ATTACHMENT 2

ERCOT INDEPENDENT REVIEW

OF FREEPORT MASTER PLAN PROJECT

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ERCOT Independent Review of the CenterPoint Energy Freeport Master Plan Project

Version 1.0

Document Revisions

Date	Version	Description	Author(s)
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1. Introduction

The Freeport area located in Brazoria County is a highly industrialized region, and it has a major seaport. It has several large chemical facilities, and the customer demand is steadily on the rise.

From 2012 through 2017 various transmission upgrade projects (the 'Freeport Area Upgrades', the 'Dow-Velasco 345/138 kV Autotransformer Addition' and the 'Jones Creek Project') were completed in this region. With continued load growth the need for additional long-term transmission project solutions remains.

As a highly industrialized region, the Freeport region, serviced by the CenterPoint Energy transmission system, is forecasted to experience significant load growth. The load is forecasted to increase by 92% from 2016 to 2019 as shown in Figure 1.1 (the values shown for years 2012 through 2016 are historic peak demand and the values for years 2017 through 2022 are forecasted peak demand based on existing plus committed new customer loads).

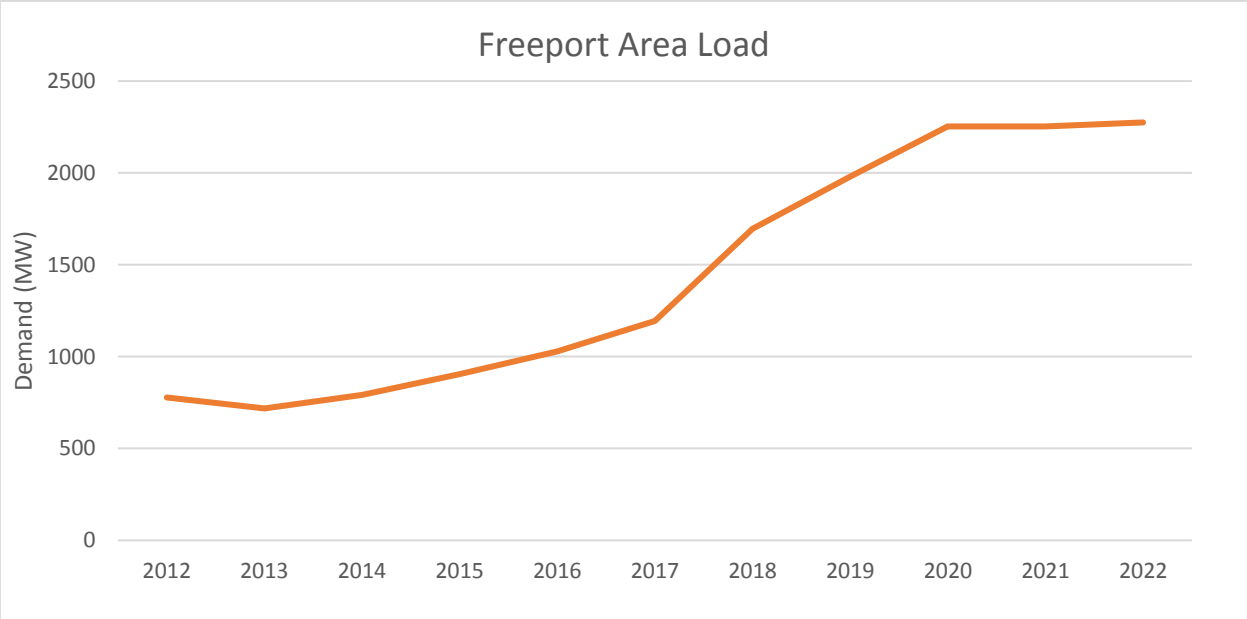

Figure 1.1: Freeport historic and projected load forecast

Table 1.1 – Historic and Projected Load

	Historical Load					*Load Projections*					
Year	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***
Total (MW)	***777***	***718***	***791***	***904***	***1028***	***1194***	***1695***	***1979***	***2254***	***2254***	***2275***

In May 2017, CenterPoint Energy Houston Electric, LLC (CenterPoint Energy) submitted the 'Freeport Master Plan Project' to the Regional Planning Group (RPG) to address the reliability concerns in the

Freeport region. The project as proposed would be completed in two phases – in 2019 and 2021/2022. The initial phase called the 'Bridge the Gap Upgrades' has an estimated cost of $32.3 Million. The second phase which includes a new approximately 48 mile 345 kV double circuit transmission line from Bailey Substation to Jones Creek Substation, is estimated to cost $214.4 Million. With a combined project cost of $246.7 Million, this proposal is classified as a Tier 1 project pursuant to Protocol Section 3.11.4.7.

Based on the Freeport Master Plan Project proposal, ERCOT completed an independent review to determine the system needs and address those needs in a cost-effective manner, while providing the flexibility to meet potential load growth in this region. ERCOT also performed sensitivity studies in accordance with the ERCOT Planning Guide.

Based on the forecasted loads and scenarios analyzed, ERCOT has determined that there is a reliability need to improve the transmission system in Freeport region. After consideration of the project alternatives, ERCOT concluded that the 'Bridge The Gap' upgrades and the new transmission lines identified in Option 3 (described below) are needed to meet reliability criteria in the most cost efficient manner:

Bridge the Gap upgrades:

- Loop 345 kV South Texas Project (STP) – Dow-Velasco circuit 27 into the Jones Creek Substation (approximately 0.9 mile)
- Install 7-ohm in-line reactors at the Jones Creek Substation on 345 kV STP – Jones Creek circuits 18 and 27
- Install 3rd 345/138 kV 800/1000 MVA Autotransformer at the Jones Creek Substation
- Install 4th 138 kV Capacitor Bank (120 MVAr) at Jones Creek Substation
- Install 1st 138 kV Automatically Switchable Capacitor Bank (140 MVAr) at Jones Creek Substation
- Install 2nd 138 kV Automatically Switchable Capacitor Bank (140 MVAr) at Jones Creek Substation

Option 3:

- Construct a new approximately 48 mile 345 kV double circuit transmission line from Bailey Substation to Jones Creek Substation (2988 MVA emergency rating)
- Upgrade 345 kV Dow-Velasco to Jones Creek circuits 18 and 27 which is approximately 3 miles (minimum 1700 MVA emergency rating)

2. Study Assumption and Methodology

ERCOT performed studies under various system conditions to identify the need for a project and to evaluate a cost-effective solution to meet the identified need in the area. The assumptions and criteria used for this review are described in this section.

2.1. Assumptions

The primary focus of this review is the Freeport area transmission system serviced by CenterPoint Energy, located in the Brazoria County.

Figure 2.1 shows the system map of the study area. The Freeport area is highlighted below in the rectangle.

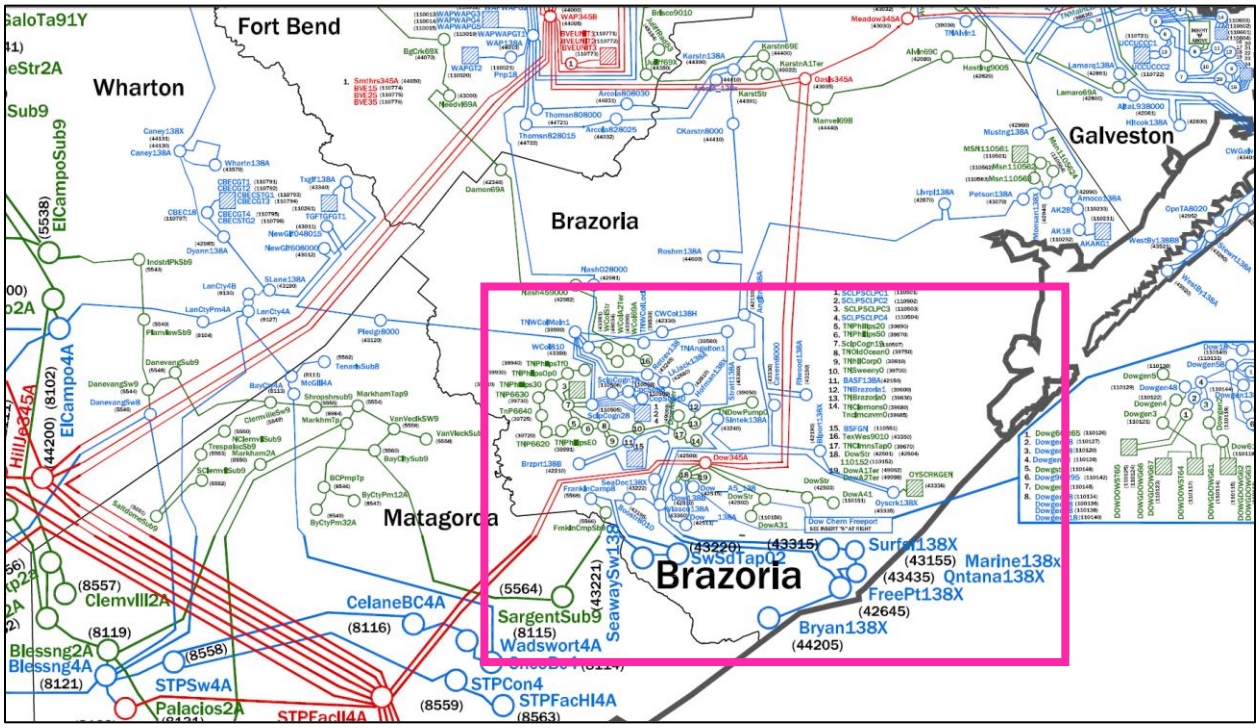

Figure 2.1: Transmission System Map of Study Area

2.1.1. Reliability Cases

The following starting cases were used in the study:

- The 2019 East/Coast (EC) summer peak case from the 2017 Regional Transmission Plan (RTP) published on the ERCOT Market Information System (MIS) in June 2017 (based on the 2016 Steady State Working Group (SSWG) cases released in February 2017)
- The 2020 East/Coast (EC) summer peak case from the 2017 RTP published on the MIS in June 2017 (based on the 2016 SSWG cases released in February 2017)
- The 2022 East/Coast (EC) summer peak case from the 2017 RTP published on the MIS in June 2017 (based on the 2016 SSWG cases released in February 2017)
- The 2023 Long Term (LT) Dynamic Working Group (DWG) summer peak flat start case (based on the 2016 SSWG cases)

2.1.2. Transmission Topology

The steady state starting cases were modified to incorporate the following changes ->

- A 345/138 kV autotransformer with 800 MVA capacity was added at PH Robinson substation. This was a Tier 4 project included in the June 2017 Transmission Projects Information Tracking (TPIT). This change was made to all the start cases.
- Two RTP reliability projects – Freeport 'Bridge the Gap Upgrades' and Bailey to Jones Creek 345 kV double circuit lines – were included in the 2020 and 2022 start cases. These projects are part of this independent review and hence, were removed from the cases.

2.1.3. Loads

Loads with signed agreements in the area of study were already incorporated in the 2017 RTP reliability cases. As such, no load changes were made to any of the steady state cases.

Table 2-1 below shows the total projected non-coincident peak load located in the Freeport area as modeled in the 2017 RTP cases.

Table 2.1 Total Non-coincident Peak Load in the Freeport area

Load Type	Projections by Year (MW)		
	2019	2020	2022
Industrial	1850.13	2124.62	2141.93
Distribution	129.16	129.4	133
Total (Industrial + Distribution)	1979.29	2254.02	2274.93

Apart from the contracted loads, CenterPoint Energy has also provided data for additional potential non-committed load, which altogether account for an additional 657 MW for the year 2021/2022. These loads were not included in the base case evaluation of project need, but they were added to separate cases and studied as a sensitivity as described in Section 7.

2.1.4. Generation

All planned generation units in the Coast weather zone that met Planning Guide Section 6.9 conditions (according to the 2017 June Generation Interconnection Status report) for inclusion in the base cases were already included in the RTP cases.

2.1.5. Maintenance Outage Scenario

Table 2.1 indicates that a majority of the Freeport area load is industrial in nature. This means the load is relatively constant throughout the year, and there are no off-peak load periods to schedule maintenances outages. Because of this, it can be challenging to schedule maintenance outages of equipment without operating in a state such that the contingency of another facility causes thermal or voltage limit exceedances. To give due consideration for such operational flexibility and reliability in

this region, ERCOT studied the system under various potential high impact maintenance outage scenarios. Violations under these N-1-1 conditions in the base case were studied. A comparison of performance of each of the project options under all the maintenance scenarios is also included in this analysis.

2.1.6. Capital Cost Estimates

Capital costs estimates for transmission options were provided by CenterPoint Energy. ERCOT used these values to calculate total project costs for various options.

2.2. Contingencies and Criteria for Violations

For steady-state reliability analysis the following contingencies relevant to the study region were considered:

- NERC TPL-001-4 and ERCOT Planning Criteria
  - P0
  - P1-1, P1-2, P1-3, P1-4,
  - P2-1, P2-2, P2-3 (All EHV only)
  - P3 (G-1 + N-1 worst case only)
  - P4-1, P4-2, P4-3, P4-4, P4-5 (All EHV only)
  - P5-1, P5-2, P5-3, P5-4, P5-5 (All EHV only)
  - P6 (X-1 + N-1; S-1 + N-1; N-1-1 for EHV only)
  - P7-1

All the violations identified in this report used the criteria described in this section.

All 100 kV and above busses, transmission lines, and transformers in the study region were monitored (excluding generator step-up transformers).

- Thermal violation
  - Rate A for Pre-contingency Conditions
  - Rate B for Post-contingency Conditions
- Voltage violation criteria
  - 0.95 < V P.U. < 1.05 Pre-contingency Conditions
  - 0.92 < V P.U. < 1.05 Post-contingency Conditions
- Post Contingency voltage deviations
  - 8% on non-radial load buses
- Voltage Stability Analysis
  - PV calculations for load transfer
- Transfer Capability Analysis
  - Voltage stability criteria for load transfer

2.3. Study Tools

ERCOT utilized the following software tools for the independent review of the Freeport Master Plan Project:

- PSS/e version 33.10 was used to perform the dynamic stability analysis
- PowerWorld Simulator version 19 for SCOPF and steady state contingency analysis
- VSAT version 16 was used for voltage stability transfer analysis
- UPLAN v 10.2.0.7 for economic analysis

3. Project Need

The need for a transmission improvement project was evaluated for all three study cases – 2019, 2020 and 2022 (steady state cases).

For 2019, the study case showed no thermal or voltage violations under any of the studied contingency categories, and there were no unsolved contingencies.

For 2020, there were no unsolved contingencies, but ERCOT found both thermal and voltage violations. Tables 3-1 and 3-2 summarize all of the violations for the 2020 study case under various contingency categories.

Table 3-1: Steady State Thermal Violations for 2020 Study Case under Base Load Conditions

Contingency Category	Branch Violations		
	Element	KV	Max. Loading (%)
P1, P2-1, P7	-	-	-
P2-2, P2-3, P4-2, P4-3, P4-4, P4-5, P5	STP to Jones Creek Ckt 18	345	102.8
P3 (G-1 + N-1)	-	-	-
P6-2 (X-1 + N-1)	-	-	-

Table 3-2: Steady State Voltage Violations for 2020 Study Case under Base Load Conditions

Contingency Category	Bus Violations		
	Bus	kV	Voltage (P.U)
P1, P2-1, P7	-	-	-
P2-2, P2-3, P4-2, P4-3, P4-4, P4-5, P5	-	-	-
P3 (G-1 + N-1)	Dow	345	0.905
	Jones Creek	345	0.908
	Dow Chemical (all three POI buses)	138	0.872
P6-2 (X-1 + N-1)	Dow Chemical (all three POI buses)	138	0.895

For 2022, there were several violations and two unsolved contingencies. Tables 3-3 to 3-6 summarize all the violations for 2022 study case under various contingency categories.

Table 3-3: Steady State Unsolvable Contingencies for 2022 Study Case under Base Load Conditions

#	Contingency Category	Status
1	P3 (G-1 + N-1)	Unsolvable
2	P3 (G-1 + N-1)	Unsolvable

Table 3-4: Steady State Thermal Violations for 2022 Study Case under Base Load Conditions

Contingency Category	Branch Violations		
	Element	KV	Max. Loading (%)
P2-2, P2-3, P4-2, P4-3, P4-4, P4-5, P5	STP to Jones Creek Ckt 18	345	103.3
P3 (G-1 + N-1)	Oasis to WA Parish Ckt 99	345	102.6
	BASF to Hofman Ckt 02	138	111.3

Table 3-5: Steady State Voltage Violations for 2022 Study Case under Base Load Conditions

Contingency Category	Bus Violations		
	Bus	kV	Voltage (P.U)
P1, P2-1, P7	Dow	345	0.919
	Dow Chemical (all three POI buses)	138	0.895
P3 (G-1 + N-1)	Dow	345	0.905
	Jones Creek	345	0.902
	Dow Chemical (all three POI buses)	138	0.872
P6-2 (X-1 + N-1)	Dow Chemical (all three POI buses)	138	0.895

Table 3-6: Steady State Voltage Deviations > 8% for 2022 Study Case under Base Load Conditions (P1, P7)

Bus	kV	% Voltage Deviation
Camden	138	8.22
Jones Creek	138	9.06
Sintek	138	8.16

Detailed base case violations for all the study years are provided in the Appendix A.

From Tables 3-1 to 3-6, it can be seen that there is a need for transmission improvement to reliably serve load in the Freeport area.

It is to be noted that CenterPoint Energy provided a list of 138 kV violations that are not a part of the scope submitted for the review of the Freeport Master Plan Project. CenterPoint Energy indicated to ERCOT that it intends to conduct separate studies for those issues and address them separately. As a result, ERCOT will not be addressing these violations in this independent review.

3.1. Bridge the Gap Upgrades

CenterPoint Energy proposed the following upgrades to address the needs for the near term (2020):

- Loop 345 kV South Texas Project (STP) – Dow-Velasco circuit 27 into the Jones Creek Substation (approximately 0.9 mile)
- Install 7-ohm in-line reactors at the Jones Creek Substation on 345 kV STP – Jones Creek circuits 18 and 27
- Install 3rd 345/138 kV 800/1000 MVA Autotransformer at the Jones Creek Substation
- Install 4th 138 kV Capacitor Bank (120 MVAr) at Jones Creek Substation
- Install 1st 138 kV Automatically Switchable Capacitor Bank (140 MVAr) at Jones Creek Substation
- Install 2nd 138 kV Automatically Switchable Capacitor Bank (140 MVAr) at Jones Creek Substation

Based on steady state studies, it was found that each of these individual upgrades was required until a long-term upgrade can be constructed in the Freeport area. Looping the existing Dow-Velasco to STP 345 kV line into Jones Creek Substation was required for resolving the thermal violations observed under P2 contingencies for both 2020 and 2022. A third 345/138 kV autotransformer was required at Jones Creek Substation, as two existing autotransformers at the Jones Creek substation were overloaded under X-1 + N-1 conditions. One 7-ohm reactor placed on each 345 kV STP – Jones Creek circuit was required to reduce the loading under P1 contingency. The 7-ohm reactor was determined to be a reasonable size to limit the highest contingency flows while building in sufficient margin for operational flexibility. All of the capacitor banks listed above were required to resolve the voltage violations.

Although the ‘Bridge the Gap Upgrades’ resolved many issues in the short term, they were not sufficient to solve all of the violations in the long-term.

The following Tables 3-7 and 3-8 display the thermal violations seen in the 2020 and 2022 study cases after the ‘Bridge the Gap Upgrades’ were incorporated. There were no voltage violations remaining.

Table 3-7: Steady State Thermal Violations for 2020 Study Case under Base Load Conditions with ‘Bridge the Gap Upgrades’

Contingency Category	Branch Violations		
	Element	KV	Max. Loading (%)
P3 (G-1 + N-1)	Oasis to WA Parish Ckt 99	345	100.4

Table 3-8: Steady State Thermal Violations for 2022 Study Case under Base Load Conditions with 'Bridge the Gap Upgrades'

Contingency Category	Branch Violations		
	Element	KV	Max. Loading (%)
P3 (G-1 + N-1)	Oasis to WA Parish Ckt 99	345	101.7

Detailed study results can be found in the Appendix B.

ERCOT determined that no other upgrades could be put in place in time to resolve the marginal overload identified in the 2020 case. For the remainder of the review, ERCOT analyzed only long-term solutions in the 2022 case. The 'Bridge the Gap Upgrades' were added to the 2022 study case model.

3.2. Maintenance Outage Scenarios

As described in Section 2.1.5, the majority of the Freeport area load is industrial in nature and remains relatively constant throughout the year. This makes taking maintenance outages challenging because transmission loading remains high throughout the year. To study these conditions ERCOT considered four maintenance outage scenarios (M1, M2, M3 and M4):

- M1 – Dow to Oasis 345 kV Ckt 18
- M2 – Dow to Jones Creek 345 kV Ckt 18
- M3 – Jones Creek to STP 345 kV Ckt 18
- M4 – Jones Creek 138 kV Switched Shunt (140MVAr)

These maintenance outages were applied individually to the 2022 study case (with 'Bridge the Gap Upgrades' modeled). The load in the Coast weather zone was reduced by 6% to reflect off-peak season load. This 6% reduction was calculated using Real-Time ERCOT Coast weather zone load data.

There were no voltage violations seen under any of the maintenance scenarios. The thermal violations seen are listed in Table 3-9.

Table 3-9: Steady State Thermal Violations for 2022 Study Case under Maintenance Scenarios

Element	Contingency	kV	Max. Loading (%)			
			M1	M2	M3	M4
Oasis to Dow Ckt 27	STP to Jones Creek Circuits 18 & 27	345	135.8	-	-	-
STP to Jones Creek Ckt 27	Dow to Oasis Circuits 18 & 27 and Oasis to WAP Ckt 18	345	-	-	109.2	-

Considering all the violations listed in this section of this report (Refer Tables 3-7 to 3-9), five different project options were considered to address the reliability violations. A detailed description and analysis of each of these options is presented in the next section.

4. Project Options

The reliability need for Freeport area improvements stems from the thermal violations seen under G-1+N-1 and N-1-1 analyses as discussed in Section 3. ERCOT considered a total of five project options to resolve these violations. Four of these options were included in CenterPoint Energy's RPG proposal.

The detailed description of the five project options is provided below and a one-line diagram for each is included in the Appendix C.

Option 1

- Construct a new approximately 50.4 mile 345 kV double circuit transmission line from STP Substation to Jones Creek Substation (2988 MVA emergency rating)
- Upgrade 345 kV Dow-Velasco to Jones Creek circuits 18 and 27 which is approximately 3 miles (minimum 1700 MVA emergency rating)

The total cost estimate for Option 1 is approximately $223.2 Million.

Option 2

- Construct a new approximately 62.4 mile 345 kV double circuit transmission line from Hillje Substation to Jones Creek Substation (2988 MVA emergency rating)
- Upgrade 345kV Dow-Velasco to Jones Creek circuits 18 and 27 which is approximately 3 miles (minimum 1700 MVA emergency rating)

The total cost estimate for Option 2 is approximately $272.5 Million.

Option 3

- Construct a new approximately 48 mile 345 kV double circuit transmission line from Bailey Substation to Jones Creek Substation (2988 MVA emergency rating)
- Upgrade 345kV Dow-Velasco to Jones Creek circuits 18 and 27 which is approximately 3 miles (minimum 1700 MVA emergency rating)

The total cost estimate for Option 3 is approximately $214.4 Million.

Option 4

- Construct a new approximately 60 mile 345 kV double circuit transmission line from PH Robinson Substation to Jones Creek Substation (2988 MVA emergency rating)

The total cost estimate for Option 4 is approximately $220.0 Million.

Option 5

- Upgrade 345 kV Oasis to WA Parish circuit 99 which is approximately 19.5 miles (minimum 1435 MVA emergency rating)
- Upgrade 345 kV Dow-Velasco to Oasis circuits 18 and 27 which is approximately 36 miles (re-conductor with 3-959 ACSS)
- Upgrade 345 kV Dow-Velasco to Jones Creek circuits 18 and 27 which is approximately 3 miles (minimum 1700 MVA emergency rating)
- Upgrade 345 kV STP to Jones Creek circuits 18 and 27 which is approximately 42.5 miles (re-conductor with 3-959 ACSS)

The total cost estimate for Option 5 is approximately $281.8 Million.

5. Steady State Performance of Project Options

To compare and contrast each of the long-term (2022) options several analyses were performed. This section discusses the performance of the five project options under ERCOT and NERC contingency criteria. As mentioned earlier, these options were tested using the 2022 study case with the 'Bridge the Gap Upgrades' included. Tables 5-1 and 5-2 show the results from this analysis.

Table 5-1: 2022 Steady State Thermal Violations for all the Project Options

Contingency Category	Option 1	Option 2	Option 3	Option 4	Option 5
P1, P2-1, P7	No Violations	No Violations	No Violations	No Violations	No Violations
P2-2, P2-3, P4-2, P4-3, P4-4, P4-5, P5	No Violations	No Violations	No Violations	No Violations	No Violations
G-1 + N-1 (P3)	No Violations	No Violations	No Violations	No Violations	No Violations
X-1 + N-1 (P6-2)	No Violations	No Violations	No Violations	No Violations	No Violations
N-1-1 (P6-1, P6-3)	No Violations	No Violations	No Violations	No Violations	No Violations

Table 5-2: 2022 Steady State Voltage Violations for all the Project Options

Contingency Category	Option 1	Option 2	Option 3	Option 4	Option 5
P1, P2-1, P7	No Violations	No Violations	No Violations	No Violations	No Violations
P2-2, P2-3, P4-2, P4-3, P4-4, P4-5, P5	No Violations	No Violations	No Violations	No Violations	No Violations
G-1 + N-1 (P3)	No Violations	No Violations	No Violations	No Violations	No Violations
X-1 + N-1 (P6-2)	No Violations	No Violations	No Violations	No Violations	No Violations
N-1-1 (P6-1, P6-3)	No Violations	No Violations	No Violations	No Violations	No Violations

ERCOT also considered a contingency involving an extreme event where the impact of loss of a substation was studied. Table 5-3 summarizes this extreme event contingency impact for all five options.

Table 5-3: Extreme Event Contingency Impact for all the Project Options

Contingency Category	Option 1	Option 2	Option 3	Option 4	Option 5
Substation Fault	*Unsolved contingency*	No unsolved contingency	No unsolved contingency	*Unsolved contingency*	*Unsolved contingency*

From the tables described in this section it can be seen that Option 2 and 3 alone resolve all the violations. Options 1, 4 and 5 fail under the occurrence of the tested extreme events. Detailed lists of the violations can be found in the Appendix D.

6. Transfer Capability Analysis – Voltage Stability

A transfer capability analysis was performed on the 2023 Summer Peak Case from the LT 2023 summer peak dynamics data set with 'Bridge the Gap Upgrades' for all the five project options using VSAT.

This transfer study was conducted by increasing load in the Coast weather zone and reducing the load across East, West, South-Central, and South weather zones in ERCOT. All the major 345 kV and 138 kV buses in and around the Freeport area were monitored. Table 6-1 shows the potential maximum transfer capability in the Coast weather zone after increasing the transfer to the voltage stability limit.

Table 6-1: Transfer Capability Limit for all the Project Options

Options	Description	Base load level (MW)	Maximum transfer (MW)	Margin (MW)
1	STP-Jones Creek	**20451**	22691	**2240**
2	Hillje-Jones Creek		22611	**2160**
3	Bailey-Jones Creek		22531	**2080**
4	PH Robinson-Jones Creek		22011	**1560**
5	Only line upgrades		20811	**360**

The variations in voltage stability margins shown in these results were considered in the development of the final recommendation of this ERCOT independent review. Additional details of this analysis are provided in Appendix E.

7. Sensitivity Studies

7.1. Higher Load Sensitivity Analysis

CenterPoint Energy indicated that there were approximately 657 MW of additional potential uncommitted industrial load in the area. Because these customers have not signed a contract with CenterPoint for this additional demand, ERCOT did not include this additional 657 MW in the project need analysis. This potential load along with the base case committed load makes up the total Freeport load of 2932 MW for this higher load sensitivity analysis. This potential load growth scenario was used to compare the relative long-term performance of the options.

The 2022 potential load case included the 'Bridge the Gap Upgrades'. All five options were tested on this case.

First, ERCOT studied the impact of P1, P2-1 and P7 contingency categories on each of the options. Tables 7-1 and 7-2 show the violations for each of the options under this sensitivity analysis.

Table 7-1: 2022 Potential Load P1, P2-1 and P7 Steady State Violations – Total number of Unsolved Contingencies

Option 1	Option 2	Option 3	Option 4	Option 5
0	0	0	0	1

Table 7-2: 2022 Potential Load P1, P2-1 and P7 Max. Thermal Loading under Steady State

Element	Option 1	Option 2	Option 3	Option 4	Option 5
Oasis to WA Parish 345kV Circuit 99	-	-	-	106.2	-

Option 5 had one unsolved contingency due to voltage collapse, but there were no other voltage violations for any of the options.

Based on the previous analyses, ERCOT concluded that Options 2 and 3 were the best alternatives for meeting the long-term needs in the area. ERCOT conducted G-1+N-1 and X-1+N-1 contingency analysis for these two options with the potential loads. There were no voltage violations under G-1+N-1 (P3) and X-1+N-1 (P6-2) for either option. ERCOT observed thermal violations as shown in Table 7-3. However, the Singleton-Zenith 345 kV line overload is related to overall Houston area import and is not significantly impacted by the more localized Freeport area transmission solutions.

Table 7-3: G-1 + N-1 and X-1 + N-1 Contingency Analysis Thermal Violations for 2022 Potential Load Case

Contingency category	Element	Option 2	Option 3
G-1 + N-1 (P3)	Singleton to Zenith 345 kV Circuits 98 & 99	-	100.5
X-1 + N-1 (P6-2)	Singleton to Zenith 345 kV Circuits 98 & 99	101.5	101.3

Please refer to Appendix F for detailed results.

7.2. Planning Guide Section 3.1.3 (4) Sensitivities

7.2.1. Generation Addition Sensitivity Analysis

ERCOT performed a generation sensitivity analysis based on Planning Guide Section 3.1.3(4)(a). Generator additions with signed Interconnection Agreements (IA) but that did not meet Planning Guide Section 6.9 conditions were added based on the 2017 August Generator Interconnection Status report. These generators were applied to the 2022 study case with base loads and 'Bridge the Gap Upgrades' included. These units were dispatched per the 2017 RTP scope.

Table 7-4 shows all the generators that were added to the Study Case for this analysis.

Table 7-4: Generators with IA that did not meet Planning Guide Section 6.9 Conditions (2017 August GIS report)

GINR Number	Project Name	MW	Fuel	County
15INR0023	Indeck Wharton	654	Gas	Wharton
16INR0044	Halyard Wharton	419	Gas	Wharton
16INR0074	Chocolate Bayou W	150	Wind	Brazoria
17INR0022	MIRAGE (NET Power LA Porte)	11	Gas	Harris

There were no voltage violations under this generation addition sensitivity analysis. However, there were thermal violations as displayed in Table 9-5. Detailed results are listed in Appendix G.

Table 9-5: Steady State Thermal Violations with Generation meeting Planning Guide Section 3.1.3 (4) (a)

Contingency Category	Branch Violations		
	Element	KV	Max. Loading (%)
P1, P2-1, P7	Oasis to WA Parish Ckt 99	345	100.6
P2-2, P2-3, P4-2, P4-3, P4-4, P4-5, P5	-	-	-
P3 (G-1 + N-1)	Oasis to WA Parish Ckt 99	345	101.7
P6-2 (X-1 + N-1)	-	-	-
P6-1, P6-3 (N-1-1)	Oasis to Dow Ckt 27	345	133.6
	STP to Jones Creek Ckt 27	345	110.4

These generator additions were not able to resolve the reliability criteria violations and, hence, the final recommendation would remain the same even if all these generators were included in the base case analysis.

7.2.2. Load Scale Impact Sensitivity Analysis

Planning Guide Section 3.1.3(4)(b) requires evaluation of the impact of various load scaling on the criteria violations seen in this ERCOT independent review. As stated in Section 3.1.1, ERCOT used the 2022 East Coast (EC) summer peak case from the 2017 RTP for the steady state analysis. This case was created in accordance with the 2017 Regional Transmission Plan Study Scope and Process document which included load scaled down from the respective non-coincident peaks forecasted in the North, North Central, West, Far West, South, and South Central weather zones.

There were five 345 kV circuits with thermal violations under steady state analysis as described in Section 3. Power Transfer Distribution Factors (PTDFs) were calculated using PowerWorld Simulator for these five lines using Coast weather zone as the sink. Each of the six weather zones on which the load scaling was done in the RTP case (North, North Central, West, Far West, South, South-Central) was considered a source. Appendix G contains the PTDFs for each of the five circuits under various transfers.

Based on these results, the weighted sum of the calculated PTDFs were 2.38% and 3.66% for Oasis – Dow 345 kV and STP – Jones Creek 345 kV overloads, respectively. These values were not significant enough to impact the overloads of these lines. ERCOT concluded that the load scaling did not have a material impact on the project need, which was primarily driven by the load growth in the immediate Freeport area.

8. Dynamics Performance

8.1. Study Data and Assumptions

A dynamics stability study was performed for the final options that were selected based the steady state analysis. This dynamics study scope was limited to observing the transient performance of the Freeport system under various contingencies.

8.1.1. Cases

The Dynamics Working Group (DWG) LT 2023 summer peak flat start data set posted in March 2017 and prepared using the 2016 SSWG base cases was used for this study.

8.1.2. Contingencies

The following sources were used to screen for the contingencies to include in the dynamics analysis:

- VSAT screening (filtered based on counties)
- SSWG contingency dataset (filtered based on counties)
- Internal ERCOT prepared contingencies

8.1.3. Topology

The power flow case from the flat start data set was modified to incorporate the following changes:

- A 345/138 kV autotransformer with 800 MVA capacity was added at PH Robinson substation. This is a Transmission Projects Information Tracking (TPIT) approved project.
- Freeport 'Bridge the Gap Upgrades' were included
- Option 2 and Option 3 were studied separately and corresponding flat start cases were prepared

8.1.4. Load Modeling

Initially, the load in the 2023 base case was higher than the load in the 2022 steady state study case. All the Freeport area bus loads were modified to match what was used in the steady state analysis in the 2022 study case.

The dynamic load model was submitted by CenterPoint Energy. This model reflects the behavior of the industrial and residential loads in the study region.

8.1.5. Generation

Oyster Creek generation was added to reflect the changes that were approved in the Regional Transmission Plan (RTP) case in the Freeport area. No other generation changes were made to the base case.

8.2. VSAT Screening

The 2023 base case was used to prepare the following four VSAT scenarios:

1. Bridge The Gap Upgrades
2. Option 2
3. Option 3
4. Option 3 with Potential Uncommitted Load

The voltage stability assessment was used to identify the top contingencies and buses of interest for each of the four scenarios. All the contingencies (P1, P2, P4/P5 and P7) were filtered by counties in and around the study area - Brazoria, Matagorda, Wharton, Fort Bend, Galveston and southern side of Harris County. Based on the analysis, selected P1 and P7 contingencies were used to prepare an extensive combination of P3 and P6 events.

8.3. PSS/e Transient Analysis

The transient stability analysis was performed using PSS/e version 33.10 for a selected contingency events as listed in section 8.1.2 for the following four scenarios:

1. Bridge The Gap Upgrades
2. Bridge The Gap Upgrades + Option 2
3. Bridge The Gap Upgrades + Option 3
4. Bridge The Gap Upgrades + Option 3 with Potential Uncommitted Load

Based on simulation results, all the four scenarios met both the NERC and ERCOT reliability criteria. There were no non-consequential load shed or post fault voltage recovery issues for the contingencies events studied. Table 8-1 shows the summary of dynamic stability analysis results for the four scenarios. The transient stability simulations results for selected contingency events and their corresponding plots are presented in Appendix H.

Table 8-1 – Dynamics Stability Analysis Summary

Case	Topological Changes	Contingency Category					
		P1	P2	P3	P4, P5	P6	P7
LT2023 SP	BTG Upgrades	Stable	Stable	Stable	Stable	Stable	Stable
	BTG Upgrades + Option 2						
	BTG Upgrades + Option 3						
	BTG Upgrades + Option 3 + Potential Load						

9. Economic Analysis

Although the need for the project was driven by reliability needs, ERCOT also conducted an economic analysis to compare the relative performance of Options 2 and 3.

The base case for the economic analysis was the 2023 economic case built for the 2017 RTP as the starting case. There were no topology changes or generation additions required for this analysis. ERCOT modeled Option 2 and 3 in separate UPLAN scenarios and performed production cost simulations for the year 2023.

This relative change in annual system production costs between the two cases was not significant and there were no major differences in congestion between the options as studied.

10. Conclusion

An overview of various analyses completed for the long-term options is show in Table 10-1.

Table 10-1 Results Summary

Option #	Option 1	Option 2	Option 3	Option 4	Option 5
Description	STP-Jones Creek	Hillje-Jones Creek	Bailey-Jones Creek	PH Robinson-Jones Creek	Only line upgrades
Extreme Event Contingency Limitation	Yes	No	No	Yes	Yes
Voltage Stability Transfer Limit (MW)	2240	2160	2080	1560	360
Dynamic Stability Criteria Violations?	Not studied	No	No	Not studied	Not studied
Projected Load for 2022 Criteria Violations?	No	No	No	No	No
Projected Load for 2022 + High Load Sensitivity	None	P6	P3/P6	Not studied	Not studied
New ROW Distance (miles)	50.4	62.4	48	60	0
Estimated Cost (Million)	$223.2	$272.5	$214.4	$220.0	$281.8

The results showed that while all options met the reliability criteria for 2022, Option 5 had the highest estimated cost, lowest voltage stability transfer margin, and had an extreme event contingency limitation. Therefore, Option 5 was eliminated.

Option 4 had the next lowest voltage stability transfer margin, had an extreme event contingency limitation, and had an estimated cost higher than Option 3. Therefore, Option 4 was eliminated.

Option 1 had the highest voltage stability transfer margin, but it was not significantly higher than Options 2 and 3. Option 1 was not preferable because it had an extreme event contingency limitation, and it would also create a second STP-Jones Creek 345 kV path, making the Freeport area increasingly dependent on that one corridor. This was concern since the STP-Jones Creek corridor parallels the Gulf of Mexico coastline, an area that is prone to hurricanes. Additionally, Option 1 had a higher cost estimate than Option 3.

Option 2 performed similarly to Option 3, however it had a significantly higher cost estimate and more Right of Way (ROW) impact than Option 3. For these reasons Option 3 was the preferred solution to meet the long-term reliability needs for the Freeport area.

In conclusion, based on forecasted loads and scenarios analyzed, ERCOT determined that there was a reliability need to improve the transmission system in the Freeport area in the near-term (2020) and long-term (2022).

The ‘Bridge the Gap Upgrades’ were required to meet the near-term reliability needs. These upgrades are estimated to cost of these upgrades is $32,340,000 and they are described as follows:

- Loop the 345 kV South Texas Project (STP) – Dow-Velasco circuit 27 into the Jones Creek Substation (approximately 0.9 mile)
- Install 7-ohm in-line reactors at the Jones Creek Substation on the 345 kV STP – Jones Creek circuits 18 and 27
- Install 3rd 345/138 kV 800/1000 MVA Autotransformer at the Jones Creek Substation
- Install 4th 138 kV Capacitor Bank (120 MVAr) at the Jones Creek Substation
- Install 1st 138 kV Automatically Switchable Capacitor Bank (140 MVAr) at Jones Creek Substation
- Install 2nd 138 kV Automatically Switchable Capacitor Bank (140 MVAr) at Jones Creek Substation

Of the long-term (2022) alternatives studied, Option 3 met the reliability criteria in the most cost effective manner. Option 3 had a cost estimate of $214.4 Million and is described as follows:

- Construct a new approximately 48 mile 345 kV double circuit transmission line from Bailey Substation to Jones Creek Substation (2988 MVA emergency rating)
- Upgrade the 345kV Dow-Velasco to Jones Creek circuits 18 and 27 which is approximately 3 miles (minimum 1700 MVA emergency rating)

11. 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.

CenterPoint Energy owns both Bailey Substation, Jones Creek Substations and all the transmission facilities associated with the 'Bridge the Gap Upgrades'. Therefore, ERCOT designates CenterPoint Energy as the designated provider for the 345 kV Bailey to Jones Creek transmission facilities and all the transmission facilities listed as 'Bridge the Gap Upgrades' in this report.

12. Appendices

Appendix A	2020, 2022 Study Case Violations_A.xl
Appendix B	2020, 2022 Study Case Violations_witl
Appendix C	Options diagram_C.docx
Appendix D	Options_Summary_ Committed_Load_D.
Appendix E	VSAT_Transfer_Resu lts_E.xlsx
Appendix F	2022 PotLoadCase Violations_AllOptio
Appendix G	2022_PG_3.1.3(4)a_V iolations_G.xlsx PG_3.1.3(4)b_LoadS caleSensitivity_G.xls

Appendix H	 Options_Transient_ Analysis.zip