Report on Existing and Potential

Electric System Constraints and Needs

December 2014

ERCOT Report on Existing and Potential Electric System Constraints and Needs

Executive Summary

The annual Electric System Constraints and Needs report is provided by the Electric Reliability Council of Texas, Inc. (ERCOT) to identify and analyze existing and potential constraints in the transmission system that pose reliability concerns or may increase costs to the electric power market and, ultimately, to Texas consumers. This report satisfies the annual reporting requirements of Public Utility Regulatory Act (PURA) Section 39.155(b) and a portion of the requirements of Public Utility Commission Substantive Rules 25.361(i)(2)(I) and 25.505(c).

In 2014, the most significant constraints experienced on the ERCOT System were related to system outages. System outages can occur when equipment fails or when equipment owners take facilities out of service to perform transmission system improvements or maintenance. Between January and October 2014 fourteen of the top fifteen constraints on the ERCOT System were either primarily caused by outages on the transmission system or experienced increased congestion due to outages. The constraint with the highest amount of congestion rent was the Heights 138/69 kV transformer. This constraint, which is located on the south side of the Houston area, was caused by an outage on the transmission system.

In recent years the Houston area has seen persistent load growth but also a lack of new generation development. Demand in all customer classes has been increasing since 2009, and the rate of growth for commercial and residential classes has been increasing since 2010. On the generation side, 1,800 MW of new generation has been added in the Houston area over the last ten years, but 3,800 MW of older generation has retired over the same time period resulting in a net decrease of local generation.

The transmission system is used to import the difference in electric power between load and local generation. The transmission lines used to import power into the Houston and Bryan/ College Station areas from the north were highly congested in 2014. The ERCOT Board of Directors endorsed the reliability need for a new 345 kV double circuit line project for the area. Depending on weather and outages there is a risk of significant congestion and even reliability constraints related to the import of power into the Houston area prior to the completion of the project, which is currently planned for 2018.

Elsewhere on the ERCOT System, transmission system improvements have substantially reduced congestion in West Texas compared to previous years. In 2014, only three of the top fifteen constraints were located in West Texas. However, demand growth related to oil and natural gas exploration and production remains strong. Peak demand in the Far West weather zone, which contains most of the Permian Basin, has increased at an average annual rate of 8.4% since 2009. Some of the growth in peak demand in 2014 can be attributed to the moving of load on the Sharyland Utilities system from the Eastern Interconnection to ERCOT. ERCOT has begun the process of conducting a special study to identify the ongoing system needs.

The Panhandle region of the CREZ project is experiencing significantly more interest from wind generation developers as compared to what was initially planned for the area in terms of transmission export capability. In 2014, ERCOT completed an analysis to determine the next steps for transmission system improvements in order to meet the future needs in the Panhandle region. Some of the improvements can be implemented in a relatively short time period. These include installing shunt reactors, synchronous condensers, and adding the second circuit on existing transmission towers that were constructed to be double-circuit capable with originally just one circuit in place.

In the Lower Rio Grande Valley (LRGV), a new 345 kV import line and the upgrade of the two existing 345 kV import lines are part of a project to increase the overall import capability into the area by 2016. Additionally, a new 345 kV line that runs east-west across the LRGV is planned to meet reliability needs in and around the Brownsville area. ERCOT is currently evaluating the need for additional system improvements after 2016. This assessment is being driven by the recent announcement that one unit in the LRGV will be switched from serving ERCOT load to the Mexico system. Potential needs for additional transmission may be deferred by several potential generation projects which are under study in the area.

A new proposed liquefied natural gas (LNG) project in the Freeport area, south of Houston, could have a noteworthy impact on the ERCOT System. The project is expected to add 690 MW of load which by itself is roughly equal to 1% of the ERCOT peak demand and nearly 3% of minimum demand. A proposed $80 million transmission upgrade project is planned to meet the needs of the Freeport LNG facility. Several other potential LNG projects have been proposed along the Texas Gulf Coast and could require transmission system improvements.

ERCOT Report on Existing and Potential Electric System Constraints and Needs

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1. Introduction

The Electric Reliability Council of Texas (ERCOT), as the independent organization (IO) under the Public Utility Regulatory Act (PURA), is charged with nondiscriminatory coordination of market transactions, system-wide transmission planning and network reliability, and ensuring the reliability and adequacy of the regional electric network in accordance with ERCOT and North American Electric Reliability Corporation (NERC) Reliability Standards. The IO ensures access to the transmission and distribution systems for all buyers and sellers of electricity on nondiscriminatory terms. In addition, ERCOT, as the NERC registered Planning Coordinator/ Planning Authority, is responsible for assessing the longer-term reliability for the ERCOT Region.

ERCOT supervises and exercises comprehensive independent authority of the overall planning of transmission projects for the ERCOT System as outlined in the PURA and Public Utility Commission of Texas (PUCT) Substantive Rules. ERCOT's authority, with respect to transmission projects that are local in nature, is limited to supervising and coordinating the planning activities of Transmission Service Providers (TSPs). The PUCT Substantive Rules further indicate that the IO shall evaluate and make a recommendation to the PUCT as to the need for any transmission facility over which it has comprehensive transmission planning authority. In performing its evaluation of different transmission projects, ERCOT takes into consideration the need for and cost-effectiveness of proposed transmission projects in meeting the ERCOT planning criteria and NERC Reliability Standards.

Transmission planning (facilities 60 kV and above) is a complex undertaking that requires significant work by, and coordination between, ERCOT, the TSPs, stakeholders, and other market participants. ERCOT works directly with the TSPs, stakeholders, and market participants through the Regional Planning Group (RPG). Each of these entities has responsibilities to ensure that appropriate transmission planning and construction occurs.

The Protocols and Planning Guide describe the practices and procedures through which ERCOT meets its requirements related to system planning under PURA, NERC Reliability Standards, and PUCT Substantive Rules.

2. ERCOT Transmission Planning

Every year ERCOT performs a planning assessment of the transmission system. This assessment is primarily based on three sets of studies.

1. The Regional Transmission Plan (RTP) addresses region-wide reliability and economic transmission needs and includes the recommendation of specific planned improvements to meet those needs for the upcoming six years. The 2014 RTP report is posted on the ERCOT Market Information System website.
2. The Long-Term System Assessment (LTSA) uses scenario-analysis techniques to assess the potential needs of the ERCOT System up to 15 years into the future. The role of the LTSA is to identify upgrades that provide benefits across a range of scenarios or might be more economic than the upgrades that would be determined considering only near-term needs in the RTP development. The LTSA does not recommend the construction of specific system upgrades due to the high degree of uncertainty associated with the amount and location of loads and resources in this timeframe. The LTSA study is conducted in even-numbered years and reviewed in odd-numbered years. The 2014 Long-Term System Assessment report is posted on the ERCOT website in the following location: http://www.ercot.com/news/presentations/.
3. Stability studies are performed to assess the angular, voltage, and frequency response of the ERCOT System. Due to the security-related sensitive nature of the information contained in these study reports, they are not normally published on the ERCOT website.

These studies are conducted using models that represent expected future transmission topology, demand, and generation. The models are tested against reliability and economic planning criteria per NERC Standards and the ERCOT Protocols and Planning Guide. When system simulations indicate a deficiency in meeting the criteria, a corrective action plan will be put in place and typically includes a planned transmission improvement project. TSPs also perform studies to assess the reliability of their portion of the ERCOT System.

Transmission improvement projects that are estimated to cost more than $15 million or that require a Certificate of Convenience and Necessity (CCN) are reviewed by the RPG prior to implementation[1]. The RPG is a non-voting forum made up of ERCOT, TSPs, Market

[1] Per ERCOT Protocol Section 3.11.4 certain projects are exempt from RPG review, such as projects to serve new generation or load customers.

Participants, other stakeholders, and PUCT Staff. In 2014, $857.3 million of transmission improvement projects were reviewed and accepted through the RPG process.

Transmission system improvements are built by TSPs and are paid for by consumers. During the twelve-month period from October 2013 through September 2014, TSPs completed $2.80 billion in transmission projects, of which $1.95 billion was related to the Competitive Renewable Energy Zone (CREZ) project. The total includes the addition or upgrade of 1,975 miles of transmission circuits, the addition of 4,924 MVA of autotransformer capacity, and the addition of 2,541 MVAr of reactive capability. A comprehensive list of recently completed and future transmission projects can be found in the Transmission Project Information Tracking (TPIT) report which is updated three times a year and can be found on the ERCOT website in the following location: http://www.ercot.com/gridinfo/sysplan/.

3. Recent Constraints

Congestion occurs when transmission limitations do not allow for the most efficient dispatch of generation to meet a given demand. Table 3.1 and Figure 3.1 show the top 15 congested constraints on the ERCOT System from January through October 2014 based on real-time data.

Table 3.1: Top 15 Congested Constraints on the ERCOT System (January-October 2014)

Map Index	Constraint	Congestion Rent
1	Heights 138/69 kV transformer	$63,917,791
2	Lytton Springs 345/138 kV transformer	$55,956,002
3	Midland East – Buffalo 138 kV line	$46,790,259
4	North to Houston Import	$31,806,449
5	Harlingen Switch – Oleander 138 kV line	$26,943,341
6	Odessa North 138/69 kV transformer	$23,944,433
7	Rio Hondo – East Rio Hondo 138 kV line	$23,683,772
8	Moss Switch – Westover 138 kV line	$19,511,591
9	Hockley – Betka 138 kV line	$15,850,200
10	Lon Hill – Smith 69 kV line	$14,052,406
11	Valley Import	$11,853,636
12	Hutto – Round Rock Northeast 138 kV line	$10,033,349
13	Paris Switch 345/138 kV transformer	$9,940,305
14	Marshall Ford – Lago Vista 138 kV line	$9,871,526
15	Gila – Hiway 9 138 kV line	$8,622,377

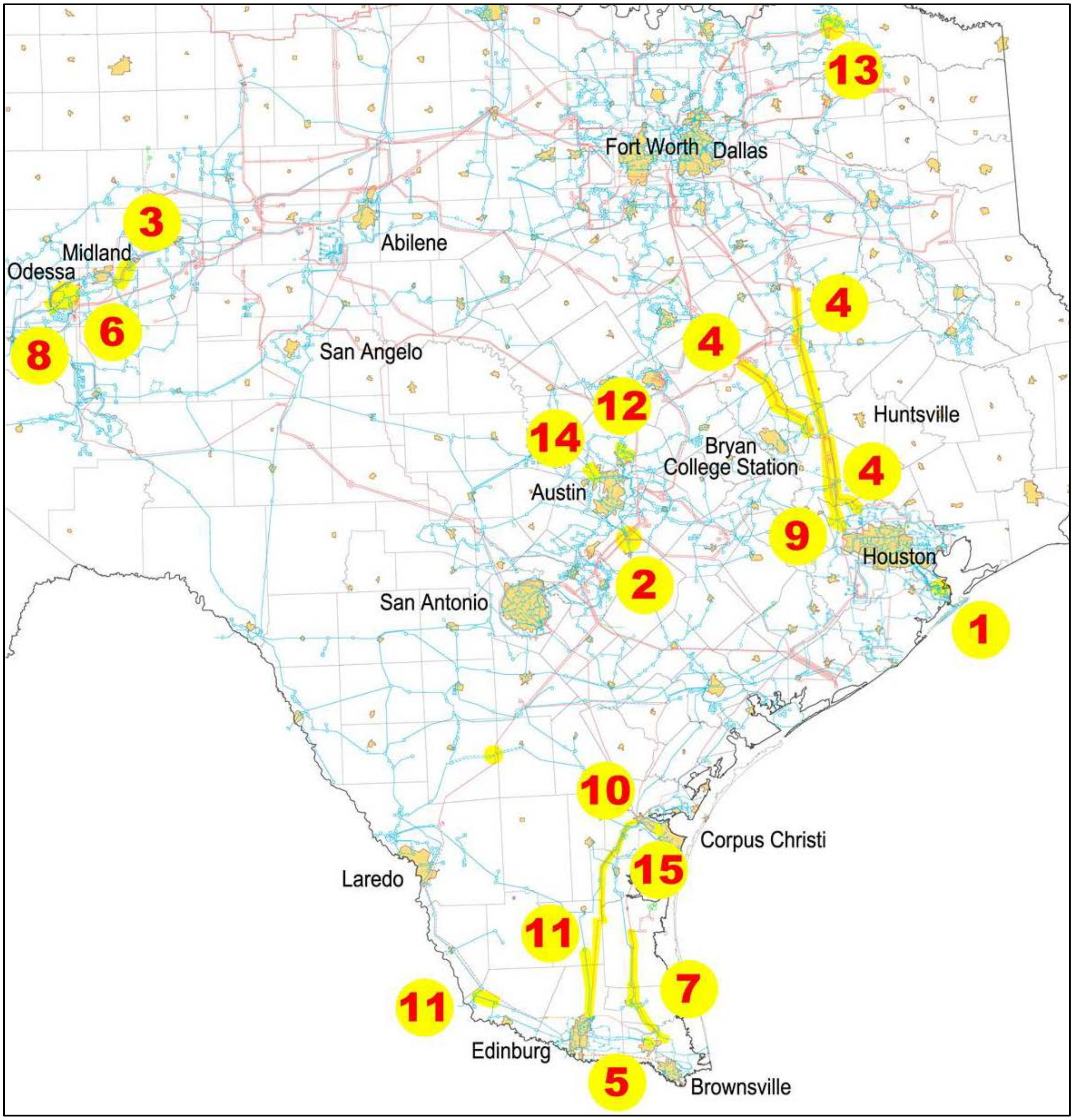

Figure 3.1: Map of Top 15 Congested Constraints on the ERCOT System (January-October 2014)

The following sections provide more details on recent constraints on the ERCOT System.

3.1 Houston Import

The load in the Houston metropolitan area is currently served by the generation in the area and the power imported through 345 kV lines from the north and south into the Houston area.

Load growth in the region is expected to continue. Based on anecdotal evidence, a significant challenge is also anticipated in developing new resources in this dense urban area due to restrictions such as air quality standards and site availability inside the city. Historical data indicates that approximately 1,800 MW of new generation has been added in the Houston region over the past ten years (2004 to 2013), while approximately 3,800 MW of generation has been retired over that time. The continuous load growth and lack of new generation additions in the load center has resulted in the Houston system relying more on power imports through the existing 345 kV lines into the area. In addition, increasing dependence on power imports causes significant challenges in scheduling a planned outage with a sufficient duration on any of the major 345 kV lines along the Houston import path.

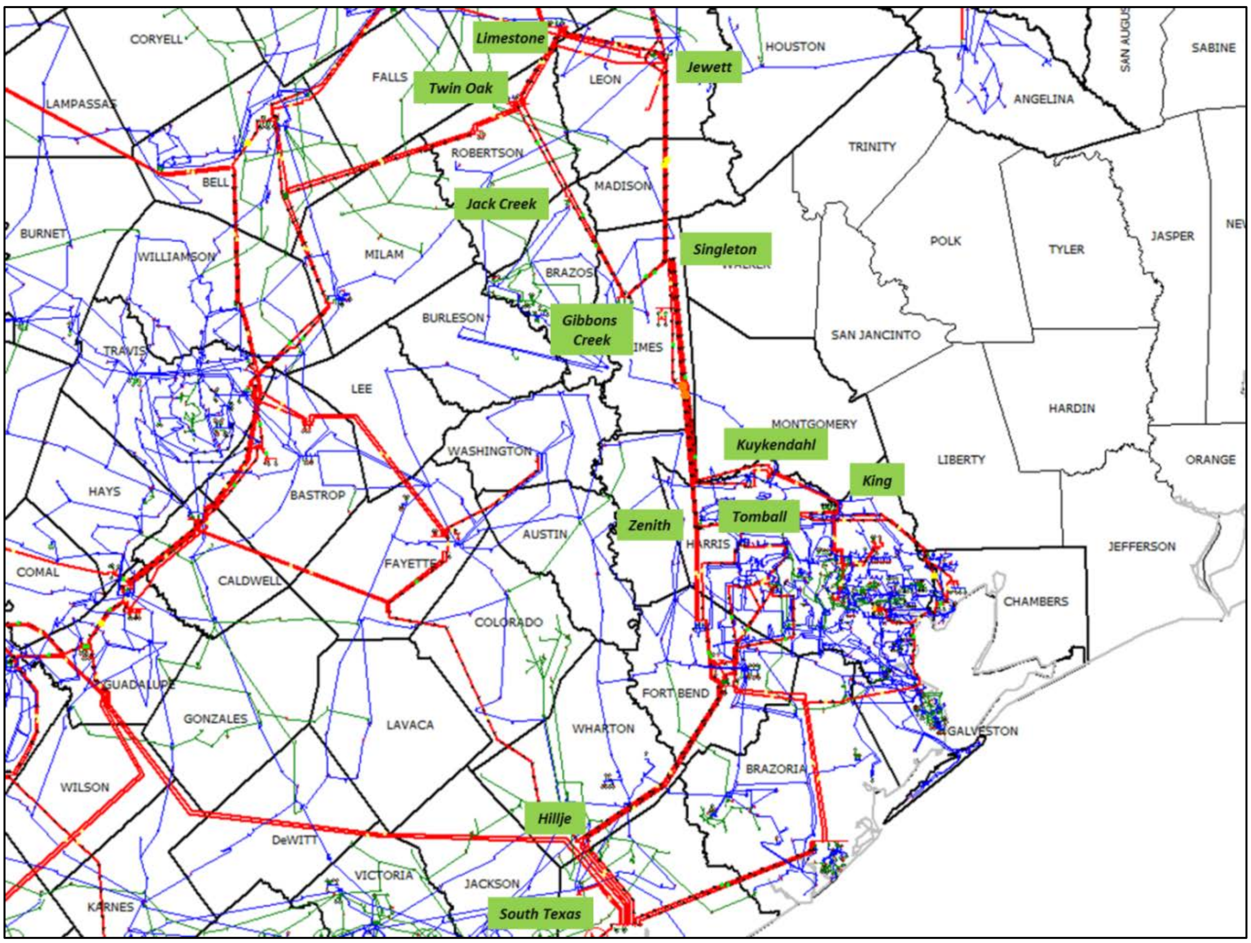

Figure 3.2: Map of Houston Area Transmission System

One of the highest congested areas on the system in 2014 was related to the import of power into the Houston area. Multiple 345 kV lines coming into the area from the north were congested, including the Twin Oak – Jack Creek 345 kV line, Twin Oak – Gibbons Creek 345 kV line, Big Brown – Jewett 345 kV line, Jewett – Singleton 345 kV line, Singleton – Zenith 345 kV line, and Singleton – Tomball 345 kV line. Congestion rent on these lines was greater than $31 million for the second year in a row.

The Houston metropolitan area is one of the major load centers in Texas, serving more than 25% of the entire load in the ERCOT System. It is the fifth most populous metropolitan area in the United States and is expected to continue growing at a rate of over 100,000 new residents per year. The Gross Area Product for the Houston metropolitan area is projected to grow at an average annual rate of 3.5%. The area has almost 40% of the nation's petrochemical manufacturing capacity and the Port of Houston has ranked first among United States seaports in terms of import tonnage for 22 consecutive years[2].

According to the U.S. Bureau of Labor Statistics the Houston area added more than 600,000 jobs between January 2005 and August 2014, an increase of more than 26%. Recently the Economic Development and Tourism Division of the Texas Office of the Governor listed five key growth industries in Texas, shown in Table 3.2[3]. The Houston area was listed as a primary growth region for all five of these industries.

Table 3.2: Five Key Growth Industries in Texas[3]

Industry	Job Growth (since 2010)	Primary Regions
Oil and Gas	44%	Houston, Coastal Bend, Eagle Ford, Permian Basin, North Texas
Fabricated Metals	22%	Houston, DFW, East Texas, Permian Basin
Oilfield Machinery	39%	Houston, DFW, Permian Basin
Refineries and Chemicals	7%	Houston, DFW, Beaumont-Port Arthur, Corpus Christi
IT Services	29%	Austin, DFW, Houston

[2] https://www.houston.org/economy/#HoustonFactsPublication
[3] http://www.ercot.com/content/meetings/lts/keydocs/2014/0113/ERCOT_Presentation_-_Eric_Clennon_-_1-13-20141.ppt

One way to measure economic growth in an area is by evaluating the change in the number of premises with electric meters in ERCOT. ERCOT tracks this information for each of the eight weather zones that span the ERCOT System. Figure 3.3 shows the annual premises count growth from 2009 through 2013 for the Coast weather zone broken down by industrial, commercial, and residential customer classes. The Houston area represents the majority of the electric demand within the Coast weather zone. The data shows that all three customer classes have experienced premises count growth in each of the last five years and that the rate of growth for the commercial and residential classes has been increasing since 2010.

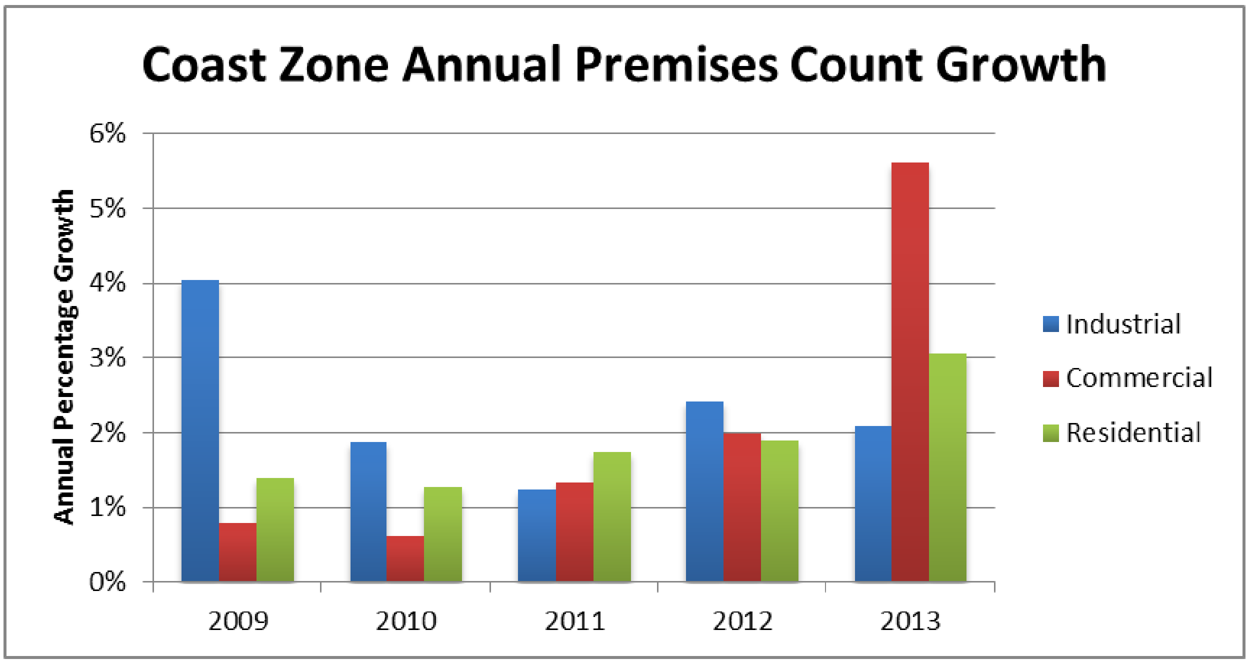

Figure 3.3: Coast Zone Annual Premises Count Growth (2009-2013)

The biennial ERCOT Long-Term System Assessments from 2006, 2008, 2010, and 2012 all identified a need to increase the import capability of the transmission system serving the Houston area. Several of the projects identified in these long-term studies have already been constructed. Table 3.3 and Figure 3.4 display three of the major Houston import projects identified in previous Long-Term System Assessments.

Table 3.3: Three Major Houston Import Projects as Identified in Past LTSAs

Map Index	Project	Year Completed
1	Hillje 345 kV switch station and Hillje – WAP 345 kV line	2007
2	Singleton 345 kV switch station	2009
3	Zenith 345 kV switch station	2011

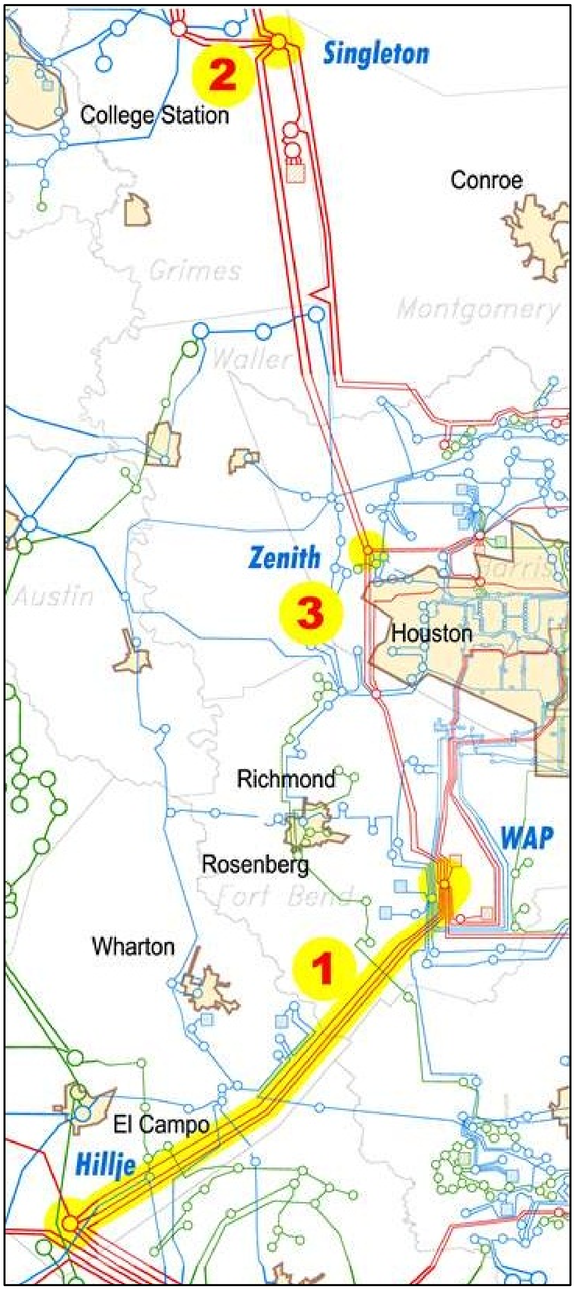

Figure 3.4: Map of Three Major Houston Import Projects as Identified in Past LTSAs

Each of the Long-Term System Assessments from 2006, 2008, 2010, and 2012 also identified a need to construct a new import path to serve the Houston area. In the summer of 2013, ERCOT received three separate proposals for RPG review to construct a new 345 kV double circuit line into the Houston area. Each of the three proposals identified reliability criteria violations that were required to be resolved by 2018. ERCOT conducted an independent review of the proposals and confirmed that there was a reliability need for a Houston Import Project. In addition to the base scenario, ERCOT conducted sensitivity analyses on three alternate scenarios based on stakeholder feedback. All three of the sensitivity analyses showed a reliability need for a project. Figure 3.5 illustrates the transmission lines found to be overloaded in the ERCOT analysis.

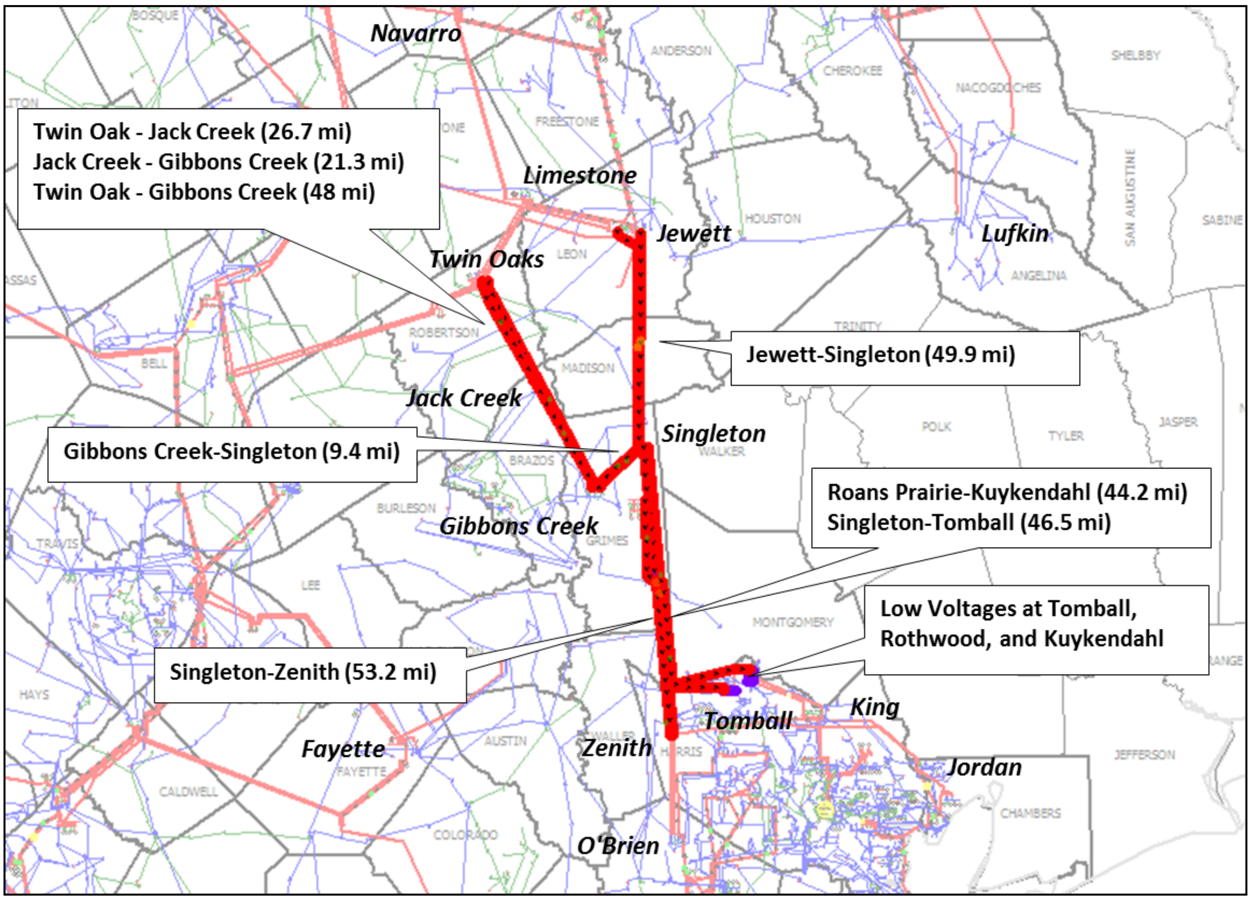

Figure 3.5: Map of Overloaded Houston Import Lines Found in ERCOT Analysis

ERCOT analyzed 21 options for solving the reliability criteria violations. To select the best long-term and most cost-effective option ERCOT performed a variety of analyses. In early 2014, ERCOT recommended the construction of a new 345 kV double circuit line from Limestone to Gibbons Creek, a new 345 kV double circuit line from Gibbons Creek to Zenith, and the upgrade of the TH Wharton to Addicks 345 kV line. The ERCOT Board of Directors endorsed the need for the project in April 2014, and deemed the new 345 kV double circuit lines as critical to reliability. The project is expected to be completed by summer of 2018.

While growth in the Houston area is a primary driver for the need for the project, another significant driver is growth in the Bryan-College Station area. According to the City of College Station, the population in Brazos County increased nearly 28% between 2000 and 2010 and the population of the city itself increased an estimated 2.2% between November 2013 and October 2014. In fact, approximately two-thirds of the area congestion experienced in 2014 occurred on lines from the north, which terminate at the Gibbons Creek, Jack Creek, or Singleton stations located in Brazos and Grimes Counties. These same lines were shown to have reliability violations in the ERCOT analysis of the need for the project. Therefore, the project will have considerable reliability and economic congestion benefits for the Brazos and Grimes Counties area.

Since ERCOT completed the analysis of the need for the Houston Import Project, three plants in the Houston area have committed to add generation in the area before 2018. These plants were not included in the ERCOT analysis and will add 676 MW of generation to the area. However, there was 961 MW of generation in the area that was counted as being available that is now mothballed. The net effect of these generation changes is an increased need for the project. There is nearly 1,200 MW of additional generation within the area that will be more than fifty years old by 2018. Most of the similar units in ERCOT have already been retired. The retirement of these units was not considered in ERCOT's assessment of project need due to the current planning rules. If these units retire and more generation is not constructed, it could increase the need to import power into the area. Figure 3.6 illustrates the net effect of generation additions and retirements in the Houston area since 2004.

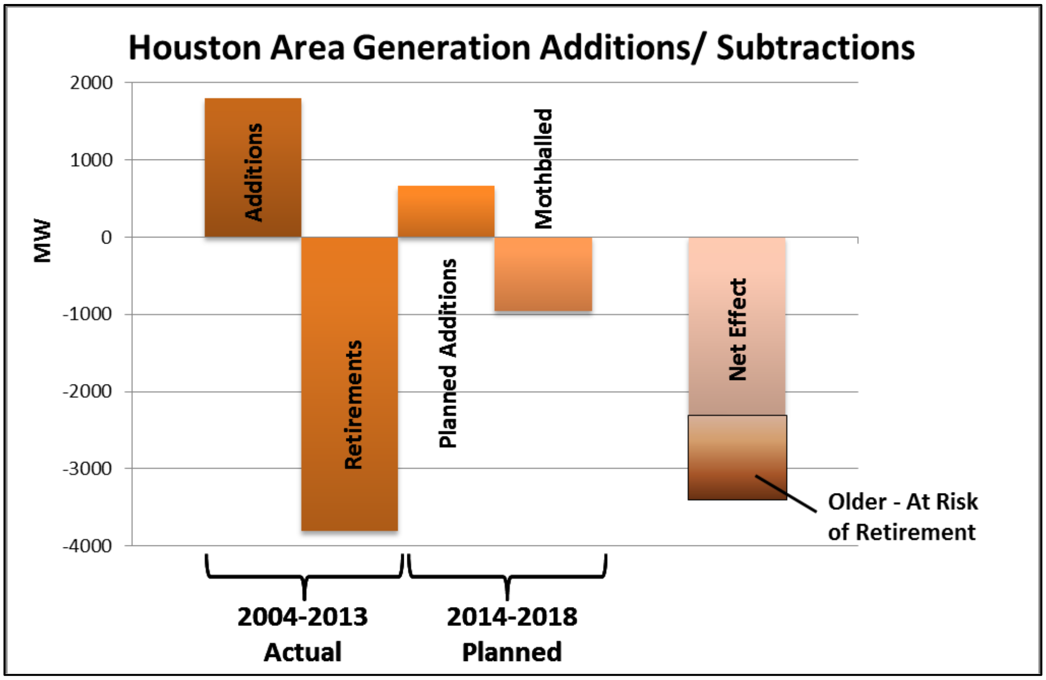

Figure 3.6: Houston Area Generation Additions and Subtractions

The growth in customer demand and the lack of new generation development in the area has led to increased imports into the Houston area. Figure 3.7 illustrates the import of power into the area from the north for summer hours in 2011 through 2014. The top 300 hours of highest flow for each summer are included in the figure. The results indicate that the number of hours of high import of power into Houston from the north has been steadily increasing since 2011.

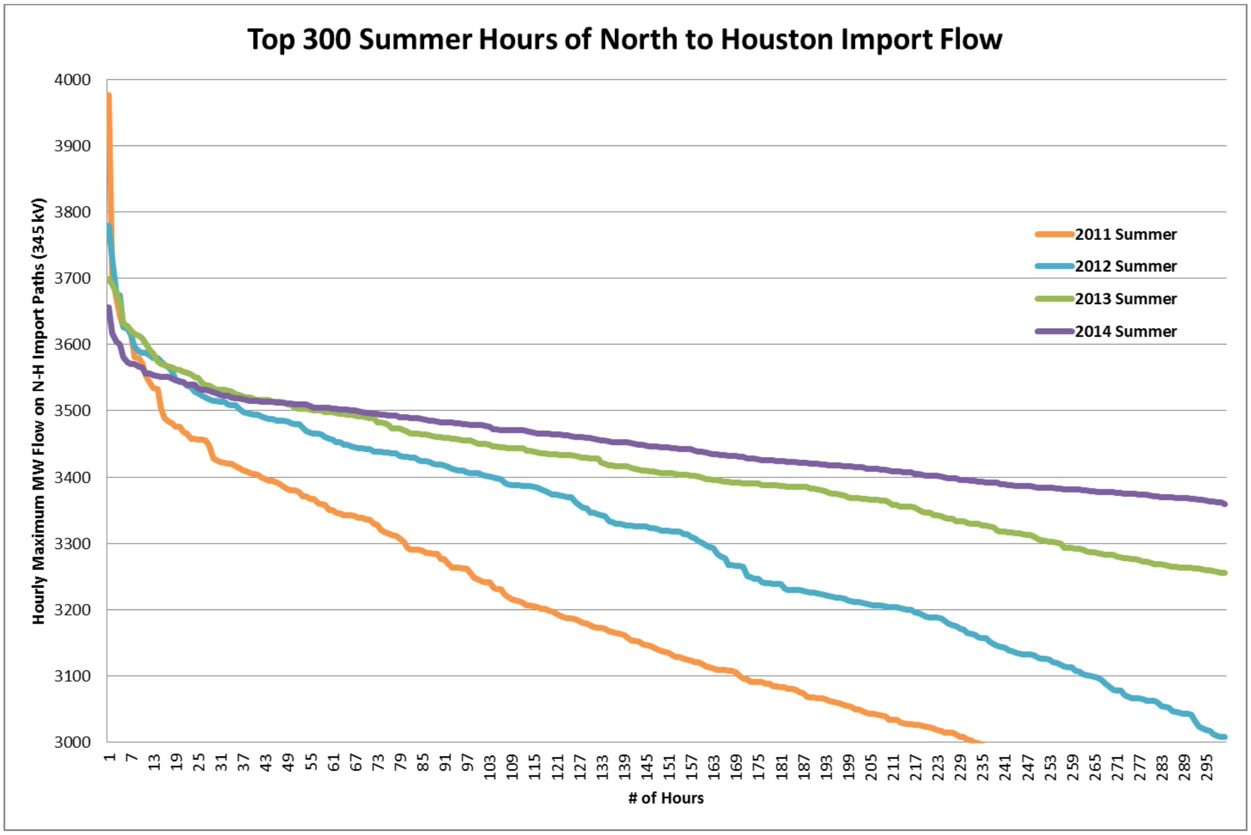

Figure 3.7: Import of Power from North to Houston During Summer Hours (2011-2014)

The 2014 RTP was conducted using more up-to-date assumptions than were used in the independent review of the Houston Import Project. Although the independent review indicated that the project was needed by 2018, a reliability criteria violation was found in the 2014 RTP for year 2017. However, it is unlikely that the project can be completed by 2017, and consequently, weather and outages could result in significant congestion costs on the import lines prior to completion. ERCOT operators will need to develop mitigation measures to ensure reliability for the system as a whole. These may include plans to shed load should certain contingencies occur on the system. It should also be noted that the Freeport LNG project (discussed further in Section 4.4), which will add a sizable amount of load to the south side of the Houston area, was not included in either the Houston Import Project analysis or the 2014 RTP since the customer had not provided financial commitment for the whole project to the TSP at the time of those studies. This load addition is expected to begin coming onto the system in the third quarter of 2017 and would increase the need for the project.

3.2 West Texas Load Growth

In 2012 and 2013, the most significant congestion on the ERCOT System was experienced in West Texas due to the growth in electric demand from the oil and natural gas industry and associated economic expansion in residential and commercial developments in the Permian Basin area. However, from January through October 2014, only three of the top fifteen constraints on the ERCOT System were located in West Texas (Midland East – Buffalo 138 kV line, Odessa North 138/69 kV transformer, and Moss Switch – Westover 138 kV line). In comparison, of the top fifteen constraints over the same time period in 2012, eight were related to West Texas load and in 2013; six were related to West Texas load. This improvement can be attributed to the implementation of system improvement projects. In fact, of the three constraints to make the list in 2014, two were related to equipment being taken out of service in order to construct transmission upgrades.

Table 3.4 and Figure 3.8 show some of the significant West Texas transmission upgrades projects completed in the first half of 2014.

Table 3.4: Recently Completed West Texas Transmission Upgrades

Map Index	Project	Completion Date
1	Moss – Holt Switch 138 kV line upgrade	January 2014
2	Wink – Loving 138 kV line upgrade	January 2014
3	Odessa North – Goldsmith Junction 138 kV line upgrade	May 2014
4	Odessa North 138 kV switching station construction	May 2014
5	Moss 345 kV switching station circuit breaker installation	May 2014
6	Odessa North – Cowden 69 kV line upgrade	May 2014
7	Moss – Odessa EHV 138 kV line upgrade	May 2014
8	Loving – Elmar 138 kV line upgrade	June 2014

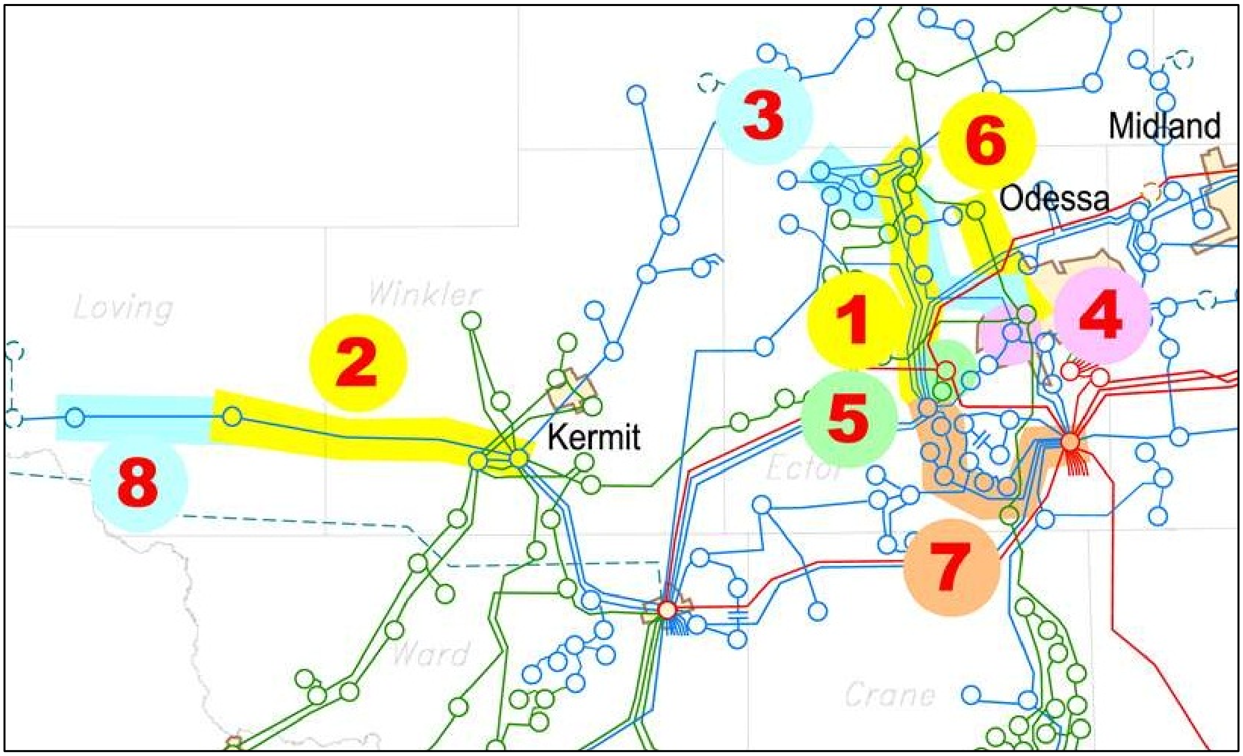

Figure 3.8: Map of Recently Completed West Texas Transmission Upgrades

Even though the congestion has decreased, load growth remains strong in the area. Peak demand in the Far West weather zone, which contains most of the Permian Basin, has increased at an average annual rate of 8.4% since 2009. Annual energy use in the Far West weather zone has experienced similar growth, increasing by an average annual rate of 7.0% from 2009 through 2013. Figures 3.9 and 3.10 show the Far West weather zone growth in peak demand and energy, respectively, since 2009.

Some of the growth in peak demand in 2014 can be attributed to the moving of load on the Sharyland Utilities system from the Eastern Interconnection to ERCOT. Beginning in 2013 Sharyland Utilities transferred approximately 300 MW of load and the associated transmission network in West Texas into the ERCOT System. This transfer was completed in early 2014. The transfer caused changing flow patterns on the transmission system which led to high congestion on the Midland East to Buffalo 138 kV line during July and August of 2014.

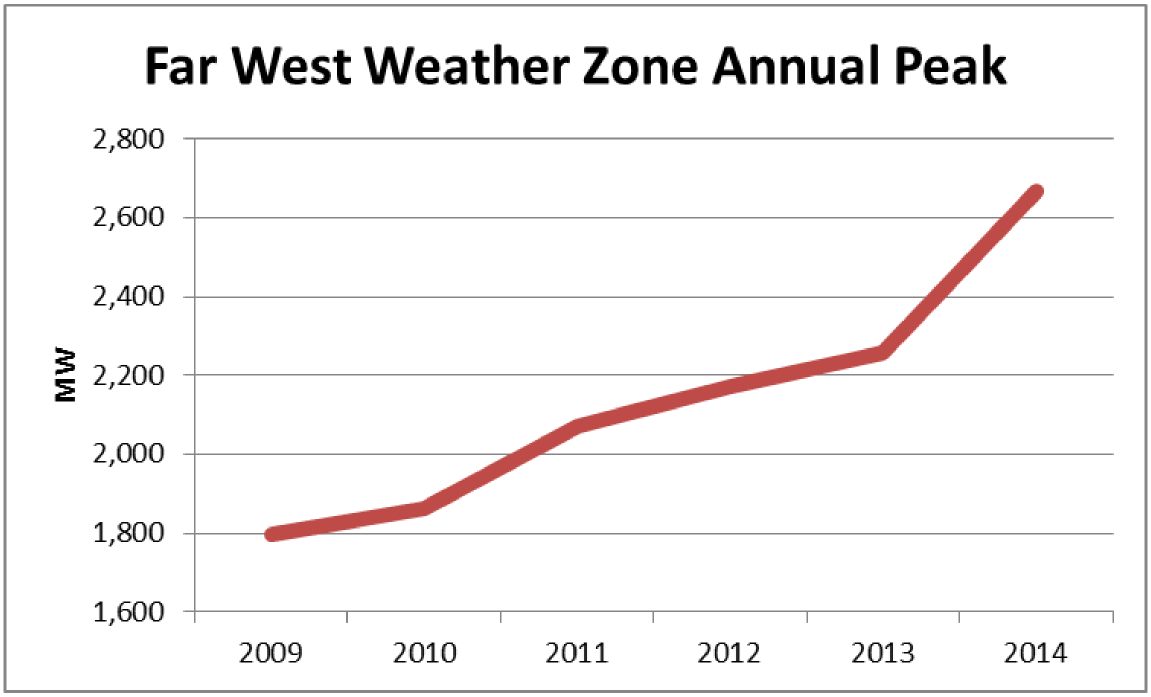

Figure 3.9: Far West Weather Zone Annual Peak (2009-2014)

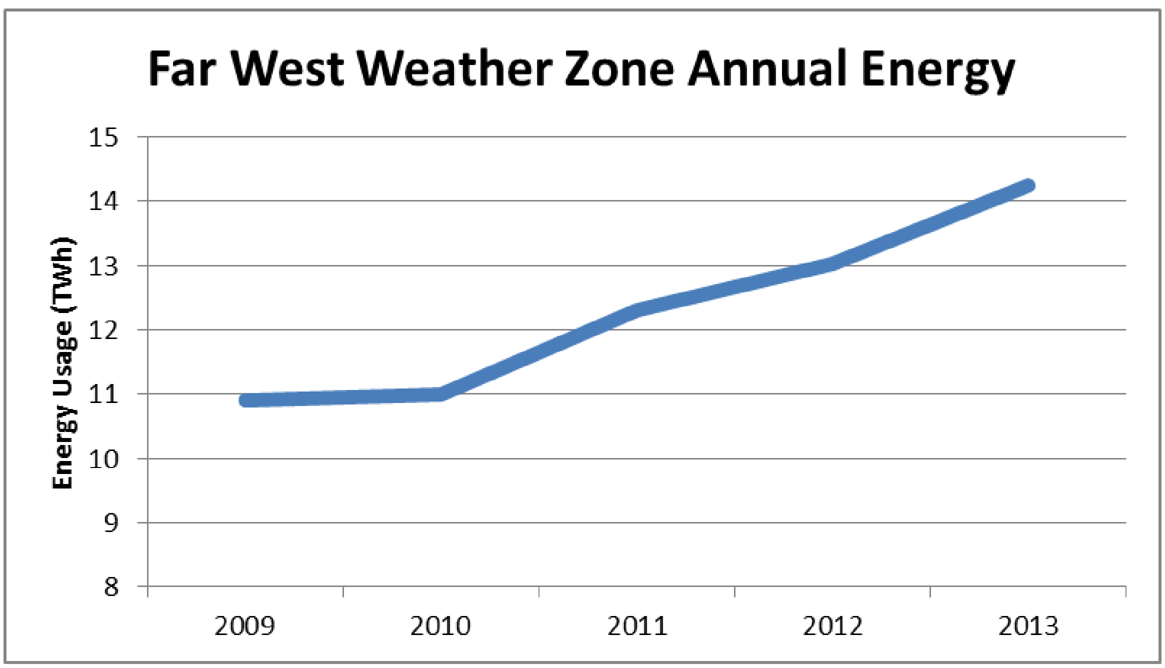

Figure 3.10: Far West Weather Zone Annual Energy (2009-2013)

According to a recent report published by Texas Tech University,[4] the Permian Basin has the greatest rig count of any basin/region in the world. It accounts for 27% of the rigs in the United States and over half of the rigs in Texas. Additionally, since December 2013, the number of horizontal, oil-directed rigs in the Permian Basin has increased by 63%. That represents half of the total increase of those types of rigs in the United States. This is a significant development since the horizontal wells consume approximately three to five times as much electrical energy as vertical wells.

ERCOT performed a special West Texas Sensitivity Study in 2013 to evaluate the transmission system needs due to this oil and gas related load growth. Sixty-three projects were identified in the study and many have been implemented. ERCOT is planning to conduct a similar analysis beginning in early 2015 because the development has been increasing at a rate that is faster than the normal transmission planning study cycle.

3.3 Outage Related Constraints

Ten of the top fifteen constraints on the ERCOT System between January and October 2014 were primarily caused by outages on the transmission system. Of the other five constraints, four had increased congestion rent due to outages, including the North to Houston import lines, the Hockley – Betka 138 kV line, the Lon Hill – Smith 69 kV line, and the Hutto – Round Rock Northeast 138 kV line. The only one of the top fifteen constraints in 2014 that was entirely unrelated to outages was the Midland East – Buffalo 138 kV line.

Outages occur on the transmission system when equipment experiences a failure and must be taken out of service or when equipment must be taken out of service to facilitate maintenance or an upgrade. When this happens, power that is normally flowing on the outaged equipment must flow on other circuits. Often this will cause congestion on the system. Congestion rent can add up quickly if outages cause circuits to approach reliability limits.

In January a 345/138 kV transformer at the Lytton Springs station experienced a catastrophic equipment failure. This led to higher flows on the remaining transformers at the station and caused a high amount of congestion from January through March on cold winter days when

[4] http://www.depts.ttu.edu/communications/media/downloads/PermianBasin.pdf

heating demand was high in the area. ERCOT stakeholders recently adopted a revision to the planning criteria such that potential future transformer failures are considered when planning transmission system upgrades.

Figure 3.11 shows the number of daily transmission outages on the ERCOT System for 2011 through 2013. It is most common to take equipment out of service for maintenance or upgrade in the spring or fall since this is the time of year when electric demand is lowest in Texas. Even though this is the time of lowest demand on the system, it is often the time of highest congestion due to the outages.

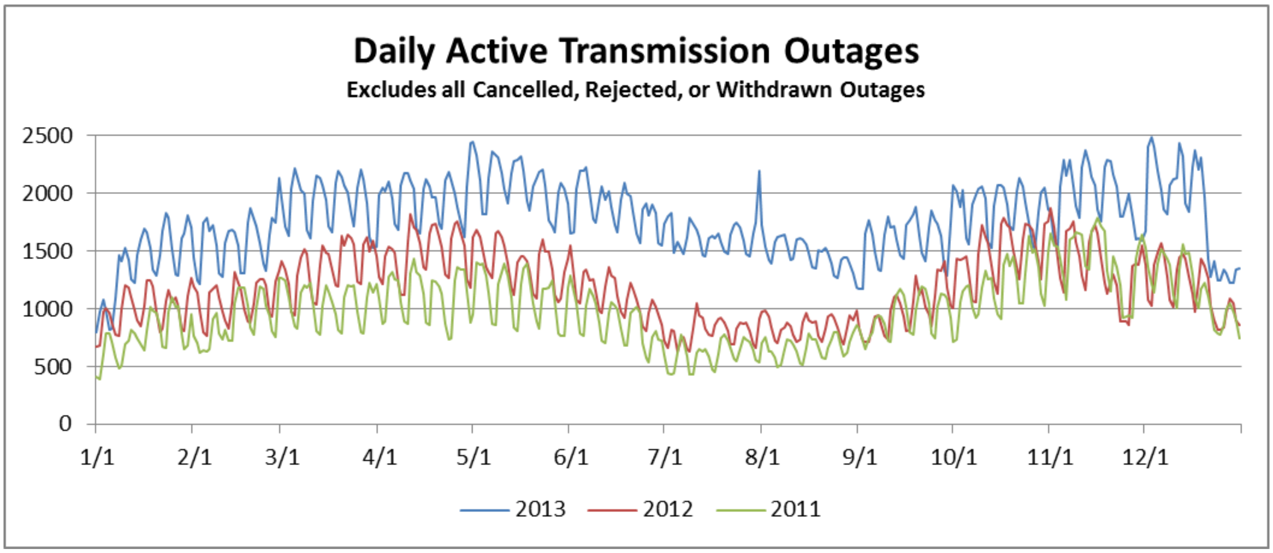

Figure 3.11: Daily Transmission Outages on the ERCOT System (2011-2013)

Figure 3.12 shows the monthly congestion rent for January through October 2014. The data shows a correlation between number of outages (Figure 3.11) and congestion rent (Figure 3.12).

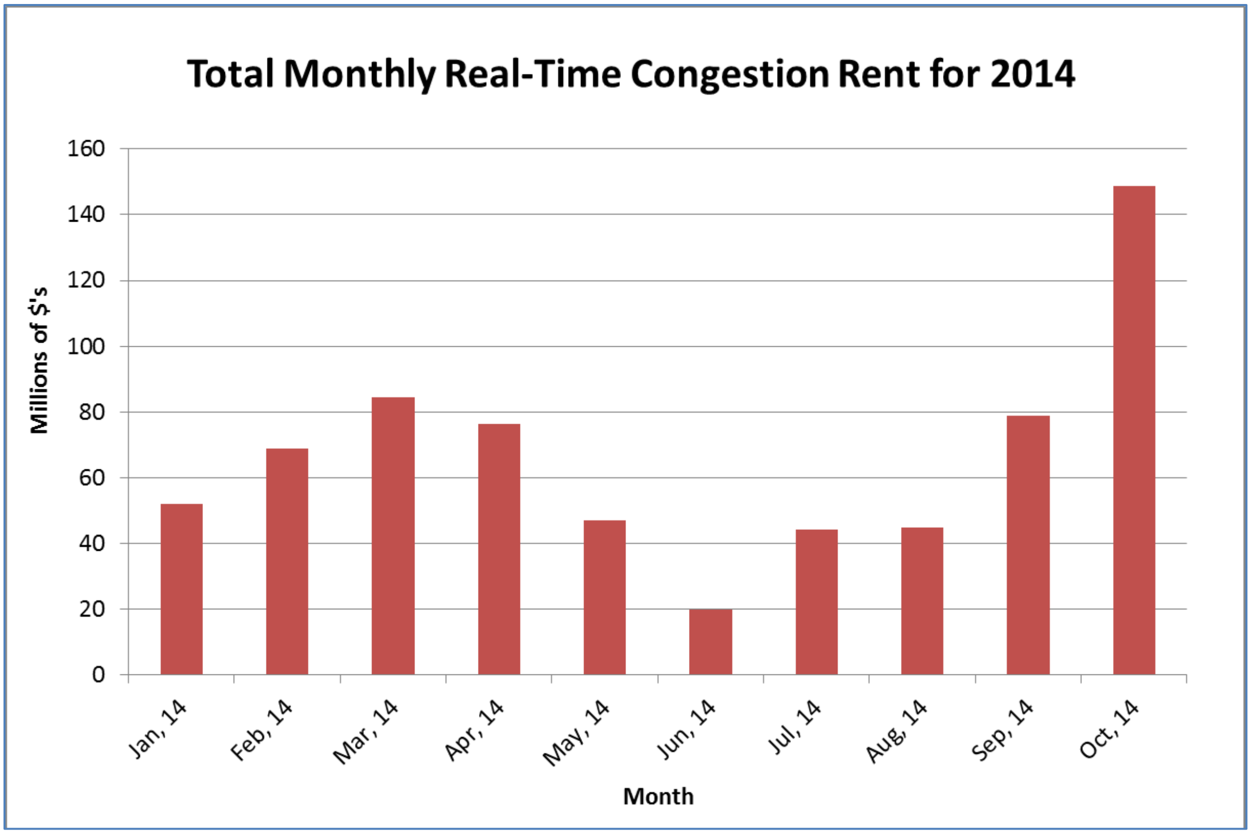

Figure 3.12: Monthly Congestion Rent for 2014

Of the top constraints in 2014, all of the congestion on the Rio Hondo – East Rio Hondo 138 kV line and the Moss – Westover 138 kV line was driven by transmission system outages in October. Additionally, most of the congestion on the Heights 138/69 kV transformer and the Harlingen – Oleander 138 kV line occurred in October and were due to outages. Similarly, in the spring, transmission system outages caused most of the Valley Import congestion and all of the Paris Switch 345/138 kV transformer congestion that occurred in March. All of the Odessa North 138/69 kV transformer congestion occurred in April due to an outage.

When a facility owner requests to take a piece of equipment out of service, ERCOT's authority to review the outage is limited to an evaluation of the expected reliability impact. An economic impact analysis is not conducted, though ERCOT may inform the owner if it believes there may be an effect on congestion.

At this time transmission outages for maintenance or upgrade are not considered when performing future-year economic transmission planning studies since outages are typically not known more than a year in advance and change from year to year. ERCOT is currently evaluating this practice to determine if a methodology can be developed to take these factors into account.

4. Planned Improvements

Currently, there are $4.7 billion of future transmission improvement projects that are planned to be in service between 2015 and the end of 2020. This involves the addition or upgrade of over 3,900 miles of transmission circuits, the addition of 15,391 MVA of autotransformer capacity, and the addition of 1,195 MVAr of reactive capability. Table 4.1 and Figure 4.1 show some of the significant improvements planned to be in-service within the next six years.

Table 4.1: Planned Transmission Improvement Projects

Map Index	Transmission Improvement	In-service Year
1	Temple Switch – Bell County East 345 kV line upgrade	2015
2	New Lobo –North Edinburg 345 kV line (Valley Import)	2016
3	New North Edinburg – Loma Alta 345 kV line (Cross Valley)	2016
4	New Fowlerton 345 kV station with 345/ 138 kV transformer	2017
5	Add second Jewett 345/ 138 kV transformer	2017
6	Add second Jordan 345/ 138 kV transformer	2017
7	Add second Twin Buttes 345/ 138 kV transformer	2017
8	McDonald Road – Spraberry 138/ 69 kV line upgrade	2017
9	New South McAllen 345 kV station with 345/ 138 kV transformer	2017
10	Tradinghouse – Sam Switch 345 kV line upgrade	2017
11	New Jones Creek 345 kV station with two 345/ 138 kV transformers	2017
12	Houston Import Project	2018
13	Venus – Navarro 345 kV line upgrade	2019
14	Big Brown – Navarro 345 kV line upgrade	2019
15	Trinidad – Watermill 345 kV line upgrade	2019
16	San Antonio Transmission System Addition Project	2019
17	Jack County 345/138 kV transformer addition	2020

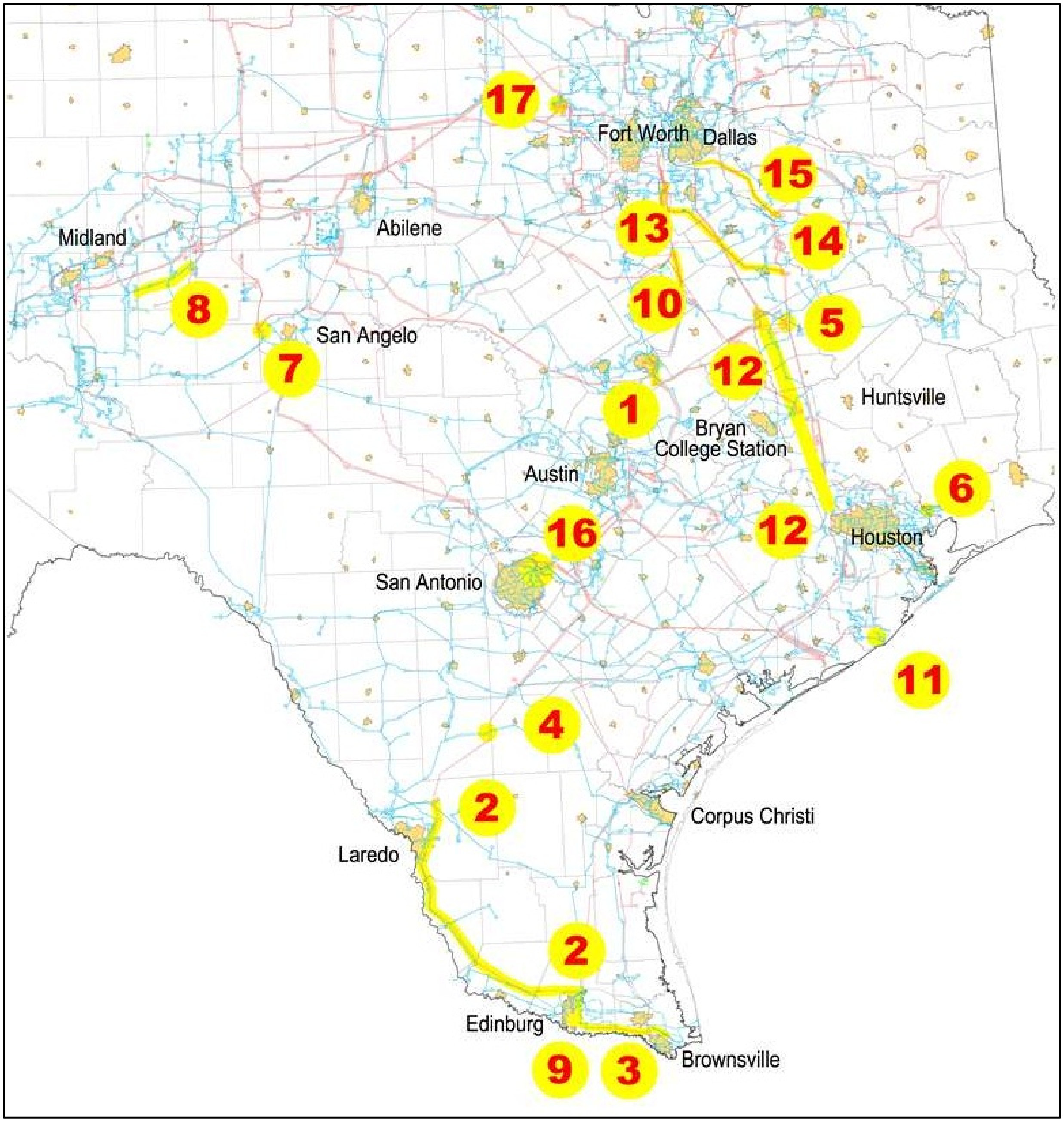

Figure 4.1: Map of Planned Transmission Improvement Projects

The following sections detail some of the significant improvements planned on the ERCOT System.

4.1 Lower Rio Grande Valley Projects

In late 2011 and early 2012, the ERCOT Board of Directors endorsed the reliability need for two significant transmission projects to support the Lower Rio Grande Valley (LRGV). The first involved the construction of a new 345 kV line from the Lobo station, near Laredo, to the North Edinburgh station in the LRGV. This new line will provide a third 345 kV import circuit into the LRGV. Additionally, the project includes upgrading both of the existing 345 kV import lines.

Currently, demand in the LRGV is supported by the two existing 345 kV lines, three smaller 138 kV lines, and approximately 1,700 MW of natural gas generation at four plants. The area also has some hydroelectric and wind generation and an asynchronous tie with the Mexico system. Because the area is dependent on such a small number of resources, maintenance outages must be carefully planned in order to reliably serve the area. The area is vulnerable to contingency events that cause multiple pieces of equipment to be out of service due to equipment failure. Figure 4.2 shows a map of the area's transmission system.

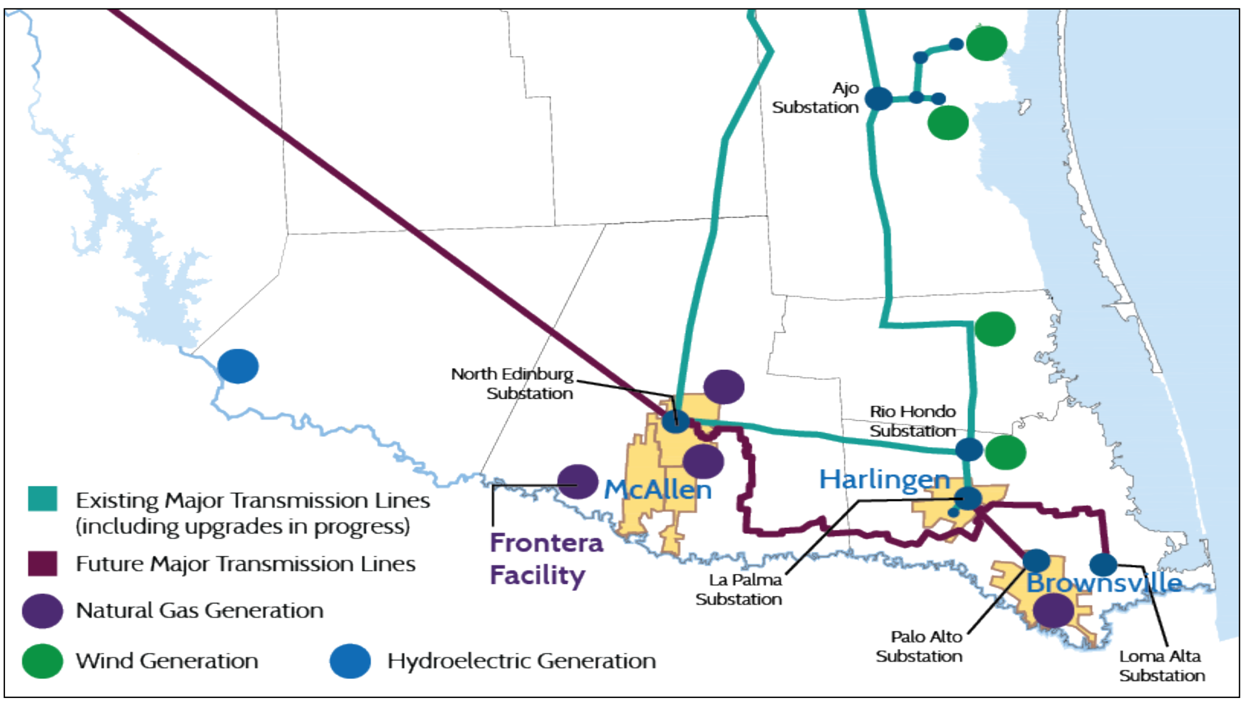

Figure 4.2: Map of Lower Rio Grande Valley Transmission System

In October 2014, two such contingency events occurred where multiple pieces of equipment were out of service. This led to ERCOT taking emergency actions, including asking TSPs in the area to shed load in order to maintain overall reliability for the area.

The new import project is expected to be complete by the summer of 2016 and will significantly improve reliability for the area.

The second significant project, the “Cross Valley” project, includes a new 345 kV line from the North Edinburg station, located on the west side of the LRGV, to the Loma Alta station, located on the east side of the LRGV. It is expected to be in-service by the summer of 2016. This new line will support load growth in the cities along the eastern side of the LRGV, including the city of Brownsville. The city of Brownsville is currently supported by four 138 kV lines and a small natural-gas-powered plant.

In July 2014, the owners of the Frontera generation plant, a 524 MW natural gas facility located on the west side of the LRGV, announced that they were planning to switch part of the facility (170 MW) out of the ERCOT market in 2015, and the entire facility would no longer be available to ERCOT in 2016. Going forward the plant will be generating electricity for the Mexico power system.

ERCOT evaluated the impact of the absence of the Frontera generation plant on the reliability of the LRGV system. ERCOT concluded that a reliability risk will be exacerbated when one of the existing 345 kV import lines or other generation in the area is out of service when there is high demand, such as during extremely hot or cold days. ERCOT will coordinate with the plant owner to potentially switch back to ERCOT during these times in order to minimize this risk. ERCOT also concluded that the two planned 345 kV projects will largely relieve the reliability issues in 2016, but additional system improvements will be required after 2016.

As of October 2014, the LRGV has two new sizeable natural gas plants in the final stage of the interconnection study process and one new natural gas plant that had a signed generation interconnection agreement (SGIA), but the developers had not yet provided financial commitment. Together these new plants could add over 1,800 MW of generation in the LRGV and defer or eliminate the need for future transmission system improvements. ERCOT is currently studying the transmission needs for the area considering scenarios where the new generation gets constructed and a scenario where it does not. This analysis is expected to be completed in 2015.

4.2 San Antonio Transmission System Additions Project

The city of San Antonio, located in Bexar County, is the seventh most populous city in the United States and was the fastest growing of the top 10 largest cities from 2000 to 2010[5]. Claritas projects the population of Bexar County to grow an additional 15.18% between 2010 and 2018[6]. Comal and Hays Counties, located north of Bexar County on the IH-35 corridor between Austin and San Antonio, are also expected to see significant growth. In fact, according to Forbes[7], Hays County was the third fastest growing county in the United States between 2010 and 2012.

The JT Deely coal plant, located in Bexar County, is planned to be retired at the end of 2018. The plant, with an output of approximately 850 MW, currently represents nearly 20% of the generation capacity in Bexar County. The combination of demand growth and the retirement of local generation will cause reliability criteria violations on the transmission system in the Northeast Bexar County area extending into Comal and Hays Counties unless improvements are constructed by 2019. In June 2014, CPS Energy and LCRA Transmission Services Corporation submitted a project proposal to the RPG to address these violations. ERCOT is in the process of conducting an independent review of the proposal. ERCOT has identified reliability criteria violations on 98 miles of 345 kV lines, 42 miles of 138 kV lines and multiple transformers. ERCOT is evaluating 13 project alternatives to resolve the violations and is expected to make a project recommendation in early 2015. Figure 4.3 shows the area under study and the project proposed by CPS Energy and LCRA Transmission Services Corporation.

[5] http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf
[6] http://www.sanantonioedf.com/living/demographics/
[7] http://www.forbes.com/sites/joelkotkin/2013/09/26/americas-fastest-growing-counties-the-burbs-are-back/

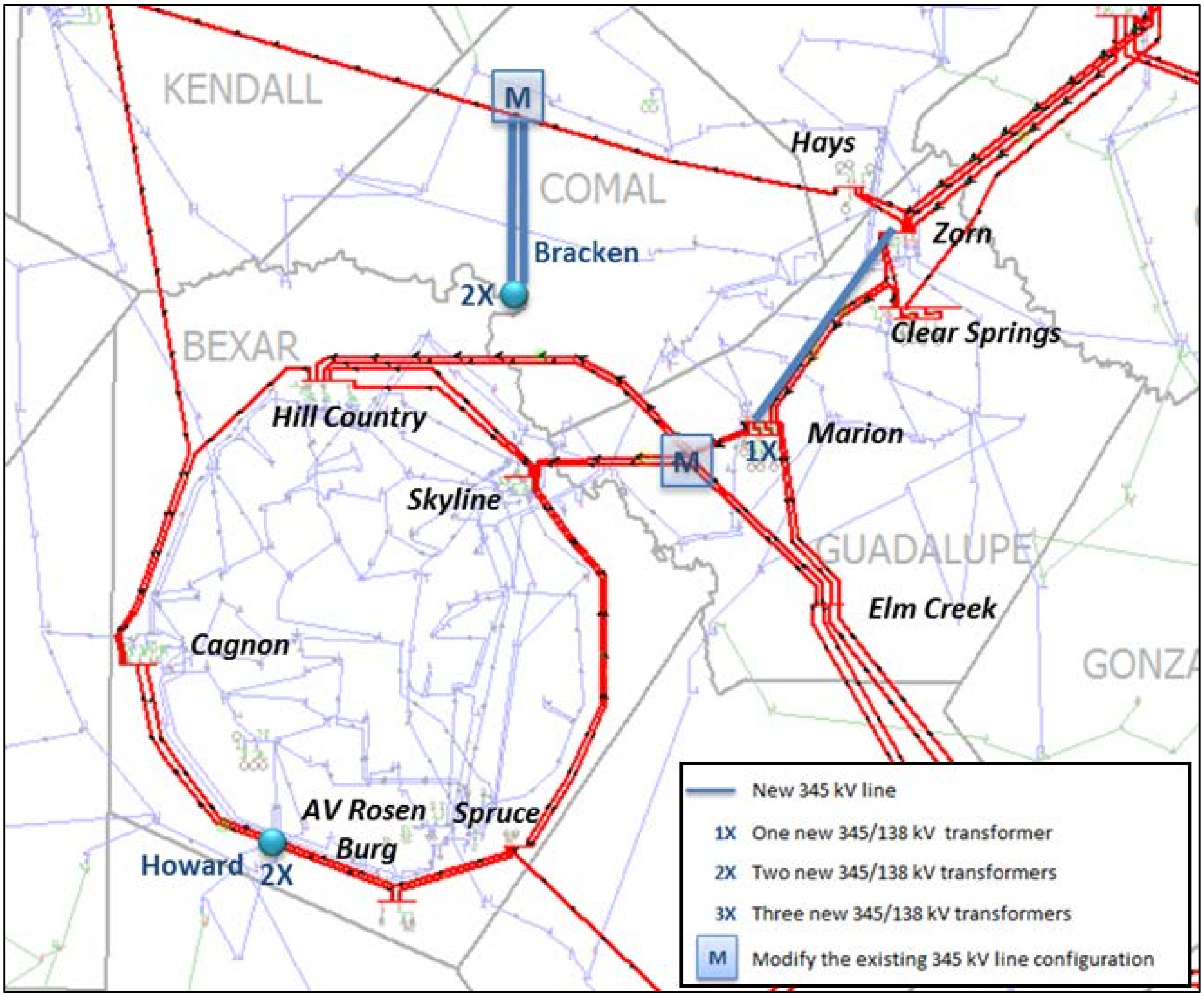

Figure 4.3: Map of Proposed Transmission Additions in San Antonio

4.3 Panhandle Export Project

The Competitive Renewable Energy Zone (CREZ) transmission improvements were endorsed by the PUCT in 2008 to accommodate approximately 18,500 MW of wind generation capacity in ERCOT. The projects include new transmission facilities in the Texas Panhandle. Prior to the CREZ project, there were no ERCOT transmission lines extending into the Texas Panhandle and therefore no load or generation in the area connected to ERCOT. Also, at the time the PUCT ordered the CREZ transmission projects to be constructed, there were no generation plants with signed generation interconnection agreements (SGIA) for connection to the proposed Panhandle CREZ facilities. The reactive equipment necessary to support the export of power from the Panhandle was implemented for 2,400 MW of wind generation capacity, even though the transmission lines were constructed to accommodate a larger capacity. This decision was made because the size and location of any additional equipment would be dependent upon the size, location, and type of the wind generation that actually developed in the area. Figure 4.4 shows a map of the CREZ transmission system.

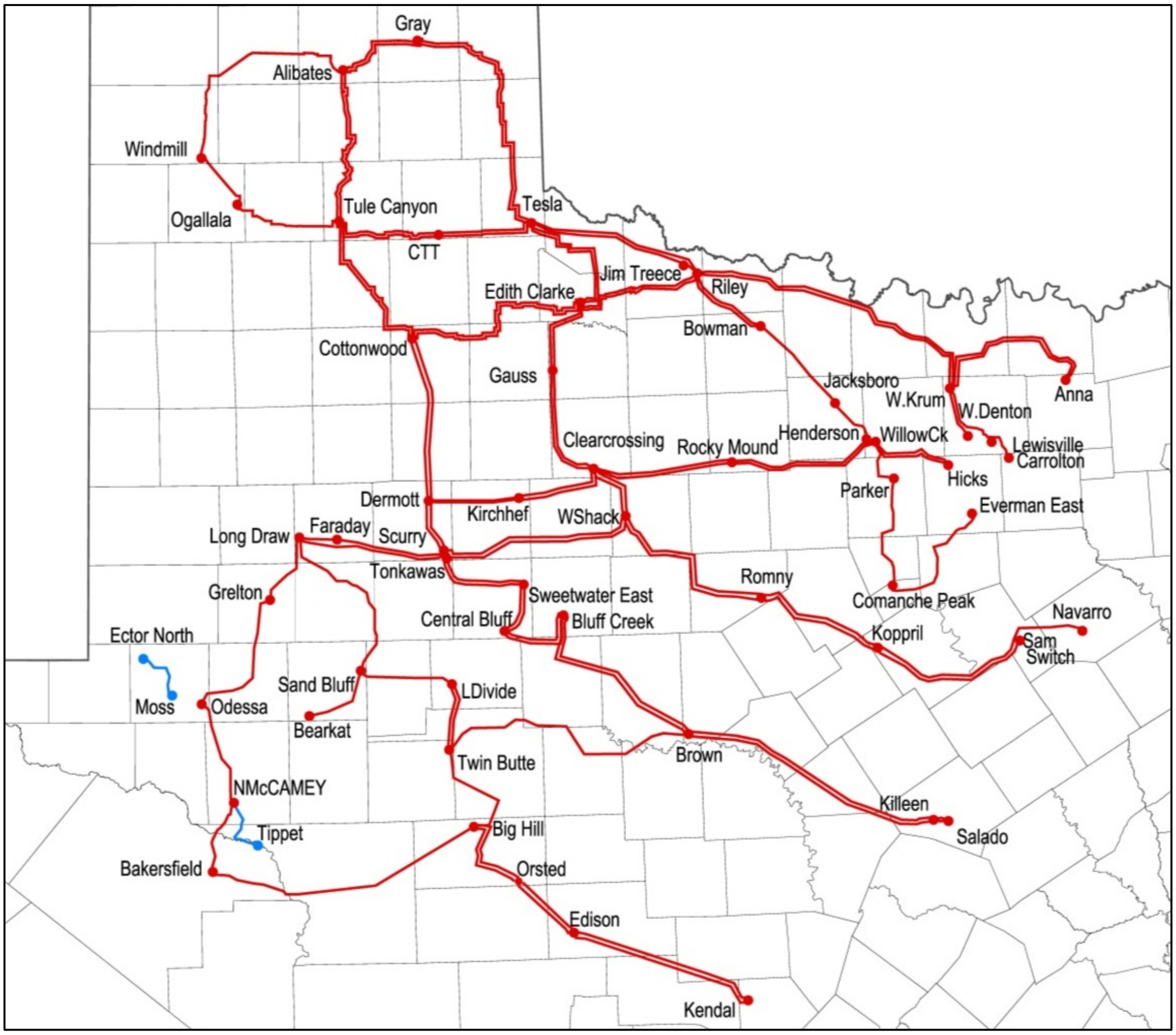

Figure 4.4: Map of CREZ Transmission

The Panhandle region is currently experiencing significantly more interest from wind generation developers than what was initially planned for the area. As of October 2014, there was nearly 11.5 GW of wind generation in service on the ERCOT System. According to the Generation Interconnection Status report (http://www.ercot.com/gridinfo/resource/index.html) reviewed in

October 2014, there was over 7 GW of wind generation capacity with a SGIA in the Texas Panhandle and more than 12 GW wind generation capacity proposed to connect to the Texas Panhandle that was progressing through the interconnection process. This information indicates that the wind generation projects located in the Texas Panhandle are likely to exceed the 2,400 MW capacity for which reactive support was initially installed. Figure 4.5 shows the amount of wind generation planned for the Panhandle.

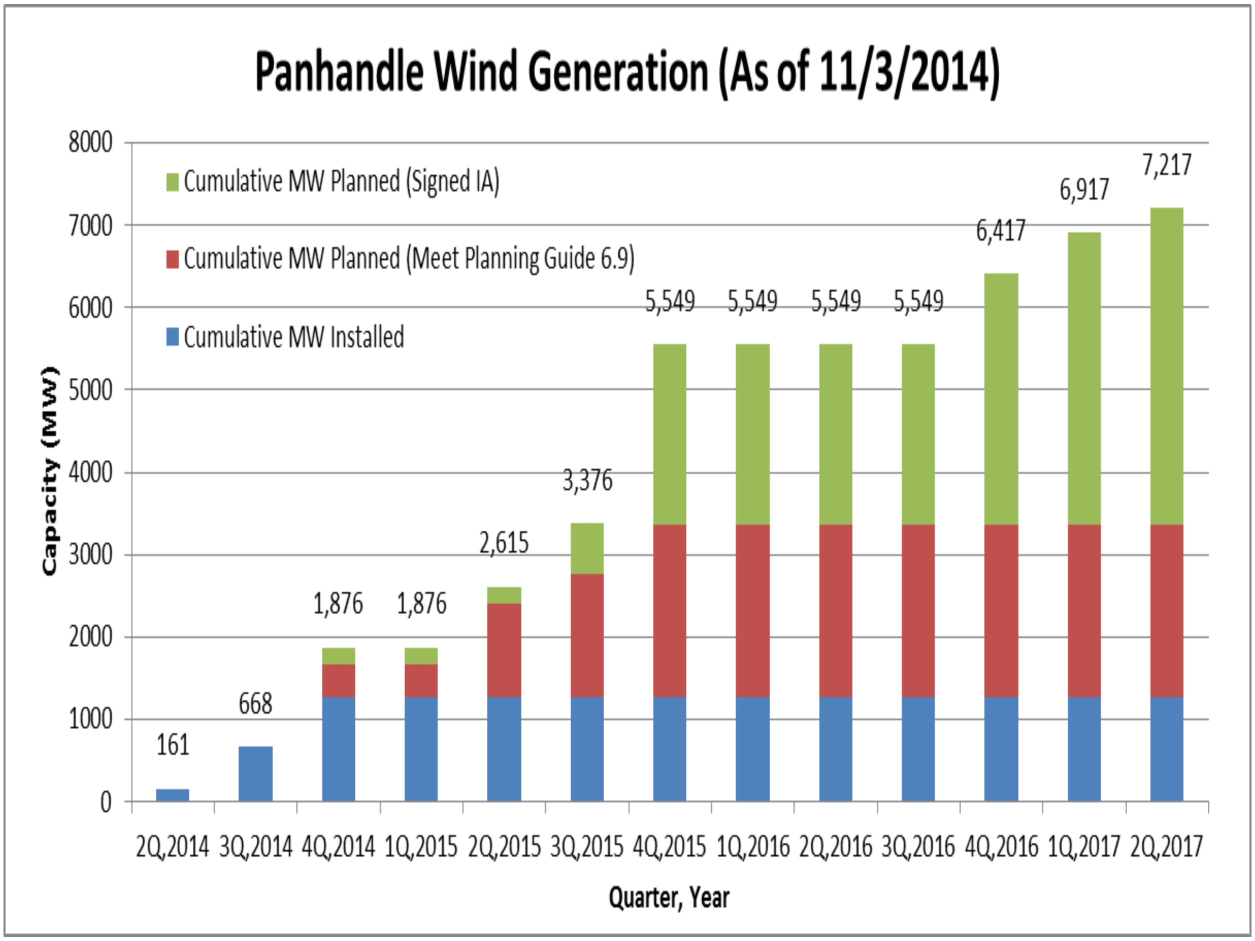

Figure 4.5: Planned Panhandle Wind Generation

The ERCOT Panhandle grid is remote from synchronous generators and requires long distance power transfer to the load centers in ERCOT. All wind generation projects in the Panhandle are expected to be equipped with power electronic devices that will further weaken the system strength due to limited short circuit current contributions. Under weak grid conditions, a small variation of reactive support results in large voltage deviations and in extreme cases can lead to a voltage collapse. Stability challenges and weak system strength are expected to result in significant constraints for Panhandle export.

Recognizing the challenges associated with connecting a large amount of wind generation in the Panhandle, ERCOT initiated the Panhandle study in early 2013. The purpose of the Panhandle study was to identify the potential system constraints and transmission upgrade needs for the Texas Panhandle to accommodate wind generation projects that exceed the existing designed Panhandle export capability. The results provide a path to both ERCOT and TSPs that includes the upgrade needs and the associated triggers in terms of wind generation capacity in the Panhandle.

Several transmission improvements can be implemented at a relatively low cost and in a relatively short timeframe to increase the Panhandle export capability. These include installing shunt reactors, synchronous condensers, and adding the second circuit on existing transmission towers that were constructed to be double-circuit capable with originally just one circuit in place. Additional improvements to increase export limits will include new transmission lines on new right of way (ROW). These improvements will require significant wind generation development commitment in order to be justified per the ERCOT planning criteria requirements.

4.4 Liquefied Natural Gas Facilities

In July 2014, ERCOT received a project submittal for a transmission upgrade to serve a load unlike any previously connected to the ERCOT System, a natural gas liquefaction and export facility. The production of liquefied natural gas (LNG) is an energy-intensive process and the construction of such a facility can add a significant increase to the load already being served in an area. Several potential LNG facilities have been proposed across the United States, including many along the Gulf Coast. The Freeport LNG liquefaction project is the first of several potential LNG export facilities within the ERCOT Region.

The Freeport LNG facility will be located on Quintana Island and, at full production, will require 690 MW to serve its load. Freeport LNG has executed and announced long-term agreements for the output from all three of the production trains planned for the facility. LNG deliveries are expected to begin in 2017 and reach full output in 2018. CenterPoint Energy submitted an $80 million project to the RPG for upgrades necessary to serve the facility. Previously, other

Freeport-area improvements have undergone the necessary review and approvals including the upgrades to serve the Freeport LNG Pretreatment facility located nearby.

CenterPoint Energy's proposed transmission project improvements needed to serve the liquefaction facility include the construction of a new Jones Creek substation with two 345/138 kV autotransformers to provide a 345 kV injection point to the 138 kV system that will serve the facility along with other upgrades and reconfigurations.

In addition to its significance in the Freeport area, this LNG facility is the first of several potential LNG facilities that may be constructed in the ERCOT area and represents a type of load expansion that can impact local electric service. For instance, the Freeport area load is currently less than 80 MW. The natural gas pretreatment facility will add an additional 146 MW of load to the Freeport area; however, some of that load will be offset by 80 MW of dedicated generation. Finally, the LNG liquefaction facility will add an additional 690 MW of load resulting in a nearly ten-fold increase to the local load. This single project will have a major impact on the need for electrical infrastructure in the Freeport area. The construction of other LNG liquefaction facilities in other locations may have similar impacts.

Companies have applied to the Department of Energy (DOE) for licenses to export LNG from proposed facilities, including several located in the ERCOT area. All proposed ERCOT-area facilities have received authority to export to countries that currently have, or in the future enter into, a Free Trade Agreement (FTA) covering natural gas or LNG. So far, of the proposed facilities in the ERCOT area, only the Freeport LNG facility has received authority to export to non-FTA countries[8] as well as authority to construct and operate its LNG facility.[9]

As shown Table 4.2, several other LNG facilities in the ERCOT Gulf Coast region have applied for the necessary DOE authorizations. In addition to the Freeport facility (exporting 2.8 billion cubic feet per day (Bcf/d)), a proposed plant in Calhoun County, two in the Corpus Christi area, and five in Brownsville seek authority to export nearly an additional 12 Bcf/d. In total,

[8] DOE/FE Docket No. 11-141-LNG, Order Conditionally Granting Long-Term Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Freeport LNG Terminal on Quintana Island, Texas to Non-Free Trade Agreement Nations, (Nov. 15, 2013).

[9] FERC Docket No. CP12-29-000, Order Granting Authorizations Under Section 3 of the Natural Gas Act, (July 30, 2014).

companies across the Lower 48 States have filed export applications with the DOE for over 40 Bcf/d.

Table 4.2: Proposed LNG Facilities in ERCOT

Company	Export Quantity (Bcf/d)	FTA Application	Non-FTA Application	Location
Freeport LNG	2.8	Approved	Approved (1.8 Bcf/d)	Freeport
Gulf Coast LNG Export	2.8	Approved	Under review	Brownsville
Excelerate Liquefication Solutions I	1.38	Approved	Under review	Calhoun County
Cheniere Marketing	2.1	Approved	Under review	Corpus Christi
Pangea LNG Holdings	1.09	Approved	Under review	Ingleside
Eos LNG	1.6	Approved	Under review	Brownsville
Barca LNG	1.6	Approved	Under review	Brownsville
Annova LNG	0.94	Approved	n/a	Brownsville
Texas LNG	0.27	Approved	Under review	Brownsville

Figure 4.6 illustrates the general location of the proposed LNG facilities that could connect to the ERCOT System.

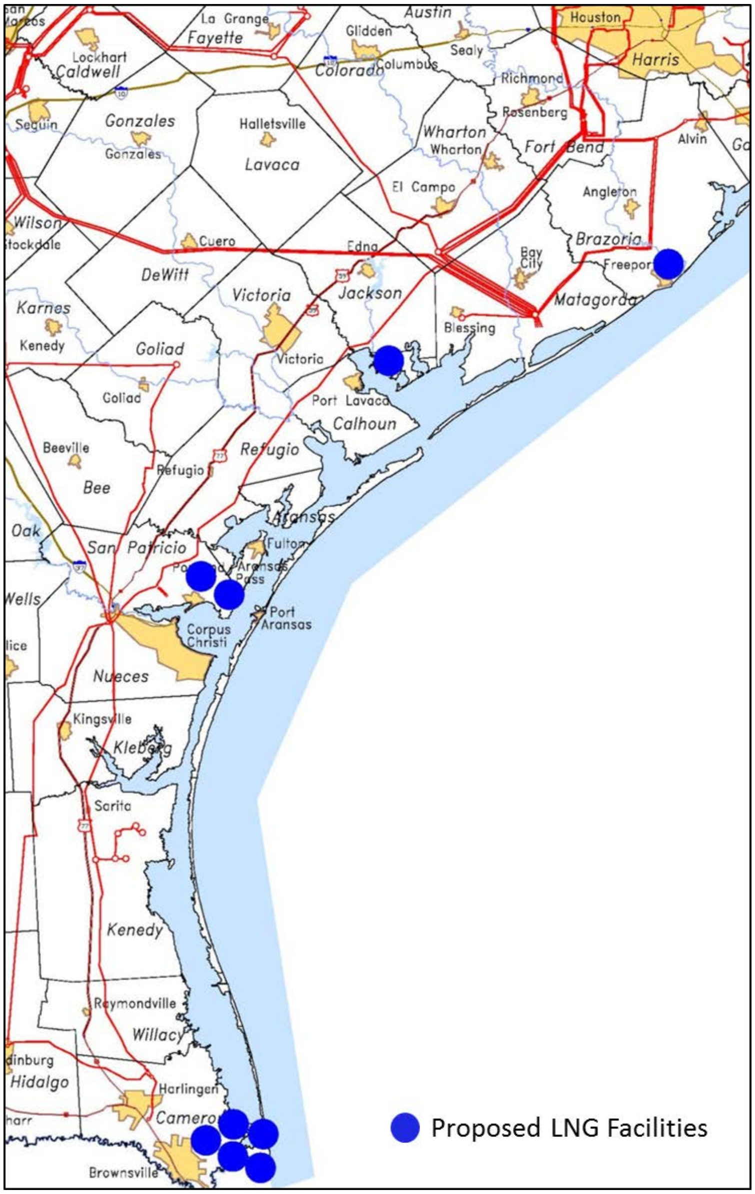

Figure 4.6: Proposed LNG Facilities in ERCOT

The local load impact of an LNG liquefaction facility depends strongly on the technology used to drive the compressor used to make LNG. If each facility is constructed to its full announced capacity, ERCOT could be looking at load additions between 2,000 and 3,000 MW within a few years. The LNG liquefaction process includes the use of large natural gas compressors. Most LNG liquefaction plants drive those compressors with natural gas engines. The Freeport LNG facility plans to power its compressors with very large electric motors, which increases its electrical load compared to facilities with natural gas-drive compressors. The load impact of the other proposed projects will depend in part on the technology the developer selects to drive the compression. Also, although the Freeport LNG liquefaction facility is not planned to have self-supplied generation, other LNG facilities may be designed with this capability, which would reduce the net impact to the ERCOT grid.

4.5 Additional Reliability Driven Planned Improvements

Continued growth of load throughout the state is a key driver for transmission improvements in the ERCOT Region. The recently completed 2014 Regional Transmission Plan identified more than 100 projects needed to satisfy reliability planning criteria in the 2015 to 2020 timeframe. These projects are in addition to those previously planned for the ERCOT System. More information on these projects can be found in the 2014 Regional Transmission Plan report posted on the ERCOT Market Information System website.

5. Projected Constraints

The following sections describe projected future constraints on the ERCOT System.

5.1 2015 Reliability Constraints

When ERCOT develops the annual Regional Transmission Plan there are usually a number of reliability needs that are identified where the projects designed to meet the needs will not be in place before the reliability needs are realized. There are several reasons that this occurs, the most common being faster-than-expected load growth and construction delays. Coordinating construction of multiple projects and equipment outages in the same area affects the completion of projects.

When projects needed for reliability cannot be installed prior to need, the responsible TSPs and ERCOT work to design temporary operational solutions to resolve the reliability issue until the transmission project can be completed. Such operational solutions may include temporarily reconfiguring the system, running less efficient generation, or, in the worst case, establishing a procedure to shed load if an overload is expected to occur or actually occurs. While these actions ensure that reliability standards are upheld, they can often lead to substantial amounts of congestion on the system if generation redispatch is needed or is not sufficient.

The recently completed 2014 Regional Transmission Plan identified the projected 2015 reliability constraints (Table 5.1 and Figures 5.1, 5.2 and 5.3) that will not have the transmission project planned to solve the constraint in place before the constraint is expected to occur. A considerable number of these constraints are located in the Permian Basin and Eagle Ford Shale oil and natural gas exploration and production areas where demand has increased faster than previously anticipated.

Table 5.1: Projected 2015 Reliability Constraints

Map Index	Transmission Element
1	Bosque Switch – Olsen TNP 138 kV line
2	Olsen TNP 138/69 kV transformer
3	Collin Switch – Frisco138 kV line
4	Flat Top TNP – Barilla Tap 138kV tie
5	McDonald – Spraberry 138 kV lines
6	Big Lake 138/69 kV transformer
7	Big Lake – Big Lake Phillips Tap 69 kV line
8	San Angelo Concho – San Angelo Mathis Field 69 kV line
9	Wink – Odessa Basin SS 69 kV line
10	Twin Buttes 345/138 kV transformer
11	Campwood – Montell - Uvalde 69 kV line
12	Skywest – Driver 138 kV line
13	Alice – San Diego 69 kV line
14	Freer – San Diego 69 kV line
15	Asherton – Carrizo Springs 69 kV line
16	Asherton 138/69 kV transformer
17	Pleasanton 138/69 kV transformer
18	Howard – Somerset 138 kV line

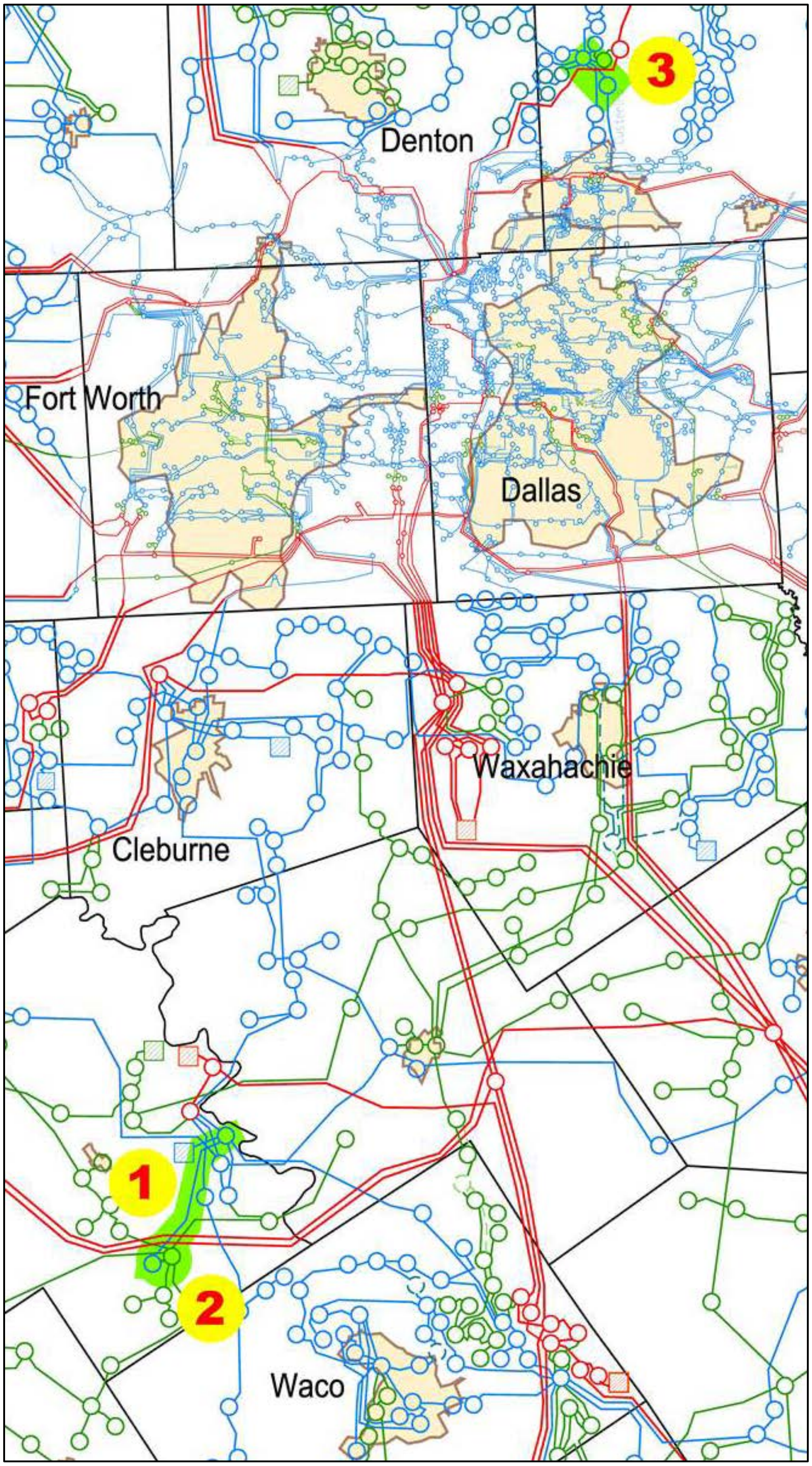

Figure 5.1: Map of Projected 2015 Reliability Constraints

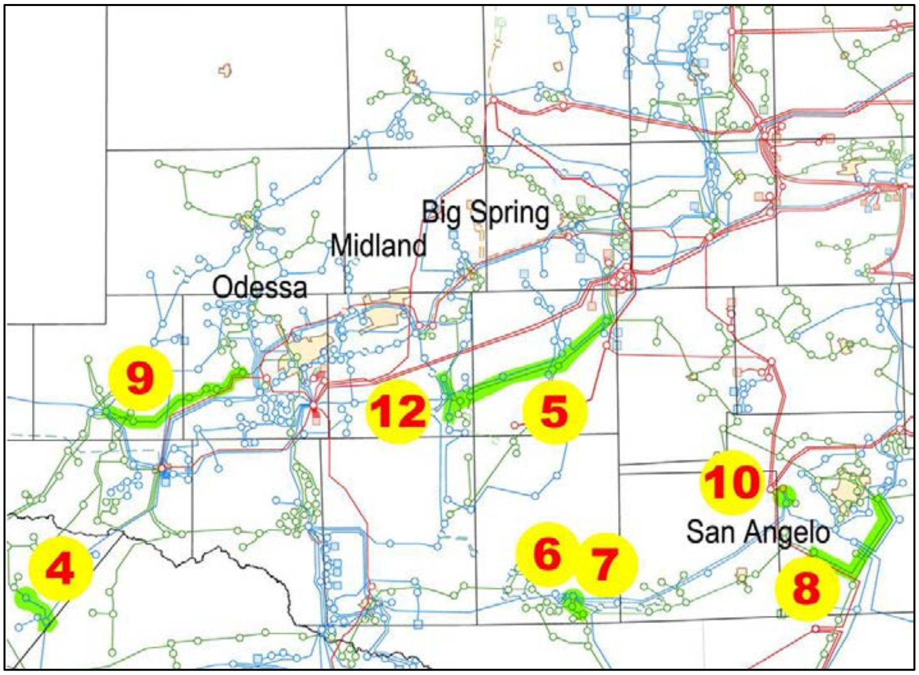

Figure 5.2: Map of Projected 2015 Reliability Constraints

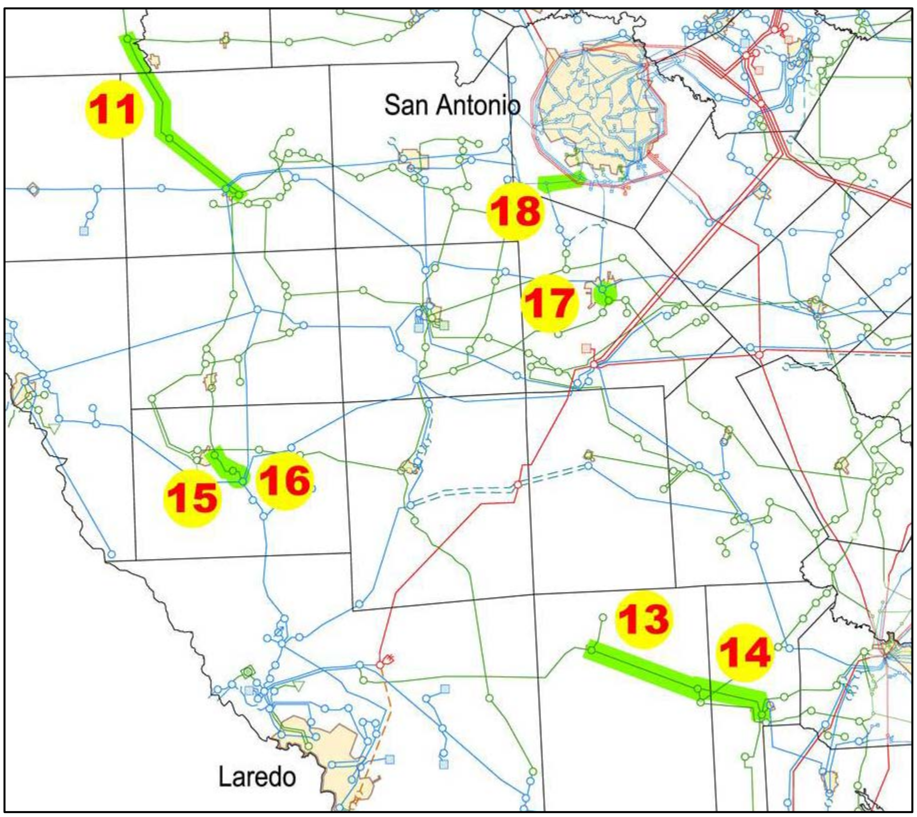

Figure 5.3: Map of Projected 2015 Reliability Constraints

5.2 2017 and 2020 Projected Constraints

Future year constraints are also analyzed as part of the annual Regional Transmission Plan. Projects are identified to resolve the constraints expected to cause the most congestion on the system. If a project meets the economic planning criteria by reducing overall system costs, it is included in the recommended project set. Many times, however, the capital cost of the project is greater than the expected system-wide production cost savings. When this occurs, the project will not be constructed and the congestion will persist. Table 5.2 and Figure 5.4 show the constraints projected to be the most congested for 2017 and 2020 based on model simulation.

Table 5.2: List of Projected Most-Congested Constraints (2017-2020)

Congestion Color Key	
(white)	None
(yellow)	Low
(orange)	Medium
(red)	High

Map Index	Projected Constraining Element	2017 Congestion	2020 Congestion
1	Baytown Energy Center 345/138 kV transformer	Medium	Medium
2	Dupont Switch – Dupont PP-1 (Ingleside) 138 kV line	Medium	High
3	Escondido – Eagle Hydro 138 kV line	Low	Medium
4	Glen Rose – Meridian 69 kV line	Medium	Medium
5	Goldthwaite – San Saba Switch 69 kV line	Medium	Medium
6	Hamilton Road – Maverick 138 kV line	Medium	High
7	Jack Creek – Twin Oak Switch	High	Low
8	Jewett – Singleton 345 kV line	Medium	None
9	Kiamichi Energy Facility – Kiowa Switch 345 kV line	High	High
10	Loop 337 – GPI Switch 138 kV line	Medium	None
11	Morris Dido – Eagle Mountain 138 kV line	High	High
12	Nevada – Royse Switch 138 kV line	Low	Low
13	Randolph – Weiderstein 138 kV line	None	Medium
14	Singleton – Zenith 345 kV line	High	None
15	Spur – Aspermont 138 kV line	Medium	Medium
16	Wolfgang – Rotan 69 kV line	Medium	Medium
17	Panhandle Export Limit	High	High

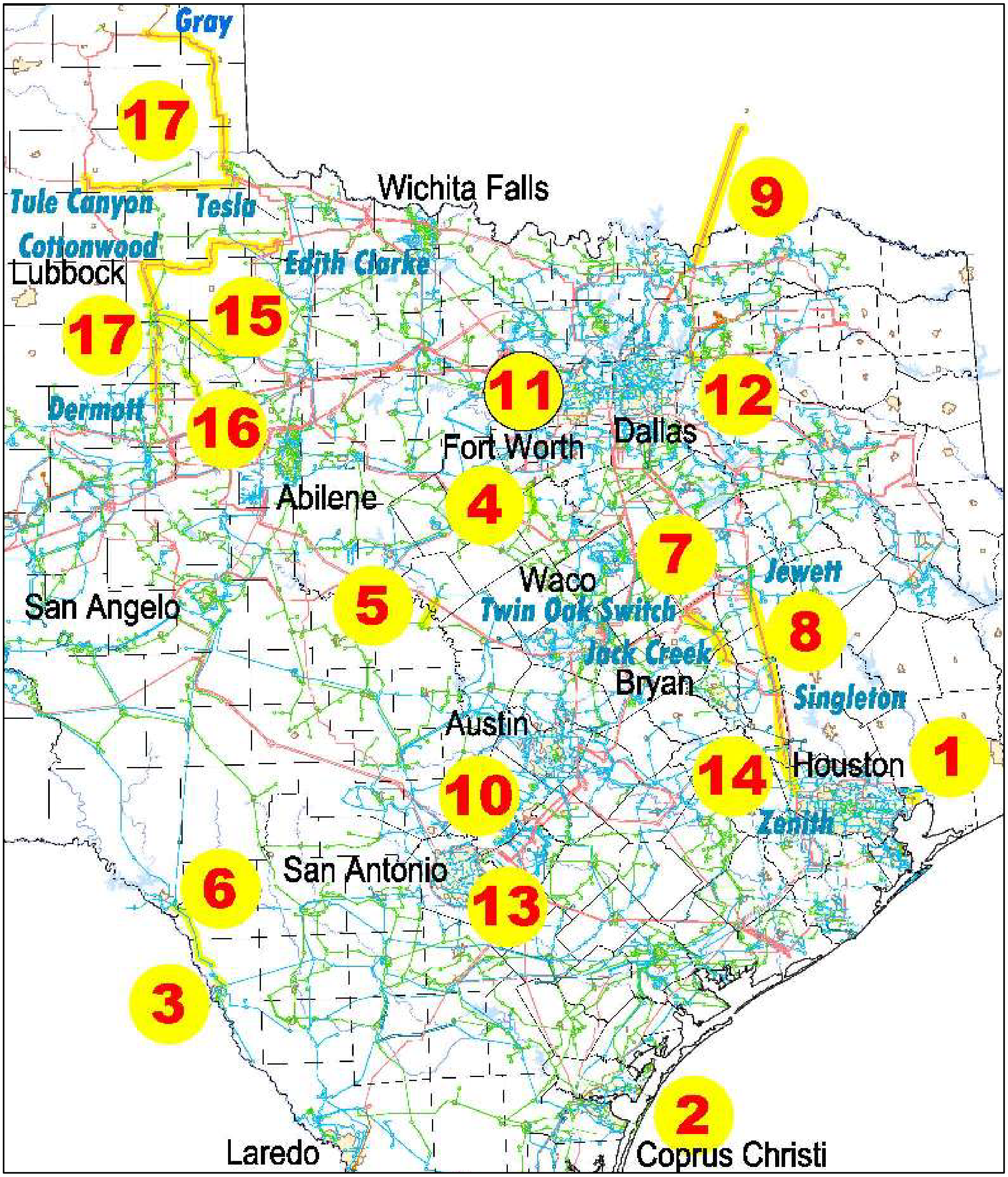

Figure 5.4: Map of Projected Most-Congested Constraints (2017-2020)

6. Long-Term System Assessment

The 2014 Long-Term System Assessment (LTSA) focused on analyzing the needs of the ERCOT System in the 10-15 year time horizon. Long-term load forecasting and generation and transmission expansion analysis was conducted. Scenario analysis was performed when analyzing the system in this time horizon since study assumptions that far into the future are less certain.

Early in the planning phase of the 2014 LTSA, ERCOT engaged The Brattle Group to facilitate a stakeholder-driven process for developing future scenarios for the study. Previously, ERCOT had used stakeholder input to develop scenarios for two reports: its 2012 LTSA and a concurrently performed long-term planning assessment, funded by the Department of Energy. ERCOT desired to make the stakeholder process more effective and address suggestions and comments received from stakeholders at the conclusion of the DOE-funded study. One key criticism was that a lack of confidence in the scenarios undermined the acceptance of the study results. Two definitive reasons, among many possible explanations, for the lack of acceptance were (1) the process was new, so the stakeholders could not fully anticipate how the developed information would be used, and (2) the process may not have offered stakeholders sufficient appreciation of how their engagement in the development process and acceptance of inputs and assumptions would shape the final results of the study.

ERCOT wanted the 2014 LTSA scenario development process to engage stakeholders directly in developing the future scenarios that will be used for analyzing the ERCOT System over the long term. Furthermore, ERCOT wanted that engagement in scenario and input development to translate into acceptance of the study results. Toward that end, Brattle provided ERCOT's stakeholders with a structured and inclusive process for developing future scenarios. The process considered the input of the stakeholders, as well as insights and input from internal and external experts on important issues for consideration in long-term transmission planning. The process, as shown in Figure 6.1, included a series of three workshops conducted in January and February of 2014 and involved a variety of stakeholders and outside experts.

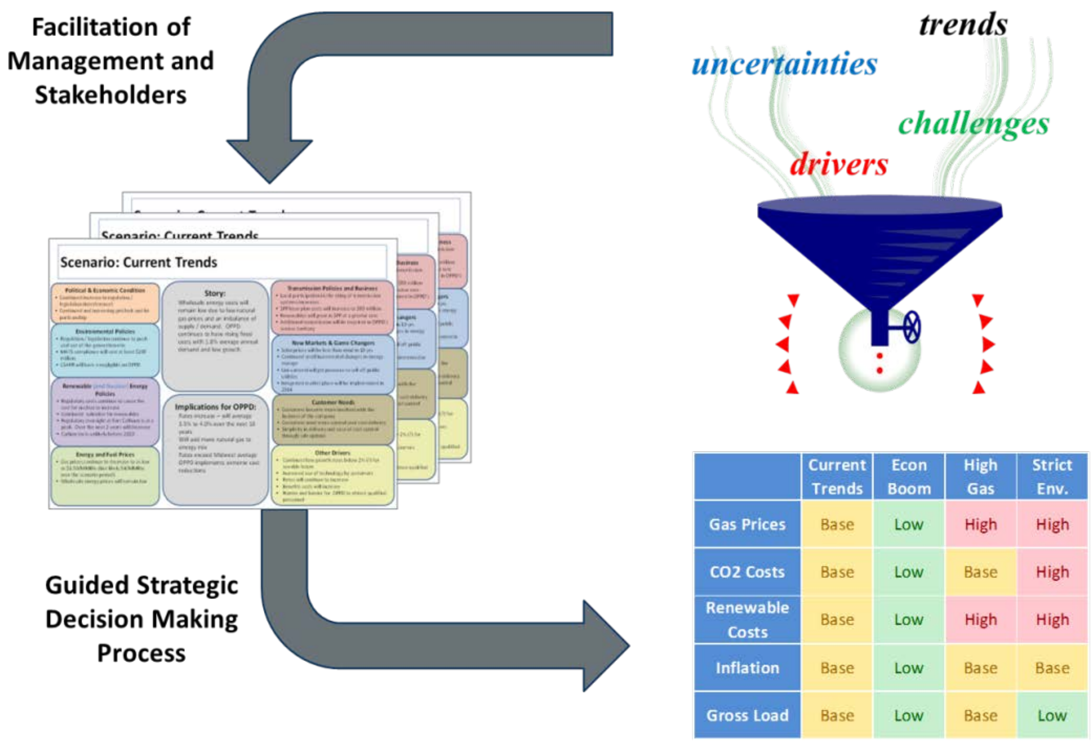

Figure 6.1: LTSA Scenario Building Process

Through these workshops stakeholders identified the key drivers for the future ERCOT System, as shown below.

- Economic Conditions
- Environmental Regulations and Energy Policy
- Alternative Generation Resources
- Natural Gas and Oil Prices
- Transmission Regulation and Policies
- Generation Resource Adequacy Standards
- End-Use/New Markets
- Weather and Water Conditions

Having developed a list of key drivers that could affect future transmission needs, the stakeholders then created ten possible future scenarios for ERCOT. The ten scenarios are listed below.

- Current Trends
- High Economic Growth
- Global Recession
- Stringent Environmental Regulation/Solar Mandate

- High Efficiency/High DG/Changing Load Shape
- Low Global Oil Prices
- High Natural Gas Prices
- LNG Export Growth
- High System Resiliency
- Water Stress

Study input assumptions were developed for each of the ten scenarios. These scenarios and input assumptions formed the starting point for the analyses performed in the 2014 LTSA. ERCOT created a load forecast and performed a generation retirement and expansion analysis for all ten scenarios. Based on stakeholder input ERCOT selected the Current Trends, High Economic Growth, Global Recession, and Stringent Environmental scenarios for transmission planning analysis.

ERCOT identified six major transmission upgrades that were required for three scenarios with higher load levels, namely, Current Trends, Stringent Environmental and High Economic Growth. Some of these six were also required in the Global Recession scenario. Of the six major projects, four were in the Dallas-Fort Worth area. Figure 6.2 shows a map with the location of the major projects.

A noteworthy finding from multiple scenarios, but most significant in the Stringent Environmental scenario, was the addition of solar generation in West Texas may require significant transmission investment to move the power from sites most favorable for solar generation to load centers. Much of this generation development is expected to occur in areas that do not have substantial transmission infrastructure. Some of the best sites from a solar perspective are located west of where the CREZ facilities were constructed.

The Brattle report on the scenario development process and the 2014 Long-Term System Assessment report can be found on the ERCOT Market Information System.

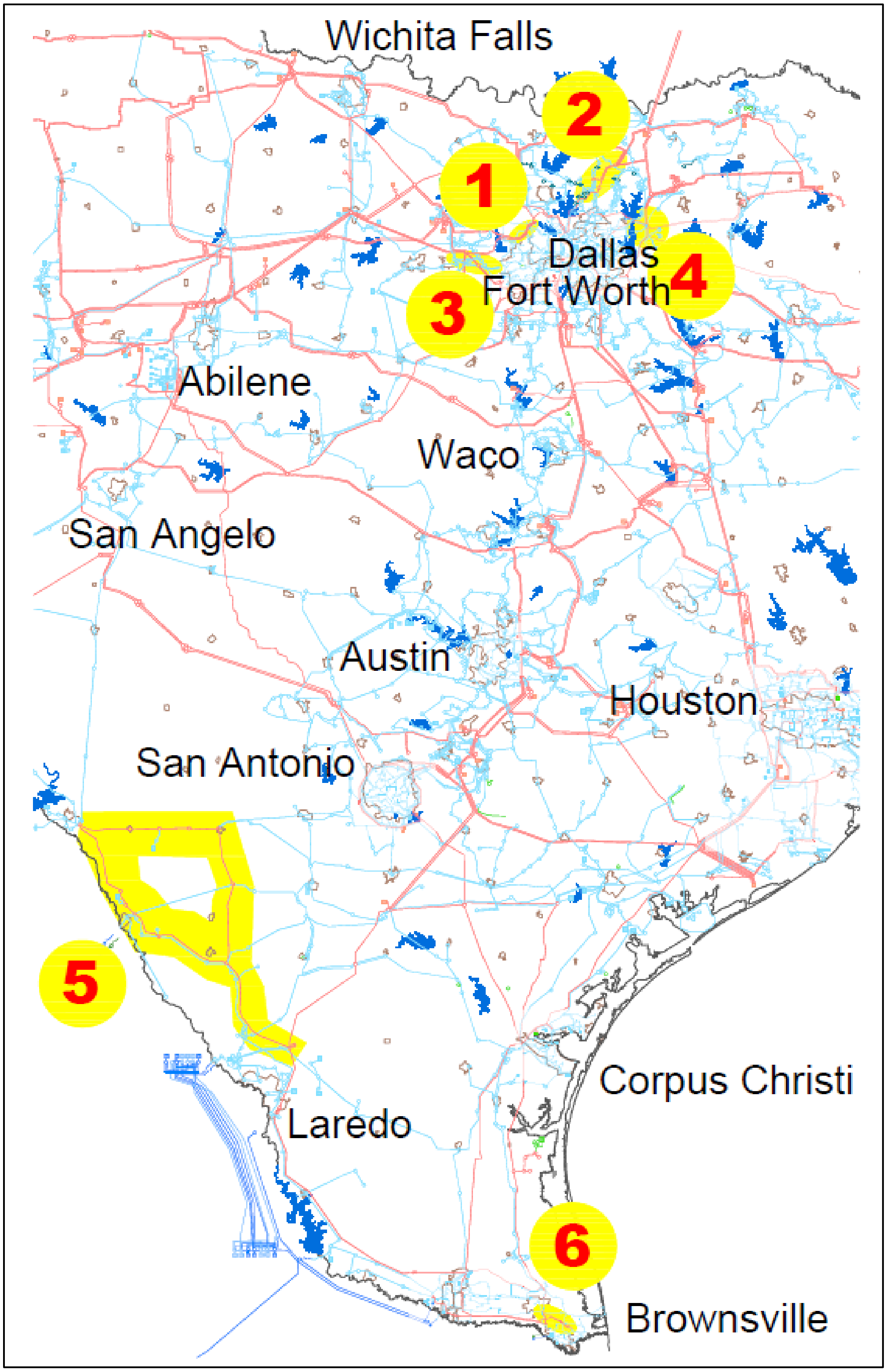

Figure 6.2: Map of LTSA Major Projects

7. Contacts and Links

7.1 Contacts and Information

For general communications and queries, the public can submit a request for information at: http://www.ercot.com/about/contact/inforequest.cfm

Media:
Robbie Searcy
512-225-7213

Regulatory and Government Relations:
Shelly Botkin
512-225-7177

7.2 Internet Links

ERCOT Home Page: http://www.ercot.com

Market Information System: https://mis.ercot.com/pps/tibco/mis

Users must obtain a digital certificate for access to this area. Folders in this area include data, procedures, reports and maps for both operations and planning purposes. Helpful information that can be found on this site includes:

- ☐Generation Project Interconnection Information
- ☐Regional Planning Group Information
- ☐Steady-State Base Cases
- ☐System Protection Data

8. Disclaimer

This report was prepared by the Electric Reliability Council of Texas (ERCOT) staff. It is intended to be a report of the status of the transmission system in the ERCOT Region and ERCOT's recommendations to address transmission constraints. Transmission system planning is a continuous process. Conclusions reached in this report can change with the addition (or elimination) of plans for new generation, transmission facilities, equipment, or loads. Information on congestion costs presented herein is based on the most recent settlement calculations at the time of the development of this report. Future settlements as well as ERCOT Board of Directors and Public Utility Commission of Texas directives may change the figures presented herein.

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