Estimation of Annual Reductions of NO_x Emissions in ERCOT for the HB3693 Electricity Savings Goals

Presented to the Public Utility Commission of Texas

By the United States Environmental Protection Agency

Prepared by
the United States Environmental Protection Agency and
the Energy Systems Laboratory

December 2008

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Acknowledgements

This report was developed by Art Diem and Denise Mulholland of the United States Environmental Protection Agency (EPA) State and Local Clean Energy-Environment Program Branch, and by Jim Yarbrough of EPA Region 6, and by Juan-Carlos Baltazar, Ph.D., Piljae Im, and Jeff S. Haberl, Ph.D., P.E., of Texas A&M University's Energy Systems Laboratory (ESL). EPA greatly appreciates the substantial contributions provided by Jess Totten, Theresa Gross, and Richard Greffe of the Public Utility Commission of Texas (PUCT); Warren Lasher of the Electric Reliability Council of Texas (ERCOT); Cory Chism, Ron Thomas, and Barry Exum of the Texas Commission on Environmental Quality (TCEQ); and Dub Taylor and Steven Ross of the Texas State Energy Conservation Office.

I. Summary

Increasing the level of energy efficiency in Texas, as proposed by House Bill 3693, an Act related to energy demand, energy load, energy efficiency incentives, energy programs and energy performance measures, would reduce the amount of electricity demanded from Texas utilities. Since approximately eighty-eight percent of electricity generated in Texas is from plants powered by fossil fuels, such as coal and natural gas, this decrease would also reduce the air pollution that would otherwise be associated with burning these fuels. This report presents the potential emission reductions of nitrogen oxides (NO_x) that would occur in the Electric Reliability Council of Texas (ERCOT) region if new energy efficiency targets for investor owned utilities are established for 2010 and 2015. These energy efficiency targets are the subject of a feasibility study as prescribed by Texas House Bill 3693. This report describes the details of the methodology, data and assumptions used, and presents the results of the analysis.

The total energy savings targets for utilities within ERCOT are 745,710 megawatt-hours (MWh) by 2010 under the 30 percent reduction of growth scenario and 1,788,953 MWh by 2015 under the 50 percent reduction of growth scenario. The total projected annual NO_x emissions reductions from these electricity savings are 191 tons in 2010 and 453 tons in 2015, or converting the annual totals into average daily avoided emissions totals, 0.5 tons per day by 2010 and 1.25 tons per day by 2015. The average avoided emission rate is approximately 0.51 pounds (lb) of NO_x reduced per MWh of electricity savings.

While House Bill 3693 is an Act related to energy and does not target emissions levels, the energy efficiency improvements would achieve air pollution benefits that could positively affect air quality and human health. The emissions reductions projected to result in 2010 and 2015 are comparable to the Texas Emission Reduction Program (TERP) Energy-Efficiency Grants Program, which does target emission reductions and estimated 2005 annual NO_x emissions reductions of about 89 tons. While the projected emissions reductions are small compared to the total emission reductions needed to bring the state's non-attainment areas into attainment of the national ambient air quality standards for ozone, they can be a part of an overall strategy to reduce emissions and improve human health in Texas.

II. Introduction and Background

Approximately 88 percent of electricity generated in Texas is from plants powered by fossil fuels such as coal and natural gas (EPA, 2008). The combustion of fossil fuels for electric generation produces primary criteria air pollutants which include: particulate matter (PM), volatile organic compounds (VOCs), carbon monoxide (CO), sulfur dioxide (SO_2) and NO_x. In the presence of sunlight, VOCs, NO_x and CO react with other compounds in the air forming ozone (O_3). NO_x and SO_2 react in the atmosphere forming fine particulate matter ($PM_{2.5}$). O_3 and $PM_{2.5}$ are linked most frequently with a variety of respiratory and cardiovascular illnesses and premature death. The combustion of fossil fuels also produces greenhouse gas emissions which contribute to global warming.

Using energy efficiency to serve the growth in energy demand in Texas will reduce the amount of electricity that would otherwise be generated by fossil fuels and reduce the amount of pollution in Texas associated with that generation. The purpose of this analysis is to estimate the amount of NO_x emissions reductions that are likely to occur in 2010 and 2015 under the scenarios being explored by the PUCT. These reductions would achieve air quality benefits and human health benefits for the state of Texas and can be considered as the state considers expanding its energy efficiency programs.

A. Texas House Bill 3693

Texas House Bill 3693, signed into law June 15, 2007 by Governor Rick Perry and effective September 1, 2007, is an Act relating to energy demand, energy load, energy efficiency incentives, energy programs, and energy performance measures. This Act called for, among other things, utility administered programs and incentives for increasing energy efficiency. Specifically, the utilities are to achieve or facilitate energy efficiency improvements for residential and commercial customers equivalent to at least:

- 10 percent of the electric utility's annual growth in demand of residential and commercial customers by December 31, 2007;
- 15 percent of the electric utility's annual growth in demand of residential and commercial customers by December 31, 2008, provided that the electric utility's program expenditures for 2008 funding may not be greater than 75 percent above the utility's program budget for 2007 for residential and commercial customers, as included in the April 1, 2006, filing; and
- 20 percent of the electric utility's annual growth in demand of residential and commercial customers by December 31, 2009, provided that the electric utility's program expenditures for 2009 funding may not be greater than 150 percent above the utility's program budget for 2007 for residential and commercial customers, as included in the April 1, 2006, filing;[1]

The Act also called for the Public Utility Commission to conduct a study, to be submitted to the Legislature not later than January 15, 2009, that evaluates the feasibility of achieving an increase in the goal to using energy efficiency to achieve 30 percent of the growth in demand for each affected utility by December 31, 2010 and 50 percent of the growth in demand for electricity by December 31, 2015.

B. Previous Uses of this Methodology

The basic elements of the methodology used in this report have precedent in a number of reports regarding NO_x emission reductions in the ERCOT region. This methodology has been used to estimate NO_x emission reductions for the Dallas Fort Worth State Implementation Plan, and by TCEQ and ESL to estimate NO_x reductions from various energy efficiency and renewable energy programs implemented in the ERCOT region.

On March 5, 2003, TCEQ submitted its State Implementation Plan (SIP) for the control of ozone air pollution for the Dallas/Fort Worth non-attainment area which included an analysis of NO_x emission reductions from energy efficiency programs[2]. The energy efficiency measures in this SIP revision encompassed the energy efficiency mandates pursuant to Senate Bill 7 of the 76th Texas Legislature and pursuant to Senate Bill 5 of the 77th Texas Legislature.

[1] See HB3693, section 22 which describes how the utilizes code is amended http://www.legis.state.tx.us/tlodocs/80R/billtext/html/HB03693F.HTM

[2] See http://www.tceq.state.tx.us/implementation/air/sip/mar2003dfw.html, specifically "Appendix A: Description of the Methodology for Determining Credit for Energy Efficiency"

Additionally, this methodology was used in several reports prepared by the Energy Systems Laboratory, some of which were submitted to the Texas Legislature, including:

- Preliminary Report: Integrated NOx Emissions Savings From EE/RE Statewide, Energy Efficiency/Renewable Energy Impact (ESL, 2008a)
- NOx Emissions Reduction From Continuous Commissioning® Measures for the Dallas-Fort Worth International Airport (ESL, 2008b);
- 15% Above-Code Energy Efficiency Measures for Residential Buildings in Texas (ESL, 2007a);
- 15% Above-Code Energy Efficiency Measures for Commercial Buildings in Texas (ESL, 2007b);
- Statewide Air Emissions Calculations from Wind and Other Renewables: A Report to the TCEQ for Sept. 2006 - Aug. 2007 (ESL, 2007c);
- A Methodology for Calculating Emissions Reductions from Renewable Energy Programs and its Application to the Wind Farms in the Texas ERCOT Region (ESL, 2007d);
- A Methodology for Calculating Integrated NOx Emissions Reduction from Energy-Efficiency and Renewable Energy (EE/RE) Programs across State Agencies in Texas (ESL, 2007e).

III. Methodology, Data, and Assumptions

This analysis uses a simplified dispatch approach of the ERCOT grid to estimate NO_x emission reductions across the ERCOT region in Texas. The simplified dispatch method reduces the generation from plants that are expected to be operating in future years and reduces NO_x emissions at these plants by the expected reduction in output emission rate of these plants. This method does not use an electric system planning model, or an electric system dispatch model, which could more fully reflect some of the dynamics of the electricity system than is presented here.

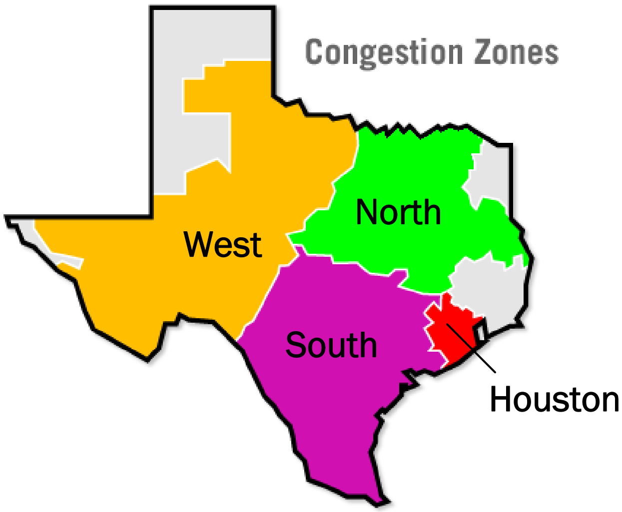
Based on the reduction targets identified by the legislature for investor owned utilities, this study assigns the electric generation reductions at specific fossil fuel fired plants that currently exist and to plants that are scheduled to be online in the years examined in this analysis, 2010 and 2015. Step one of the method assigns the potential energy savings targets of each affected investor owned utility in ERCOT, which are then applied to the respective congestion management (CM) zones based on the proportion of the utility's load in each CM zone. The second step applies the energy savings to generation from each CM zone based on year 2007 generation and power flows across these zones. The third step applies the CM zone specific reductions in generation to each plant within the CM zone based on the amount of the plant's generation that could be affected by energy efficiency measures, which is derived from a function of the plant's capacity factor. The fourth step is to apply a plant specific output NO_x emission rate to the expected reduction in electric generation. These emission rates are based on year 2005 EPA's eGRID emission rates and TCEQ's most current baseline emissions inventory for year 2005 and for projected year 2018. The last step is to sum the plant specific emission reductions to the county level. The potential emissions reductions are presented for each of the investor owned utilities and in aggregate for all five ERCOT utilities under the year 2010 and 2015 energy savings scenarios. The specific steps, assumptions, and data sources and results are described below.

A. Assigning Energy Savings to CM Zones

Assigning ERCOT 2010 and 2015 investor owned utility savings targets to CM zones

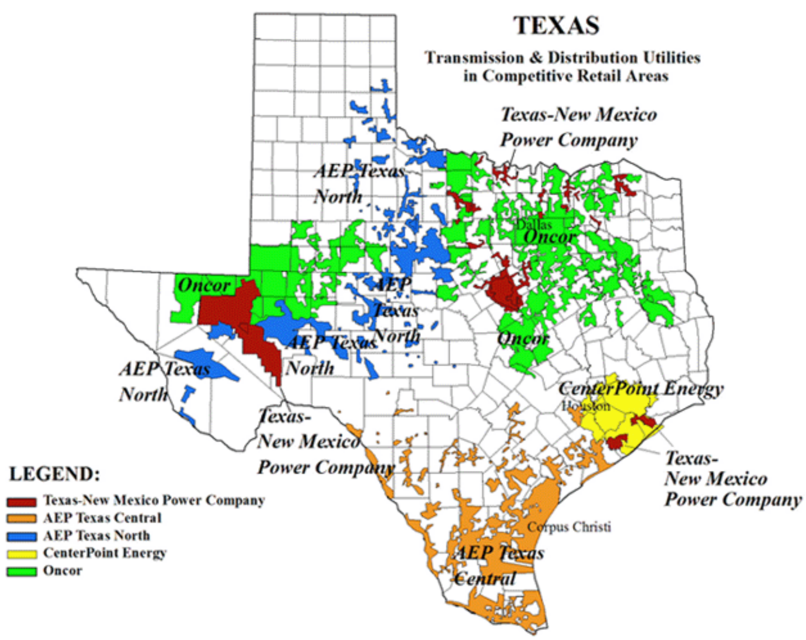
ERCOT is currently divided into four CM zones that are defined by their impact on commercially significant constraints (CSC) between the zones. These CSCs limit the flow of energy from one of the major zones in the ERCOT Region into another. There were four CM zones in ERCOT in 2007: Houston (H), North (N), South (S), and West (W). There are limits on the amount of power that can flow between these zones. ERCOT currently structures its balancing energy market based on CM zones. Figure 1 shows the CM zones for the year 2007.

Figure 1: ERCOT Congestion Management Zones, Year 2007[3]



This study apportioned the energy savings from each ERCOT utility into each congestion management zone based on a historical proportion of consumption in each zone. The utilities examined in this analysis and the location of their service territories are found in Figure 2 below.

Figure 2: Utilities in ERCOT[4]



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[3] Source of graphic: http://www.tractebelenergyservices.com/Marketfund/ERCOT.aspx

[4] Source of graphic: http://www.puc.state.tx.us/electric/maps/map.cfm (as updated 06/05/2007).

Tables 1 and 2 show each utility's total energy saving target in MWh and the percentage of total energy savings within each zone used in the analysis. For AEP Central, AEP North, and Centerpoint, the consumption is assumed to be completely in the South, West and Houston zones, respectively. For Oncor and TNMP, the consumption percentages were based on the average actual loads for each utility in each CM zone on January 1, April 1, July 1, and October 1, 2008, as provided by ERCOT. For example, the energy savings target for Oncor is distributed about 85% to the North (N) CM Zone, about 12% to the West (W) Zone, and about 3% to the South (S) Zone.

Table 1: 2010 Energy Savings Targets by ERCOT Utility by Zone (30 Percent Reduction Scenario)

	Target 2010 Energy Savings (MWh)	Percent of savings in each CM Zone			
		H	N	W	S
AEP Central	68,760				100.00%
AEP North	1,860			100.00%	
Centerpoint	408,311	100.00%			
Oncor	220,803		84.97%	11.87%	3.16%
TNMP	45,976	64.03%	28.67%	7.31%	
Total	*745,710*	*58.70%*	*26.93%*	*4.21%*	*10.16%*

Table 2: 2015 Energy Savings Targets by ERCOT Utility by Zone (50 Percent Reduction Scenario)

	Target 2015 Energy Savings (MWh)	Percent of savings in each CM Zone			
		H	N	W	S
AEP Central	118,300				100.00%
AEP North	9,200			100.00%	
Centerpoint	864,428	100.00%			
Oncor	734,264		84.97%	11.87%	3.16%
TNMP	62,761	64.03%	28.67%	7.31%	
Total	*1,788,953*	*50.57%*	*35.88%*	*5.64%*	*7.91%*

Power flows across CM zones

Since electricity flows between CM zones, the energy savings targets that occur in one CM zone will reduce generation within and outside the CM zone. This analysis calculates the proportion of generation in each zone for consumption in a particular zone by examining the 2007 generation in each CM zone and the 2007 power flow between each CM zone. A set of four equations with four unknowns that simultaneously balances annual generation and annual interchanges between each zone was solved using matrix algebra. Table 3 contains the year 2007 generation data by CM zone as provided by ERCOT.

Table 3: Year 2007 Generation Data by CM Zone

CM Zone Data	Gen (MWh)
Houston	57,359,385
North	138,182,204
West	20,834,067
South	91,407,605
Total	307,783,261

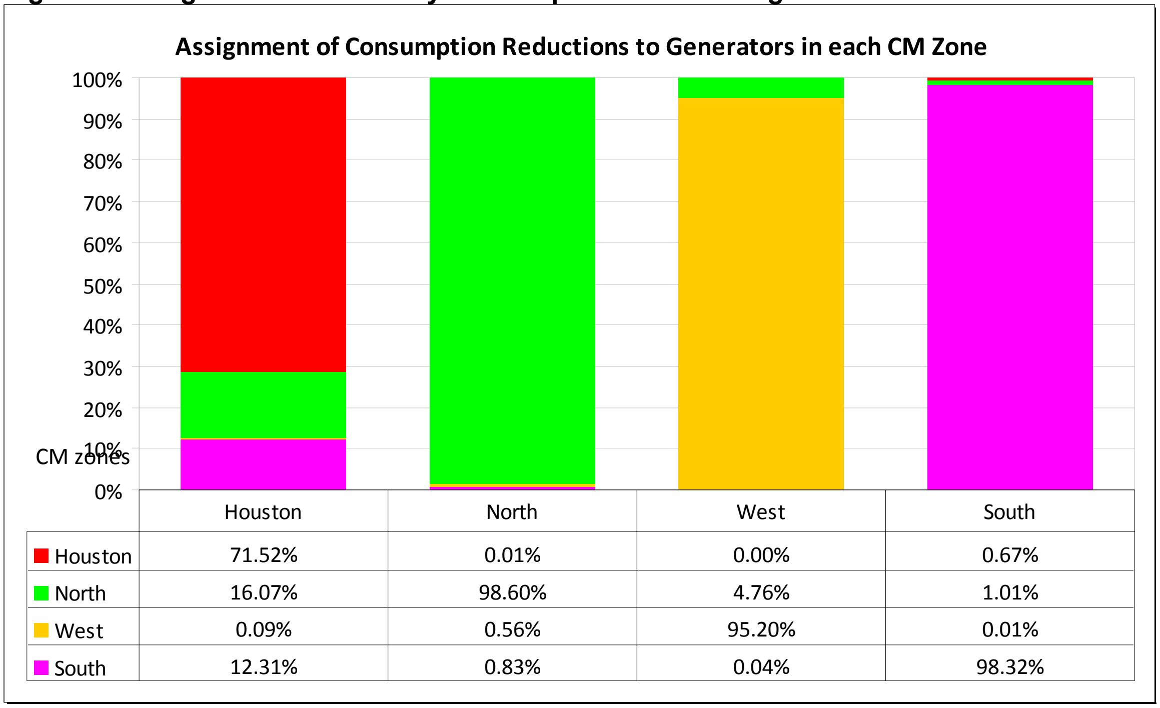
Table 4 contains the power flow data (ERCOT, 2008). In this table, the rows are the importing zones and the columns are the zones from which the energy is imported. For example, in the first row, 12,986,824 MWh were imported to the Houston (H) CM zone from the North (N) CM Zone, and 9,943,695 MWh were imported to the Houston (H) CM zone from the South (S) CM zone.

Table 4: Power Energy Flow Data between the CM Zones in Year 2007 (MWh)

Importing Zones Below Exporting Zones Right	H	N	W	S	Total Import
H		**12,986,824**		**9,943,695**	22,930,519
N	**6,701**		**825,555**	**1,182,743**	2,015,000
W		**1,057,394**			1,057,394
S	**871,989**	**807,564**			1,679,553
Sum Export	878,690	14,851,783	825,555	11,126,438	

Figure 3 shows the results of the calculation of simultaneous equations. To read Figure 3, each stacked bar shows how much electricity consumption of the labeled bar is sourced from generation in each zone. For example, for the Houston zone, 71.52 percent of consumption originates from generation in the Houston Zone, 16.07 percent originates from the North Zone, 0.09 percent from the West Zone, and 12.31 percent from the South Zone. The percentages in Figure 3 are used to assign consumption reductions from energy efficiency to the generators in each CM zone.

Figure 3: Assignment of electricity consumption to reduced generation in each CM zone



	Houston	North	West	South
Houston	71.52%	0.01%	0.00%	0.67%
North	16.07%	98.60%	4.76%	1.01%
West	0.09%	0.56%	95.20%	0.01%
South	12.31%	0.83%	0.04%	98.32%

The results show that most of the electricity savings occurring in each zone would result in reductions of generation from plants within that same zone. However, because of the relatively large amount of power that is imported into the Houston Zone, a larger proportion of energy savings in the Houston area would reduce generation at plants outside of the Houston Zone, particularly from the South and North Zones.

This 2007-based pattern of power flow is assumed to be the same for both years of the analysis, 2010 and 2015. In the forthcoming nodal market, which will replace today's CM zones, the ERCOT grid will have more than 4,000 nodes. This change will likely have some influence over how electricity flows within the grid, however, the fundamental locations of electricity production and consumption are not expected to change drastically. Also, for this analysis, the small amount of interchange between ERCOT and other grids outside of ERCOT is assumed to be zero.

B. Assigning Generation Reductions within Each CM Zone to Individual Plants

The generation reductions within each zone are apportioned to the fossil fuel fired plants in the zone. This analysis assumes that nuclear, hydro-electric, and wind generation will not be curtailed due to reduced electricity consumption from energy efficiency programs. The sources of data for the electric generating units are eGRID2007 (Year 2005 operational data), new and proposed generating units from ERCOT, and from TCEQ's baseline emissions inventory (year 2005 and projections for year 2018) provided by TCEQ.

Some plants are broken down into more than one unit. This is to accommodate new units at existing plants and the reality that the dispatch of electricity frequently occurs at the unit level, rather than at the plant level.

The emission factors and capacity factors at units that are scheduled to have increased capacity, that is “uprates,” are kept the same, and only the capacity and annual generation are increased according to the number of megawatts (MW) scheduled.

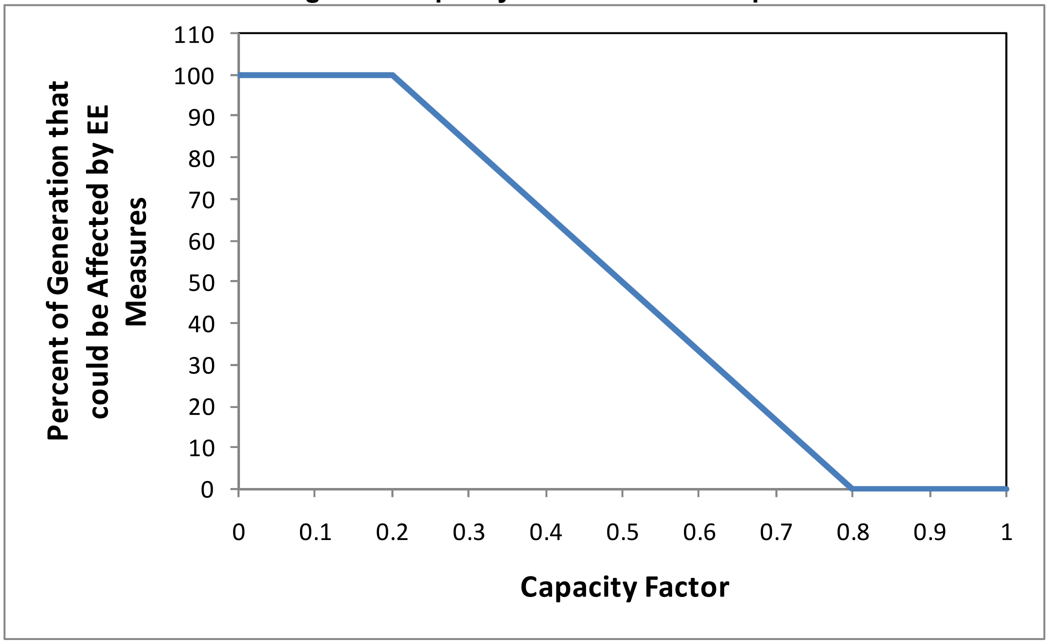
This analysis assigns a 25 percent capacity factor for new gas units and a 75 percent capacity factor for new coal units. According to eGRID, the year 2005 total weighted average capacity factor for all plants in ERCOT that generated electricity from coal was 76.2 percent. The 75 percent assumption for new coal plants approximates the year 2005 value for coal plants. According to eGRID, the year 2005 total weighted average capacity factor for all plants in ERCOT that generated at least 90 percent of electricity from natural gas was 26.1 percent. The 25 percent assumption for new natural gas plants approximates this year 2005 value.

Use of capacity factor to assign generation reductions to individual plants and units

The amount of generation that could potentially be affected by efficiency is determined by a function of the unit’s capacity factor. The capacity factor is a measure of how much generation the unit produces compared to running at its maximum rated capacity for the entire year. In this step, plants that have a capacity factor of 0.8 or greater are considered to be baseload units and none of their generation would be affected by energy efficiency measures. In addition, plants that have a capacity factor of 0.2 or less are considered to be “peaking” units and all of their generation would be affected by energy efficiency measures. Figure 4 illustrates the relationship between capacity factor and how much of each plant’s generation could be affected by energy efficiency. For example, a unit with a capacity factor of 25 percent would have about 92 percent of its generation that could be affected by efficiency measures, and a unit with a capacity factor of 75 percent would have about 8 percent of its generation that could be affected by efficiency measures.

Within each zone, all of the generation that could be affected by energy efficiency measures is summed. Each plant’s available generation reductions are then divided by this total amount, expressing the values as a percent of the CM zone total. This procedure assumes that there are no transmission constraints within each CM zone. However, grid loss factors are accounted for later in the procedure.

Figure 4: Capacity Factor Relationship



The energy savings in each zone are applied to each unit's generation in proportion to the amount of "non-baseload" generation determined by the capacity factor relationship.

C. Determining Plant Specific NO_x Emission Rates

The annual NO_x emission rate for each plant or unit was determined in this step. The original annual emission rate in lb/MWh from the eGRID year 2005 data was used as a baseline. Some of the power plants were broken into individual units in a similar fashion with the previous step, and the individual emission rate for the unit was used for the calculation.

Then, the daily NO_x emissions in tons for each plant and unit from the TCEQ baseline year 2005 and 2018 (scenario B) were used to bring the eGRID 2005 emission rates to current level. The projected emission inventory 2018 scenario B used in this analysis is a NO_x emissions inventory forecast for electric generators without the Clean Air Interstate Rule. This is a scenario proposed by TCEQ for sensitivity purposes in its ongoing HGB SIP modeling work as of October 2008. Scenario B includes more pending permit fossil fuel fired electric generating units than in Scenario A. For the existing plants, the eGRID 2005 emission rate was multiplied by the annual emission from 2018 scenario B over the emission from 2005 scenario.

$$a = b \times (c / d)$$

Where: *a: Calculated NO_x emission rate (lb/MWh)*
b: Annual NOx emission rate from the eGRID 2005 (lb/MWh)
c: Daily NO_x emissions from the TCEQ 2018 scenario (Tons)
d: Daily NO_x emissions from the TCEQ 2005 scenario (Tons)

After calculating the NO_x emission rate using the equation above, if the calculated NO_x emission rate was larger than the rate from the eGRID 2005, the rate from the eGRID 2005 was assigned instead. This procedure ensures that any reductions in plant emission rates since the year

2005 are incorporated into the analysis. If (c / d) is greater than one, then the eGRID emission rate for year 2005 is used.
For new plants or units, the NO_x emission rate from the TCEQ 2018 scenario was assigned. Since the TCEQ scenario provides emissions in tons of NO_x per typical day, the emission rate in lb/MWh was calculated as shown below.

$$e = (f \times 2000) / (g \times 24 \times h)$$

Where:
e: Plant annual NO_x emission rate (lb/MWh)
f: Typical daily NO_x emissions from the TCEQ 2018 scenario (Tons per day)
g: Plant nameplate capacity (MW)
h: Plant capacity factor

The NO_x emission rate of the new power plants that were not found in the TCEQ data was assumed to be 1 lb/MWh.

D. Final Steps of Analysis – Putting the Pieces Together

As a final step of the analysis, the information from the previous steps (that is, power energy flow data between CM zones, percent generation reduction in CM zone, and the NO_x emission rate) are combined so that the generation reductions and the corresponding NO_x emission reductions for each “non-baseload” plant within ERCOT are determined for a given amount of electricity demand savings that is implemented in a particular CM zone. Then, the plant level data were summed into countywide totals.

The NO_x emission reductions calculated using this analysis can be determined with or without grid loss factors. In the conservative case, 1 kWh reduction in consumption relates to about 1 kWh of generation reduction. In the case considering the transmission and distribution loss factor, 1 kWh of reduction in electricity consumption relates to 1.0618 kWh of generation reduction. The Texas specific 6.18 percent factor is from eGRID2007 (year 2005 data). This eGRID value is calculated from various EIA sources, specifically, EIA Electric Power Annual state specific generation and electric sales data, and EIA-861 data.

IV. Results

The analysis showed that the total energy savings targets of 745,710 MWh by 2010 under the 30% reduction of growth scenario and 1,788,953 MWh by 2015 under the 50% reduction of growth scenario would achieve total projected annual NO_x emissions reductions of 191 tons in 2010 and 453 tons in 2015. By converting the annual totals into average daily avoided emissions totals, another way to present this is that the electricity reductions would reduce NO_x emissions 0.5 tons per day by 2010 and 1.25 tons per day by 2015. The average avoided emission rate is approximately 0.51 pounds of NO_x reduced per MWh of electricity savings.

The estimate above takes into account the transmission and distribution losses that occur between the points of generation and the points of consumption. As discussed in section III D above, the grid loss factor used in this analysis is 6.18%. If the energy losses that occur during transmission and distribution of electricity are not factored into the results, the avoided emissions avoided would be smaller. Table 5 displays the total estimated emission reduction results for years 2010 and 2015, including and excluding the grid loss factor.

Table 5: Results of Analysis Including and Not Including Energy Losses

	2010		2015	
	Including energy losses	Without energy losses	Including energy losses	Without energy losses
Annual NO_x Emission Reductions (tons)	191	180	453	427
Average Daily NO_x Emission Reductions (tons/day)	0.52	0.49	1.24	1.17
Total NO_x Emission Reductions divided by Total energy savings goal (tons reduced per MWh of savings)	0.512	0.482	0.507	0.477

Tables 6 and 7 present the distribution of the emissions per CM zone for each county and for the total energy savings targets under the 2010 and 2015 goals, respectively. Figures 5 and 6 provide graphical representations of the cumulative NO_x emission reductions for Texas counties for the savings targets under 2010 and 2015 goals, respectively. These numbers are based on the addition of a factor of transmission and distribution losses of 6.18 percent. As expected most of the NO_x emission reduction would come for the Houston-Galveston-Brazoria (HGB) area. Similar plots for utility specific year 2010 and 2015 goals are presented in Appendix A.

Table 6: Distribution of the Emission Reductions per CM Zone for each County (Year 2010)

County	CM Zones: H (lb/MWh)*	H lb	N (lb/MWh)*	N lb	W (lb/MWh)*	W lb	S (lb/MWh)*	S lb	Total (lbs)	Total (Tons)
Andrews	0.000004	1.740	0.000023	4.897	0.003900	130.146	0.000000	0.019	136.8028	0.0684
Atascosa	0.000204	94.703	0.000014	2.930	0.000001	0.022	0.001627	130.854	228.5091	0.1143
Bastrop	0.003378	1,570.200	0.000228	48.577	0.000011	0.367	0.026980	2,169.605	3788.7491	1.8944
Bexar	0.013891	6,456.359	0.000937	199.738	0.000045	1.510	0.110936	8,920.999	15578.6051	7.7893
Bosque	0.002220	1,032.054	0.013621	2,904.167	0.000658	21.954	0.000139	11.175	3969.3500	1.9847
Brazoria	0.056203	26,123.269	0.000007	1.520	0.000000	0.011	0.000527	42.342	26167.1433	13.0836
Brazos	0.002409	1,119.647	0.011231	2,394.456	0.000542	18.101	0.004783	384.623	3916.8262	1.9584
Calhoun	0.000947	439.972	0.000064	13.611	0.000003	0.103	0.007560	607.926	1061.6125	0.5308
Cameron	0.006354	2,953.170	0.000429	91.361	0.000021	0.691	0.050742	4,080.508	7125.7301	3.5629
Chambers	0.020450	9,505.171	0.000003	0.553	0.000000	0.004	0.000192	15.407	9521.1349	4.7606
Cherokee	0.002739	1,273.160	0.016803	3,582.633	0.000812	27.083	0.000171	13.786	4896.6619	2.4483
Coke	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Collin	0.001293	601.065	0.007933	1,691.378	0.000383	12.786	0.000081	6.508	2311.7371	1.1559
Dallas	0.002483	1,153.917	0.015230	3,247.086	0.000736	24.546	0.000155	12.495	4438.0449	2.2190
Denton	0.000127	58.873	0.000777	165.667	0.000038	1.252	0.000008	0.637	226.4306	0.1132
Ector	0.001922	893.118	0.000660	140.794	0.091135	3,041.027	0.014653	1,178.311	5253.2503	2.6266
Ellis	0.002992	1,390.679	0.018354	3,913.326	0.000887	29.583	0.000187	15.059	5348.6469	2.6743
Fannin	0.000004	1.885	0.000025	5.304	0.000001	0.040	0.000000	0.020	7.2488	0.0036
Fayette	0.005187	2,410.781	0.010322	2,200.682	0.000499	16.636	0.028399	2,283.760	6911.8595	3.4559
Fort Bend	0.031346	14,569.784	0.000004	0.848	0.000000	0.006	0.000294	23.616	14594.2536	7.2971
Freestone	0.004764	2,214.467	0.029227	6,231.438	0.001412	47.106	0.000298	23.979	8516.9894	4.2585
Frio	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Galveston	0.022662	10,533.291	0.000003	0.613	0.000000	0.005	0.000212	17.073	10550.9817	5.2755
Goliad	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Grimes	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Guadalupe	0.003203	1,488.704	0.000216	46.055	0.000010	0.348	0.025579	2,057.000	3592.1074	1.7961
Harris	0.148691	69,111.694	0.000019	4.022	0.000001	0.030	0.001393	112.021	69227.7678	34.6139
Hays	0.000833	387.239	0.000056	11.980	0.000003	0.091	0.006654	535.062	934.3715	0.4672
Henderson	0.000691	321.073	0.004238	903.489	0.000205	6.830	0.000043	3.477	1234.8689	0.6174
Hidalgo	0.005372	2,496.710	0.000362	77.240	0.000017	0.584	0.042899	3,449.801	6024.3347	3.0122
Hood	0.005077	2,359.836	0.031145	6,640.503	0.001504	50.199	0.000318	25.553	9076.0903	4.5380
Howard	0.000241	112.072	0.000764	162.907	0.128394	4,284.322	0.000949	76.314	4635.6151	2.3178
Hunt	0.008846	4,111.780	0.004707	1,003.501	0.000227	7.586	0.065282	5,249.745	10372.6119	5.1863
Jack	0.003078	1,430.801	0.018884	4,026.229	0.000912	30.436	0.000193	15.493	5502.9592	2.7515
Johnson	0.000726	337.259	0.004451	949.035	0.000215	7.174	0.000045	3.652	1297.1199	0.6486
Kaufman	0.005972	2,775.718	0.036634	7,810.780	0.001769	59.045	0.000374	30.056	10675.5988	5.3378
Lamar	0.004000	1,859.268	0.024539	5,231.919	0.001185	39.551	0.000250	20.133	7150.8695	3.5754
Limestone	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Llano	0.004031	1,873.818	0.000272	57.970	0.000013	0.438	0.032197	2,589.127	4521.3529	2.2607
McLennan	0.005658	2,629.665	0.034707	7,399.793	0.001676	55.939	0.000354	28.475	10113.8712	5.0569
Milam	0.001269	589.649	0.000086	18.242	0.000004	0.138	0.010132	814.740	1422.7685	0.7114
Mitchell	0.000031	14.469	0.000191	40.714	0.032426	1,082.006	0.000002	0.157	1137.3460	0.5687
Nolan	0.000029	13.598	0.000179	38.264	0.030474	1,016.888	0.000002	0.147	1068.8972	0.5344
Nueces	0.012858	5,976.301	0.000867	184.886	0.000042	1.398	0.102687	8,257.684	14420.2686	7.2101
Palo Pinto	0.003613	1,679.295	0.022164	4,725.483	0.001071	35.722	0.000226	18.184	6458.6840	3.2293
Parker	0.000001	0.571	0.000008	1.608	0.000000	0.012	0.000000	0.006	2.1980	0.0011
Pecos	0.000002	0.916	0.000012	2.577	0.002052	68.473	0.000000	0.010	71.9753	0.0360
Reagan	0.000006	2.751	0.000036	7.742	0.006166	205.744	0.000000	0.030	216.2668	0.1081
Robertson	0.003951	1,836.228	0.005575	1,188.745	0.000269	8.986	0.024617	1,979.599	5013.5587	2.5068
Rusk	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
San Patricio	0.001510	701.827	0.000102	21.712	0.000005	0.164	0.012059	969.741	1693.4447	0.8467
Scurry	0.000027	12.461	0.000164	35.064	0.027926	931.838	0.000002	0.135	979.4977	0.4897
Tarrant	0.000474	220.400	0.002909	620.199	0.000141	4.688	0.000030	2.387	847.6746	0.4238
Titus	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Travis	0.005179	2,406.985	0.000349	74.464	0.000017	0.563	0.041358	3,325.824	5807.8359	2.9039
Upton	0.000003	1.182	0.000016	3.327	0.002649	88.408	0.000000	0.013	92.9292	0.0465
Victoria	0.002119	984.984	0.000143	30.472	0.000007	0.230	0.016924	1,360.991	2376.6777	1.1883
Ward	0.000200	92.737	0.001224	260.958	0.207834	6,935.095	0.000012	1.004	7289.7940	3.6449
Webb	0.004202	1,952.964	0.000283	60.418	0.000014	0.457	0.033557	2,698.485	4712.3240	2.3562
Wharton	0.002110	980.503	0.000142	30.333	0.000007	0.229	0.016847	1,354.798	2365.8632	1.1829
Wichita	0.000012	5.631	0.000074	15.845	0.012619	421.077	0.000001	0.061	442.6130	0.2213
Wilbarger	0.017971	8,352.932	0.110243	23,504.881	0.005325	177.685	0.001125	90.447	32125.9453	16.0630
Wise	0.001020	474.180	0.006258	1,334.328	0.000302	10.087	0.000064	5.135	1823.7299	0.9119
Young	0.007105	3,302.593	0.043588	9,293.391	0.002105	70.253	0.000445	35.761	12701.9989	6.3510
Total	**0.441687**	**205,296.100**	**0.481501**	**102,660.654**	**0.568671**	**18,975.696**	**0.684564**	**55,049.947**	**381,982.398**	**190.99120**
Energy Savings (MWh)	437,747.6		200,800.3		31,426.4		75,735.6			

Total Energy Savings (MWh)	745,709.8
% T&D Loss	6.18 %

* (lb/MWh) are pounds of NOx reduced from one megawatt-hour of electricity savings in that CM Zone.
(lb) are mass of projected NOx emissions reductions from multiplying the total energy savings for the CM Zone at the bottom of the chart by the (lb/MWh) factor in the column to the left.

Table 7: Distribution of the Emission Reductions per CM Zone for each County (Year 2015)

County	CM Zones									
	H		N		W		S			
	(lb/MWh)*	lb	(lb/MWh)*	lb	(lb/MWh)*	lb	(lb/MWh)*	lb	Total (lbs)	Total (Tons)
Andrews	0.000004	3.596	0.000023	15.655	0.003900	417.998	0.000000	0.035	437.2851	0.2186
Atascosa	0.000202	194.058	0.000014	9.287	0.000001	0.071	0.001614	242.418	445.8337	0.2229
Bastrop	0.003350	3217.538	0.000226	153.981	0.000011	1.169	0.026753	4019.366	7392.0548	3.6960
Bexar	0.013774	13229.894	0.000929	633.142	0.000045	4.809	0.110002	16526.858	30394.7029	15.1974
Bosque	0.002149	2064.419	0.013185	8986.465	0.000637	68.252	0.000135	20.210	11139.3454	5.5697
Brazoria	0.052595	50518.480	0.001053	717.602	0.000051	5.450	0.000068	10.223	51251.7555	25.6259
Brazos	0.002346	2252.898	0.010872	7409.883	0.000525	56.278	0.004740	712.139	10431.1973	5.2156
Calhoun	0.000939	901.558	0.000063	43.146	0.000003	0.328	0.007496	1126.232	2071.2635	1.0356
Cameron	0.006300	6051.418	0.000425	289.602	0.000021	2.200	0.050315	7559.466	13902.6855	6.9513
Chambers	0.019075	18321.635	0.000002	1.649	0.000000	0.013	0.000179	26.849	18350.1453	9.1751
Cherokee	0.002651	2546.704	0.016265	11085.866	0.000786	84.196	0.000166	24.931	13741.6977	6.8708
Coke	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Collin	0.001252	1202.311	0.007679	5233.689	0.000371	39.750	0.000078	11.770	6487.5200	3.2438
Dallas	0.002403	2308.182	0.014742	10047.574	0.000712	76.311	0.000150	22.596	12454.6625	6.2273
Denton	0.000123	117.764	0.000752	512.631	0.000036	3.893	0.000008	1.153	635.4412	0.3177
Ector	0.001906	1830.818	0.000659	449.376	0.091135	9767.029	0.014529	2182.922	14230.1454	7.1151
Ellis	0.002896	2781.777	0.017766	12109.144	0.000858	91.968	0.000181	27.232	15010.1212	7.5051
Fannin	0.000004	3.770	0.000024	16.411	0.000001	0.125	0.000000	0.037	20.3426	0.0102
Fayette	0.005104	4902.695	0.009997	6813.496	0.000483	51.748	0.028158	4230.482	15998.4210	7.9992
Fort Bend	0.029238	28083.898	0.000004	2.528	0.000000	0.019	0.000274	41.154	28127.6000	14.0638
Freestone	0.004612	4429.600	0.028290	19282.157	0.001366	146.447	0.000289	43.364	23901.5672	11.9508
Frio	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Galveston	0.021138	20303.381	0.000003	1.828	0.000000	0.014	0.000198	29.753	20334.9758	10.1675
Goliad	0.017491	16800.188	0.000002	1.512	0.000000	0.011	0.000164	24.619	16826.3314	8.4132
Grimes	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Guadalupe	0.003176	3050.543	0.000214	145.990	0.000010	1.109	0.025364	3810.755	7008.3963	3.5042
Harris	0.138692	133215.829	0.000018	11.993	0.000001	0.091	0.001299	195.215	133423.1280	66.7116
Hays	0.000826	793.501	0.000056	37.975	0.000003	0.288	0.006598	991.246	1823.0094	0.9115
Henderson	0.000669	642.243	0.004102	2795.699	0.000198	21.233	0.000042	6.287	3465.4619	1.7327
Hidalgo	0.005326	5116.075	0.000359	244.840	0.000017	1.860	0.042538	6391.029	11753.8035	5.8769
Hood	0.004914	4720.382	0.030147	20547.941	0.001456	156.060	0.000308	46.211	25470.5944	12.7353
Howard	0.000240	230.645	0.000764	520.730	0.128394	13760.193	0.000941	141.388	14652.9560	7.3265
Hunt	0.008756	8410.184	0.004569	3114.040	0.000221	23.651	0.064732	9725.418	21273.2926	10.6366
Jack	0.002980	2862.033	0.018279	12458.501	0.000883	94.621	0.000186	28.018	15443.1741	7.7216
Johnson	0.000702	674.619	0.004309	2936.633	0.000208	22.304	0.000044	6.604	3640.1592	1.8201
Kaufman	0.005781	5552.271	0.035460	24169.171	0.001713	183.563	0.000362	54.354	29959.3589	14.9797
Lamar	0.003872	3719.095	0.023753	16189.311	0.001147	122.957	0.000242	36.408	20067.7705	10.0339
Limestone	0.000172	164.730	0.001052	717.073	0.000051	5.446	0.000011	1.613	888.8621	0.4444
Llano	0.003998	3839.690	0.000270	183.756	0.000013	1.396	0.031926	4796.563	8821.4046	4.4107
McLennan	0.009476	9101.765	0.033595	22897.785	0.001623	173.907	0.000380	57.124	32230.5814	16.1153
Milam	0.001258	1208.265	0.000085	57.824	0.000004	0.439	0.010046	1509.371	2775.8985	1.3879
Mitchell	0.000031	29.900	0.000191	130.154	0.032426	3475.139	0.000002	0.293	3635.4857	1.8177
Nolan	0.000029	28.100	0.000179	122.321	0.030474	3265.995	0.000002	0.275	3416.6916	1.7083
Nueces	0.012750	12246.195	0.000860	586.065	0.000042	4.451	0.101823	15298.015	28134.7255	14.0674
Palo Pinto	0.003497	3359.096	0.021453	14622.228	0.001036	111.055	0.000219	32.884	18125.2628	9.0626
Parker	0.000001	1.143	0.000007	4.976	0.000000	0.038	0.000000	0.011	6.1682	0.0031
Pecos	0.000002	1.892	0.000012	8.237	0.002052	219.919	0.000000	0.019	230.0664	0.1150
Reagan	0.000006	5.685	0.000036	24.749	0.006166	660.799	0.000000	0.056	691.2891	0.3456
Robertson	0.003897	3742.805	0.005402	3681.717	0.000261	27.962	0.024409	3667.169	11119.6535	5.5598
Rusk	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
San Patricio	0.001497	1438.132	0.000101	68.825	0.000005	0.523	0.011958	1796.523	3304.0024	1.6520
Scurry	0.000027	25.750	0.000164	112.091	0.027926	2992.837	0.000002	0.252	3130.9295	1.5655
Tarrant	0.000459	440.867	0.002816	1919.105	0.000136	14.575	0.000029	4.316	2378.8630	1.1894
Titus	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.0000	0.0000
Travis	0.005135	4932.217	0.000346	236.041	0.000017	1.793	0.041010	6161.353	11331.4027	5.6657
Upton	0.000003	2.443	0.000016	10.635	0.002649	283.943	0.000000	0.024	297.0448	0.1485
Victoria	0.002101	2018.358	0.000142	96.592	0.000007	0.734	0.016782	2521.343	4637.0270	2.3185
Ward	0.000200	191.642	0.001224	834.220	0.207834	22273.828	0.000012	1.876	23301.5659	11.6508
Webb	0.004166	4001.870	0.000281	191.517	0.000014	1.455	0.033274	4999.158	9193.9994	4.5970
Wharton	0.002092	2009.174	0.000141	96.153	0.000007	0.730	0.016706	2509.871	4615.9274	2.3080
Wichita	0.000012	11.636	0.000074	50.651	0.012619	1352.396	0.000001	0.114	1414.7965	0.7074
Wilbarger	0.017395	16708.378	0.106711	72731.982	0.005154	552.394	0.001089	163.568	90156.3224	45.0782
Wise	0.000987	948.503	0.006058	4128.859	0.000293	31.358	0.000062	9.285	5118.0059	2.5590
Young	0.006878	6606.181	0.042191	28756.867	0.002038	218.406	0.000430	64.672	35646.1265	17.8231
Total	**0.441552**	**424118.419**	**0.468411**	**319259.869**	**0.568038**	**60877.526**	**0.678325**	**101912.488**	**906,168.302**	**453.08415**
Energy Savings (MWh)	904,611.9		641,911.0		100,933.8		141,496.8			

Total Energy Savings (MWh)	1,788,953.5
% T&D Loss	6.18 %

* (lb/MWh) are pounds of NOx reduced from one megawatt-hour of electricity savings in that CM Zone.
(lb) are mass of projected NOx emissions reductions from multiplying the total energy savings for the CM Zone at the bottom of the chart by the (lb/MWh) factor in the column to the left.

Figure 5: Total Projected Annual NO_x Emission Reductions for ERCOT (Year 2010)

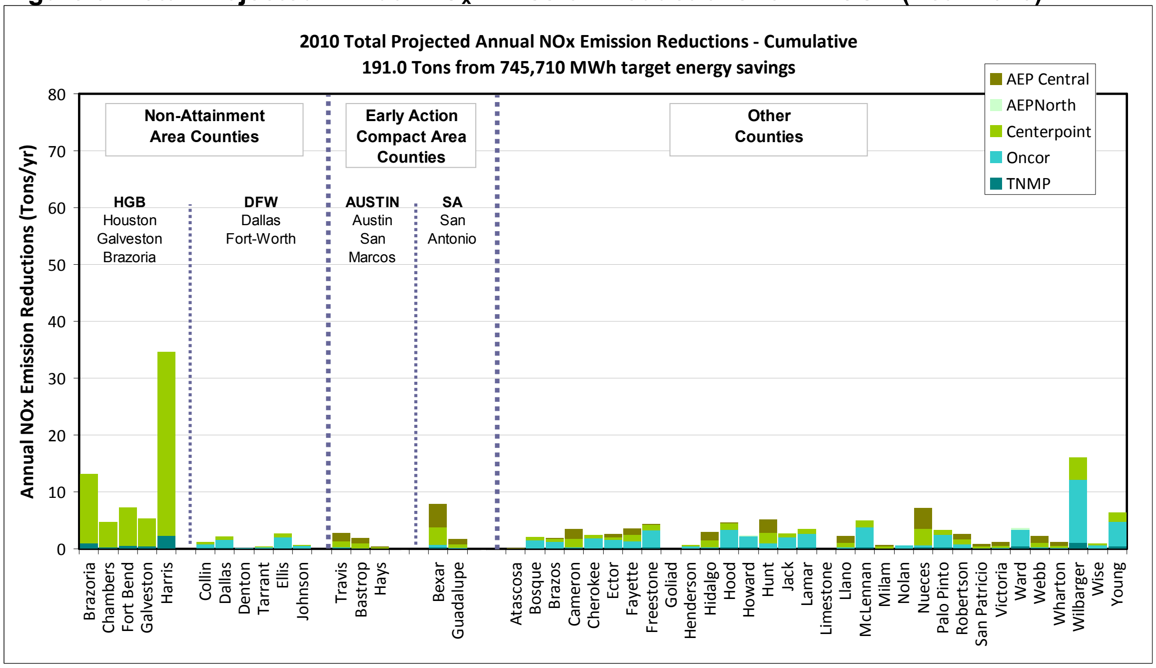
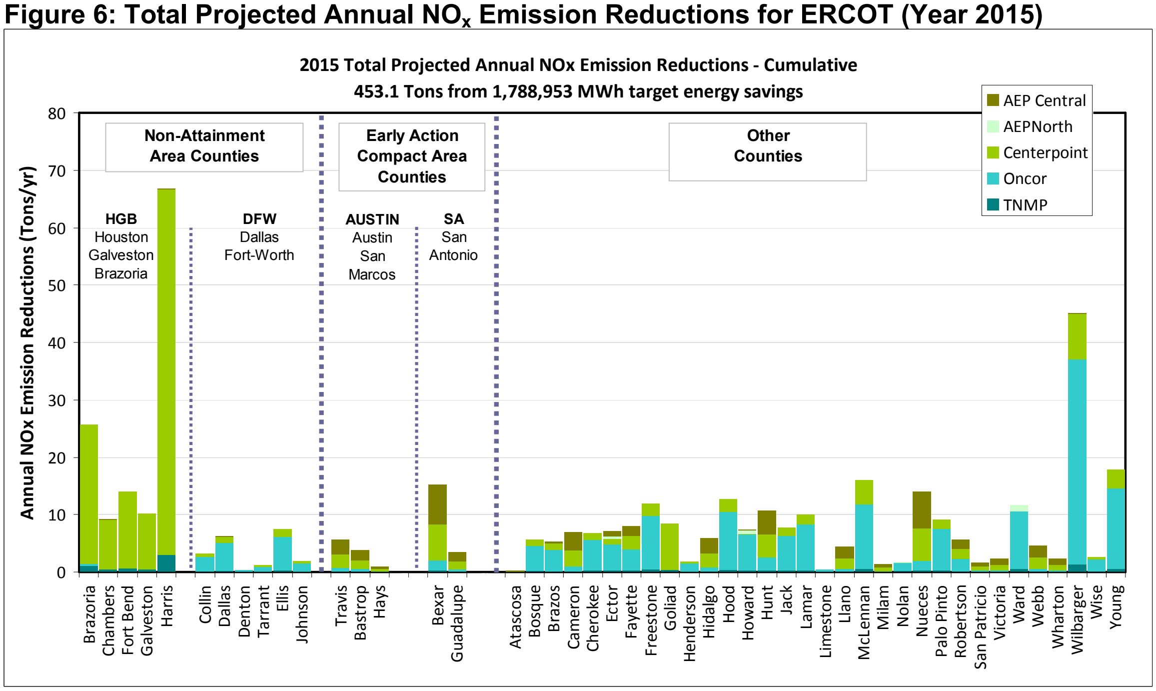


Figure 6: Total Projected Annual NO_x Emission Reductions for ERCOT (Year 2015)



IV. Conclusion

While House Bill 3693 is an Act related to energy and does not target emissions levels, the energy efficiency improvements would achieve air pollution benefits that could positively affect air quality and human health. The analysis estimates that ERCOT wide annual NO_x emissions reductions of 191 tons by 2010 and 453 tons by 2015 are likely to result from the energy savings targets under consideration. When the analysis negates energy losses that occur between the generation of electricity and consumption, the annual NO_x emission reductions are estimated to be 180 tons by 2010 and 427 tons by 2015. By converting these values into average tons per day, these emission reductions range from 0.49 to 0.52 tons per day by 2010 and range from 1.17 to 1.24 tons per day by 2015.

These NO_x reductions may be most helpful to the Houston Galveston Brazoria non-attainment area, as the reductions within this area are estimated to be 0.17 tons per day by 2010 and 0.34 tons per day by 2015. By comparison, the measure to Controlling Emissions from Off-Road Large Spark-Ignition Engines is estimated to reduce NO_x emissions in the HGB area by at least 2.8 tons per day. (TNRCC, 2000). The emissions reductions projected to result in 2010 and 2015 are comparable to the Texas Emission Reduction Program (TERP) Energy-Efficiency Grants Program, which does target emission reductions and estimated 2005 annual NO_x emissions reductions of about 89 tons (PUCT 2006). Also, the emission reductions are comparable to those from the statewide adoption of the International Residential Code and the International Energy Conservation Code for residential, commercial, and industrial Buildings, which were included in the Dallas Fort Worth SIP at 0.72 tons NO_x per day (TCEQ, 2008).

While the projected emissions reductions are small compared to the total emission reductions needed to bring the state's non-attainment areas into attainment of the national ambient air quality standards for ozone, they can be a part of an overall strategy to reduce emissions and improve human health in Texas.

Future Considerations

This analysis estimates annual emission reductions from annual electricity energy savings targets. If energy savings estimates are broken down into monthly values, this method could be revised to give results in monthly emission reductions values. It is likely that the emission reductions might be greater in the summer, that is, the ozone season, when ozone pollution is of greater concern, than in the winter, especially if a significant portion of the energy saving targets is met by improving the energy efficiency of cooling loads and/or improving building envelopes.

This analysis did not address the trading aspect of the NO_x cap and trade program in the Houston area. If such reductions are sought to be incorporated into the SIP for this area of Texas, according to EPA guidance, retirement of NO_x allowances or further analysis that demonstrates that changes in emissions due to the efficiency measure would improve air quality without the retirement of NO_x allowances (EPA, 2004).

Although NO_x was the only pollutant examined in this analysis, the saving of electricity through energy efficiency programs would also reduce other pollution associated with the combustion of fossil fuels, including, but not limited to, carbon monoxide, carbon dioxide, sulfur dioxide, particulate matter, and mercury.

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Appendix A. Additional Figures: Estimate NO_x Emissions Reductions by Utility Specific Energy Savings Targets

Figures A-1 through A-5 below show the county specific estimated annual NO_x emissions reductions for the 2010 energy savings targets under the 30% reduction of growth scenario of each ERCOT utility. Figures A-6 through A-10 show the county specific estimated annual NO_x emissions reductions for the 2015 energy savings targets under the 50% reduction of growth scenario of each ERCOT utility.

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Figure A- 1: Projected Annual NO_x Emission Reductions for 2010 for AEP Central by County

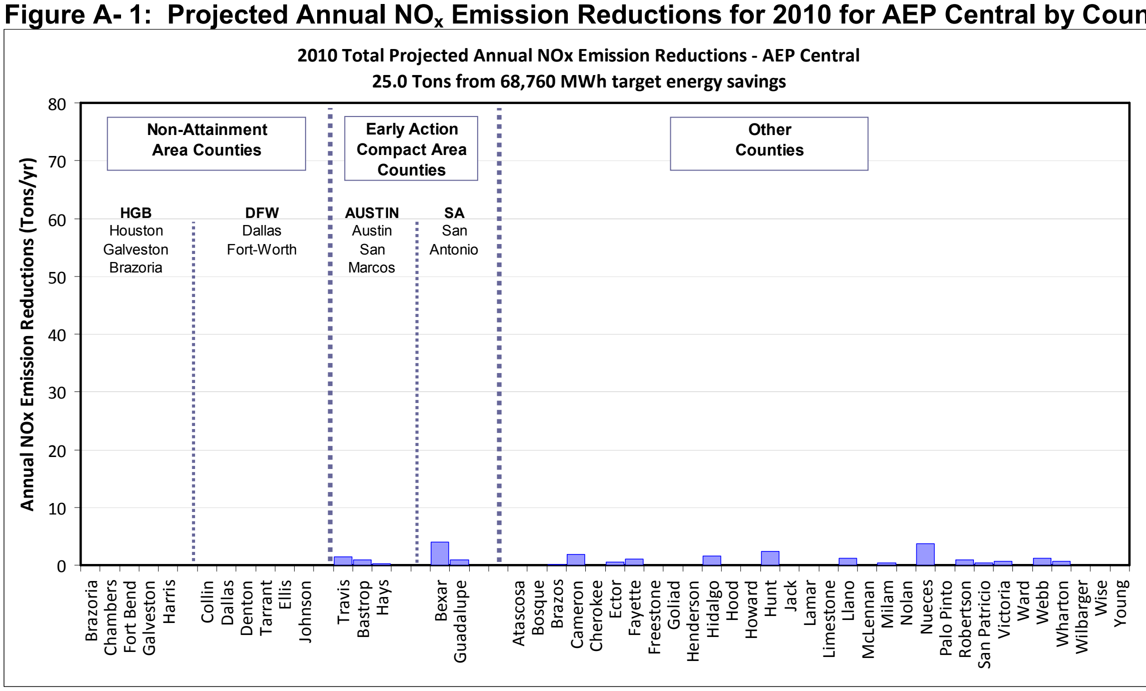


Figure A- 2: Projected Annual NO_x Emission Reductions for 2010 for AEP North by County

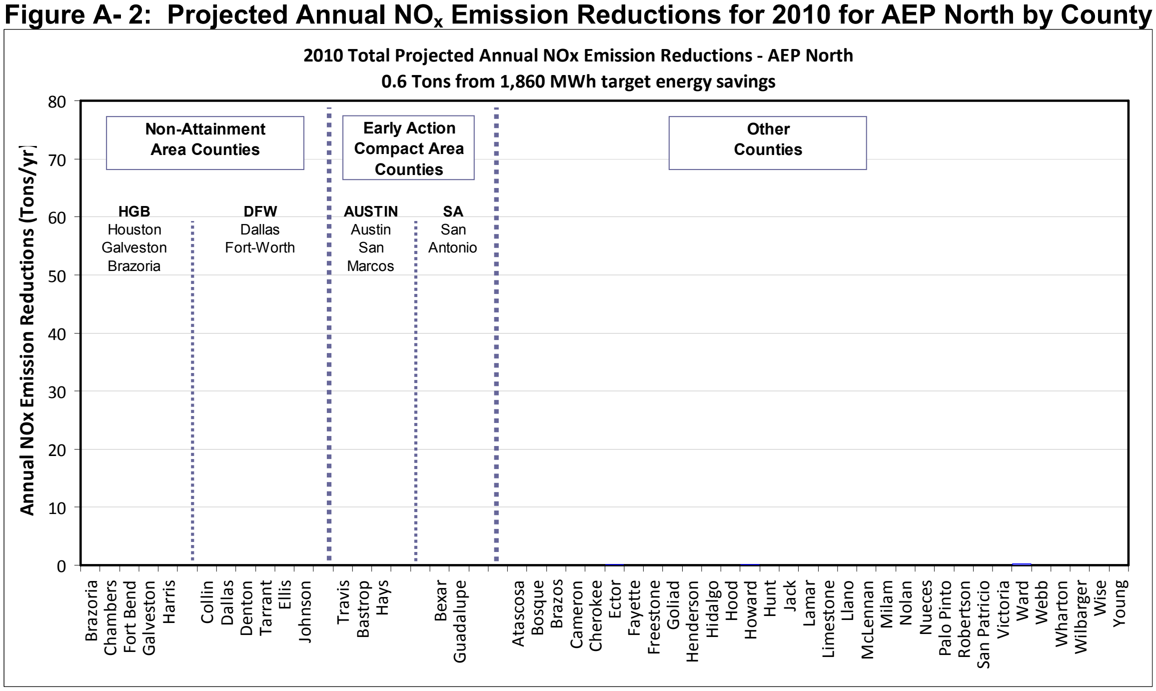


Figure A- 3: Projected Annual NO_x Emission Reductions for 2010 for Centerpoint by County

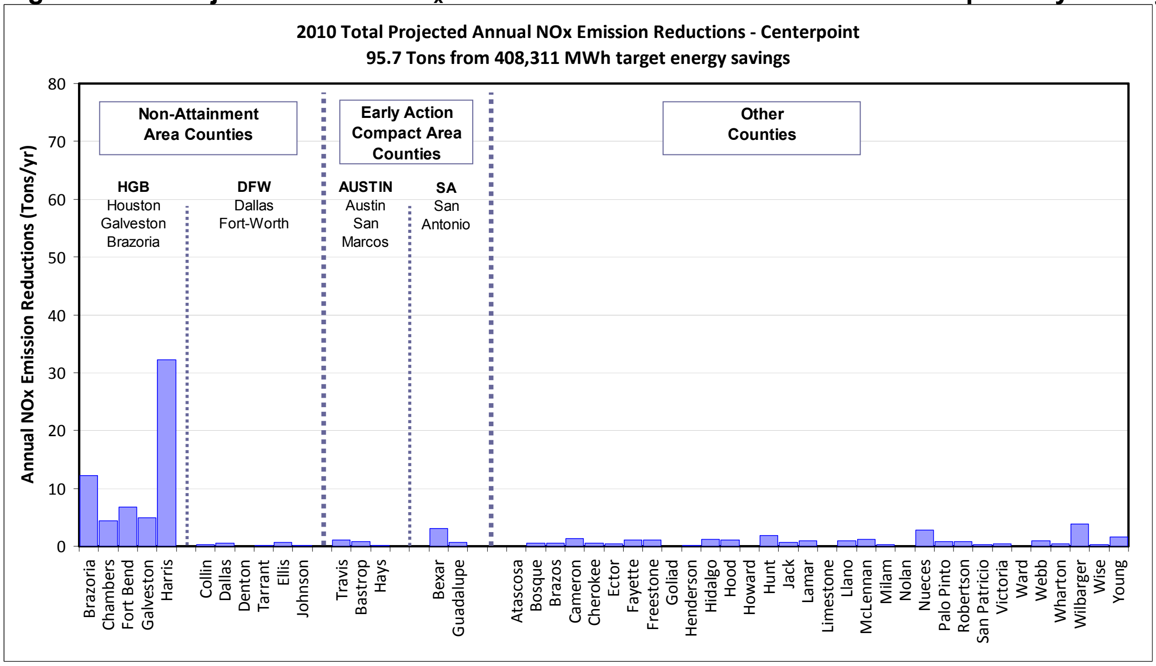


Figure A- 4: Projected Annual NO_x Emission Reductions for 2010 for Oncor by County

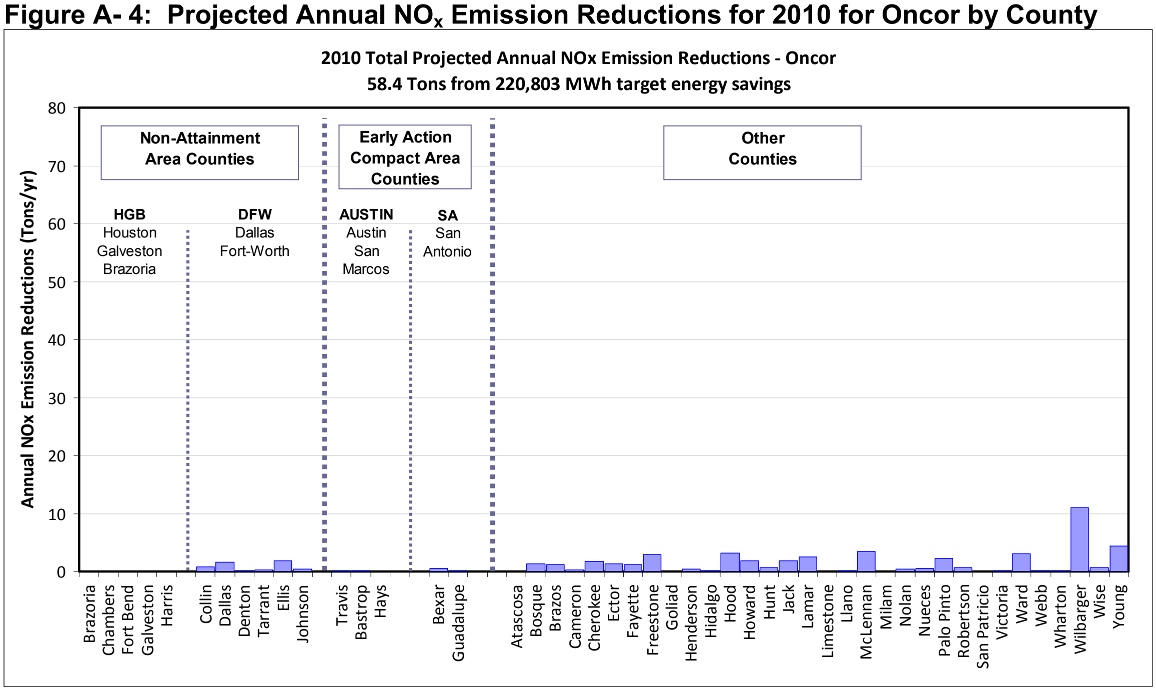


Figure A- 5: Projected Annual NO_x Emission Reductions for 2010 for TNMP by County

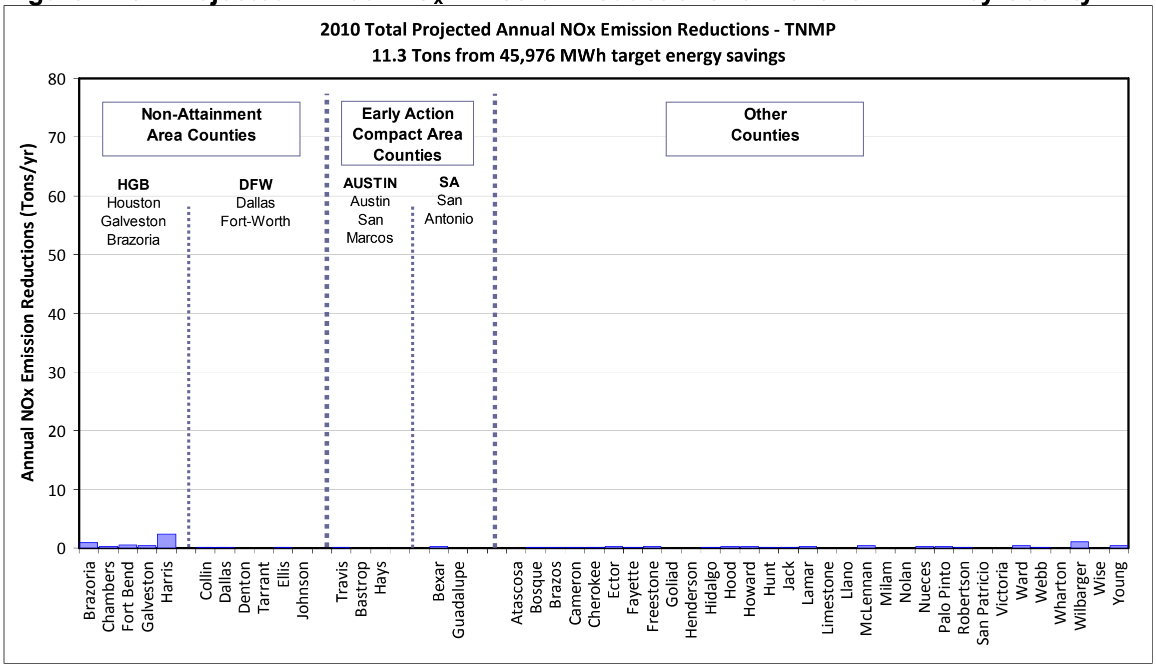


Figure A- 6: Projected Annual NO_x Emission Reductions for 2015 for AEP Central by County

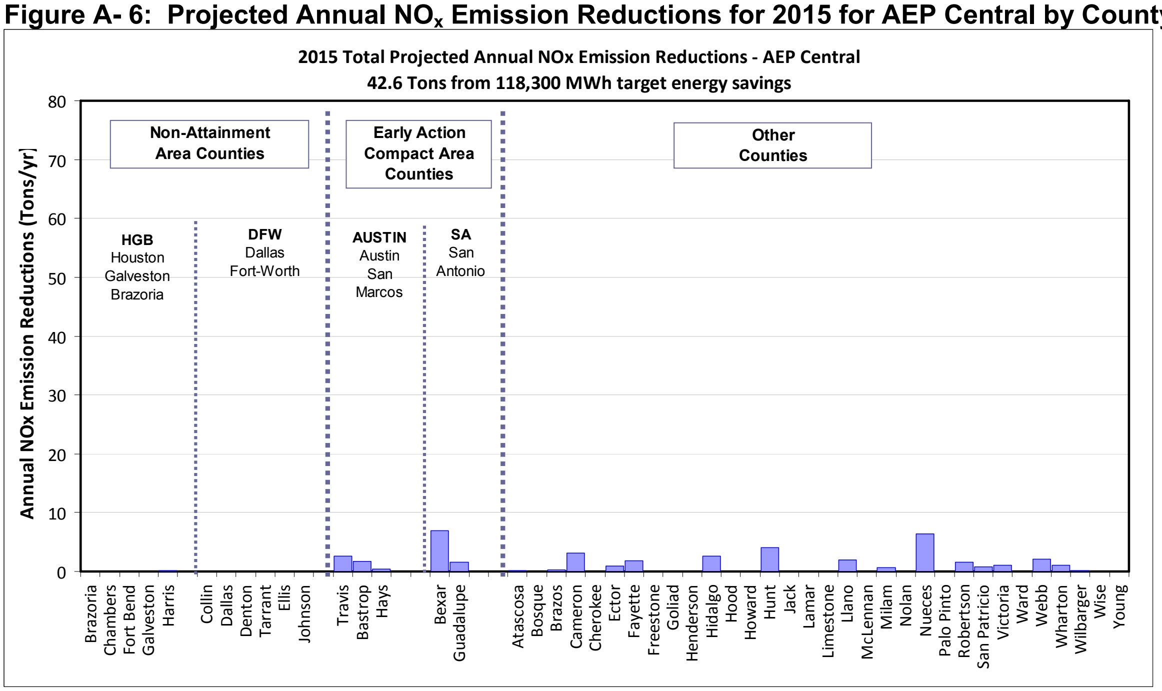


Figure A- 7: Projected Annual NO_x Emission Reductions for 2015 for AEP North by County

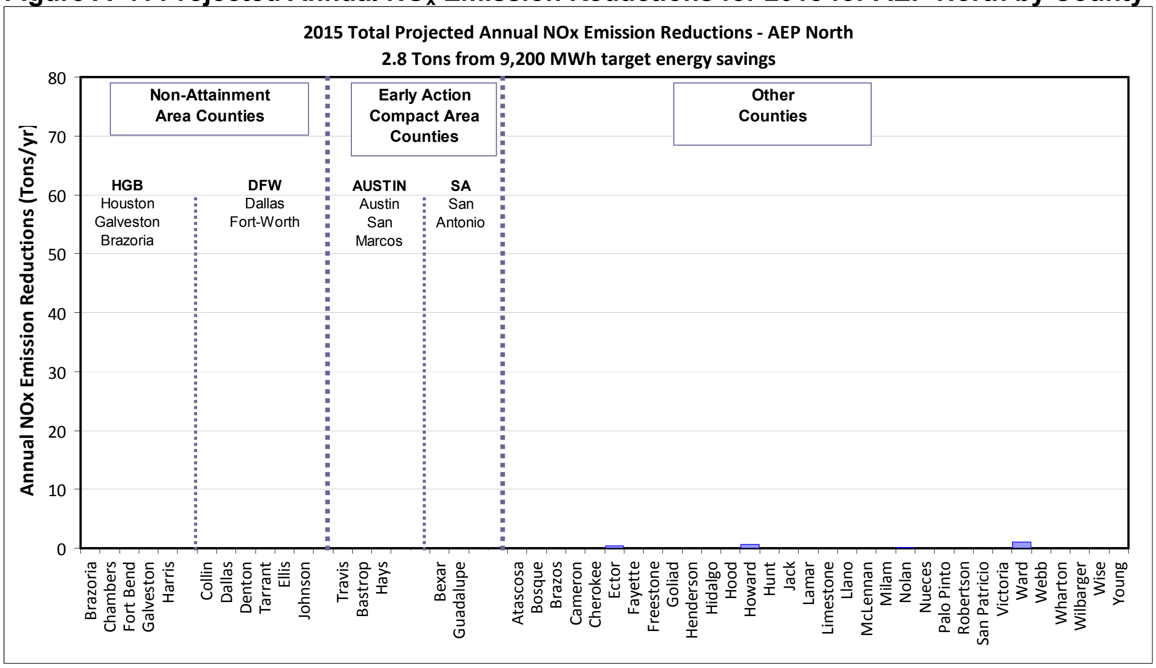


Figure A- 8: Projected Annual NO_x Emission Reductions for 2015 for Centerpoint by County

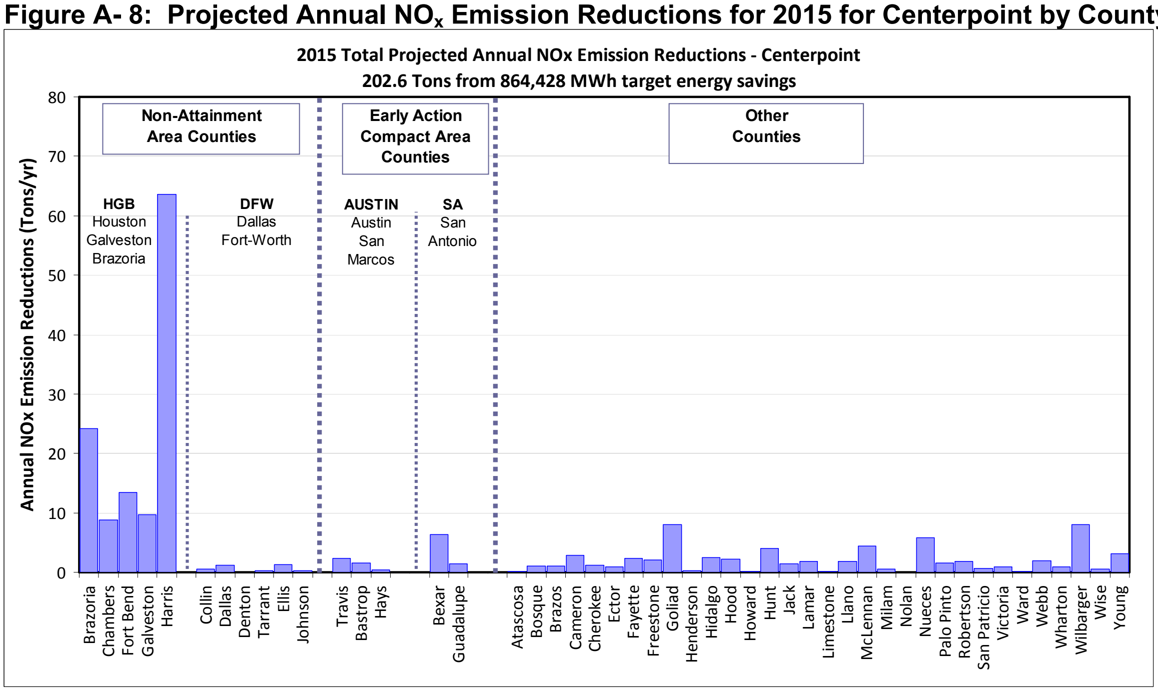


Figure A- 9: Projected Annual NO_x Emission Reductions for 2015 for Oncor by County

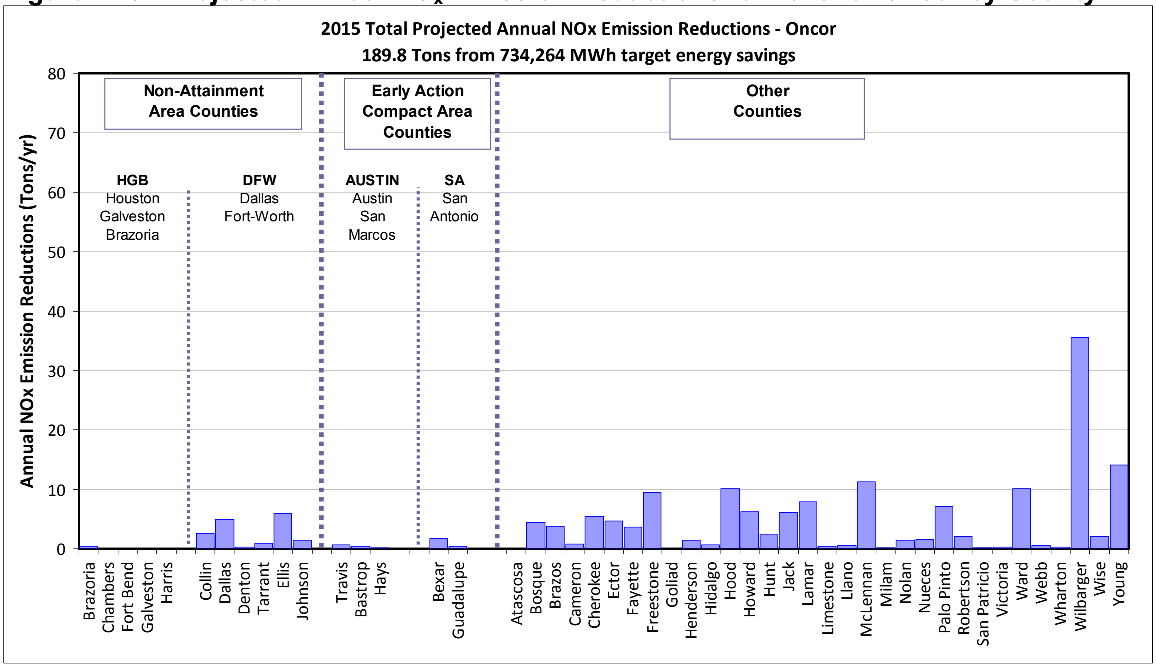
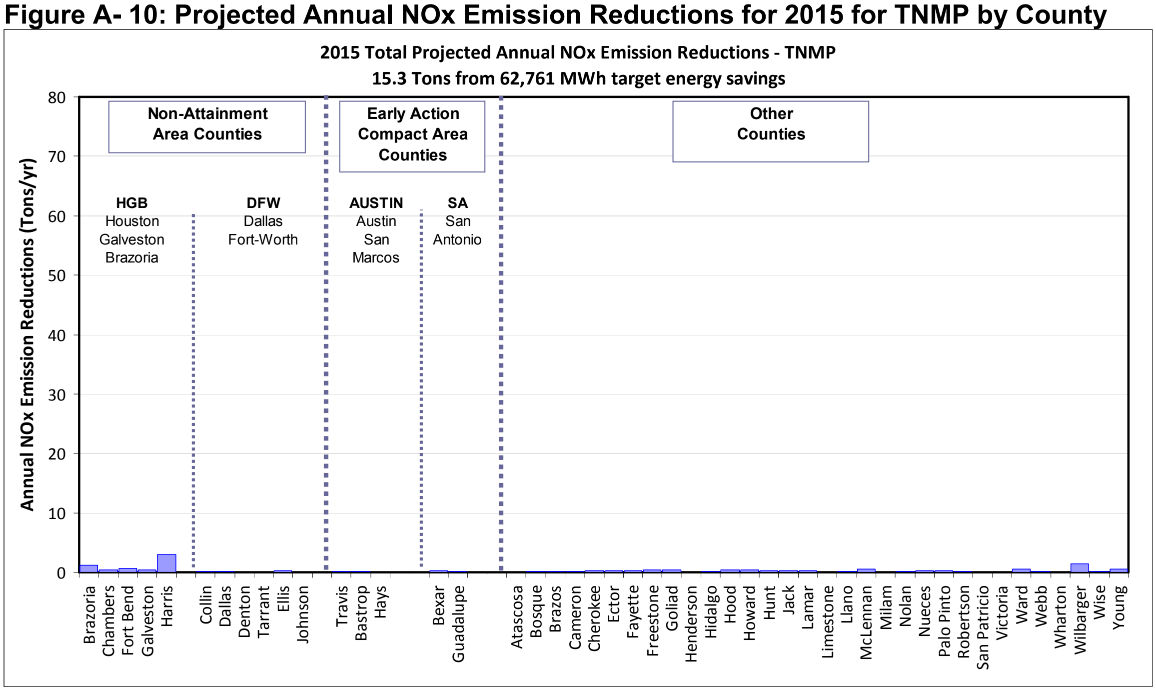


Figure A- 10: Projected Annual NOx Emission Reductions for 2015 for TNMP by County



Appendix B. Abbreviations and Acronyms

CO	carbon monoxide
CM zone	congestion management zone
CSC	commercially significant constraint
EPA	United States Environmental Protection Agency
ERCOT	Electric Reliability Council of Texas
ESL	Texas A&M University System Energy Systems Laboratory
HGB	Houston-Galveston-Brazoria
lb	pound
lb/MWh	pounds per megawatt-hour
MW	megawatt
MWh	megawatt-hour
NO_x	nitrogen oxides
O_3	ozone
PM	particulate matter
$PM_{2.5}$	fine particulate matter
PUCT	Public Utility Commission of Texas
SIP	State Implementation Plan
SO_2	sulfur dioxide
TCEQ	Texas Commission on Environmental Quality
TERP	Texas Emission Reduction Program
VOCs	volatile organic compounds