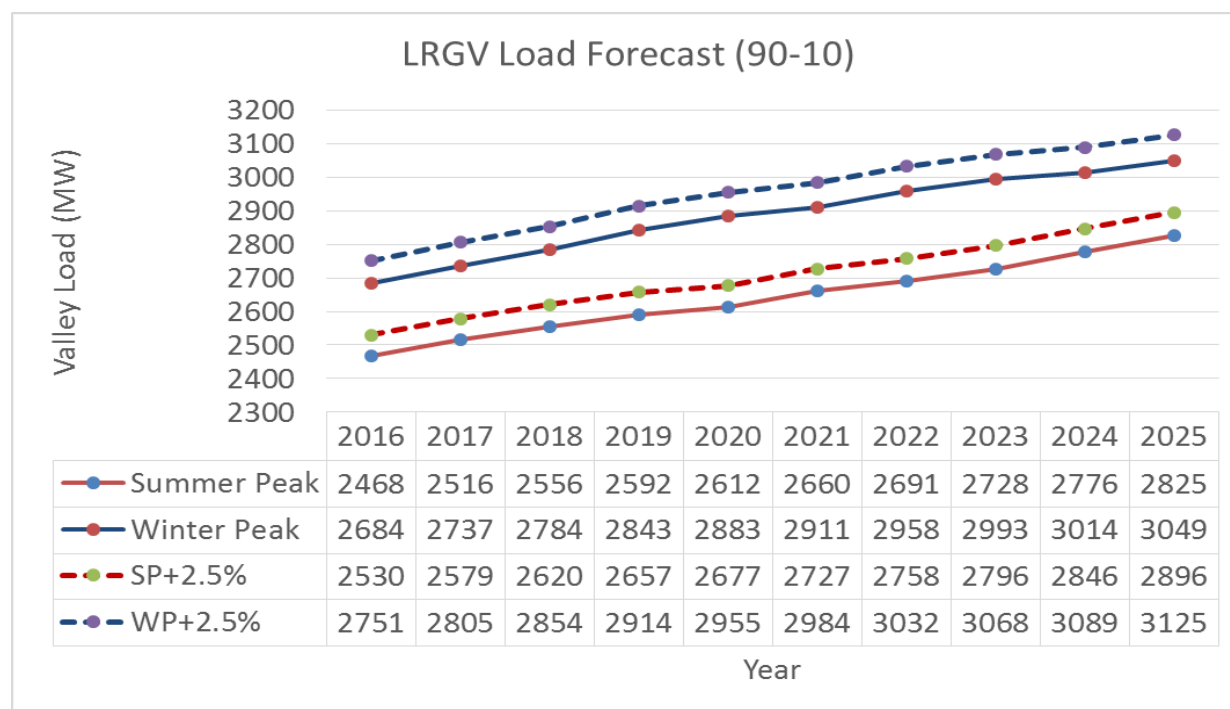


Figure 2.1: LRGV Area 90/10 Summer and Winter Peak Load Forecast

The switching of Frontera generation facility (524 MW), located in Hidalgo County, to Mexico in late 2016³, results in less local generation in the LRGV area. As of October, 2015, a total of 1,470 MW⁴ conventional generation capacity, including 1,245 MW of existing generation projects and 225 MW of new generation that satisfied Planning Guide Section 6.9., was available in the LRGV area.

In addition, approximate 4,000 MW wind generation capacity, including existing and new planned projects that met Planning Guide Section 6.9 requirements, in and near the LRGV area will be available to serve the LRGV demand. Under low wind output or generation outage conditions, the local generation plus import capability in the LRGV area will not be sufficient to meet the growing demand in the Cameron, Willacy, Hidalgo, and Starr Counties. The import needs are currently met through the following three 345 kV lines, three 138kV lines, and a DC tie with Mexico:

1. Ajo – Rio Hondo 345 kV line
2. Lon Hill – North Edinburg 345 kV line
3. New Lobo – North Edinburg 345 kV line (in-service in 2016)

² Include 2.5% voltage stability margin as required by ERCOT Planning Guide Section 4 requirements.

³ <http://www.ercot.com/content/news/presentations/2014/ERCOT%20Frontera%20Letter.pdf>

⁴ Exclude Frontera Plant Facility

4. Loyola – Armstrong 138 kV line
5. Falfurrias – Rachal 138 kV line
6. Zapata – Lopeno 138 kV line
7. Railroad DC tie

Figure 2.1 shows the system map of the study area and the generation projects in the LRGV area.

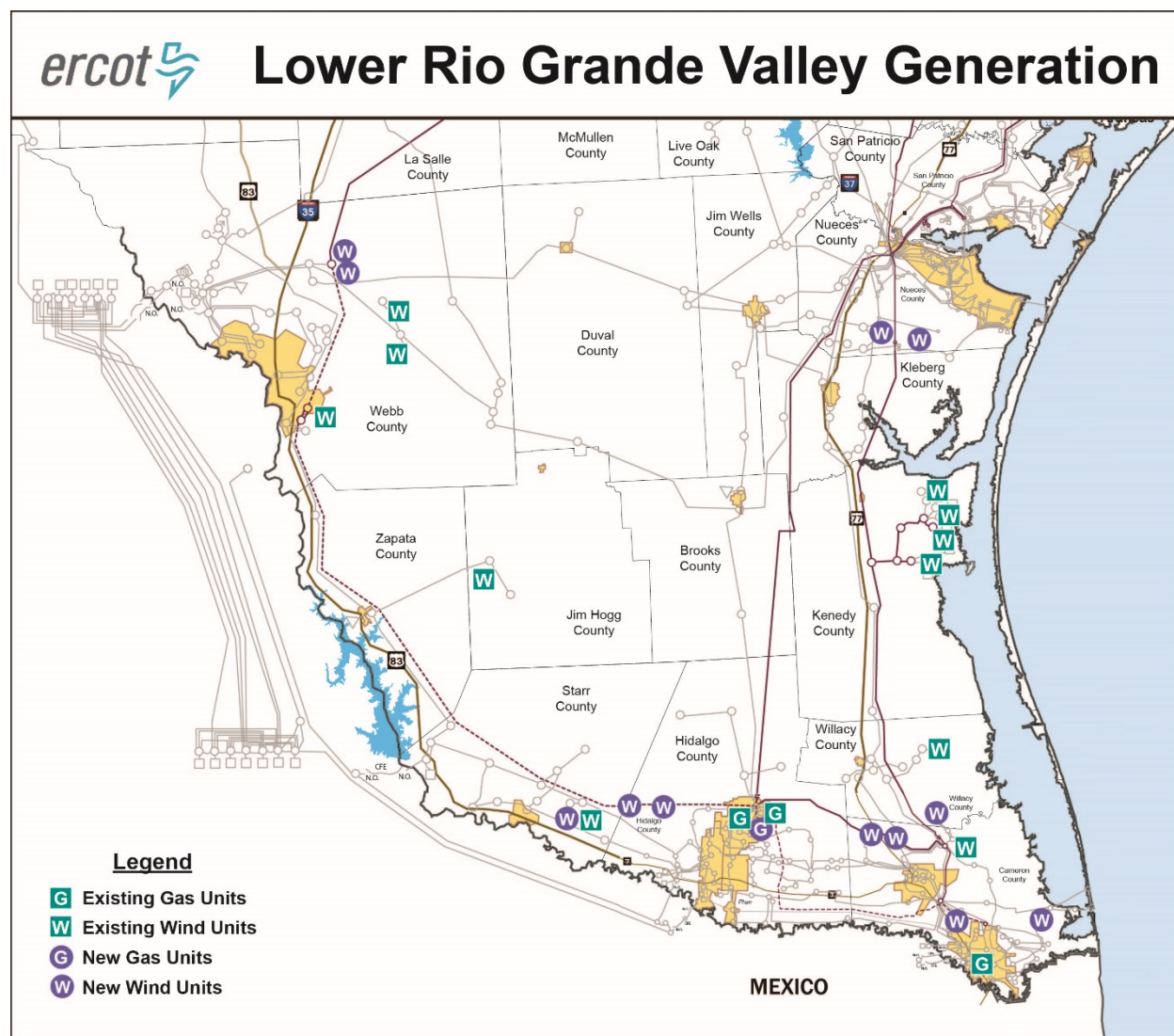


Figure 2.1: Transmission System Map of Study Area

Beginning in the year 2021, the new NERC TPL-001-4 standard (approved by the Federal Energy Regulatory Commission (FERC) on October 17, 2013) requires that the loss of a generating unit (followed by system adjustments) plus loss of a second generator, transmission circuit, transformer or shunt device must not result in the loss of non-consequential load. Based on ERCOT Planning Guide requirement, loss of an entire combined cycle train is considered loss of a single generator. This new NERC requirement (P3 event) is more stringent than the previous NERC criteria and the existing ERCOT criteria.

The Entities below independently submitted RPG proposals that identify transmission upgrade needs that are required to improve the LRGV area and avoid potential NERC TPL-001-4 and ERCOT planning criteria violations.

- AEPSC – Lower Rio Grande Valley Area Transmission Improvements Project
 - Install a +600/-200 MVAR SVC at South McAllen
 - Install a +600/-200 MVAR SVC at LaPalma
 - Install a +400/-200 MVAR SVC at Weslaco
 - Add two new 345-kV terminals at the existing Ajo Station
 - Construct a new 345-kV switching station (“NSUBLH”) approximately 1.5 miles west of the existing Lon Hill Station, bisecting the Lon Hill - Coleta Creek and Lon Hill - STEC Pawnee 345-kV transmission lines with cut-ins to the new “NSUBLH” Station. Include a 345-kV terminal for the proposed BOLD line to Ajo
 - Construct a new 345-kV BOLD line from the new NSUBLH Station to the existing Ajo Station utilizing 3 x 954 ACSR (Cardinal) conductor on double-circuit capable BOLD lattice steel structures
 - Construct a new 345/138-kV station (NSUBXING) west of the Rio Hondo Station at a point near the crossing of the east-west double-circuit North Edinburg – Rio Hondo 345-kV and Rio Hondo – South Santa Rosa 138-kV lines and the north-south Raymondville - Harlingen 69kV transmission lines. Cut-in the existing North Edinburg - Rio Hondo 345-kV and Rio Hondo - South Santa Rosa 138-kV lines. Terminate the proposed 345-kV BOLD line from Ajo. Install two (2) 675MVA, 345/138-kV autotransformers
 - Construct a new 345-kV BOLD transmission line from Ajo to NSUBXING utilizing 3 x 954 ACSR (Cardinal) conductor on double-circuit capable BOLD lattice steel structures
- Sharyland Utilities LP & CPS Energy – LRGV Import Project
 - 25 mile 345kV La Palma – Palmito single circuit line
 - 280 mile 345 kV Palmito – Elm Creek double circuit line
 - Add second 345/138 kV 450 MVA transformer at 345 kV Palmito
 - +400/-100 MVAR SVC at 138kV Loma Alta
 - +400/-100 MVAR SVC at 138kV Railroad
 - +600/-200 MVAR SVC at 138kV North Edinburgh

Upgrades for the intra-LRGV area are not included.

For the two RPG proposals submitted, ERCOT has conducted one combined independent review to identify transmission upgrades that are required to meet NERC TPL-001-4 and ERCOT planning criteria.

3. Criteria, Study Assumption and Methodology

ERCOT performed studies under various system conditions to evaluate the reliability need and to identify a cost-effective solution from both near-term and long-term transmission planning perspectives. The study criteria, assumptions and methodology for the ERCOT independent review are described in this section.

3.1. Study Region and Criteria

The primary focus of the study was the transmission system in and around the LRGV area, which consists of the following six zones as defined in the Steady State Working Group (SSWG) base cases:

- 610 (E Valley)
- 615 (W Valley)
- 800 (BPUB)
- 829 (SHRY)
- 875 (MVEC_E)
- 876 (MVEC_W)

The following reliability criteria were applied in this study.

- NERC Reliability Standard TPL-001-4 and ERCOT Planning Guide.

3.2. Study Assumption and Methodology

3.2.1. Study Base Cases and Modification

The following base cases were used in the study:

- The 2021 South/South Central (SSC) summer peak case from the 2015 RTP (based on the 2015 SSWG Dataset B) for voltage stability analysis
- The long term 2021 Dynamic Working Group (DWG) flat start case posted on ERCOT MIS in March, 2015 for transient stability analysis

The ERCOT Upgrade D listed in the “*ERCOT Independent Review of AEPSC Hidalgo Starr Transmission Project*” was included in the based case. These upgrades are as follows:

- Expand the existing Stewart Road 138 kV substation to include new breakers and protection equipment for two new 345 kV transmission lines and two 345/138 kV transformers.
- Install two 345/138 kV autotransformers at Stewart Road 138 kV substation
- Construct a new 345 kV double circuit transmission line (a single ROW), approximately 5 miles from Stewart Road 138 kV substation to a tap location on the North Edinburg to Loma Alta 345 kV line, 30 miles from North Edinburg 345/138 kV substation.
- Expand the existing West Edinburg 138 kV substation to a new 5 breaker ring bus to accommodate the termination of two new 138 kV transmission lines.
- Construct approximately 1000 feet of new 138 kV transmission line to loop in the North Edinburg to Palmhurst 138 kV line into the West Edinburg 138 kV substation.

- Operate the Pharr –North McAllen 138 kV line segment normally closed except for certain N-1-1 conditions

Generators in the South Weather Zone that met Planning Guide Section 6.9 requirements for inclusion in the planning models at the time of study, which were not included in the 2015 RTP cases, were added. The added generators are listed in Table 2.1.

Table 2.1: Generators Met Planning Guide Section 6.9 Requirements as of October 21, 2015

GINR Number	Project Name	MW	Fuel	County	Weather Zone
13INR0055	Javelina Wind	250	Wind	Zapata	Southern
14INR0013	San Roman I	103	Wind	Cameron	Southern
14INR0041a	Redfish Wind 2a	115	Wind	Willacy	Southern
14INR0041a	Redfish Wind 2b	115	Wind	Willacy	Southern
14INR0045a	Torrecillas Wind A	200	Wind	Webb	Southern
14INR0045b	Torrecillas Wind B	200	Wind	Webb	Southern
15INR0021	Los Vientos V	110	Wind	Starr	Southern
15INR0037	Los Vientos IV	200	Wind	Starr	Southern
16INR0024	Hidalgo & Starr	250	Wind	Hidalgo	Southern
16INR0055	Chapman Ranch Wind I	250	Wind	Nueces	Southern
11INR0057	Cameron County wind	165	Wind	Cameron	Southern
11INR0062	Patriot Wind	180	Wind	Nueces	Southern
12INR0068	Sendero	78	Wind	Jim Hogg	Southern

3.2.2. Study Assumptions

Key assumptions applied in this study include the following:

- The Frontera generation facility (524MW) was kept offline in study base cases.
- Railroad DC tie exports was dispatched at 0 MW to Mexico during multiple outage (n-1-1) scenarios. The capacitor banks at ERCOT Rail Road substation were unavailable at 0 MW transfer level.
- Distributed generators in the LRGV area were offline since they have been assumed unavailable for dispatch.
- Wind generation in and around the LRGV area was dispatched at 10% and 25% of its rated capacity for summer and winter peak conditions; respectively.
- Dynamic load models and UVLS (under voltage load shed scheme) models submitted by the TSPs as part of the proposal submittals were included in the transient analysis.

3.2.3. Study Methodology

This study focused on voltage and transient stability issues for the LRGV area. As identified in the *ERCOT Independent Review of AEPSC Hidalgo Starr Transmission Project*, both the thermal and voltage violations under N-1 condition are localized issues that can be fixed by local projects and they are not included in the consideration of this Valley import reliability need analysis.

3.2.4. Study Tools

ERCOT utilized the following software tools for the independent review of Panhandle transmission upgrades:

- VSAT version 15 was used for voltage stability analysis
- PSS/e version 33 was used for transient stability simulations

4. Analysis Results

Based on transient stability assessment results, the LRGV transmission system is capable of supporting a LRGV load level of approximately 2700 MW. The most limiting contingency is loss of two large combined cycle train in the LRGV area. It should be noted that a small amount of under voltage load shedding (UVLS, less than 100 MW) and slow voltage recovery at various locations in the LRGV area was observed in the simulation results. The load shedding around LaPalma substation (East Valley) was observed along with slow voltage recovery in the western LRGV region. The voltage recovery plots of a few substations may be found in Appendix.

Transmission upgrades are required to avoid UVLS for the projected load in the LRGV area in 2021 to meet NERC TPL-001-4 requirements.

Based on the submitted proposals and system upgrade needs, ten upgrade options were developed and the detailed description of these options are listed below. Topology of these ten upgrade options are listed in the Appendix. The SVC locations in Option 1 were determined based on two major considerations: the UVLS locations and the capability to provide broader voltage support (in terms of electrical connectivity to the rest of LRGV area) to both East and West LRGV area.

- Option 1
 - Install a 300 MVAR SVC at LaPalma 138 kV substation
 - Install a 300 MVAR SVC at AEP Pharr 138 kV substation
- Option 2
 - Install a 300 MVAR SVC at LaPalma 138 kV substation
 - Install a 300 MVAR SVC at AEP Pharr 138 kV substation
 - Build a new NSUBLH – LaPalma 345 kV line (requiring approximately 150 miles of new Right of Way) using BOLD structures
- Option 3
 - Install a 300 MVAR SVC at LaPalma 138 kV substation
 - Install a 300 MVAR SVC at AEP Pharr 138 kV substation
 - Build a new NSUBLH – NSUBXING 345 kV line (requiring approximately 136 miles of new Right of Way) using BOLD structures
 - Install two 345/138 kV autotransformers at NSUBXING where North Edinburg – Rio Hondo 345-kV and Rio Hondo – South Santa Rosa 138-kV lines cross
- Option 4
 - Install a 300 MVAR SVC at LaPalma 138 kV substation

- Install a 300 MVAR SVC at AEP Pharr 138 kV substation
- Add a second circuit to the San Miguel – LOBO – North Edinburg 345 kV line (approximately 230 miles and requiring approximately 7 miles of new Right of Way)
- Option 5
 - Option 5 is similar to Option 3 with the new import line looped and connecting the Ajo 345 kV substation
- Option 6
 - Option 6 is similar to Option 2 with the new import line looped and connecting the Ajo 345 kV substation
- Option 7
 - Install a 300 MVAR SVC at LaPalma 138 kV substation
 - Install a 300 MVAR SVC at AEP Pharr 138 kV substation
 - Build a new Elm Creek – Palmito 345 kV line (requiring approximately 280 miles of new Right of Way)
- Option 8
 - Option 8 is similar to Option 7 with the new import line looped and connecting the Ajo 345 kV substation
- Option 9
 - Install a 300 MVAR SVC at LaPalma 138 kV substation
 - Install a 300 MVAR SVC at AEP Pharr 138 kV substation
 - Build a new NSUBLH – North Edinburg 345 kV line (requiring approximately 140 miles of new Right of Way) and loop the Ajo 345 kV substation into it
- Option 10
 - Install a 300 MVAR SVC at LaPalma 138 kV substation
 - Install a 300 MVAR SVC at AEP Pharr 138 kV substation
 - Build a new San Miguel – North Edinburg 345 kV line (requiring approximately 150 miles of new Right of Way)

ERCOT performed voltage stability assessment (steady state PV analysis) to identify the LRGV load serving capability for each developed upgrade option and the associated limiting contingencies. Based on the load serving capability and cost estimate and load serving capability, a few selected upgrade options were then included in the transient stability analysis to verify the upgrade needs while meeting NERC and ERCOT planning criteria.

The voltage stability transfer assessment results and cost estimates for all developed ten upgrade options are shown in figure 5.1. All ten upgrade options can serve the projected LRGV load forecast for 2021 and the only top three upgrade options based on capital cost estimate and new ROW impact were selected for transient stability analysis to ensure the identified upgrades are adequate to satisfy the NERC TPL-001-4 and ERCOT planning criteria while including detailed dynamic load models as provided by AEPSC.

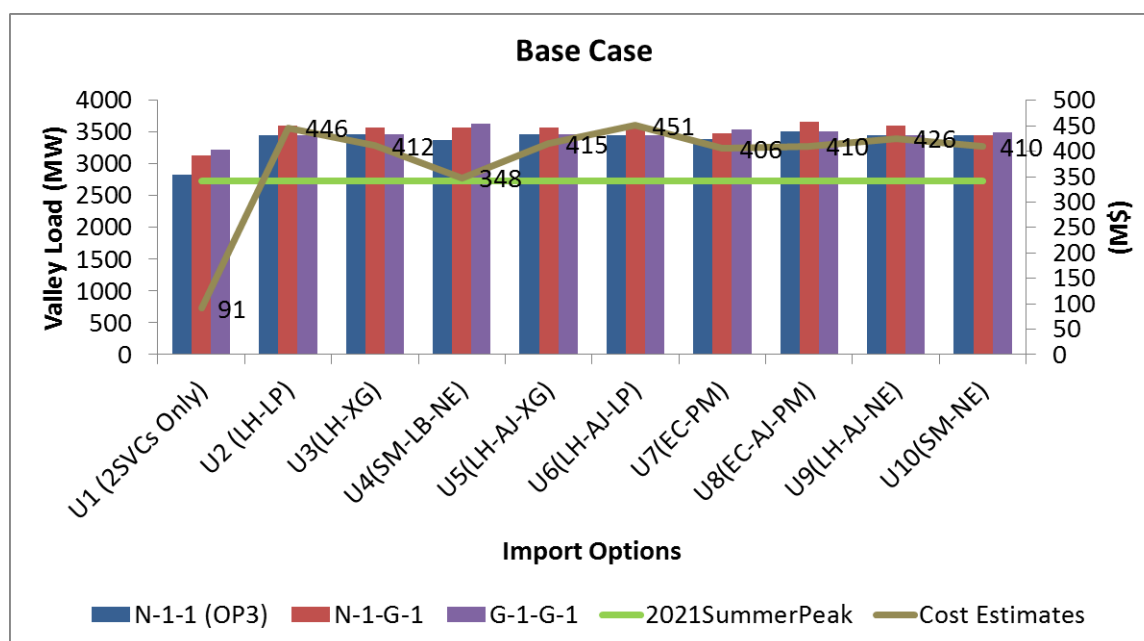


Figure 5.1: VSAT Results and Cost Estimate of Each Upgrade Options

Table 5.1 summarizes the comparison of the three selected upgrade options.

Table 5.1: Comparison of Three Selected Upgrade Options

Items	Option 1 (2 SVCs)	Option 4 (2 SVCs + 2 nd circuit)	Option 5 (2 SVCs + new import)
Summer Peak Load Serving Capability (MW)(1)	2800	3300	3400
Winter Peak Load Serving Capability (MW)	~3100	>3300	>3400
Reliability Criteria Exceedance by Year	2023	Beyond 2025	Beyond 2025
Cost Estimate (\$million)	91	330 ~ 348	415
Total New ROW Required (miles)	0	~7	~140
Estimated Implementation Time	3	3	5

(1). No UVLS triggering was observed.

5. Sensitivity Analyses

5.1. LNG Load

Currently, there are six proposed Liquefied Natural Gas (LNG) plants that could potentially be constructed in the LRGV at the Port of Brownsville⁵. These plants could add up to potentially 2,400 MW of load in the LRGV. None of the proposed plant developers had provided financial commitment with a notice to proceed with the construction of the interconnection facilities to their respective Transmission Service Provider (TSP) at the time of this review. ERCOT performed sensitivity analysis with an assumed 700 MW LNG load (a portion of the proposed LNG facilities).

The load was interconnected to Rio Hondo, LaPalma, and Palmito 345 kV substations via three 345 kV lines. The actual integration could be different and will be dependent on the future conditions of the system. It was assumed that a large capacitor bank will be installed at the site of the LNG load for voltage support.

The analysis showed that if this amount of load were to be added without new generation located within the LRGV, additional transmission facilities would be required beyond Option 1, potentially including the addition of a new 345 kV import line into the east side of the LRGV in order to meet the ERCOT and NERC reliability criterion.

5.2. New Generation Project

ERCOT also performed a sensitivity analysis to identify the impact of potential new generation that might be constructed in the LRGV area. There are currently two large natural gas combined cycle facilities proposed to be constructed in the LRGV that have a signed Standard Generation Interconnection Agreement (SGIA). It should be noted that neither of these facilities met the Planning Guide Section 6.9 requirements for inclusion in the planning models at the time of this study because neither developer had provided the required financial security with notice to proceed with construction of the interconnection facilities to their respective interconnecting TSP. ERCOT performed this sensitivity analysis by testing the ability of the system to meet reliability criteria without any additional system upgrades if one of the potential new generation facilities were to be constructed. For this test ERCOT modeled one of the proposed new generators (La Paloma – 780 MW), though the results are expected to be similar if the other proposed facility were to be constructed.

The results of this sensitivity analysis showed that NERC and ERCOT reliability criteria could be met without any additional import facilities at this time, including those recommended in Option 1. It should be noted that the addition of either or both of these generation facilities would require transmission upgrades to facilitate the generator interconnection.

ERCOT further studied this scenario by adding 700 MW of LNG load. The results showed that with one of the new proposed generation facilities (780 MW) and 700 MW of LNG load no additional LRGV import facilities were required.

⁵ See ERCOT 2015 Report on Existing and Potential Electric System Constraints and Needs at page 21; <http://www.ercot.com/content/news/presentations/2016/2015ERCOTConstraintsAndNeedsReport.pdf>

6. Conclusion and Recommendation

Based on the independent review, ERCOT recommends upgrade Option 1 identified an upgrade need to meet NERC and ERCOT planning criteria:

- Install a 300-MVAR Static Var Compensator (SVC) at LaPalma 138 kV substation
- Install a 300-MVAR Static Var Compensator (SVC) at AEP Pharr 138 kV substation

The estimated cost for Option 1 upgrades is approximately \$91 million. The estimate may vary as the designated providers of the new transmission reinforcement perform more detailed cost analysis. ERCOT recommends that the designated provider for the transmission upgrades consult with ERCOT if different specifications of the dynamic reactive devices are considered for implementation. For example, a dynamic reactive device with a nominal rating less than 300 MVAR but with a short-term duty rating of at least 300 MVAR may achieve acceptable performance.

ERCOT performed sensitivity analysis with an assumed 700 MW LNG load (a portion of the proposed LNG facilities). The analysis showed that if this amount of load were to be added without new generation located within the LRGV, additional transmission facilities would be required beyond Option 1, potentially including the addition of a new 345 kV import line.

ERCOT also performed a sensitivity analysis to identify the impact of potential new generation that might be constructed in the LRGV area. ERCOT performed this sensitivity analysis by testing the ability of the system to meet reliability criteria without any additional system upgrades if one of the potential new generation facilities were to be constructed. For this test ERCOT modeled one of the proposed new generators (La Paloma – 780 MW), though the results are expected to be similar if the other proposed facility were to be constructed.

The results of this sensitivity analysis showed that NERC and ERCOT reliability criteria could be met without any additional import facilities at this time, including those recommended in Option 1. It should be noted that the addition of either or both of these generation facilities would require transmission upgrades to facilitate the generator interconnection.

ERCOT's analysis showed that forecasted load growth beyond the year 2021 may require additional upgrades to meet ERCOT and NERC reliability criteria for the LRGV. However, due to the uncertainties surrounding the potential addition of LNG load or potential new generation being constructed in the LRGV ERCOT is proposing a "least-regrets" approach at this time. Option 1 represents the best option to meet the near-term reliability needs and all of the short-listed options needed beyond 2021 included the facilities listed in Option 1.

The other short-listed options also include facilities to meet the perceived longer-term needs of the LRGV, but which longer-term option is optimal may be influenced by whether or not LNG load materializes in the Port of Brownsville. Furthermore, if one of the proposed new combined cycle generation facilities constructs without the interconnection of LNG load addition then no additional upgrades will be needed to support LRGV imports.

However, if none of the proposed LNG load or generation projects move forward additional transmission upgrades may need to be recommended within the next one to two years.

7. Designated Provider of Transmission Facilities

In accordance with the ERCOT Nodal Protocols Section 3.11.4.8, ERCOT staff is to designate transmission providers for projects reviewed in the RPG. The default providers will be those that own the end points of the new projects. These providers can agree to provide or delegate the new

facilities or inform ERCOT if they do not elect to provide them. If different providers own the two ends of the recommended projects, ERCOT will designate them as co-providers and they can decide between themselves what parts of the recommended projects they will each provide.

AEPSC owns both the LaPalma and Pharr substations, therefore, ERCOT designates AEPSC as the provider for all of the recommended projects in this independent review.

8. Appendix

8.1. Simulation Results

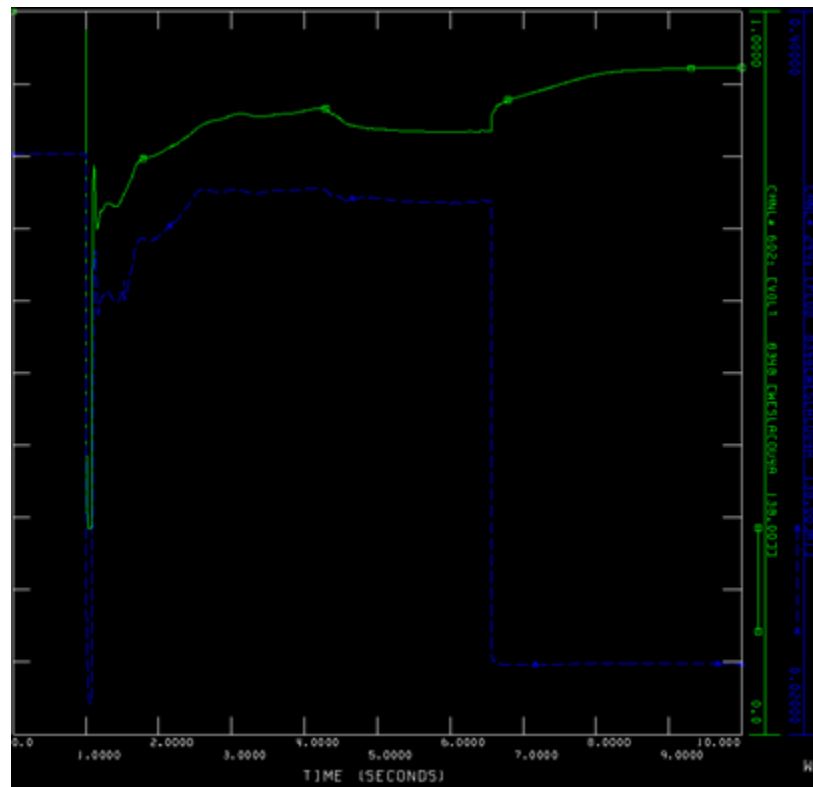


Figure 8.1: ULVS Triggering at approx. 2700 MW Summer Peak in the LRGV area

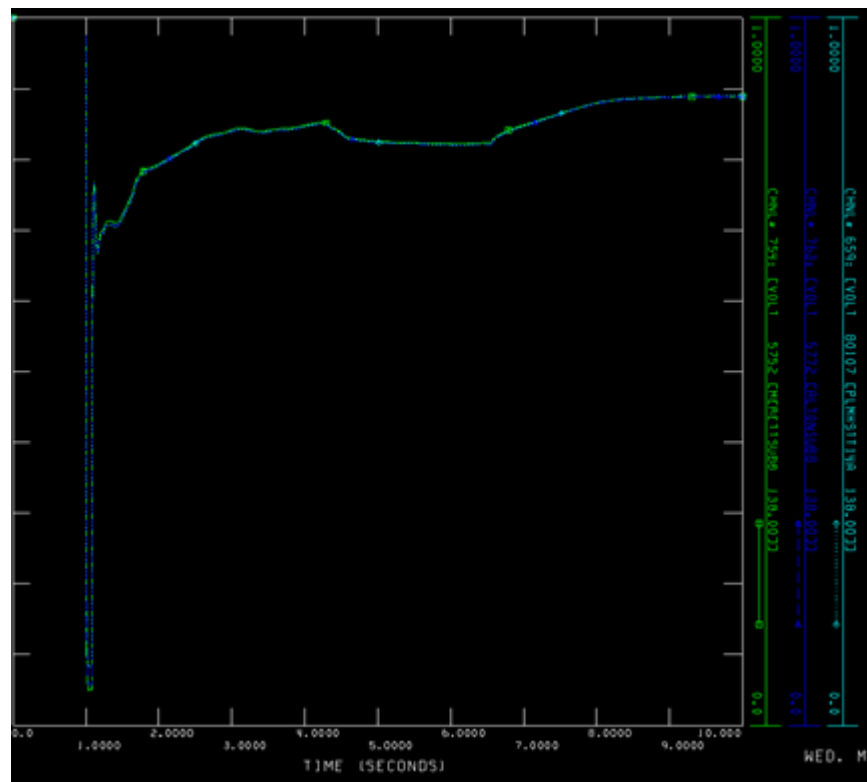
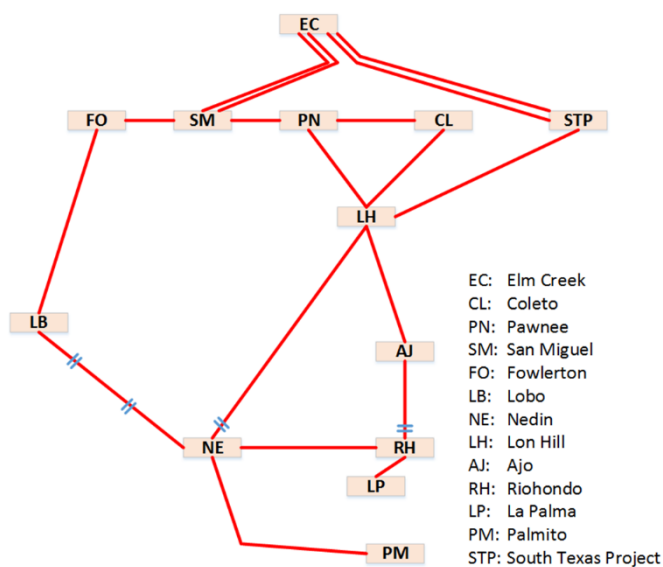


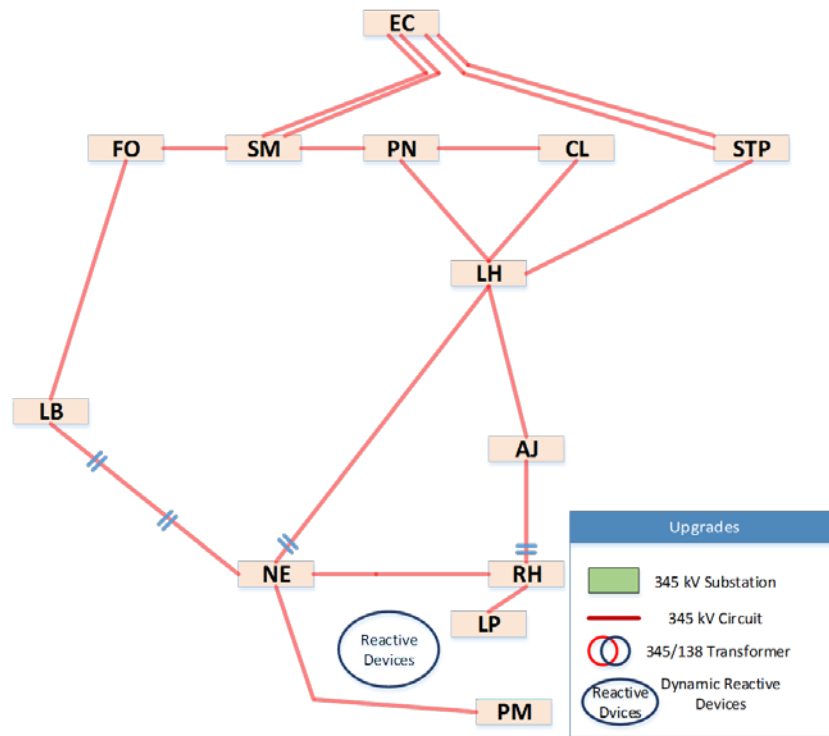
Figure 8.2: Slow Voltage Recovery at approx. 2700 MW Summer Peak in the LRGV area

8.2. LRGV Topology and Upgrade Options

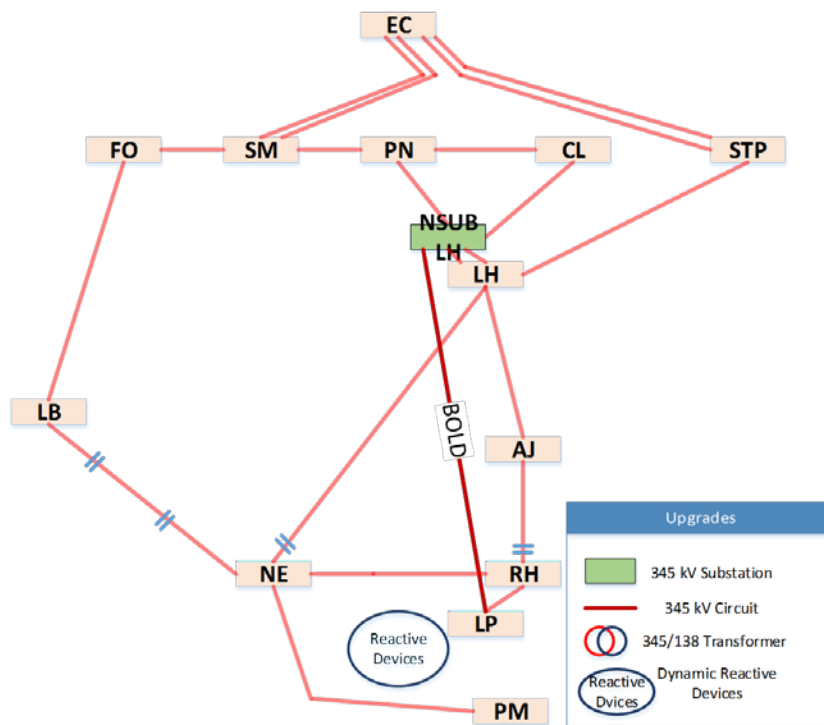
Existing LRGV Area Topology:



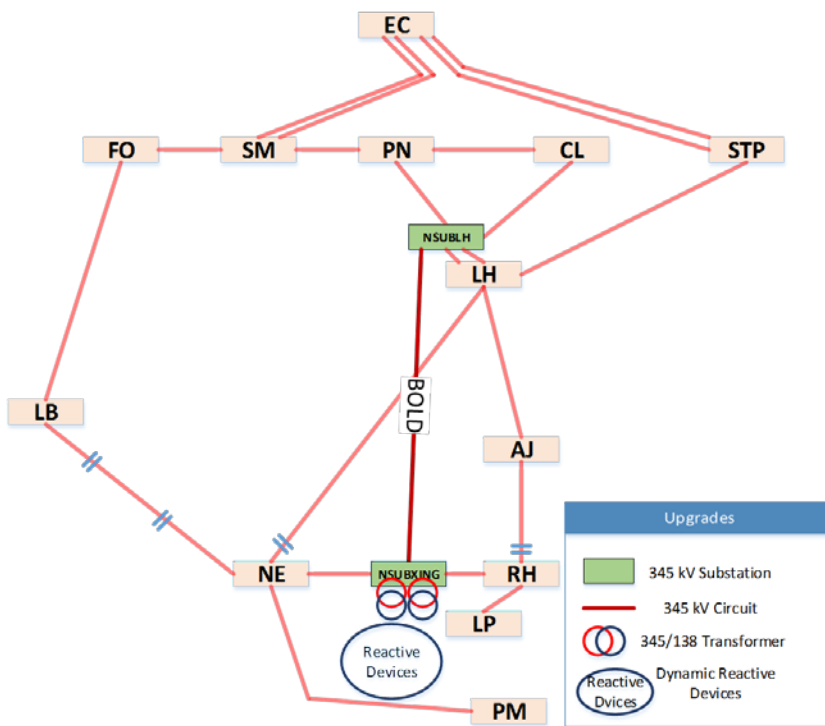
Option 1:



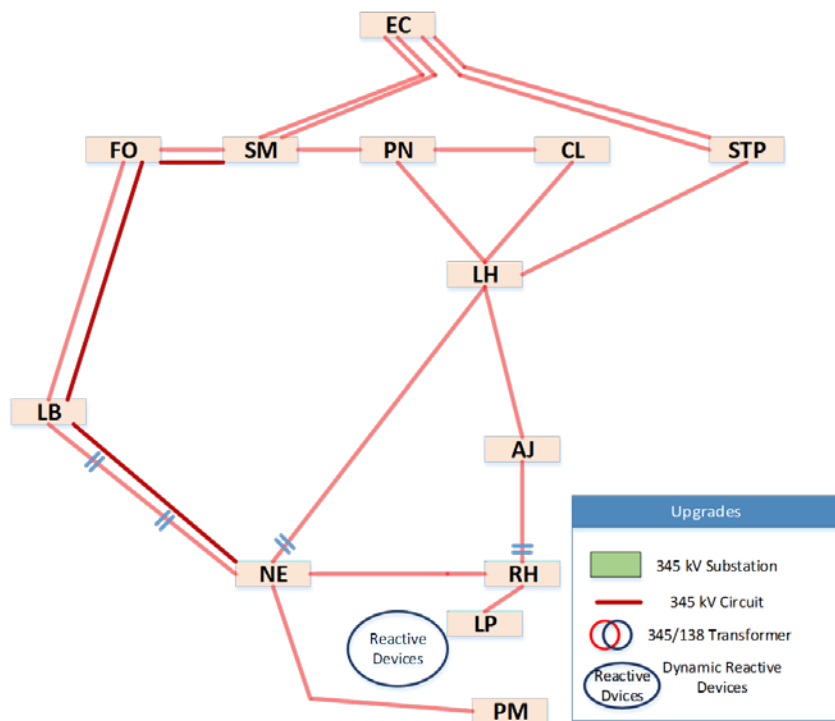
Option 2:



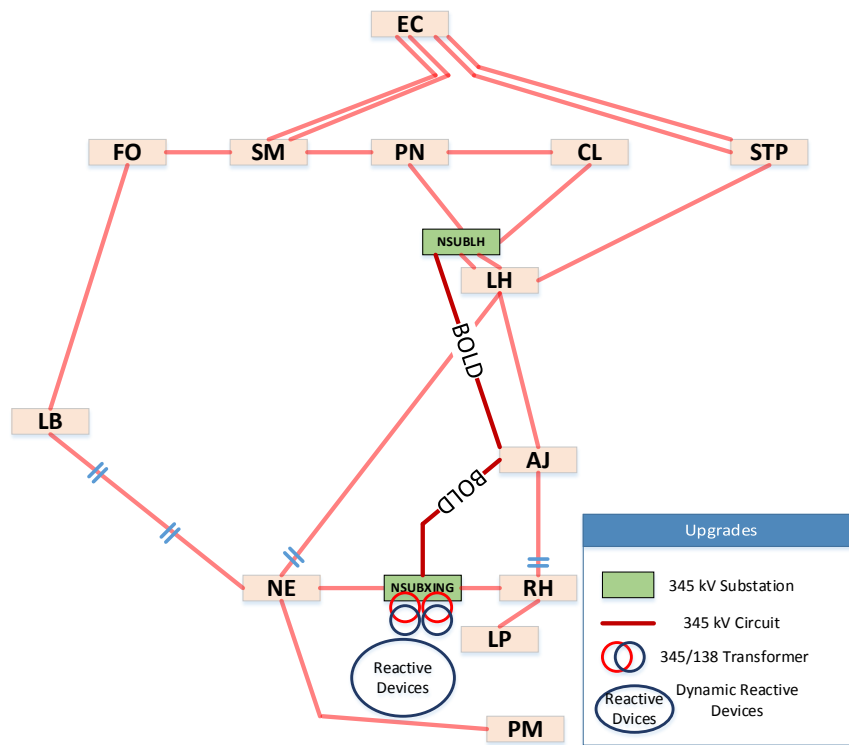
Option 3:



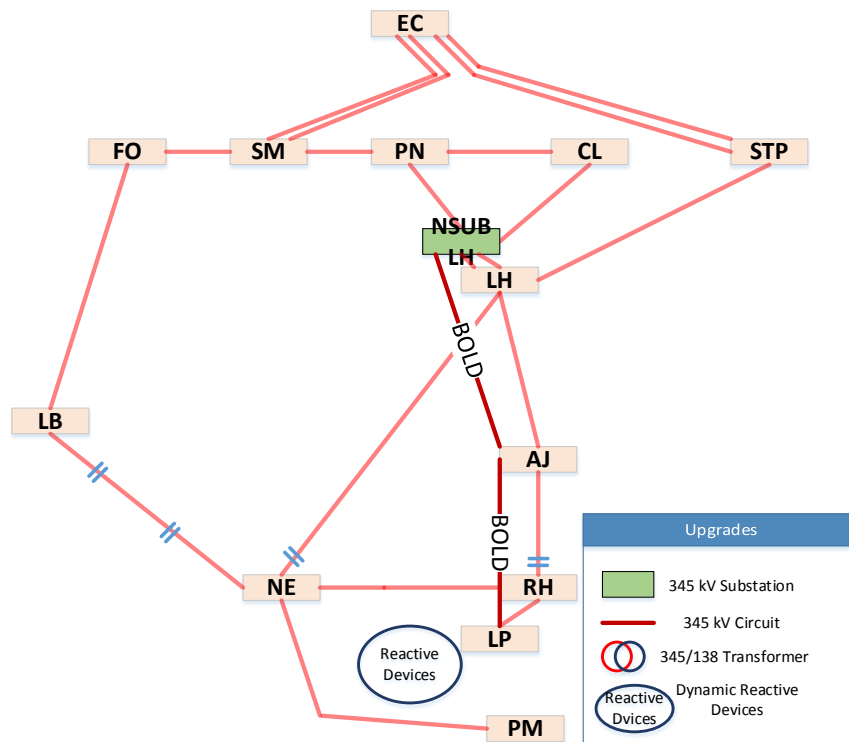
Option 4:



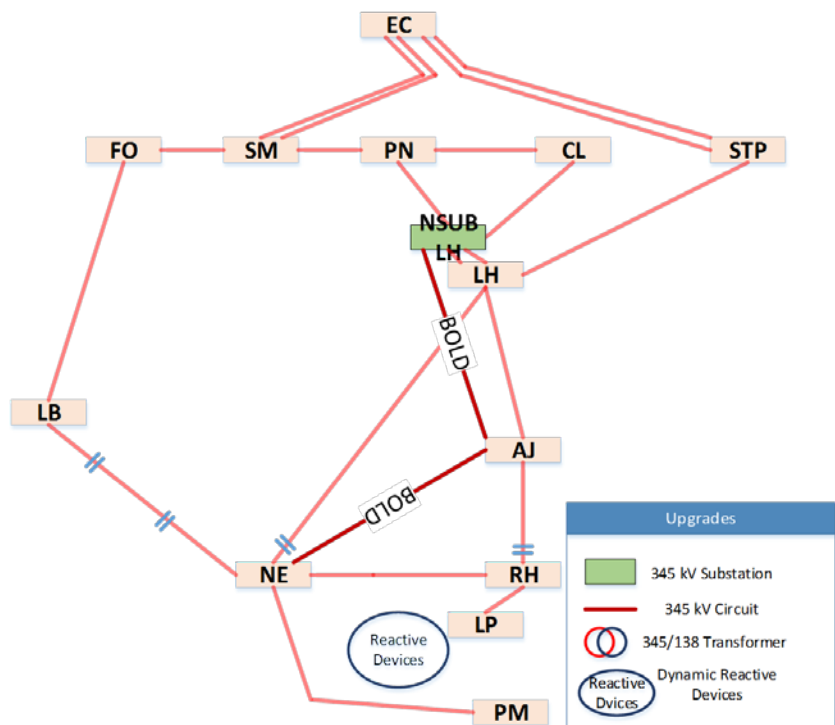
Option 5:



Option 6:



Option 9:



Option 10:

