Economic Results for the Business as Usual Scenario

Long Term Study Update

April 13, 2012

Agenda

- **Discuss the Executive Summary**
- **Review the current economic process**
- **Present the scenario specific inputs**
- **Review the resultant system congestion**
- **Discuss economic themes and conceptual projects**
- **Review the economy of each proposed conceptual project**
- **Conclusions**
- **Review/Discuss next steps**

Executive Summary

- **Forecasted load growth in the Dallas and Houston Areas will require additional import paths into both load areas for steady state stability before the year 2030.**

- **Incremental dynamic and static reactive resources may delay the need year for incremental import capacity.**

- **Given the magnitude of load growth assumed in both regions, new import paths are needed. Certain options tested and verified to satisfy voltage stability margins also returned economic benefit in terms of production cost savings.**

Executive Summary

- **Limited ability to upgrade 138kV lines in urban areas with increasing population density highlights the need for geographically diverse EHV Sources.**
- **The increasingly urban areas of ERCOT face limited and challenging transmission options as right-of-way and public acceptance for additional transmission infrastructure becomes scarce.**
- **ERCOT tested solutions that established increased access to urban loads from multiple directions.**
  - In Austin, Western EHV solutions were tested to reduce forecasted overloads of existing 138kV infrastructure that may be difficult to upgrade.
  - In Dallas, ERCOT tested options to more evenly distribute loading on the 138kV system with a partial loop East/Southeast of the DFW region.

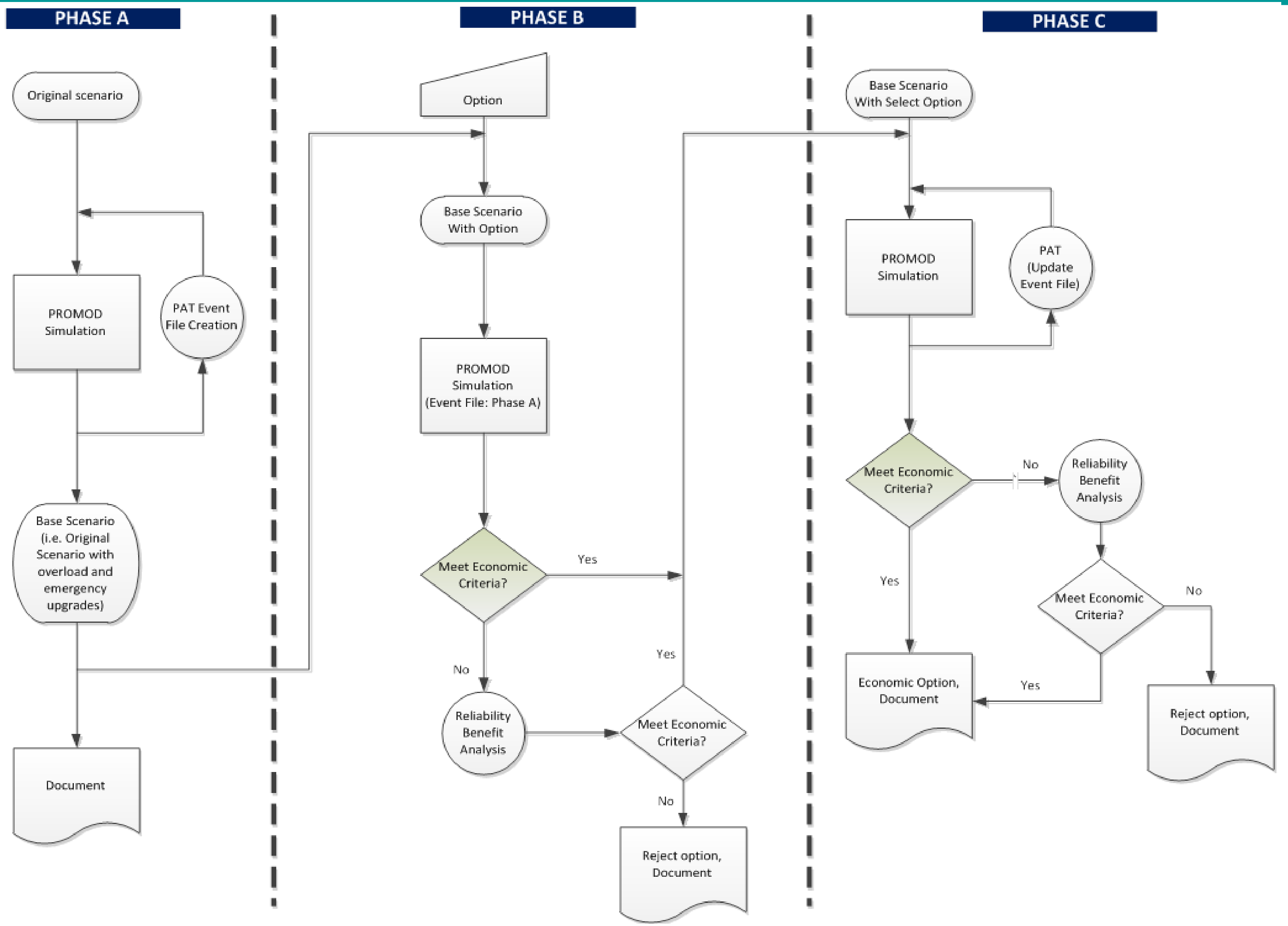
Executive Summary

- **Increasing dependency on existing import infrastructure in the South / South Texas Area, most notably San Antonio and the Lower Rio Grande Valley (Valley), may require additional, geographically diverse connections to the EHV network.**

- **San Antonio's dependence on the Northern 345 connection to the 345kV corridor East of the San Antonio area, coupled with announced retirements of thermal resources (internal to the 345kV loop) may require expanded Western or Southern connections to the 345kV loop.**

- **The Valley currently has an RPG project approved to address current import / stability issues within the scope of the five year plan. Incremental import capacity will be needed before the year 2030 if no new generation sites in this region. For the BAU scenario, ERCOT assumed sufficient generation would be sited in the Valley over the next twenty years.**

Economic Process



Scenario: Business as usual (Traditional Tech)

- This case is based on the assumption that future market conditions and regulatory requirements are generally consistent with current conditions.

- The results of this BAU scenario can be used as a benchmark to evaluate differences with other future scenarios, which will involve significant changes from current conditions.

- The scenario is defined by the set of input parameters that reflect the market conditions and regulatory requirements if the BAU version of the future were to occur

BAU Assumptions

Fuel:

EIA AEO 2011 Forecast

NG $4.48 - $8.89

Load Growth Rates:

1.8%

compounded from 2011-2031

Regulatory incentives / restrictions:

With / Without PTC renewal

Generation Expansion

Business as Usual without the PTC Generation Expansion Plan

Description	Units	2010 Actual	2011	2014	2017	2020	2023	2026	2030
CC Adds	MW			-	800	1,600	1,600	4,000	2,800
CT Adds	MW			-	400	3,000	700	500	1,100
Coal Adds	MW			925	-	-	-	-	-
Nuclear Adds	MW			-	-	-	-	-	-
Other Adds	MW			-	-	-	-	-	-
Wind Adds	MW			872	-	-	-	-	-
Annual Capacity Additions	MW			1,797	1,200	4,600	2,300	4,500	3,900
Cumulative Capacity Additions	MW			1,797	2,997	7,597	9,897	14,397	18,297
Reserve Margin	%	21.4	15.9	15.2	8.5	10.2	7.2	9.2	6.2
Coincident Peak	MW	65,776	65,206	73,375	78,869	81,665	85,928	88,318	94,318
Average LMP	$/MWh	34.41	37.42	42.51	56.76	63.23	73.69	81.50	87.75
Natural Gas Price	$/mmbtu	4.38	4.50	4.63	5.10	5.68	6.47	7.35	8.39
Average Market Heat Rate	MMbtu/MWh	7.86	8.32	9.18	11.14	11.14	11.38	11.09	10.46
Natural Gas Generation	%	38.2	41.3	45.8	47.0	49.3	51.0	53.0	59.3
Coal Generation	%	39.5	37.8	36.5	34.3	33.0	31.7	30.6	31.4
Wind Generation	%	7.8	9.2	7.3	8.4	8.0	7.7	7.4	7.6
Scarcity Hours	HRS	-	-	-	29	33	42	49	56
Unserved Energy	GWhs	-	-	-	24.1	39.9	63.9	60.1	68.8

Generation Expansion Methodology (Thermal Units)

Considerations and Constraints:

✓Access to fuel sources

- Availability of natural gas pipelines
- Access to rail infrastructure

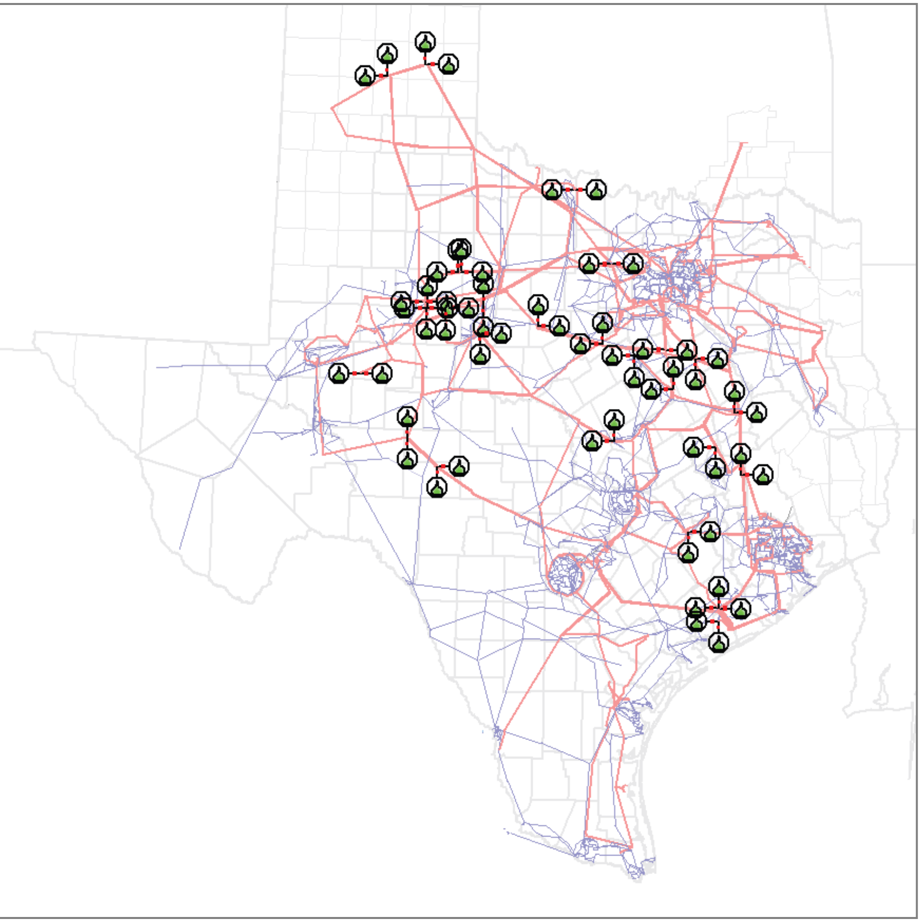
✓Population density of the surrounding area

✓Availability of surface water

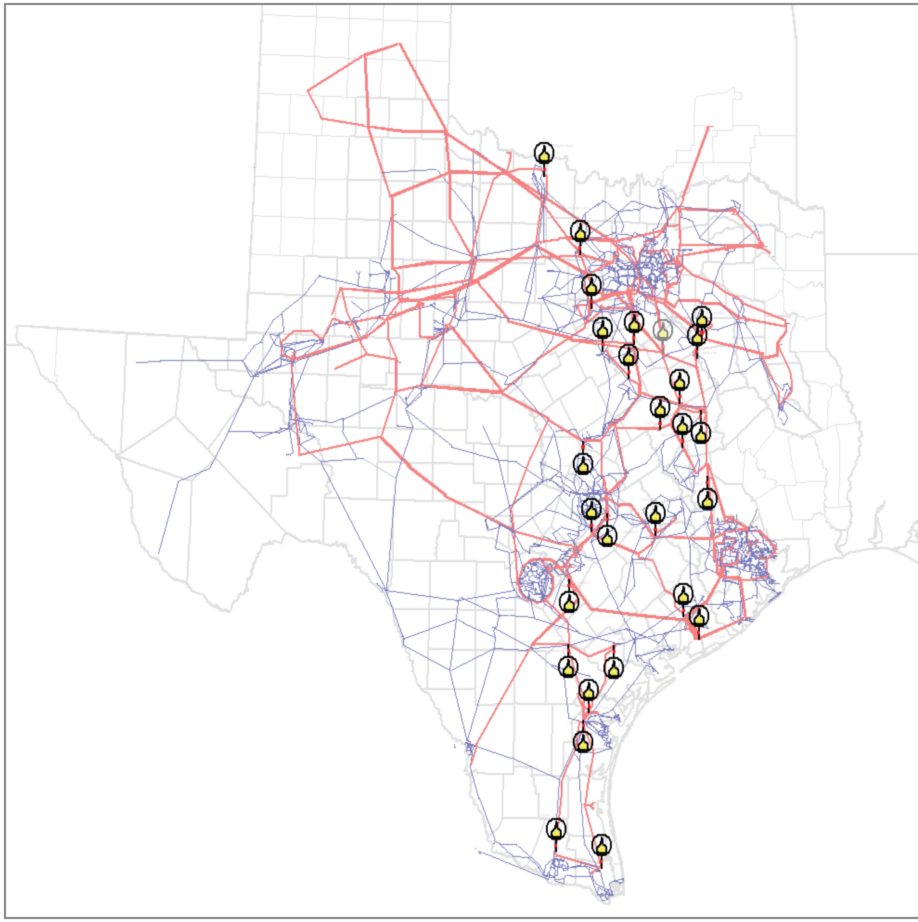
✓Environmental Constraints

✓Prevailing LMP, as modeled, on EHV busses

Generation Expansion Methodology (Thermal Units)



Potential locations of new combustion turbine units (BAU scenario; 2030)



Potential locations of new combined cycle units (BAU scenario; 2030)

Generation Sites

Bus #	Capacity Added	Area	Bus Name
5915	600	COAST	SO TEX 5
44200	600	COAST	HILLJE
1425	200	NORTH	FISHRDSS1
1684	200	NORTH	LAMARPWR
1729	200	NORTH	VAL
79000	300	NORTH	GRAY
60704	200	WEST	KIRCHHOF7A
66661	200	WEST	D3 SC BUS
5133	600	SOUTHCEN	ELMCREEK
5725	600	SOUTHCEN	PAWNEESW5
7048	600	SOUTHCEN	L
7057	600	SOUTHCEN	L
9074	600	SOUTHCEN	LYTTON34
5901	200	SOUTHERN	MIGUEL5
8164	600	SOUTHERN	COLETO 6
8318	600	SOUTHERN	RIOHND 6
8383	600	SOUTHERN	EDNBRG 6
8455	600	SOUTHERN	LNHILL 6
80220	200	SOUTHERN	RIOBRAV
80382	600	SOUTHERN	NOPALITO7A
80384	200	SOUTHERN	LBRISAS17A

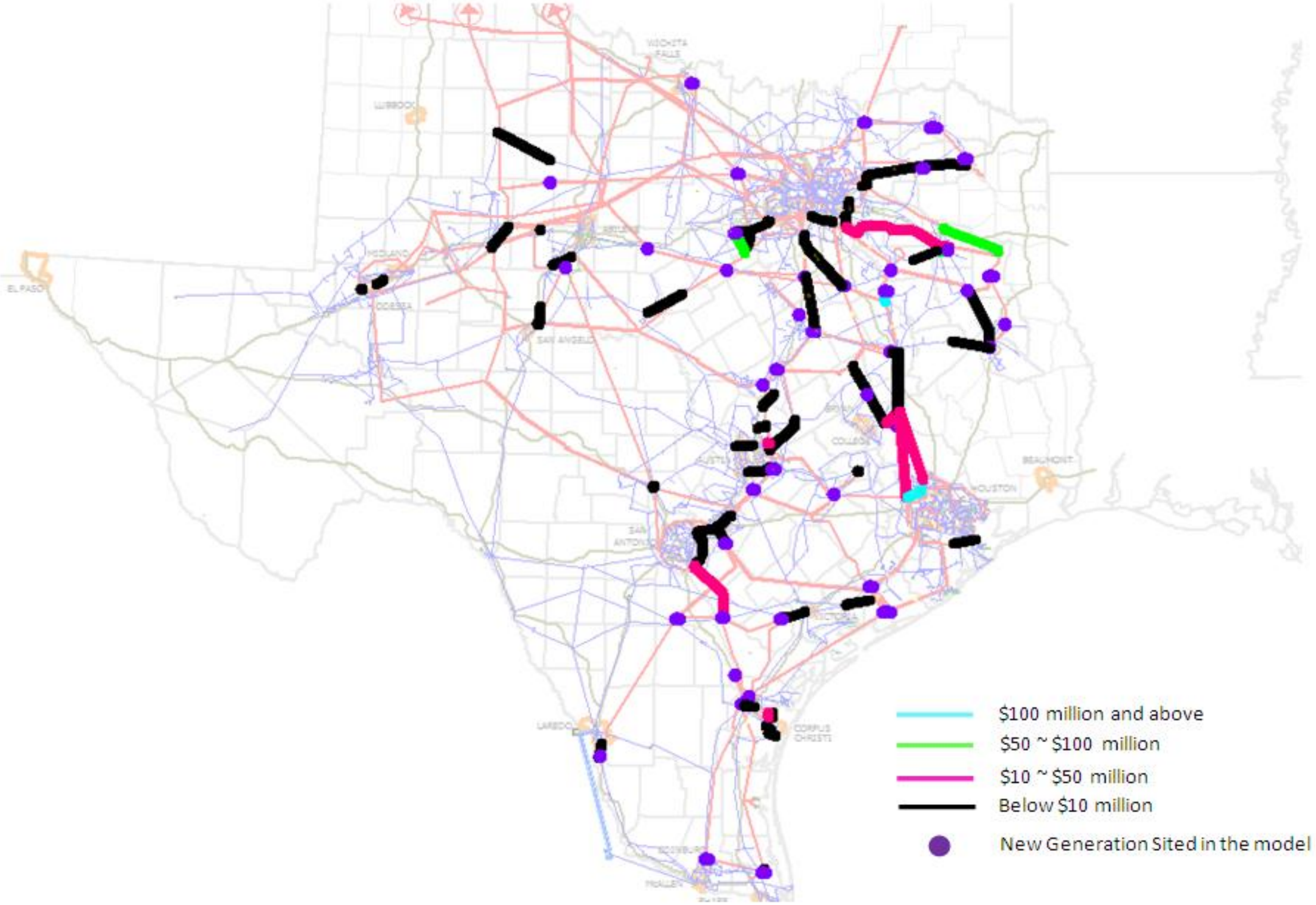
Bus #	Capacity Added	Area	Bus Name
1421	200	NORTHCEN	WILLOWCK
1876	400	NORTHCEN	WLFHOLW
3406	200	NORTHCEN	ELM
3409	400	NORTHCEN	LAKE
3414	200	NORTHCEN	TEMP
3699	400	NORTHCEN	SALADOSS
68010	200	NORTHCEN	ROMNEY1 W
68030	200	NORTHCEN	KOPPERL1 W
68090	600	NORTHCEN	SAMSWITC
68091	200	NORTHCEN	NAVARRO
975	600	EAST	JKCREEK1
1696	200	EAST	MOSES1
1697	200	EAST	SULSP
3102	400	EAST	TYLERGND
3109	600	EAST	STRYKER
3116	400	EAST	MTENTRPR
3117	600	EAST	LUFKNSS
3119	600	EAST	NACOGDSE
3123	600	EAST	TRINDAD1
3133	600	EAST	RICHLND1
3390	600	EAST	JEWETT
40600	600	EAST	ROANS

Load Forecast

Year	North	N. Central	East	Far West	West	S. Central	Coast	South	Flat	Total
2012	1,719	23,267	2,495	1,862	1,588	11,408	15,400	5,162	9470	72371
2013	1,702	24,281	2,582	1,930	1,663	11,804	15,974	5,345	9470	74751
2014	1,757	25,214	2,707	1,994	1,712	12,305	17,454	5,560	9470	78173
2015	1,841	25,910	2,783	2,047	1,752	12,712	17,934	5,735	9470	80184
2016	1,870	26,494	2,852	2,100	1,764	12,723	18,346	5,863	9470	81482
2017	1,898	26,771	2,915	2,098	1,787	13,032	18,676	6,003	9470	82650
2018	1,917	27,164	2,937	2,150	1,811	13,587	18,152	6,116	9470	83304
2019	1,877	27,928	2,993	2,181	1,874	13,825	18,431	6,236	9470	84815
2020	1,964	28,406	3,085	2,226	1,906	14,055	19,598	6,339	9470	87049
2021	1,992	28,905	3,141	2,246	1,946	13,942	19,901	6,368	9470	87911
2022	2,011	29,383	3,198	2,277	1,956	14,149	20,176	6,536	9470	89156
2023	2,040	29,586	3,254	2,273	1,979	14,376	20,437	6,639	9470	90054
2024	1,996	30,253	3,280	2,340	2,044	14,897	19,758	6,736	9470	90774
2025	2,014	30,711	3,355	2,350	2,068	15,109	21,000	6,816	9470	92893
2026	2,087	31,189	3,386	2,371	2,092	15,339	21,290	6,903	9470	94127
2027	2,096	31,646	3,430	2,382	2,108	15,225	21,620	6,909	9470	94886
2028	2,106	31,862	3,468	2,416	2,099	15,535	21,978	7,100	9470	96034
2029	2,115	32,217	3,473	2,422	2,115	16,155	21,346	7,205	9470	96518
2030	2,060	33,077	3,517	2,443	2,173	16,464	21,706	7,325	9470	98235

Congestion

High Level Congestion Cost Map of 2030 Base Model with 9000 MVA Ratings inside Cities (i.e. Dallas, Houston, San Antonio)



Economic Themes / General Observations

- Increased access to DFW loads from the East / Southeast

- Eased congestion between new and existing generation north of Houston and Houston Metro loads

- Increased access to the San Antonio 345kV Loop, Lower Rio Grande Valley

Economic Conceptual Projects

ERCOT, with guidance from incumbent transmission owners / providers, developed upgrades of system level significance to explore the economic boundaries of system expansion for the BAU scenario.

High level conceptual projects included:

- Partial EHV Ring around Dallas
- Incremental Eastern Import Paths to Dallas
- Incremental Northern Import Paths to Houston
- EHV system “backbone” spanning from DFW to the Lower Rio Grande Valley
  - Strong EHV sources for Austin / San Antonio
  - New import path into / out of South Texas / Lower Rio Grande Valley
- 500kV import paths into Dallas / Houston

Transmission Cost Assumptions

- Transmission owners provided ERCOT with individual estimates for urban and rural transmission construction.

- ERCOT calculated averages of transmission costs, including data points from recently completed CREZ projects.

- Transmission owners on neighboring interconnections operating 500kV facilities within Texas provided cost estimates for 500kV line and substation facilities.

Transmission Cost Assumptions

General Conductor Data		2012		2030	
Voltage	Conductor	Rural Cost ($Million/Mile)	Urban Cost ($Million/Mile)	Rural Cost ($Million/Mile)	Urban Cost ($Million/Mile)
345	New Single Circuit (Single circuit on double circuit capable towers)	1.95	3.25	2.72	4.52
	New Double Circuit	2.44	4.10	3.40	5.72
	Re-conductoring of existing single circuit line	0.72	1.43	1.01	1.99
	Re-conductoring of existing double circuit line	1.14	1.99	1.59	2.77
	Rebuild existing single (complete tear down of towers and conductors)	1.46	2.30	2.03	3.20
	Rebuild existing double(complete tear down of towers and conductors)	2.07	3.53	2.89	4.92
	Add second circuit to an existing double circuit capable line	0.56	0.64	0.78	0.89
138	New Single Circuit (Single circuit on double circuit capable towers)	1.14	1.96	1.59	2.74
	New Double Circuit	1.37	2.46	1.91	3.43
	Re-conductoring of existing single circuit line	0.59	0.87	0.83	1.22
	Re-conductoring of existing double circuit line	0.64	1.22	0.89	1.70
	Rebuild existing single (complete tear down of towers and conductors)	0.75	1.10	1.04	1.54
	Rebuild existing double(complete tear down of towers and conductors)	1.17	1.66	1.63	2.32
	Add second circuit to an existing double circuit capable line	0.27	0.40	0.38	0.56
500	New Single Circuit (Single circuit on double circuit capable towers)	2.7		3.76	
	New Double Circuit	2.98		4.15	
HVDC	3000 MW capacity	3.01		4.19	

Transmission Cost Assumptions

General Transformer Data	2012	2030
Transformer	**Cost ($Million)**	**Cost ($Million)**
138/345 transformers, lesser than or equal to 600 MVA	7.98	11.1
138/345 transformers, greater than or equal to 800 MVA	9.75	13.6
345/500 transformers, 1200 MVA	16.73	23.3

General Substation Data	2012	2030
Substation	**Cost ($Million)**	**Cost ($Million)**
138 kV Substation	9.05	12.6
345 kV Substation – ring bus 6 – line terminals	15.94	22.2
345 kV Substation – breaker & 1/2 > 6 – line terminals	23.22	32.4
6-Breaker 500 kV Ring Substation	25.72	35.8
TWO - HVDC 3000 MW Converter Station	510	710.6

Series Compensation (50%)	2012	2030
Series Compensator	**Cost ($Million)**	**Cost ($Million)**
SERIES COMP > 100 MILES	39	54.3
SERIES COMP < 100 MILES	25	34.8

Partial Ring Around DFW

- New 500 kV Substation with 500/345 kV Autotransformer
- Existing 345 kV Substation
- Double Circuit 500 kV Transmission Line
- Double Circuit 345 kV Transmission Line

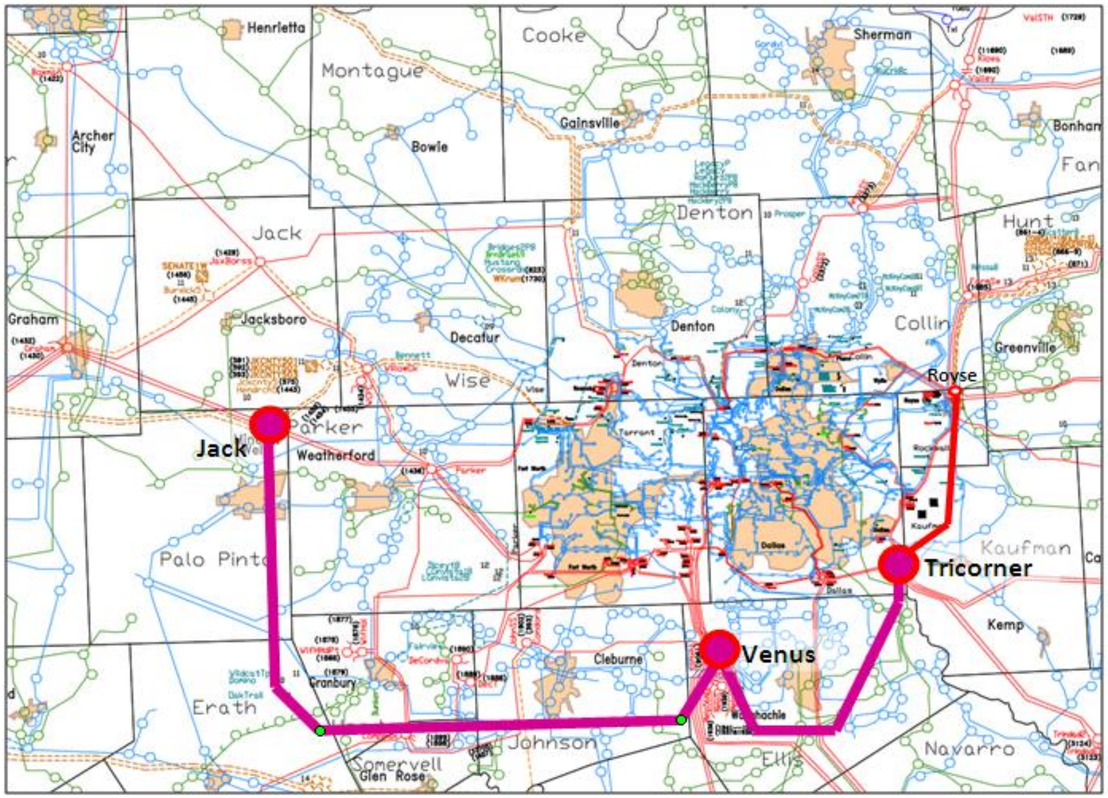


Fig – 3: 500 kV Half Ring around DFW (Project 4B)

Partial Ring / DFW

Need:

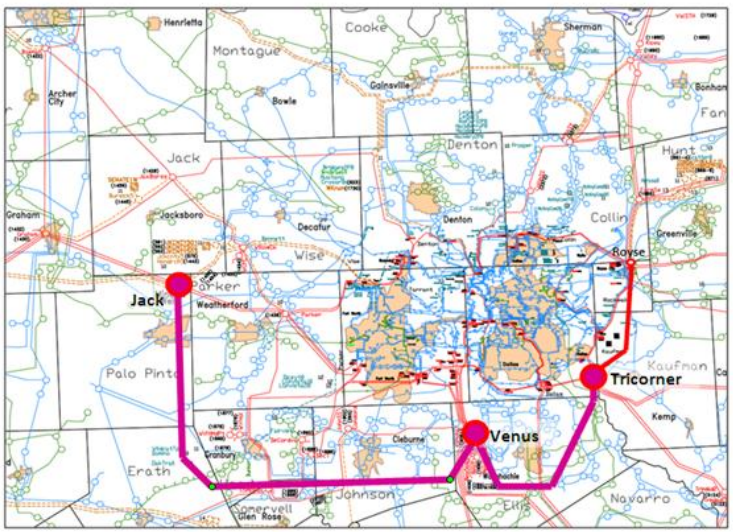
- **Lessen the impact of individual import path contingencies**
- **Increase deliverability to DFW Loads from the East / Southeast of Dallas**
- **Establish transmission infrastructure to support multiple sites in a historically generation-rich region**

Derivative projects tested:

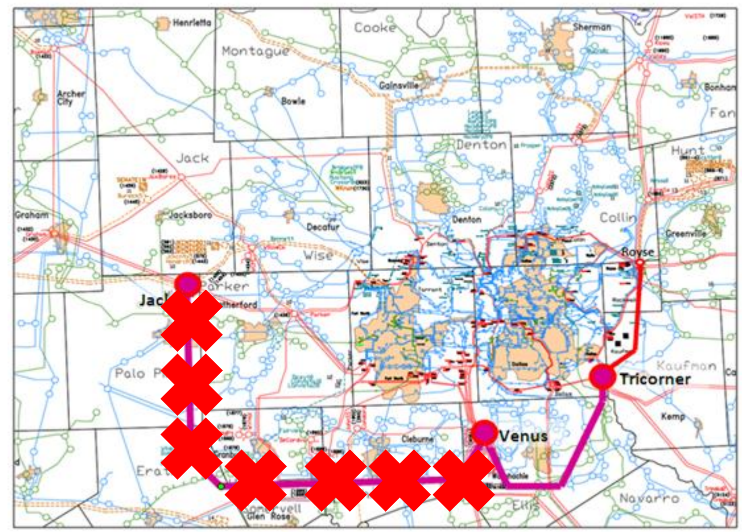
- – Partial loop energized at 345kV
- – Partial loop at 345kV from Royse to Venus

Partial Ring / DFW Economic Results

	Dallas Complete Ring (500)			Dallas Partial Ring (500)			Partial Ring (345)			Modified Partial Ring (345)		
	2012	2020	2030	2012	2020	2030	2012	2020	2030	2012	2020	2030
Total Project Costs ($M)	2822	$3,270	$3,932	$751	$870	$1,046	751	$870	$1,046	226	$262	$315
In Service Date Studied (Yr)		x	x		x	x		x	x		x	x
Reduction in System Production Costs (2030)			($64)			($62)			($52)			($52)



Partial Ring tested at 500kV and 345kV



Modified Partial Ring tested at 345kV

Economic Benefits

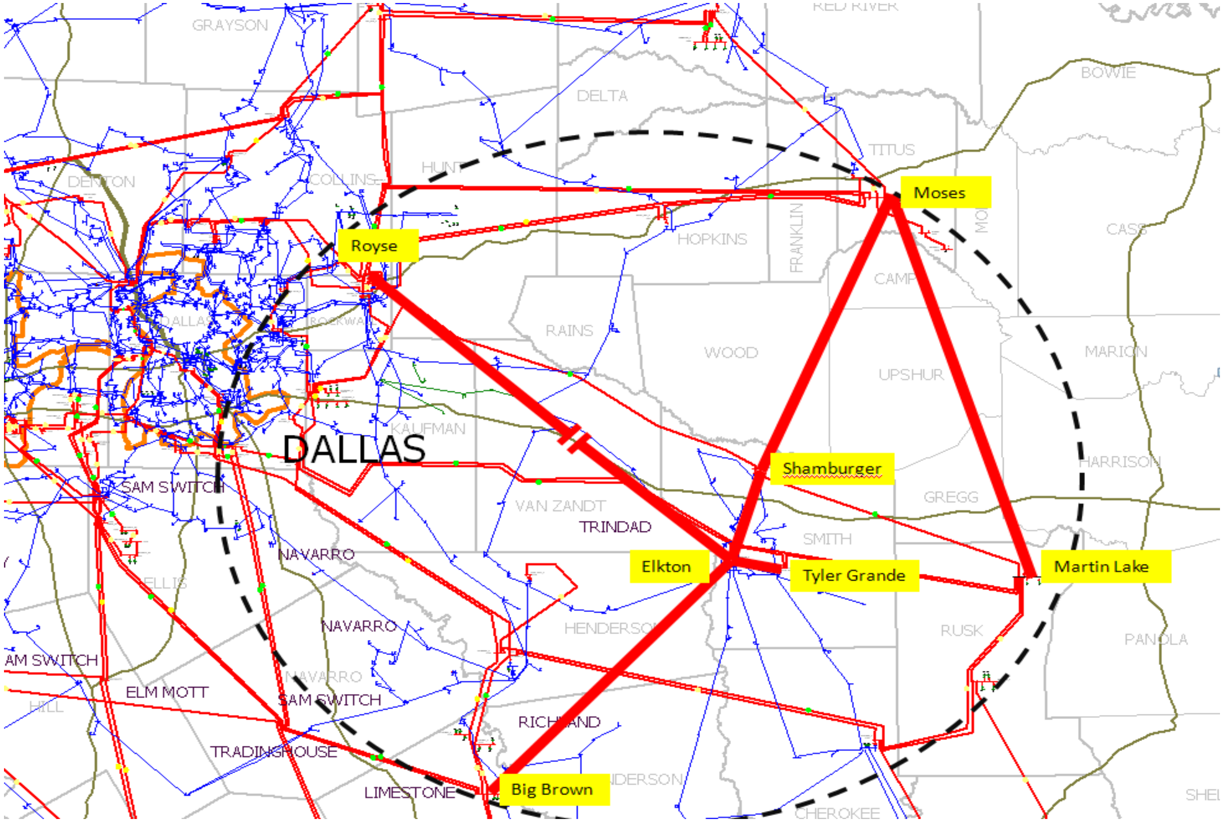
- **Alleviates congestion between generation South / Southeast of DFW**

- **Facilitates easier access to DFW loads from multiple interconnection sites in a historically functional region for generation development**

- **Meets the current 1/6th criteria in the BAU Scenario only at 345kV**

- **Derivatives will be further evaluated for scenarios where attainable economic benefit may merit this project**

Incremental Eastern Import Capacity to Dallas/Fort Worth



New 345 kV double circuits were added from Martin Lake to Monticello SES (Moses), Moses to Shamburger to Elkton, Elkton to Tyler Grande, Big Brown to Elkton and a 50% series compensated line connecting the Elkton bus to Royse substation

Eastern Import Capacity into Dallas / Fort Worth

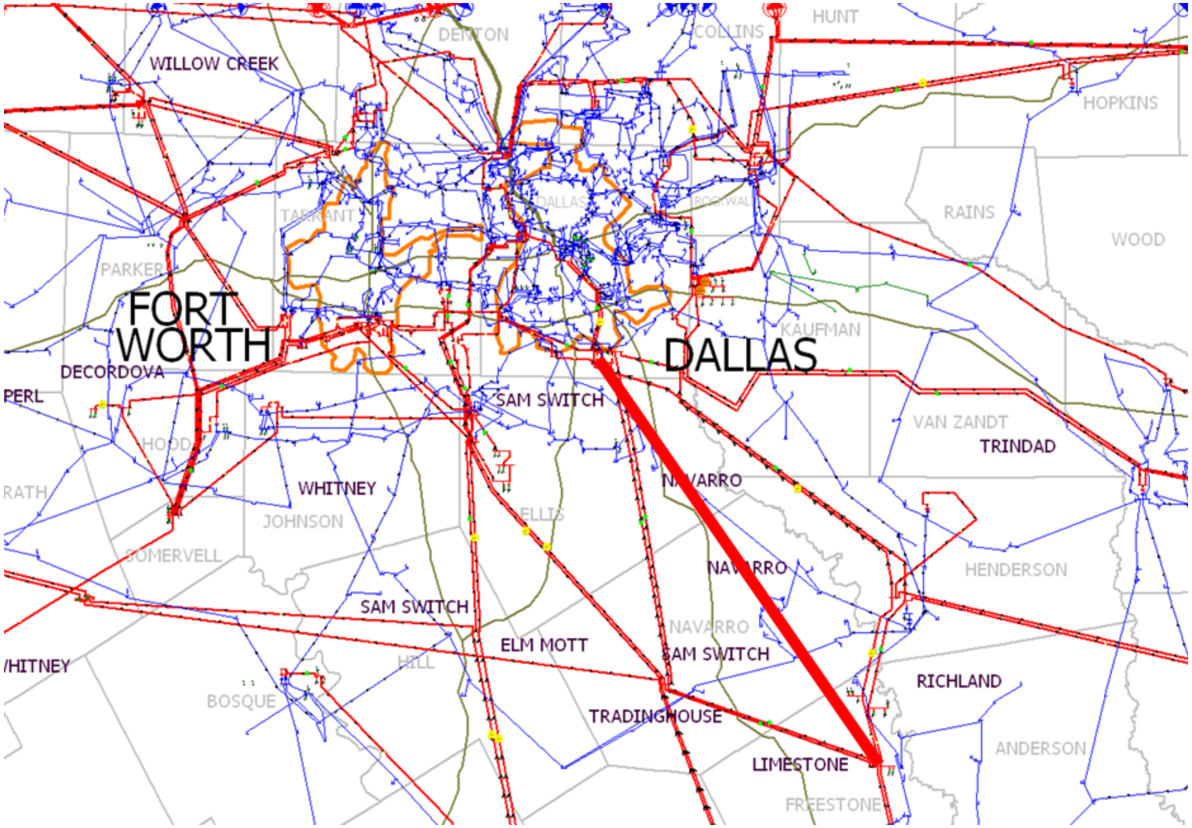
Need:

- **Lessen the impact of individual import path contingencies**
- **Increase deliverability to DFW Loads from the East of Dallas**
- **Establish transmission infrastructure to support multiple sites in a historically generation-rich region**

Alternative projects tested:

Big Brown to Watermill 500kV - This project will serve DFW from the south to enable transmission of power from central and southeast Texas.

Big Brown to Watermill – New Southern Import Path



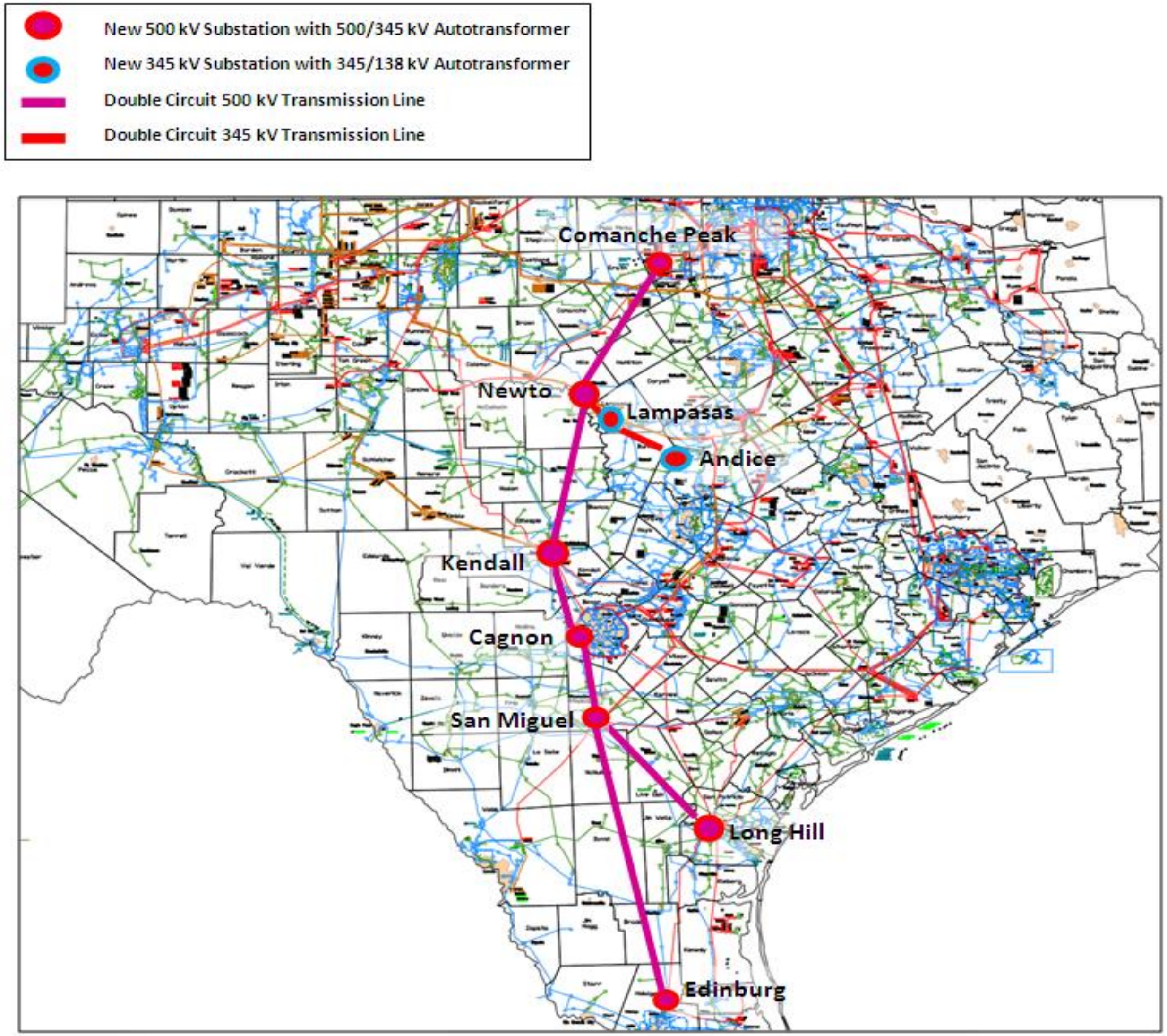
New 500 kV double circuit was added from Big Brown to Watermill to serve as a new import path to DFW from the southeast.

Economic Results/Benefits

	Incremental Eastern Import Paths			500 kV Big Brown to Watermill		
	2012	2020	2030	2012	2020	2030
Total Project Cost ($M.)	930	1078	1295	424	491	591
In Service Date Studied (Yr)		X	X		X	X
Reduction in System Production Costs ($M.)			(49)		(.05)	(2)

- **Alleviates congestion between generation South / Southeast of DFW**
- **Facilitates easier access to DFW loads from multiple interconnection sites in a historically functional region for generation development**
- **Does not meet the current 1/6th criteria in the BAU Scenario, but will be further evaluated for scenarios where attainable economic benefit may merit this project**

Central Texas Backbone



Central Texas Backbone

Need:

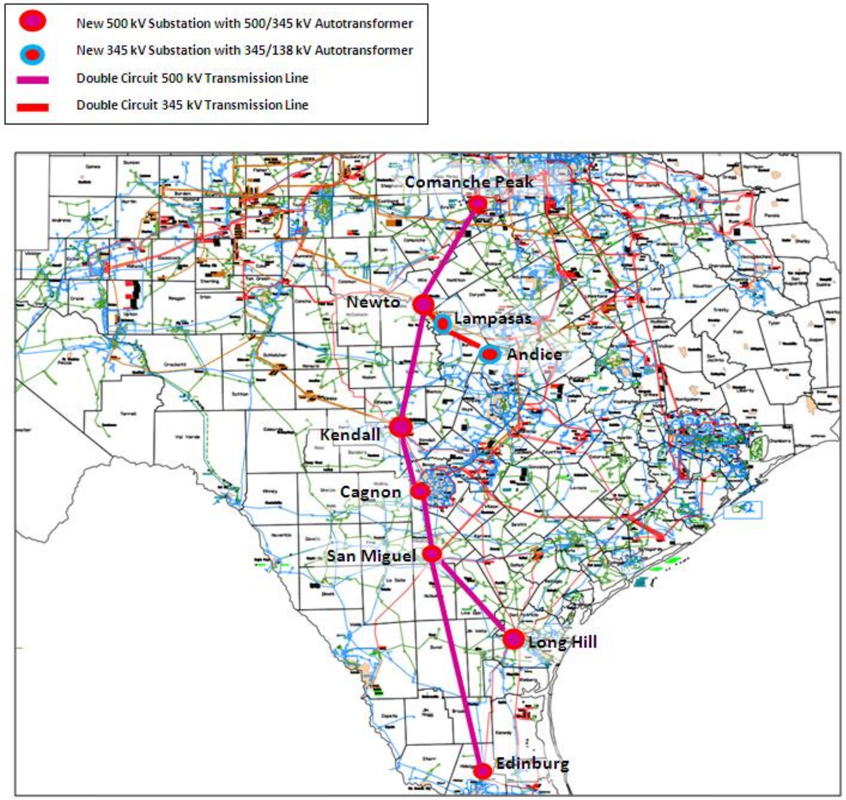
- **Provide strong source on the west of Austin and San Antonio**
- **Establish high power/low impedance path between generation concentrated in south Texas and loads in Austin/San Antonio**
- **To avoid N-1 overloads in Austin 138 kV lines that transmit power from east to west.**

Derivative projects tested:

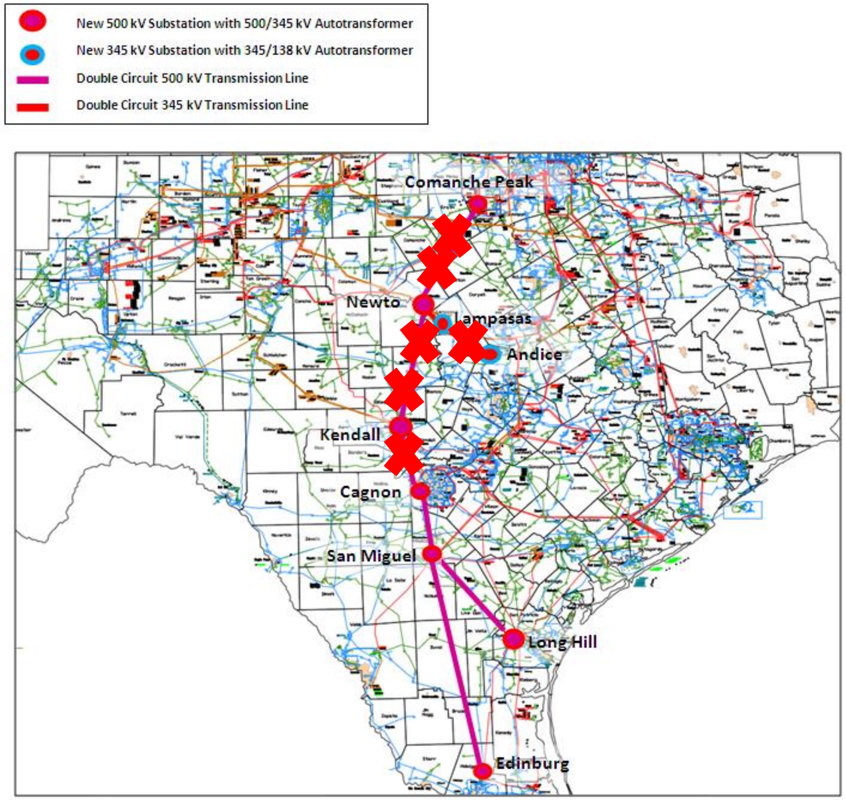
– Southern portion of the backbone, from Cagnon Substation to Lon Hill and Edinburg.

Economic Results

	Central Texas Backbone			Modified Central Texas Backbone		
	2012	2020	2030	2012	2020	2030
Total Project Cost ($M.)	2744	3180	3822	1488	1724	2073
In Service Date Studied (Yr)		X	X		X	X
Reduction in System Production Costs ($M.)			(17)			(17)



Central Texas Backbone

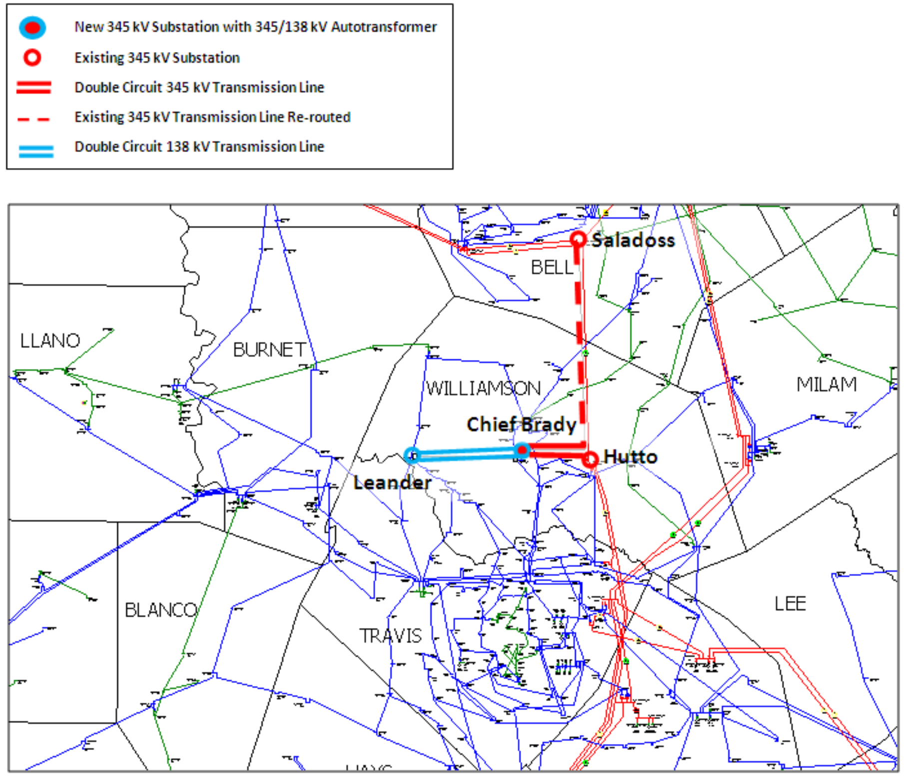


Modified Central Texas Backbone

Economic Benefits

- **The incremental generation sited in south Texas serves loads in Austin and San Antonio.**
- **Despite limited production cost savings (BAU), this project can reduce pre and post contingent overloads on 138 kV lines fed by eastern 345 kV sources.**
- **This project and its derivatives will be further evaluated for scenarios like high wind where attainable economic benefit may merit this project**

Northwest Austin EHV Sources



Existing 345kV line from Salado to Hutto is terminated at a new 345kV bus at Chief Brady. A new 345/138kV transformer ties Chief Brady to Leander substation on the low side via a new 138kV double circuited line.

Northwest Austin EHV Sources

Need:

- Establish a strong source west of Austin.
- Relieve N-1 overloads and congestion on 138 kV lines.

Alternatives Considered:

- ➢ Kendall to Trading Post 345 kV double circuit
- ➢ Newton to Andice via Lampasas 345 kV double circuit

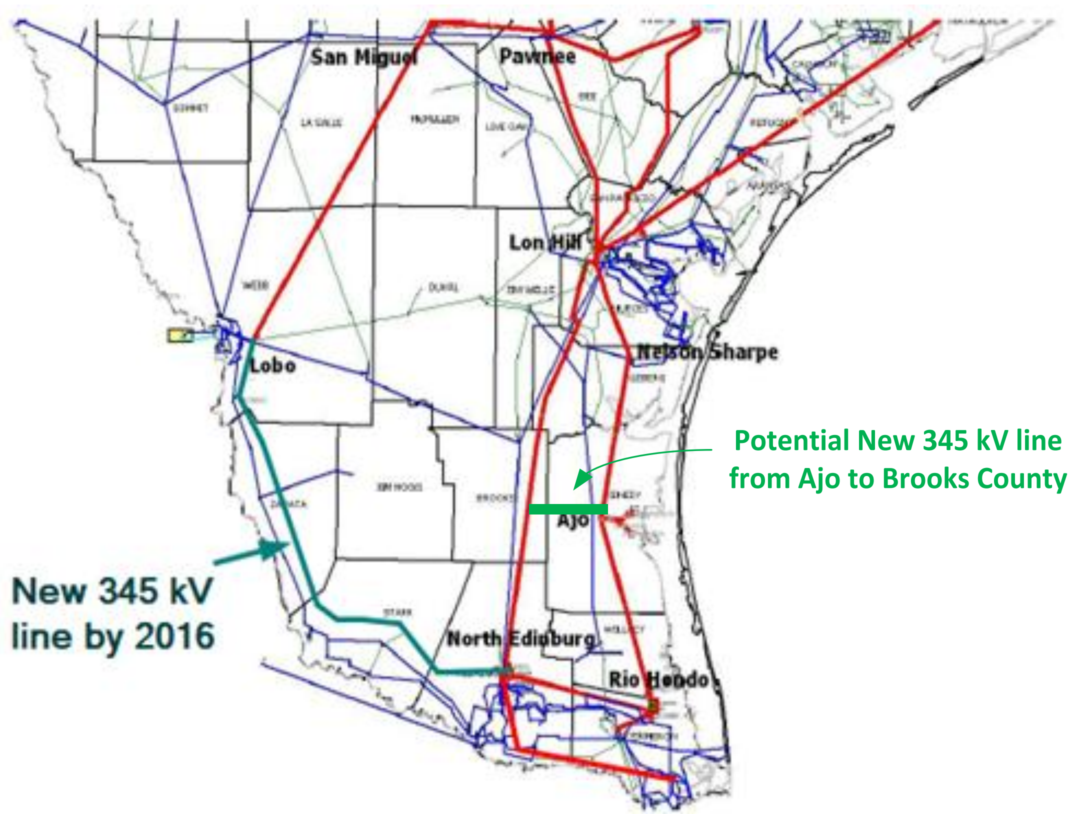
These projects yielded lesser economic benefit compared to Chief Brady Leander project and hence are not discussed in detail but will be considered in future analysis in other scenarios.

Economic Benefits / Results

	Hutto-Saladoss to CB/Leander		
	2012	2020	2030
Total Project Cost ($M.)	153	177	213
In Service Date Studied (Yr)		X	X
Reduction in System Production Costs ($M.)			(13)

- **While this project did not meet the traditional 1/6th criteria, it did relieve some 138 kV overloads that may be otherwise difficult to upgrade.**
- **This project and the alternatives will be studied under the other scenarios.**

Incremental Import Capacity into the Lower Rio Grande Valley (LRGV)



Incremental Import Capacity LRGV

Need:

- **Absent incremental generation sited in South Texas / LRGV, incremental imports into the LRGV will be needed by 2027 (stability)**
- **For the BAU Scenario, sufficient generation sited in South Texas / LRGV averted the need for incremental import capacity**

Projects Studied:

- **2nd Circuit for Lobo – North Edinburg into the LRGV**
- **HVDC into the LRGV**

Incremental Import Capacity LRGV: Economic Results

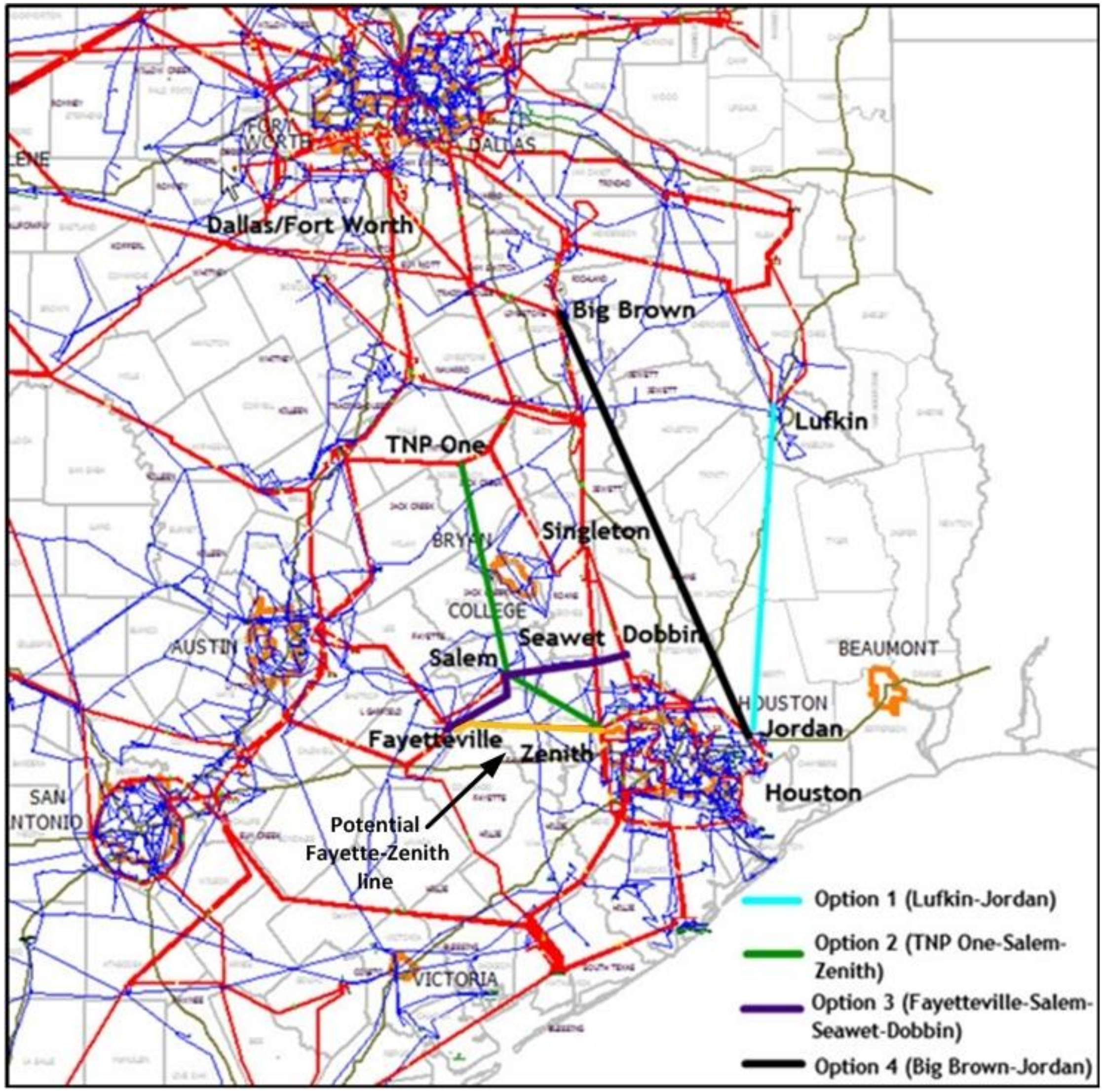
- In the BAU Scenario, with thermal and stability limits enforced, no congestion was present.

- Absent congestion, there is no economy to incremental import / export capacity in the Valley (given BAU assumptions.)

  However, absent incremental generation development in South Texas / Lower Rio Grande Valley, the second circuit* will only satisfy import needs until 2029 (based on forecasted load levels.)

  *Assumes Laredo-North Edinburg is built, as planned, with a single circuit on double circuit capable towers.

Incremental Houston Import Path



*Fayette to Zenith assumed in Service

Incremental Houston Import Path

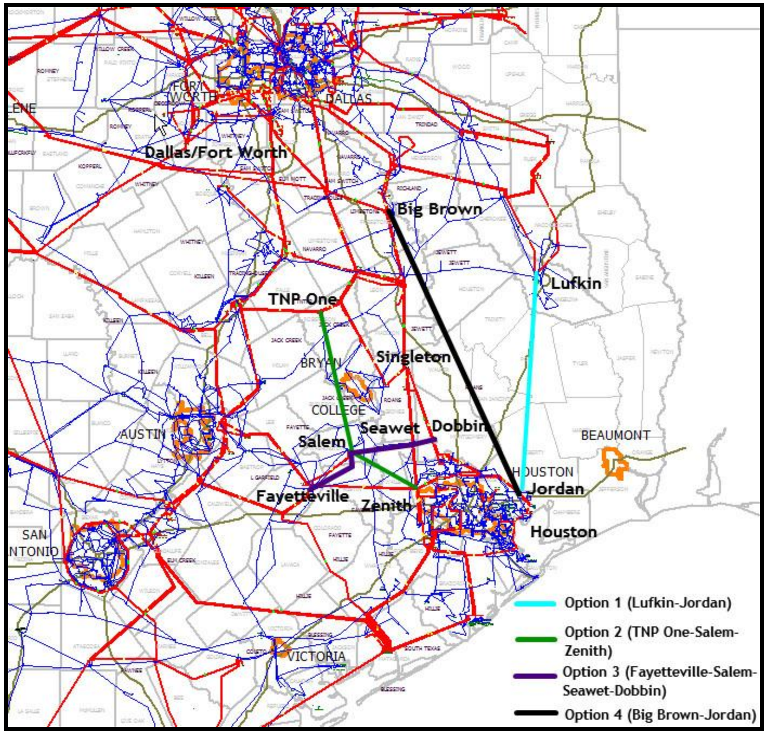
Need:

- **Between 2027 and 2030, incremental import capacity will be needed in the Houston metropolitan area***

- **Easing congestion into Houston yielded significant economic savings in most instances**

* G-1: CB2, N-1: Roan-Kuykendahl & Singleton – Tomball, Fayette – Zenith, Hillje – WA Parish, or STP – Down 345kV, Fayette to Zenith and Lufkin to Canal or other solution in-service

Economic Results



Cases	Production Cost Savings in 2030	Production Cost Savings in 2020	Estimated Cost (2020)
Option 1 (Lufkin-Jordan 345 kV)	$ 82.4 million	$ 4.9 million	287.4
Option 2 (TNP One-Salem-Zenith 345 kV)	- $ 20.7 million*	Rejected from further study	354.5
Option 3 (Fayetteville-Salem-Seawet-Dobbin 345 kV)	$ 2.4 million	Rejected from further study	209.5
Option 4 (Big Brown-Jordan 500 kV)	$ 24.5 million	$ 5.1 million	866.1

Conclusions

- **The twenty-year resource build assumptions for the BAU Scenario, with evenly distributed, similarly fueled, and equally efficient generation resources, delays or abates the need for large-scale transmission infrastructure in long term study models.**

- **Transmission congestion observed in the BAU case is highly correlated to assumed increasing urban density and dependence on imported power in the Dallas, Houston, Austin, and San Antonio load centers.**

- **Economic projects in the BAU Scenario were most cost effective in Dallas / Houston, connecting concentrated pockets of generation to urban loads.**

Next Steps

- **Increasing dependence on imported power in Urban Areas will require careful AC stability analysis, studying incremental reactive sources, *and* incremental import paths.**

- **ERCOT is currently performing a steady-state stability analysis for major load centers.**

- **The system stability needs will be an additional criterion to quantify need and economy of 2030 system solutions.**

- **Study BAU with:**
  - All Technologies
  - All Technologies + strategic retirements
- **Acquire tools, build proficiency to assess high renewable scenarios.**

Questions?