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ENERGY EFFICIENCY/RENEWABLE ENERGY IMPACT IN THE TEXAS EMISSIONS REDUCTION PLAN (TERP)

VOLUME I—TECHNICAL REPORT

Annual Report to the
Texas Commission on Environmental Quality
January 2016-December 2016

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December 2017

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

TEXAS A&M ENGINEERING EXPERIMENT STATION

Energy Systems Laboratory

December 22, 2017

Vincent Meiller
Air Quality Planning Section
Air Quality Division, Office of Air
Texas Commission on Environmental Quality Austin, TX 78711-3087

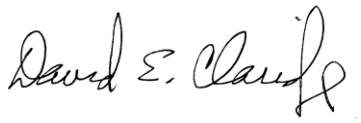
Dear Mr Meiller:

The Energy Systems Laboratory (ESL) at the Texas A&M Engineering Experiment Station of the Texas A&M University System is pleased to provide its annual report, "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)," as required under Texas Health and Safety Code 386.205, 386.252, 388.006, 389.003 (e), and under Texas Utilities Code Sec. 39.9051 (g) (h), and Sec. 39.9052 (c) (d).

The ESL is required to annually report the energy savings from statewide adoption of the Texas Building Energy Performance Standards in Senate Bill 5 (SB 5), as amended, and the relative impact of proposed local energy code amendments in the Texas non-attainment and near-non-attainment counties as part of the Texas Emissions Reduction Plan (TERP).

Please contact me at (979) 845-9213 should you or any of the TCEQ staff have any questions concerning this report or any of the work presently being done to quantify emissions reduction from energy efficiency and renewable energy measures as a result of the TERP implementation.

Sincerely,



David E. Claridge, Ph.D., P.E., FASHRAE
Director

Enclosure

cc: Commissioner Toby Baker
Commissioner Jon Niermann
Executive Director Richard A. Hyde, P. E.

Disclaimer

This report is provided by the Energy Systems Laboratory of the Texas A&M Engineering Experiment Station (TEES) as required under Sections 386.205, 386.252, 388.006, and 388.003 (e) of the Texas Health and Safety Code and Sections 39.9051 (g) (h), and 39.9052 (c) (d) of the Texas Utilities Code. The information provided in this report is intended to be the best available information at the time of publication. TEES makes no claim or warranty, express or implied, that the report or data herein is necessarily error-free. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring by the Energy Systems Laboratory or any of its employees. The views and opinions of authors expressed herein do not necessarily state or reflect those of the Texas A&M Engineering Experiment Station or the Energy Systems Laboratory.

VOLUME I – TECHNICAL REPORT

Energy Efficiency/Renewable Energy Impact
In The Texas Emissions Reduction Plan

Executive Summary

The Energy Systems Laboratory (Laboratory), a division of the Texas A&M Engineering Experiment Station and a member of The Texas A&M University System, in fulfillment of its responsibilities under Sections 386.205, 386.252, 388.006, and 388.003 (e) of the Texas Health and Safety Code and Sections 39.9051 (g) (h), and 39.9052 (c) (d) of the Texas Utilities Code, submits its annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan (TERP) to the Texas Commission on Environmental Quality.

The report is organized in two volumes.

- Volume I – Technical Report – provides a detailed report of activities, methodologies and findings, including an executive summary and overview;
- Volume II – Technical Appendix – contains detailed data from simulations for each of the counties included in the analysis.

The ESL worked with the EPA and TCEQ regarding a new version of eGRID for all ERCOT counties in Texas. A new version of eGRID was developed and presented in this report, which is based on the ERCOT congestion management zones. As the TCEQ moved the base year to more recent years, this updated version of eGRID, representing the current Texas market, has been used to estimate the emissions reduction from wind power in the next year's report.

Accomplishments:

a. Energy Code Amendments

The Laboratory was requested by several Councils of Governments (COGs) and municipalities to analyze the stringency of several proposed residential and commercial energy code amendments, including: the 2012 IECC and the ASHRAE Standards 90.1-2010. Results of the analysis are included in this Volume I-Technical Report.

b. Technical Assistance

The Laboratory provided technical assistance to the TCEQ, PUCT, SECO, ERCOT, and several political subdivisions, as well as stakeholders participating in improving the compliance of the Texas Building Energy Performance Standards (TBEPS). The Laboratory also worked closely with the TCEQ to refine the integrated NOx emissions reduction calculation procedures that provide the TCEQ with a standardized, creditable NOx emissions reduction from energy efficiency and renewable energy (EE/RE) programs, which are acceptable to the US EPA. These activities have improved the accuracy of the creditable NOx emissions reduction from EE/RE initiatives contained in the TERP and have assisted the TCEQ, local governments, and the building industry with effective, standardized implementation and reporting.

c. NOx Emissions Reduction

Under the TERP legislation, the Laboratory must determine the energy savings from energy code adoption and, when applicable, from more stringent local codes or above-code performance ratings, and must report these reductions annually to the TCEQ.

Figure 1 shows the integrated NOx emissions reduction through 2020 for the electricity and natural gas savings from the various EE/RE programs.

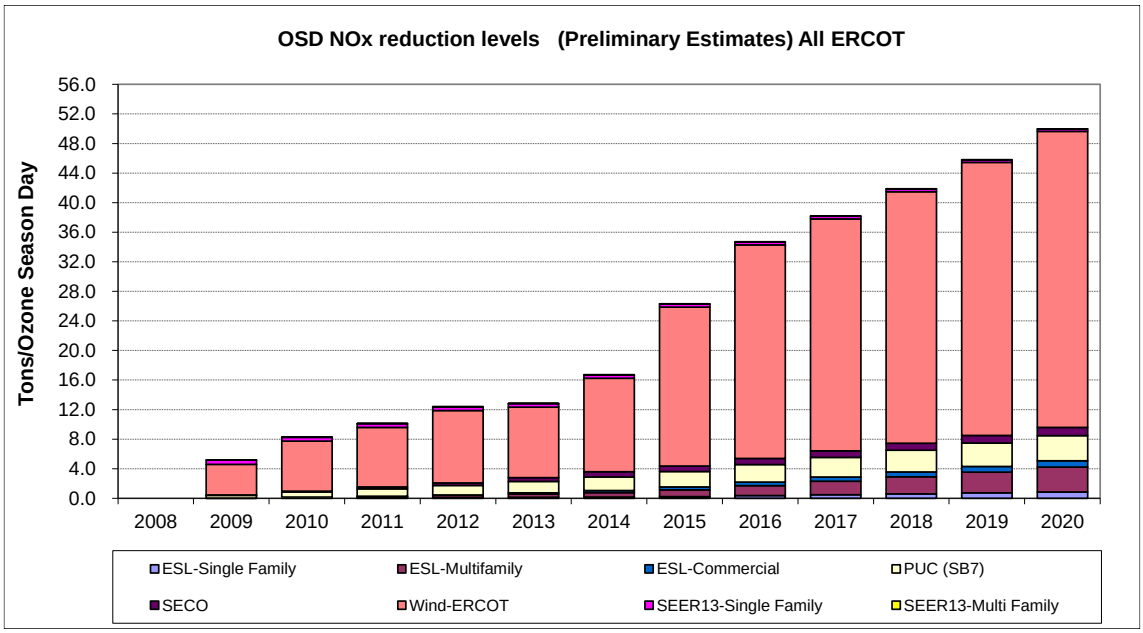


Figure 1: Integrated OSD NOx Emissions Reduction Projections through 2020 (Base Year 2008)

In 2016 (Table 1), the total integrated annual savings from all programs are 44,016,581 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 3,087,080 MWh/year (7.0% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 3,498,867 MWh/year (7.9%),
- Savings from SECO's Senate Bill 5 program are 1,100,775 MWh/year (2.5%),
- Electricity savings from green power purchases (wind) are 36,069,833 MWh/year (81.9%), and
- Savings from residential air conditioner retrofits[1] are 260,026 MWh/year (0.6%).

By 2020, the total integrated annual savings from all programs will be 63,853,554 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 7,242,298 MWh/year (11.3% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 4,975,963 MWh/year (7.8%),
- Savings from SECO's Senate Bill 5 program will be 1,435,808 MWh/year (2.2%),
- Electricity savings from green power purchases (wind) will be 49,987,692 MWh/year (78.3%), and
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.3%).

In 2016 (Table 2), the total integrated annual NOx emissions reductions from all programs are 12,142 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 769 tons-NOx/year (6.3% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 874 tons-NOx/year (7.2%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 294 tons-NOx/year (2.4%),
- NOx emissions reductions from green power purchases (wind) are 10,143 tons-NOx/year (83.5%), and
- NOx emissions reductions from residential air conditioner retrofits are 61 tons-NOx/year (0.5%).

[1] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

By 2020, the total integrated annual NOx emissions reductions from all programs will be 17,576 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 5.09 tons-NOx/day (10.2%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 3.40 tons-NOx/day (6.8%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 1.09 tons-NOx/day (2.2%),
- NOx emissions reductions from green power purchases (wind) will be 40.07 tons-NOx/day (80.1%), and
- NOx emissions reductions from residential air conditioner retrofits will be 0.35 tons-NOx/day (0.7%).

Table 1: Annual and OSD Electricity Savings for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (MWh)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	25,031	47,000	74,109	153,562	215,164	275,535	360,010	533,473	710,874	892,438	1,078,398	1,268,995
ESL-Multifamily	0	50,784	108,018	200,414	332,835	527,292	774,578	1,225,617	1,856,682	2,515,116	3,202,811	3,921,770	4,674,114
ESL-Commercial	0	0	24,066	83,255	119,422	247,952	400,015	559,947	696,924	839,015	986,534	1,139,810	1,299,190
PUC (SB7)	0	538,841	976,984	1,437,883	1,831,318	2,267,414	2,675,295	3,079,759	3,498,867	3,897,019	4,275,264	4,634,597	4,975,963
SECO	0	71,910	154,786	347,175	508,375	705,060	1,004,828	1,005,713	1,100,775	1,191,083	1,276,877	1,358,380	1,435,808
Wind-ERCOT	0	3,454,992	8,587,397	11,606,284	13,774,557	16,597,064	19,905,202	24,322,675	36,069,833	39,135,769	42,462,309	46,071,605	49,987,692
SEER13-Single Family	0	343,330	326,163	309,855	294,362	279,644	265,662	252,379	239,760	227,772	216,383	205,564	195,286
SEER13-Multi Family	0	29,021	27,569	26,191	24,881	23,637	22,456	21,333	20,266	19,253	18,290	17,376	16,507
Total Annual (MWh)	**0**	**4,513,907**	**10,251,982**	**14,085,166**	**17,039,312**	**20,863,228**	**25,323,570**	**30,827,434**	**44,016,581**	**48,535,902**	**53,330,907**	**58,427,500**	**63,853,554**

PROGRAM	OZONE SEASON DAY - OSD (MWh/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	69	129	203	421	589	755	986	1,462	1,948	2,445	2,955	3,477
ESL-Multifamily	0	139	296	549	912	1,445	2,122	3,358	5,087	6,891	8,775	10,745	12,806
ESL-Commercial	0	0	66	228	327	679	1,096	1,534	1,909	2,299	2,703	3,123	3,559
PUC (SB7)	0	1,476	2,677	3,939	5,017	6,212	7,330	8,438	9,586	10,677	11,713	12,698	13,633
SECO	0	197	424	951	1,393	1,932	2,753	2,755	3,016	3,263	3,498	3,722	3,934
Wind-ERCOT	0	15,037	24,335	29,191	35,122	34,369	45,184	76,917	102,874	111,618	121,105	131,399	142,568
SEER13-Single Family	0	2,445	2,323	2,207	2,097	1,992	1,892	1,798	1,708	1,622	1,541	1,464	1,391
SEER13-Multi Family	0	195	186	176	167	159	151	144	136	130	123	117	111
Total OSD (MWh)	**0**	**19,559**	**30,435**	**37,445**	**45,456**	**47,377**	**61,283**	**95,930**	**125,777**	**138,447**	**151,904**	**166,221**	**181,479**

Table 2: Annual and OSD NOx Emissions Reductions Values for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (in tons NOx)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	3	8	15	34	50	65	86	129	174	219	265	313
ESL-Multifamily	0	4	19	43	77	127	190	305	468	639	817	1,003	1,198
ESL-Commercial	0	0	6	20	28	59	97	138	172	207	243	281	321
PUC (SB7)	0	135	246	362	460	567	669	770	874	973	1,067	1,156	1,241
SECO	0	19	43	92	133	183	264	265	294	322	348	373	397
Wind-ERCOT	0	945	2,388	3,222	3,851	4,643	5,577	6,800	10,143	11,005	11,941	12,956	14,057
SEER13-Single Family	0	81	77	73	69	66	62	59	56	53	51	48	46
SEER13-Multi Family	0	7	6	6	6	6	5	5	5	5	4	4	4
Total Annual (Tons NOx)	**0**	**1,193**	**2,792**	**3,831**	**4,659**	**5,700**	**6,930**	**8,428**	**12,142**	**13,377**	**14,690**	**16,087**	**17,576**

PROGRAM	OZONE SEASON DAY - OSD (in tons NOx/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0.00	0.01	0.02	0.04	0.09	0.14	0.18	0.24	0.35	0.48	0.60	0.73	0.86
ESL-Multifamily	0.00	0.01	0.14	0.20	0.29	0.43	0.60	0.91	1.36	1.82	2.31	2.82	3.35
ESL-Commercial	0.00	0.00	0.02	0.05	0.08	0.16	0.27	0.38	0.47	0.57	0.67	0.77	0.88
PUC (SB7)	0.00	0.37	0.67	0.99	1.26	1.55	1.83	2.11	2.39	2.67	2.92	3.17	3.40
SECO	0.00	0.05	0.12	0.25	0.37	0.50	0.72	0.73	0.81	0.88	0.95	1.02	1.09
Wind-ERCOT	0.00	4.15	6.75	8.04	9.79	9.56	12.64	21.50	28.91	31.37	34.03	36.93	40.07
SEER13-Single Family	0.00	0.57	0.54	0.51	0.49	0.46	0.44	0.42	0.40	0.38	0.36	0.34	0.32
SEER13-Multi Family	0.00	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Total OSD (Tons NOx)	**0.00**	**5.20**	**8.30**	**10.13**	**12.41**	**12.84**	**16.72**	**26.31**	**34.72**	**38.19**	**41.88**	**45.80**	**49.99**

d. Technology Transfer

In 2016, The Laboratory, hosted the annual Clean Air Through Energy Efficiency (CATEE) conference, which is attended by top experts and policy makers in Texas and from around the country. In the 2016 conference, the latest educational programs and technology were presented and discussed, including efforts by the Laboratory, and others, to reduce air pollution in Texas through energy efficiency and renewable energy. These efforts have produced significant success in bringing EE/RE closer to US EPA acceptance in the Texas SIP. The Laboratory will continue

to provide superior technology to the State of Texas through such efforts with the TCEQ and the US EPA.

To accelerate the transfer of technology developed as part of the TERP, the Laboratory has also made presentations at national, state and local meetings and conferences, which includes the publication of peer-reviewed papers. The Laboratory continuesly provides technical assistance to the TCEQ, counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air quality for all Texans.

These efforts have been recognized nationally by the US EPA. In 2007, the Laboratory was awarded a National Center of Excellence on Displaced Emissions Reduction (CEDER) by the US EPA so that these accomplishments could be rapidly disseminated to other states for their use. The benefits of CEDER include:

- Reducing the financial, technical, and administrative costs of determining the emissions reduction from EE/RE measures;
- Continuing to accelerate implementation of EE/RE strategies as a viable clean air effort in Texas and other states;
- Helping other states better identify and prioritize cost-effective clean air strategies from EE/RE; and
- Communicating the results of quantification efforts through case-studies and a clearinghouse of information.

The Energy Systems Laboratory provides the annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan (TERP), to the Texas Commission on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Sections 386.205, 386.252, 388.006, and 388.003 (e) of the Texas Health and Safety Code and Sections 39.9051 (g) (h), and 39.9052 (c) (d) of the Texas Utilities Code. If any questions arise, please contact us by phone at (979) 845-9213.

Acknowledgements

This work has been completed as a fulfillment of Sections 386.205, 386.252, 388.006, and 388.003 (e) of the Texas Health and Safety Code and Sections 39.9051 (g) (h), and 39.9052 (c) (d) of the Texas Utilities Code, which require the Laboratory to assist TCEQ in quantifying emissions reductions credits from energy efficiency and renewable energy programs.

The authors are also grateful for the timely input provided by the following individuals, and agencies: Mr. Art Diem, US EPA, for providing the eGRID database and Vincent Meiller and Robert Gifford, TCEQ.

Numerous additional individuals at the Laboratory contributed significantly to this report, including, Sungkyun Jung, Farshad Kheiri, and Minjae Shin.

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1 Overview

The Energy Systems Laboratory (Laboratory), at the Texas A&M Engineering Experiment Station (TEES) of the Texas A&M University System, is pleased to provide our annual report, Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP), to the Texas Commission on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Sections 386.205, 386.252, 388.006, and 388.003 (e) of the Texas Health and Safety Code and Sections 39.9051 (g) (h), and 39.9052 (c) (d) of the Texas Utilities Code. This annual report:

- Provides an estimate of the energy savings and NOx reductions from energy code compliance in new residential construction in all Electric Reliability Council of Texas (ERCOT) counties;
- Provides an estimate of the standardized, cumulative, integrated energy savings and NOx reductions from the TERP programs implemented by the Laboratory, , the State Energy Conservation Office (SECO), the Public Utility Commission (PUC) and ERCOT in all ERCOT Texas;
- Describes the technology developed to enable the TCEQ to substantiate energy and emissions reduction credits from energy efficiency and renewable energy initiatives (EE/RE) to the U.S. Environmental Protection Agency (US EPA), including the development of a web-based emissions reduction calculator; and
- Outlines progress in advancing EE/RE strategies for credit in the Texas State Implementation Plan (SIP).

The report is organized in two volumes.

Volume I – Technical Report – provides a detailed report of activities, methodologies and findings, including an executive summary and overview;

Volume II – Technical Appendix – contains detailed data from simulations for each of the counties included in the analysis.

1.1 Legislative Background

The TERP was established in 2001 by the 77th Legislature through the enactment of Senate Bill 5 to:

- Ensure that Texas air meets the Federal Clean Air Act requirements (Section 707, Title 42, United States Code); and
- Reduce NOx emissions in non-attainment and near-non-attainment counties through mandatory and voluntary programs, including the implementation of energy efficiency and renewable energy programs (EE/RE).

To achieve the clean air and emissions reduction goals of the TERP, Senate Bill 5 created a number of EE/RE programs for credit in the SIP:

- The Texas Building Energy Performance Standards (TBEPS) as the building energy code for all new residential and commercial buildings;
- A municipality or county may request the Laboratory to determine the energy impact of proposed energy code changes;
- An annual evaluation by the Public Utility Commission of Texas (PUCT), in cooperation with the Laboratory, of the emissions reduction of energy demand, peak electric loads and the associated air contaminant reductions from utility-sponsored programs established under Senate Bill 5, and utility-sponsored programs established under the electric utility restructuring act (Section 39.905 Utilities Code);
- A 5% electricity reduction goal each year for facilities of political subdivisions in non-attainment and near-non-attainment counties from 2002 through 2009; and
- Annual report to TCEQ to be provided by the Laboratory on the energy savings and resultant emissions reduction from implementation of building energy codes and which identifies the municipalities and counties whose codes are more or less stringent than the un-amended code.

Passed during the 78th Legislature (2003), HB 1365 and HB 3235 amended TERP to enhance its effectiveness with these additional energy efficiency initiatives:

- TCEQ is required to conduct outreach to non-attainment and near-non-attainment counties on the benefits of implementing energy efficiency measures as a way to meet the air quality goals under the federal Clean Air Act;

- TCEQ is required develop a methodology for computing emissions reduction from energy efficiency initiatives;
- A voluntary Energy-Efficient Building Program at the General Land Office (GLO), in consultation with the Laboratory, for the accreditation of buildings that exceed the state energy code requirements by 15% or more;
- Municipalities are allowed to adopt an optional, alternate energy code compliance mechanism through the use of accredited energy efficiency programs determined to be code-compliant by the Laboratory, as well as the US EPA's Energy Star New Homes program; and
- The Laboratory is required to develop and administer a statewide training program for municipal building inspectors seeking to become code-certified inspectors for enforcement of energy codes.

Senate Bill 5 was again amended during the 79th Legislature (2005) through SB 20, HB 2481 and HB 2129. These enhanced the effectiveness of Senate Bill 5 by adding the following energy efficiency initiatives:

- 5,880 MW of generating capacity is required from renewable energy technologies by 2015;
- 500 MW from non-wind renewables;
- The PUCT is required to establish a target of 10,000 megawatts of installed renewable capacity by 2025;
- The TCEQ is required to develop methodology for computing emissions reduction from renewable energy initiatives and the associated credits;
- The Laboratory is required to assist the TCEQ in quantifying emissions reduction credits from energy efficiency and renewable energy programs;
- The Texas Environmental Research Consortium (TERC) is required to contract with the Laboratory to develop and annually calculate creditable emissions reduction from wind and other renewable energy resources for the state's SIP; and
- The Laboratory is required to develop at least three alternative methods for achieving a 15 % greater potential energy savings in residential, commercial and industrial construction.

The 80th Legislature (2007), through SB 12, and HB 3693 further amended Senate Bill 5 to enhance its effectiveness by adding the following energy efficiency initiatives:

- The Laboratory is required to provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC) or the International Energy Conservation Code (IECC) are equivalent to or better than the energy efficiency and air quality achievable under the editions adopted under the 2001 IRC/IECC. The Laboratory shall make its recommendations no later than six months after publication of new editions at the end of each three-year code development cycle of the International Residential Code and the International Energy Conservation Code.
- The Laboratory is required to consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.
- The Laboratory is required to develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences. The form must be designed to give potential buyers information on a structure's energy performance, including: insulation; types of windows; heating and cooling equipment; water heating equipment; additional energy conserving features, if any; results of performance measurements of building tightness and forced air distribution; and an overall rating of probable energy efficiency relative to the minimum requirements of the International Energy Conservation Code or the energy efficiency chapter of the International Residential Code, as appropriate.
- The Laboratory is encouraged to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of computing the energy savings and emissions reduction benefits of the home energy ratings program.
- The Laboratory is required to include information on the benefits attained from this program in an annual report to the commission.

The 81st Legislature (2009) extended the date of the TERP to 2019 and required the TCEQ to contract with Laboratory to compute emissions reduction from wind and other renewable energy resources for the SIP.

The 82nd Legislature (2011) increased the Laboratory's responsibilities under TERP with the introduction of new energy efficiency initiatives:

- Each political subdivision, institution of higher education or state agency shall establish a goal to reduce the electric consumption by the entity by at least 5% each fiscal year for 10 years, beginning September 1, 2011. Each entity shall report annuallt to SECO, on forms provided by SECO, regarding the entity's goal, the entity's efforts to meet the goal, and progress the entity has made. The Laboratory is required to calculate energy savings and emissions reduction for each political subdivision, institution of higher education or state agency, based on the information collected by SECO.
- Beginning April 1, 2012, all electric cooperatives that had retail sales of more than 500,000 MWh in 2005 and all municipally owned utilities must report annually to SECO, on a standardized form developed by SECO, information regarding the combined effects of the energy efficiency activities of the electric cooperative/utility from the previous calendar year, including the annual goals, programs enacted to achieve those goals, and any achieved energy demand or savings goals. The Laboratory is required to calculate energy savings and emissions reduction for municipally owned utilities and for electric cooperatives, based on the information collected by SECO.
- SECO is required to appoint a new advisory committee for selecting high-performance building design evaluation systems. The Laboratory will send a representative to participate at the new advisory committee.
- The Laboratory may conduct outreach to the real estate industry on the value of energy code compliance and above code construction.

The 83rd Legislature (2013) did not change any of the Laboratory's previously established responsibilities under TERP.

During the 84th Legislature session (2015), changes to the Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards, with the passage of HB 1736, affected the Laboratory's responsibilities under TERP:

- 2015 residential energy codes (IRC/IECC) editions are in effect starting Sept 1, 2016. 2015 commercial energy codes (IECC) are in effect starting Nov 1, 2016. The Laboratory's responsibilities of reviewing new energy codes and local code amendments remain. New codes will be reviewed no sooner than every 6 years.
- The legislation introduces a new energy rating index (ERI) as a voluntary compliance path for local code amendments. With the introduction of the ERI as another compliance path, the Laboratory is required to consider it when local amendments are reviewed, and needs to update the web-based code compliance tool and emissions reduction calculator to allow for the new optional compliance path.

1.2 Laboratory Funding for the TERP

The Laboratory expended $181,855 in FY 2002; $372,226 in FY 2003; $635,683.84 in FY 2004; $1,107,366.13 in FY 2005; $952,012.70 in 2006; $947,114.62 in FY 2007; $908,512.65 in FY 2008; $949,927.94 in FY 2009; $902,843.35 in FY 2010, $853,421.69 in FY 2011; $434,481.91 in FY 2012 (with the 50% Legislature cut in ESL funding), $447,907.94 in FY 2013; $453,122.25 in FY 2014; and $454,571.79 in FY 2015. In FY 2016 the Laboratory expended $458,595.49. Throughout the years, the Laboratory has also supplemented these funds with competitively awarded Federal and State grants to provide the needed statewide training for the new mandatory energy codes and to provide technical assistance to cities and counties in helping them implement adoption of the legislated energy efficiency codes. In addition, the ESL received an award from the US EPA in the spring of 2007 to establish a Center of Excellence for the Determination of Emissions Reduction (CEDER) which has helped to enhance the EE/RE emissions calculations.

1.3 Code Adoption

One of the TERP's energy efficiency programs to reduce emissions from stationary sources was the establishment of the Texas Building Energy Performance Standards (TBEPS) that define the building energy codes for all new residential and commercial construction statewide. The original TBEPS were based on the energy efficiency chapter of the 2000 International Residential Code (IRC), including the 2001 Supplement, for Single-Family residences, (i.e., one- and two-family residences of three stories or less above grade) and the 2000 International Energy Conservation Code (IECC), including the 2001 Supplement, for commercial, industrial and residential buildings over three stories.

Over the years since the establishment of the TERP, newer editions of the IRC and the IECC have been published. The Energy Systems Laboratory is mandated to review the stringency of the new code editions and provide recommendations to the State on whether to upgrade the TBEPS to the new editions.

In the time frame of 2002-2009, the laboratory provided recommendations and considered additional input from stakeholder meetings and public comment periods on new editions of the IRC/IECC energy efficiency codes. The State of Texas did not adopt any of the newer editions of the energy efficiency codes as the TBEPS. During this timeframe, several individual jurisdictions did adopt the newer editions of the IRC and the IECC.

With the laboratory's recommendation, on April 1, 2011, SECO updated the TBEPS commercial and residential (excluding single-family) energy codes to the 2009 International Energy Conservation Code (IECC). On January 1, 2012, the TBEPS for single-family residential was updated to Chapter 11 (Energy Efficiency) of the 2009 International Residential Code (IRC).

In the timeframe of 2012-2015, the laboratory provided recommendations and considered additional input from stakeholder meetings and public comment periods on new editions of the IRC/IECC energy efficiency codes. The State of Texas did not adopt either edition of the energy efficiency codes as the TBEPS. During this time, several individual jurisdictions did adopt the newer editions of the IRC and the IECC. As of the time of this report, SECO announced a timeline to adopt the 2015 IRC/IECC effective September 1, 2016.

During the 84th Legislature session (2015), the legislator adopted the 2015 residential energy codes (IRC/IECC) editions to be in effect starting September 1, 2016. 2015 commercial energy codes (IECC) were also set to be in effect starting Nov 1, 2016. The Laboratory's responsibilities of reviewing new energy codes and local code amendments remain. New codes will be reviewed no sooner than every 6 years (next review will be of 2021 code editions).The legislation also established a new energy rating index (ERI) as a voluntary compliance path for local code amendments. With the introduction of the ERI as another compliance path, the Laboratory is required to consider it when local amendments are reviewed, and local amendments are reviewed. During 2016, the Laboratory has update the IC3 web-based code compliance tool and emissions reduction calculator to allow for the new optional compliance path.

1.4 Accomplishments since January 2016

Since January 2016, the Laboratory has accomplished the following:

- Calculated energy and resultant NOx reductions from implementation of the Texas Building Energy Performance Standards (IECC/IRC codes) to new residential and commercial construction for all non-attainment and near-non-attainment counties;
- Enhanced the Laboratory's IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs;
- Enhanced the IC3 calculator, which is an energy code compliance software based on the Texas Building Energy Performance Standards by resolving minor defects found in the model and webpage.
- Continued development and testing of key procedures for validating simulations of building energy performance;
- Provided energy code training workshops, including: residential, commercial, IECC/IRC energy code training sessions at the 15th Building Professional Institute (BPI) Houston.
- Provided energy code training workshops, including: residential, commercial, IECC/IRC energy code training sessions at the 23rd Building Professional Institute (BPI), UT Arlington.
- Provided energy code training workshops, including: residential, commercial, IECC/IRC energy code training sessions to the City of San Antonio, the Bluebonnet Chapter of ICC, the Bay Area Municipal Inspectors Association and the Association of Energy Engineers;
- Maintained and updated the Laboratory's Texas Emissions Reduction Plan (TERP) website;
- Maintained a builder's residential energy code Self-Certification Form (Ver.1.3) for use by builders outside municipalities;
- Hosted the Clean Air Through Energy Efficiency (CATEE) Conference in December 2016, in San Antonio, Texas. Conference sessions included key talks by the TCEQ, PUCT, ERCOT, EPA, SECO, several ISDs and cities, and the Laboratory about quantifying emissions reduction from EE/RE opportunities and guidance on key energy efficiency and renewable energy topics; the various topics covered: Learning from Green Schools and Exisiting Buildings; Innovative Technologies and Techniques; PACE as a New Program in Texas; Alternative Financing for Energy Efficiency; Commercial & Institutional Green Building Performance; Collaboration is the Key – Public/Private Partnerships; Utilities – Efficiency Resources; Energy Codes Discussion; and Regional Applications.
- Provided technical assistance to the TCEQ regarding specific issues, including:
    - Enhancement of the standardized, integrated NOx emissions reduction reporting procedures to the TCEQ for EE/RE projects, and
    - Enhancement of the procedures for weather normalizing NOx emissions reduction from renewable projects.
- Participated as exhibitors at several conferences, including at the Clean Air Through Energy Efficiency Conference in San Antonio, Texas, the Texas Green Home Summit in Plano, Texas, and TCEQ Environmental Trade Fair and Conference, Austin, Texas; and
- The ESL participated in the South-central Partnership for Energy Efficiency as a Resource (SPEER), funded and administered by the Texas Comptroller of Public Accounts State Energy Conservation Office (SECO).
- Continued worked toward the code compliance tools for commercial buildings, retail and school buildings, and new Application Programming Interface (API)

1.5 Technology Transfer

To accelerate the transfer of technology developed as part of the TERP program, the Laboratory:

- Updated previously developed database of other renewable projects in Texas, including: solar photovoltaic, geothermal, hydroelectric, and Landfill Gas-fired Power Plants;
- Applied previously developed estimation techniques for hourly solar radiation from limited data sets;
- Along with the TCEQ and the US EPA, is host to the annual Clean Air Through Energy Efficiency (CATEE) Conference attended by top Texas and national experts, and policy makers; and
- Continued the National Center of Excellence on Displaced Emissions Reduction (CEDER) by the US EPA. The benefits of CEDER include:
    - Reducing the financial, technical, and administrative costs of determining the emissions reduction from EE/RE measures;
    - Continuing to accelerate implementation of EE/RE strategies as a viable clean air effort in Texas and other states;
    - Helping other states identify and prioritize cost-effective clean air strategies from EE/RE, and;
    - Communicating the results of quantification efforts through case-studies and a clearinghouse of information.

Three presentations to the Clean Air Through Energy Efficiency Conference held in San Antonio, Texas, December 2016.

- Baltazar, J., 2016 "Benchmarking and Profiling Airport Terminal Energy End Uses" *Clean Air Through Energy Efficiency Conference*, San Antonio, Texas, December 2016
- Ellis, S., 2016 "Introduction of the TX A&M IC3 Energy Code Compliance Tool and Other Code Compliance Tools" *Clean Air Through Energy Efficiency Conference*, San Antonio, Texas, December 2016
- Haberl, J.; Yazdani, B.; Baltazar, J., 2016 "Energy Efficiency and Renewable Energy Impacts on Emission Reductions" *Clean Air Through Energy Efficiency Conference*, San Antonio, Texas, December 2016

The Laboratory has and will continue to provide leading-edge technical assistance to the TCEQ, counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air quality for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP. These activities were designed to more accurately calculate the creditable NOx emissions reduction from EE/RE initiatives contained in the TERP and to assist the TCEQ, local governments, and the building industry with standardized, effective implementation and reporting.

1.6 Energy and NOx Reductions from New Residential and Commercial Construction, Including Residential Air Conditioner Retrofits

State adoption of the energy efficiency provisions of the International Residential Code (IRC) and International Energy Conservation Code (IECC) became effective September 1, 2001. The Laboratory has developed and delivered training to assist municipal inspectors to become certified energy inspectors. The Laboratory also supported code officials with guidance on interpretations as needed. This effort, based on a requirement of HB 3235, 78th Texas Legislature, supports a more uniform interpretation and application of energy codes throughout the state. In general, the State is experiencing a true market transformation from low energy efficiency products to high energy efficiency products. These include: low solar heat gain windows, higher efficiency appliances, high efficiency air conditioners and heat pumps, increased insulation, lower thermal loss ducts and in-builder participation in "above-code" code programs such as Energy Star New Homes, which previously had no state baseline and almost no participation.

In 2016, the following savings were calculated:

- In 2016, the annual electricity savings from code-compliant residential and commercial construction are 3,087,080 MWh/year (7.0% of the total electricity savings),
- Savings from residential air conditioner retrofits[2] are 260,026 MWh/year (0.6%).

- In 2016, the OSD electricity savings from code-compliant residential and commercial construction are 8,458 MWh/day (6.7%),
- Savings from residential air conditioner retrofits are 1,844 MWh/day (1.5%).

- By 2020, the annual electricity savings from code-compliant residential and commercial construction will be 7,242,298 MWh/year (11.3% of the total electricity savings),
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.3%).

- By 2020, the OSD electricity savings from code-compliant residential and commercial construction will be 19,842 MWh/day (10.9%),
- Savings from residential air conditioner retrofits will be 1,502 MWh/day (0.8%).

- In 2016, the annual NOx emissions reduction from code-compliant residential and commercial construction are 769 tons-NOx/year (6.3% of the total NOx savings),
- NOx emissions reductions from residential air conditioner retrofits are 61 tons-NOx/year (0.5%).

- In 2016, the OSD NOx emissions reduction from code-compliant residential and commercial construction are 2.18 tons-NOx/day (6.3%)
- NOx emissions reductions from residential air conditioner retrofits are 0.43 tons-NOx/day (1.2%).

- By 2020, the NOx emissions reduction from code-compliant residential and commercial construction will be 1,832 tons-NOx/year (10.4% of the total NOx savings),
- NOx emissions reductions from residential air conditioner retrofits will be 50 tons-NOx/year (0.3%).

- By 2020, the OSD NOx emissions reduction from code-compliant residential and commercial Construction will be 5.09 tons-NOx/day (10.2%),
- NOx emissions reductions from residential air conditioner retrofits will be 0.35 tons-NOx/day (0.7%).

[2] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

1.7 Integrated NOx Emissions Reductions Reporting Across State Agencies

In 2005, the Laboratory began to work with the TCEQ to develop a standardized, integrated NOx emissions reduction across state agencies implementing EE/RE programs so that the results can be evaluated consistently. As required by the legislation, the TCEQ receives the following reports:

- From the Laboratory, savings from code compliance and renewables;
- From the Laboratory, in cooperation with the Electric Reliability Council of Texas (ERCOT), the savings from electricity generated from wind power;
- From the Public Utility Commission of Texas (PUCT) on the impacts of the utility-administered programs designed to meet the mandated energy efficiency goals of SB7 and SB5; and
- From the State Energy Conservation Office (SECO) on the impacts of energy conservation in state agencies and political subdivisions.

In 2016, the total integrated annual savings from all programs are 44,016,581 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 3,087,080 MWh/year (7.0% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 3,498,867 MWh/year (7.9%),
- Savings from SECO's Senate Bill 5 program are 1,100,775 MWh/year (2.5%),
- Electricity savings from green power purchases (wind) are 36,069,833 MWh/year (81.9%), and
- Savings from residential air conditioner retrofits[3] are 260,026 MWh/year (0.6%).

In 2016, the total integrated OSD savings from all programs are 125,777 MWh/day, which would be a 5,241 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 8,458 MWh/day (6.7%),
- Savings from the PUC's Senate Bill 7 programs are 9,586 MWh/day (7.6%),
- Savings from SECO's Senate Bill 5 program are 3,016 MWh/day (2.4%),
- Electricity savings from green power purchases (wind) are 102,874 MWh/day (81.8%), and
- Savings from residential air conditioner retrofits are 1,844 MWh/day (1.5%).

By 2020, the total integrated annual savings from all programs will be 63,853,554 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 7,242,298 MWh/year (11.3% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 4,975,963 MWh/year (7.8%),
- Savings from SECO's Senate Bill 5 program will be 1,435,808 MWh/year (2.2%),
- Electricity savings from green power purchases (wind) will be 49,987,692 MWh/year (78.3%), and
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.3%).

By 2020, the total integrated OSD savings from all programs will be 181,479 MWh/day, which would be a 7,562 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 19,842 MWh/day (10.9%),
- Savings from the PUC's Senate Bill 7 programs will be 13,633 MWh/day (7.5%),
- Savings from SECO's Senate Bill 5 program will be 3,934 MWh/day (2.2%),
- Electricity savings from green power purchases (wind) will be 142,568 MWh/day (78.6%), and
- Savings from residential air conditioner retrofits will be 1,502 MWh/day (0.8%).

[3] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

In 2016, the total integrated annual NOx emissions reductions from all programs are 12,142 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 769 tons-NOx/year (6.3% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 874 tons-NOx/year (7.2%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 294 tons-NOx/year (2.4%),
- NOx emissions reductions from green power purchases (wind) are 10,143 tons-NOx/year (83.5%), and
- NOx emissions reductions from residential air conditioner retrofits are 61 tons-NOx/year (0.5%).

In 2016, the total integrated OSD NOx emissions reductions from all programs are 34.72 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 2.18 tons-NOx/day (6.3%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 2.39 tons-NOx/day (6.9 %),
- NOx emissions reductions from SECO's Senate Bill 5 program are 0.81 tons-NOx/day (2.3%),
- NOx emissions reductions from green power purchases (wind) are 28.91 tons-NOx/day (83.3%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.43 tons-NOx/day (1.2%).

By 2020, the total integrated annual NOx emissions reductions from all programs will be 17,576 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1,832 tons-NOx/year (10.4% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1,241 tons-NOx/year (7.1%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 397 tons-NOx/year (2.3%),
- NOx emissions reductions from green power purchases (wind) will be 14,057 tons-NOx/year (80.0%), and
- NOx emissions reductions from residential air conditioner retrofits will be 50 tons-NOx/year (0.3%).

By 2020, the total integrated OSD NOx emissions reductions from all programs will be 49.99 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 5.09 tons-NOx/day (10.2%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 3.40 tons-NOx/day (6.8%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 1.09 tons-NOx/day (2.2%),
- NOx emissions reductions from green power purchases (wind) will be 40.07 tons-NOx/day (80.1%), and
- NOx emissions reductions from residential air conditioner retrofits will be 0.35 tons-NOx/day (0.7%).

Table 3: Adjustment Factors used for the Calculation of the Annual and OSD NOx Savings for the Different Programs

	ESL-Single Family	ESL-Multifamily	ESL-Commercial	PUC (SB7)	SECO	Wind-ERCOT	SEER13 Single Family	SEER13 Multi Family
Annual Degradation Factor	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor	20.0%	20.0%	20.0%	10.0%	60.0%	5.0%	20.0%	20.0%
Growth Factor	4.1%	6.1%	5.3%	0.0%	0.0%	8.5%	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	Yes	Yes

Note: For Wind-ERCOT, the OSD energy consumption is the average daily consumption of the measured data in the months of July, August, and September.

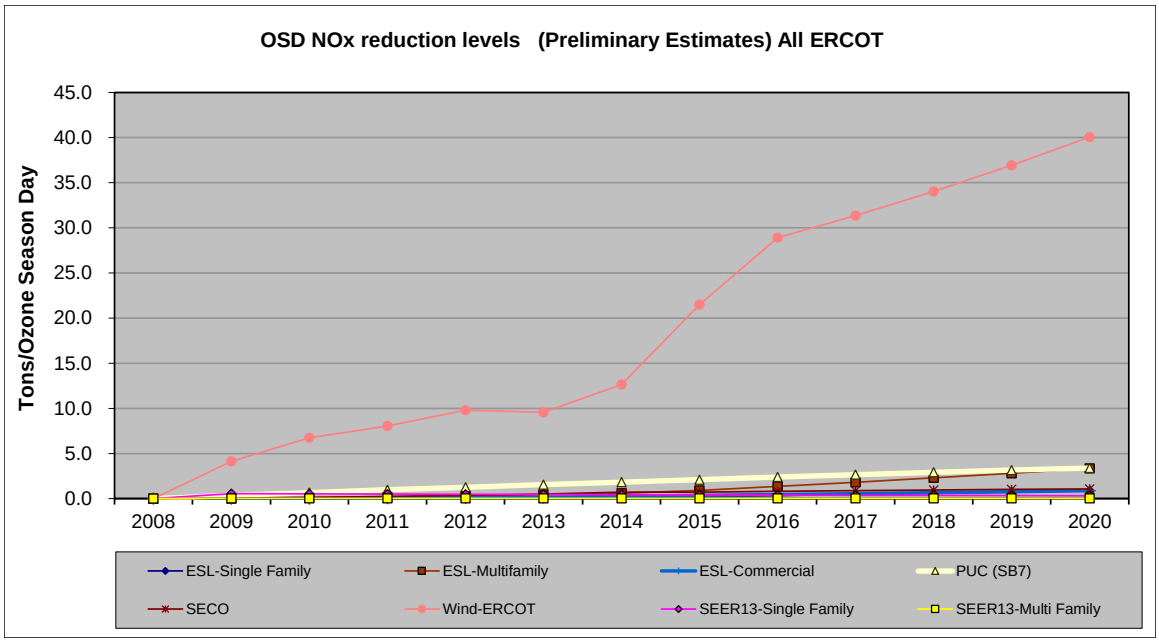


Figure 2: Integrated OSD Individual Programs NOx Emissions Reduction Projections through 2020 (Base Year 2008)

1.8 Technology for Calculating and Verifying Emissions Reduction from Energy Used in Buildings

In 2004 and 2005, the Laboratory developed a web-based Emissions Reduction Calculator, known as "*eCalc*," which contains the underlying technology for determining NOx emissions reduction from power plants that generate the electricity for the user[4]. The emissions reduction calculator was being used to calculate emissions reduction for consideration for SIP credits from energy efficiency and renewable energy programs in the TERP.

In 2007, the Laboratory enhanced the calculator to provide additional functions and usability, including:

- Renaming the product IC3 v2.0
- Enhanced the Laboratory's IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs;
- Enhanced web-based emissions calculator, including:
  - Use of the calculator to determine 15% above code residential and commercial options.
  - Gathered, cleaned and posted weather data archive for 17 NOAA stations;
  - Performed comparative testing of the calculator vs. other, non-web-based simulation programs;
  - Developed and tested radiant barrier simulation;
  - Using the web-based emissions calculator, started development of the derivative version Texas Climate Vision calculator for the City of Austin;
- Continued the development of verification procedures, including:
  - Completed the calibrated simulation of a high-efficiency office building in Austin, Texas;
  - Continued work to develop a calibrated simulation of an office building in College Station; and
  - Continued work to develop a calibrated simulation of a K-12 school in College Station;

In 2008, work on both web based calculators continued;

- Deployed IC3 v3.2 to handle a wider selection of Single-Familybuilding configurations (http://ic3.tamu.edu);
- Delivered TCV v1.0 to the City of Austin for their testing;
- Continued to operate the original eCalc;
- Supported modeling efforts by building enhanced tools for batch simulation;
- Provided training on both IC3 and TCV.

[4] eCalc reports NOx, SOx and CO2 emissions reduction from the US EPA eGRID database for power providers in the ERCOT region.

In 2009, IC3 developments included:

- A sister product, AIM was created for the State Comptroller's office.
- Usage statistics continue to climb.
- Updated to v3.6 which included 3 story houses, external cladding, more sophisticated ceiling/roof models, enhanced foundation modeling and the ability to copy projects

In 2010 there were several software updates including:

- IC3
  - 3.9.0 – Slab Insulation Support
  - 3.7.0 – 3.8.0 First Version of Multifamily Released along with numerous tweaks and fixes
  - 3.6.2 – New Building Model Integrated, Updated Artwork and Illustrations
- DDP
  - 1.7.05 – Added Heat Reject Recording for Electric and Gas
- Web Reports and Texas Building Registry
  - Registry 0.x – First versions of the Web Reports on TCV, eCalc, and IC3
  - Registry 1.0 – City and County Reports
  - Registry 1.1 – Cross-linked Reports for City and County
  - IC3 Reports 1.0 – Updated Certificate Reports which replace Registry 1.1 and evolve into the Texas Building Registry

The 2011 software updates include:

- IC3
  - 3.9.4 – Added approval workflow to start a new 2009 IECC job as further refinements were needed to the BDL
  - 3.9.5 – Various IECC 2009 fixes and refinements implemented
  - 3.9.6 – Updated BDL to 4.01.08, SHGC max does not apply to Climate Zone 4, 0.35 ACH minimum to all projects, Ventilation Fans added to % Air Conditioning Calculation
  - 3.9.7 - Corrected Certificate and Status screens to reflect insulation and floor construction.
  - 3.9.8- Set minimum R-value for insulated sheathing to R-2;
  - 3.10.0 - Updated and corrected problems with several text and value fields; Corrected and printed MF and SF Certificates;
  - 3.10.3 - Changed Certificate to Energy Audit Report; Added a new Certificate to be printed out; Added Inspector's list for a project; Added Pagination in projects page
  - 3.11.0 12/22/2011-Added Austin Energy 2009 IECC Energy Code Support
- Web Reports and Texas Building Registry
  - TBR Reports 1.0.5 – Added 4 new reports
  - TBR Reports 1.0.6 – Added 9 new reports
  - Registry 2.0 – Included 7 new Parameterized reports

The 2012 software updates include:

- IC3
  - 3.12 – Deprecated the 2000/2001 and 2006 Code (as of 1/1/2012)
  - 3.12.1 – Added a version of the energy report with a signature line, as requested by some municipalities. Improved the algorithm.
  - 3.12.2 – Alter help text to be more clear. Improved the algorithm.
  - 3.12.3 – Alter help pictures to make them clearer.
  - 3.12.4 – Added optional input for water heaters to allow for better detail. Updated user manual. Improved the transform algorithms.

The 2013 software updates include:

- IC3
    - 3.12.5 – Bug fix in energy report
    - 3.13.0 – Added support for manual J. Added NCTCOG 2012 amendments

There were no significant enhancements to IC3 in the calendar year 2014. We performed routine maintenance on the program and the database during this time. The API interface was under development.

The 2015 software updates include:

- IC3
    - Version 4.0 (June 2015)
    - Version 4.0.1 (July 2015)

The 2016 software updates include:

- IC3
    - Version 4.0.2 (April 2016)
    - Version 4.1 (September 2016)
    - Version 4.1.1 (September 2016)
    - Version 4.1.2 (October 2016)
    - Version 4.2 (October 2016)

1.9 Evaluation of Additional Technologies for Reducing Energy Use in Existing Buildings

The Laboratory provided technical assistance to the TCEQ, the PUCT, SECO and ERCOT, as well as Stakeholders participating in the Energy Code and Renewables programs.

- In 2016, the Laboratory continued to work with the TCEQ to develop an integrated NOx emissions reductions calculation that provided the TCEQ with a creditable NOx emissions reductions from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2016 by the Laboratory, PUCT, SECO, and ERCOT (i.e., wind).
- At the request of the TCEQ, the Laboratory has continued the development of procedures for quantifying NOx emissions reductions from wind turbines that includes weather normalization and the quantification of NOx emissions reductions from the new Federal regulations for SEER 13 air conditioners.

1.10 Planned Focus for 2017

In FY 2017, the Energy Systems Laboratory will continue in its cooperative efforts with the TCEQ, PUCT, SECO, US EPA and others to evaluate the energy savings resulted from the EE/RE measures and programs of the TERP and their impact on air quality, and continue with the energy code state-wide implementation assistance under the Texas Building Energy Performance Standards program of the TERP. The Laboratory team will:

- Assist the TCEQ to obtain SIP credits from energy efficiency and renewable energy using the Laboratory's Emissions Reduction Calculator technology.
- Verify, document and report energy efficiency and renewable energy savings in all TERP EE/RE programs for the SIP in each non-attainment and affected county using the TCEQ/US EPA approved technology.
- Assist the PUCT with determining emissions reductions credits from energy efficiency programs funded by SB 7 and SB 5.
- Assist political subdivisions and Councils of Governments with calculating emissions reductions from local code changes and voluntary EE/RE programs for SIP inclusion.
- Continue to refine the cost-effective techniques to implement 15% above code (2009 IECC) energy efficiency in low-priced and moderately-priced residential housing.

- Continue to refine the cost-effective methods and techniques to implement 15% above code energy efficiency in commercial buildings.
- Continue to develop creditable procedures for calculating NOx emissions reductions from green renewable technologies, including wind power, solar energy and geothermal energy systems.
- Continue development of well-documented, integrated NOx emissions reductions methodologies for calculating and reporting NOx reductions, including a unified database framework for required reporting to TCEQ of potentially creditable measures from the ESL, PUCT, and SECO SB 5 initiatives.
- Upon request, provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC), or the International Energy Conservation Code (IECC), are equivalent to, or better than, the energy efficiency and air quality achievable under the editions adopted under the 2009 IRC/IECC. This will consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.
- Develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences.
- Continue to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of computing the energy savings and emissions reductions benefits of the home energy ratings program.
- Include all benefits attained from this program in an annual report to the commission.
- Engage production builders and municipalities in overcoming obstacles to use IC3 for their new home construction.
- Release Austin Energy and NCTCOG ammendments to 2015 IECC for IC3
- Migrate all applications/databases to the TAMU ENGR cloud
- Release 2018 IECC in IC3

The Laboratory has and will continue to provide leading-edge technical assistance to counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP.

If any questions arise, please contact us by phone at 979-845-9213.

2 Introduction

2.1 Background

In 2001, the Texas Legislature adopted the Texas Emissions Reduction Plan, identifying thirty-eight counties in Texas where a focus on air quality improvements was deemed critical to public health and economic growth. These areas are shown on the map in Figure 3 as non-attainment and near nonattainment. In 2008, the twenty counties designated as nonattainment counties include: Brazoria, Chambers, Collin, Dallas, Denton, Ellis, Fort Bend, Hardin, Harris, Jefferson, Galveston, Johnson, Kaufman, Liberty, Montgomery, Orange, Parker, Rockwall, Tarrant, and Waller Counties. The fourteen counties designated as Ozone Early Action Compact counties include: Bastrop, Bexar, Caldwell, Comal, Gregg, Guadalupe, Harrison, Hays, Rusk, Smith, Travis, Upshur, Williamson, and Wilson County.

These counties represent several geographic areas of the state, which have been assigned to different climate zones by the 2001 IECC[5] as shown in Figure 4, based primarily on Heating Degree Days (HDD). These include climate zone 5 or 6 (i.e., 2,000 to 2,999 HDD_{65}) for the Dallas-Ft. Worth and El Paso areas, and climate zones 3 and 4 (i.e., 1,000 to 1,999 HDD_{65}) for the Houston-Galveston-Beaumont-Port Arthur-Brazoria areas. Also shown in Figure 4 are the locations of the various weather data sources, including the Typical Meteorological Year (TMY2) (NREL 1995) stations, the Weather Year for Energy Calculations (WYEC2) (Stoffel 1995) weather stations, the National Weather Service weather stations, (NWS) (NOAA 1993) weather stations, the ASHRAE 90.1 1989 weather locations[6], the ASHRAE 90.1 1999 weather locations, the solar stations measured by the National Renewable Energy Laboratory (NREL)[7], the solar stations measured by the TCEQ[8], and F-CHART and PV F-CHART weather locations[9].

[5] The "2000 IECC" notation is used to signify the 2000 International Residential Code (IRC), which includes the International Energy Conservation Code (IECC) as modified by the 2001 Supplement (IECC 2001), published by the ICC in March of 2001, as required by Senate Bill 5.

[6] The ASHRAE 90.1-1989 and 90.1-1999 weather stations are used in the emissions calculator for determining the building characteristics.

[7] The NREL stations were the primary source of the 1999 global horizontal, direct normal and diffuse solar radiation used to determine the 1999 peak-day and annual emissions for the DOE-2 simulations for code-compliant housing and commercial buildings.

[8] The TCEQ stations were used as the secondary source for global horizontal solar radiation when the NREL sites were missing data or no NREL site was nearby.

[9] The F-Chart and PV F-Chart weather locations are used to determine the solar thermal or electricity produced by the systems specified by the use in the emissions calculation. The monthly energy or electricity production from F-Chart or PV F-Chart is then weather-normalized using ASHRAE's Inverse Model Toolkit to develop coefficients that are then used to determine the 1999 annual and peak day energy or electricity production for emissions calculations.

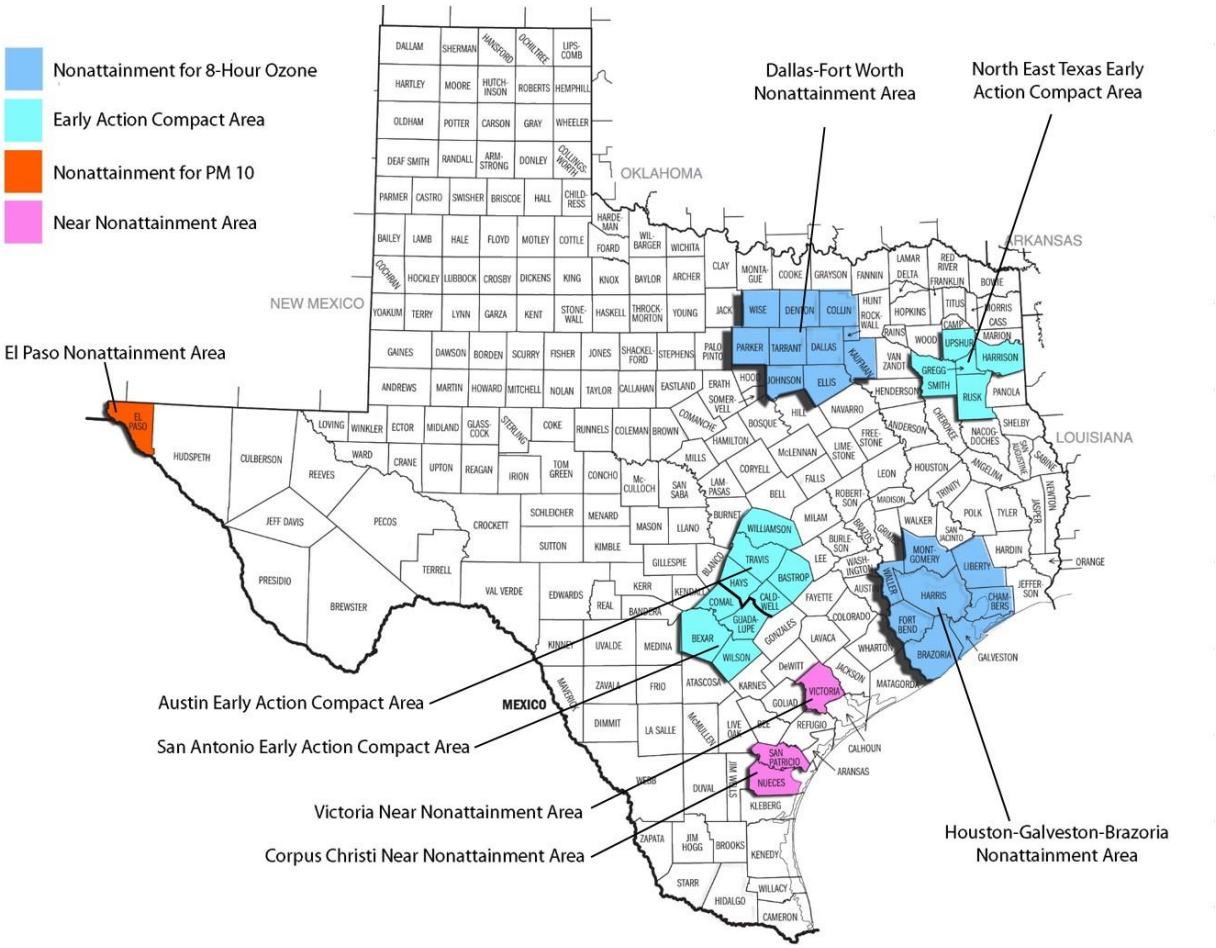


Figure 3: US EPA Nonattainment and Near Nonattainment

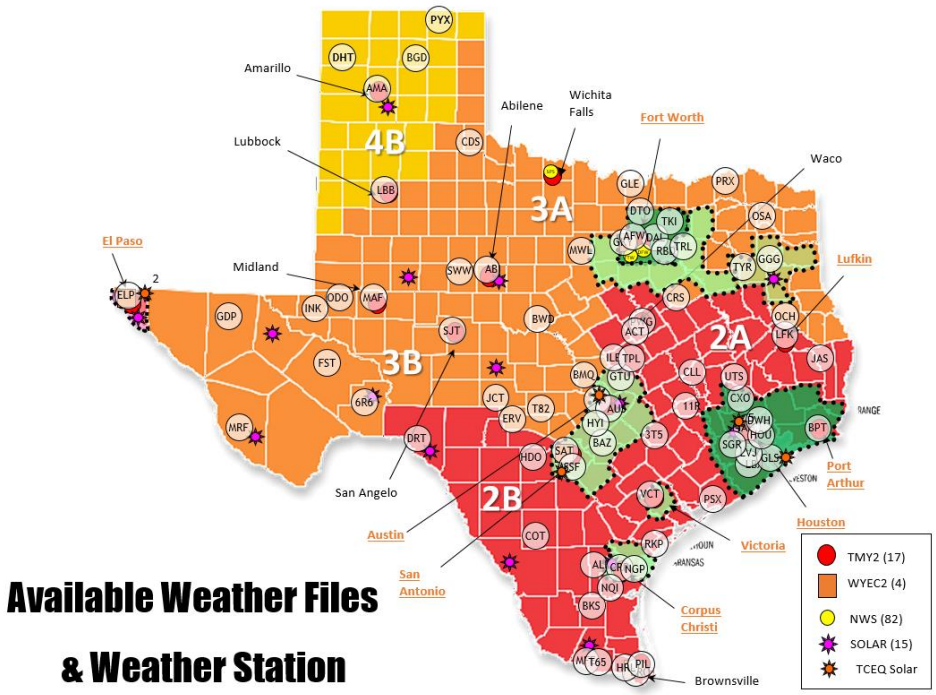
2.2 Energy Systems Laboratory's Responsibilities in the TERP

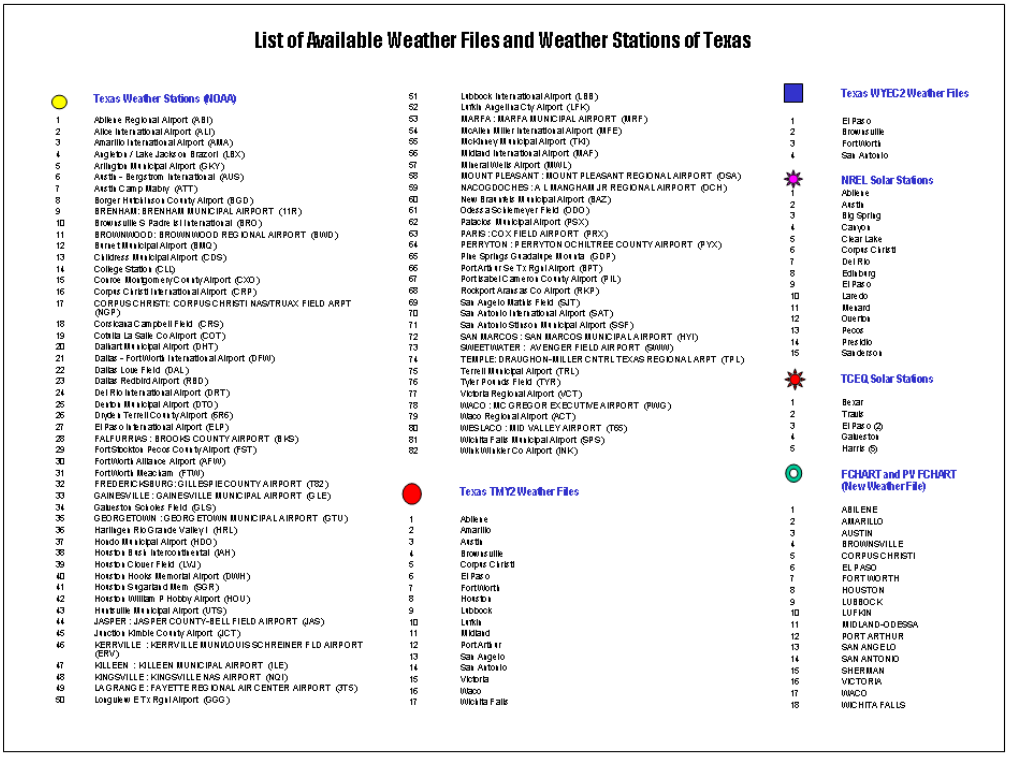
In 2001, Texas Senate Bill 5 outlined the following responsibilities for the Energy Systems Laboratory (ESL) within the TERP:

- Sec. 386.205. Evaluation of State Energy Efficiency Programs.
- Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards.
- Sec. 388.004. Enforcement of Energy Standards Outside of Municipality.
- Sec. 388.007. Distribution of Information and Technical Assistance.
- Sec. 388.008. Development of Home Energy Ratings.

In 2003 these responsibilities were modified by the following:

- House Bill 1365, including modifications to:
  - Sec. 388.004. Enforcement of Energy Standards Outside of Municipality
  - Sec. 388.009. Energy-Efficient Building Program
- House Bill 3235 which includes modifications to
  - Sec. 388.009. Certification of Municipal Building Inspectors.





List of Available Weather Files and Weather Stations of Texas

Texas Weather Stations (NOAA)

1 Abilene Regional Airport (ABI)
2 Alice International Airport (ALI)
3 Amarillo International Airport (AMA)
4 Angleton / Lake Jackson Brazoria (LBX)
5 Arlington Municipal Airport (GKY)
6 Austin - Bergstrom International (AUS)
7 Austin Camp Mabry (ATT)
8 Borger Hutchinson County Airport (BGD)
9 BRENHAM: BRENHAM MUNICIPAL AIRPORT (11R)
10 Brownsville S Padre Isl International (BRO)
11 BROWNWOOD: BROWNWOOD REGIONAL AIRPORT (BWD)
12 Burnet Municipal Airport (BMQ)
13 Childress Municipal Airport (CDS)
14 College Station (CLL)
15 Conroe Montgomery County Airport (CXO)
16 Corpus Christi International Airport (CRP)
17 CORPUS CHRISTI: CORPUS CHRISTI NAS/TRUAX FIELD ARPT (NGP)
18 Corsicana Campbell Field (CRS)
19 Cotulla La Salle Co Airport (COT)
20 Dalhart Municipal Airport (DHT)
21 Dallas - Fort Worth International Airport (DFW)
22 Dallas Love Field (DAL)
23 Dallas Redbird Airport (RBD)
24 Del Rio International Airport (DRT)
25 Denton Municipal Airport (DTO)
26 Dyess Terrell County Airport (6R6)
27 El Paso International Airport (ELP)
28 FALFURRIAS : BROOKS COUNTY AIRPORT (BKS)
29 Fort Stockton Pecos County Airport (FST)
30 Fort Worth Alliance Airport (AFW)
31 Fort Worth Meacham (FTW)
32 FREDERICKSBURG: GILLESPIE COUNTY AIRPORT (T82)
33 GAINESVILLE : GAINESVILLE MUNICIPAL AIRPORT (GLE)
34 Galveston Scholes Field (GLS)
35 GEORGETOWN : GEORGETOWN MUNICIPAL AIRPORT (GTU)
36 Harlingen Rio Grande Valley I (HRL)
37 Hondo Municipal Airport (HDO)
38 Houston Bush Intercontinental (IAH)
39 Houston Clover Field (LVJ)
40 Houston Hooks Memorial Airport (DWH)
41 Houston Sugarland Mem (SGR)
42 Houston William P Hobby Airport (HOU)
43 Huntsville Municipal Airport (UTS)
44 JASPER : JASPER COUNTY-BELL FIELD AIRPORT (JAS)
45 Junction Kimble County Airport (JCT)
46 KERRVILLE : KERRVILLE MUNI/LOUIS SCHREINER F LD AIRPORT (ERV)
47 KILLEEN : KILLEEN MUNICIPAL AIRPORT (ILE)
48 KINGSVILLE : KINGSVILLE NAS AIRPORT (NQI)
49 LA GRANGE : FAYETTE REGIONAL AIR CENTER AIRPORT (3TS)
50 Longview ETX Rgnl Airport (GGG)
51 Lubbock International Airport (LBB)
52 Lufkin Angelina Cty Airport (LFK)
53 MARFA : MARFA MUNICIPAL AIRPORT (MRF)
54 McAllen Miller International Airport (MFE)
55 Mckinney Municipal Airport (TKI)
56 Midland International Airport (MAF)
57 Mineral Wells Airport (MWL)
58 MOUNT PLEASANT : MOUNT PLEASANT REGIONAL AIRPORT (OSA)
59 NACOGDOCHES : A L MANGHAM JR REGIONAL AIRPORT (OCH)
60 New Braunfels Municipal Airport (BAZ)
61 Odessa Schlemeyer Field (ODO)
62 Palacios Municipal Airport (PSX)
63 PARIS : COX FIELD AIRPORT (PRX)
64 PERRYTON : PERRYTON OCHILTREE COUNTY AIRPORT (PYX)
65 Pine Springs Guadalupe Mountains (GDP)
66 Port Arthur Se Tx Rgnl Airport (BPT)
67 Port Isabel Cameron County Airport (PIL)
68 Rockport Aransas Co Airport (RKP)
69 San Angelo Mathis Field (SJT)
70 San Antonio International Airport (SAT)
71 San Antonio Stinson Municipal Airport (SSF)
72 SAN MARCOS : SAN MARCOS MUNICIPAL AIRPORT (HYI)
73 SWEETWATER : AVENGER FIELD AIRPORT (SWW)
74 TEMPLE: DRAUGHON-MILLER CNTRL TEXAS REGIONAL ARPT (TPL)
75 Terrell Municipal Airport (TRL)
76 Tyler Pounds Field (TYR)
77 Victoria Regional Airport (VCT)
78 WACO : MC GREGOR EXECUTIVE AIRPORT (PWG)
79 Waco Regional Airport (ACT)
80 WESLACO : MID VALLEY AIRPORT (T65)
81 Wichita Falls Municipal Airport (SPS)
82 Wink Winkler Co Airport (INK)

Texas TMY2 Weather Files

1 Abilene
2 Amarillo
3 Austin
4 Brownsville
5 Corpus Christi
6 El Paso
7 Fort Worth
8 Houston
9 Lubbock
10 Lufkin
11 Midland
12 Port Arthur
13 San Angelo
14 San Antonio
15 Victoria
16 Waco
17 Wichita Falls

Texas WYEC2 Weather Files

1 El Paso
2 Brownsville
3 Fort Worth
4 San Antonio

NREL Solar Stations

1 Abilene
2 Austin
3 Big Spring
4 Canyon
5 Clear Lake
6 Corpus Christi
7 Del Rio
8 Edinburg
9 El Paso
10 Laredo
11 Mesquite
12 Odessa
13 Pecos
14 Presidio
15 Sanderson

TCEQ Solar Stations

1 Bexar
2 Travis
3 El Paso (2)
4 Galveston
5 Harris (5)

FCHART and PV FCHART (New Weather File)

1 ABILENE
2 AMARILLO
3 AUSTIN
4 BROWNSVILLE
5 CORPUS CHRISTI
6 EL PASO
7 FORT WORTH
8 HOUSTON
9 LUBBOCK
10 LUFKIN
11 MIDLAND-ODESSA
12 PORT ARTHUR
13 SAN ANGELO
14 SAN ANTONIO
15 SHERMAN
16 VICTORIA
17 WACO
18 WICHITA FALLS

Figure 4: Available NWS, TMY2 and WYEC2 weather files compared to IECC/IRC weather zones for Texas

In 2005 these same responsibilities were further updated:

- with Senate Bill 20, House Bill 2481, and 2129.

These responsibilities were further updated in 2007:

- with Senate Bill 12 and House Bill 3693.

These responsibilities were further updated in 2009:

- with House Bill 1796.

These responsibilities were further updated in 2011:

- with Senate Bills 898 and 924, and House Bill 51.

These responsibilities were not updated in 2012. They remained unchanged in 2013. They were not updated in 2014.

These responsibilities were further updated in 2015:

- Changes to Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards
- with House Bill 1736.

In the following sections, each of these tasks is further described.

2.2.1 (SB 5) Section 386.205. Evaluation of State Energy Efficiency Programs (w/PUCT)

The Laboratory is instructed to assist the Public Utility Commission of Texas (PUCT) and provide an annual report that quantifies by county the reductions of energy demand, peak loads, and associated emissions of air contaminants achieved from the programs implemented under this subchapter and from those implemented under Section 39.905, Utilities Code (i.e., Senate Bill 7).

To implement procedures for evaluating state energy-efficiency programs, in 2004, the Laboratory held several meetings with the Public Utility Commission of Texas to discuss the development of a framework for reporting emissions reduction from the State Energy Efficiency Programs administered by the PUCT. The State Energy-Efficiency Programs administered by the PUCT include programs under Senate Bill 7 (i.e., Section 39.905 Utilities Code) and Senate Bill 5.

In 2003 and 2004, the Laboratory worked with the TCEQ to identify a method to help the PUCT more accurately report their deemed savings as peak-day savings in 1999, using the Laboratory's new emissions reductions calculator.

In 2005, this method was implemented in the TCEQ's Integrated Emissions Calculations, which was reported in previous (from 2005-2016) annual reports.

2.2.2 (SB 5) Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards

In 2001, TERP adopts the energy efficiency chapter of the 2001 International Residential Code (2001 IRC) as an energy code for Single-Family residential construction, and the 2001 International Energy Conservation Code (2001 IECC) for all other residential, commercial and industrial construction in the state. It requires that municipalities establish procedures for administration and enforcement, and ensure that code-certified inspectors perform inspections.

TERP provides that local amendments, in non-attainment areas and affected counties, may not result in less stringent energy efficiency requirements. The Laboratory is to review local amendments, if requested, and submit an annual report of savings impacts to the TCEQ. The Laboratory is also authorized to collect fees for certain of its tasks in Sections 388.004, 388.007 and 388.008.

2.2.3 (SB 5) Sec. 388.004. Enforcement of Energy Standards Outside of Municipality

For construction outside of the local jurisdiction of a municipality, TERP provides for a building to comply if:

- the building is certified by a national, state, or local accredited energy efficiency program;
- the building was subjected to inspections from private code-certified inspectors using the energy efficiency chapter of the International Residential Code or International Energy Conservation Code; or
- the builder who does not have access to either of the above methods for a building certifies compliance using a form provided by the Laboratory, enumerating the code-compliance features of the building.

2.2.4 (SB 5) Sec. 388.007. Distribution of Information and Technical Assistance

The Laboratory is required to make available to builders, designers, engineers, and architects code implementation materials that explain the requirements of the International Energy Conservation Code and the energy efficiency chapter of the International Residential Code. TERP authorizes the Laboratory to develop simplified materials to be designed for projects in which a design professional is not involved. It also authorizes the Laboratory to provide local jurisdictions with technical assistance concerning implementation and enforcement of the International Energy Conservation Code and the energy efficiency chapter of the International Residential Code.

2.2.5 (SB 5) Sec. 388.008. Development of Home Energy Ratings

TERP requires the Laboratory to develop a standardized report format to be used by providers of home energy ratings (HERs). The form must be designed to give potential buyers information on a structure's energy performance, including certain equipment. TERP requires the Laboratory to establish a public information program to inform homeowners, sellers, buyers, and others regarding home energy ratings.

2.2.6 (HB 1365) Sec. 388.004. Enforcement of Energy Standards Outside of Municipality

At the 78th Legislature (2003), House Bill 1365 modified Section 388.004 of The TERP to include the following new requirements:

- That builders shall retain for three years documentation which shows their building is in compliance with the Texas Building Energy Performance Standards, and that builders shall provide a copy of the compliance documentation to homeowners.
- That Single-Family residences built in unincorporated areas of counties, which were completed on or after September 1, 2001, but not later than August 31, 2003, are considered in compliance with the Texas Building Energy Performance Standards.

To help builders comply with these requirements, the Laboratory will enhance the current form, which is posted on the Laboratory's The TERP website.

2.2.7 (HB 1365) Sec. 388.009. Energy-Efficient Building Program, renamed in 2005 (HB 2129) Sec. 388.012. Development of Alternative Energy-Saving Methods.

In this Section, the laboratory shall develop at least three alternative methods for achieving a 15% greater potential energy savings in residential, commercial, and industrial construction than the potential energy savings of construction that is in minimum compliance with Section 388.003. The alternative methods:

(1) may include both prescriptive and performance-based approaches, such as the approach of the United States Environmental Protection Agency's Energy Star qualified new home labeling program; and

(2) must include estimates of the implementation costs and energy savings to consumers and the related emissions reductions.

2.2.8 (HB 3235) Sec. 388.009. Certification of Municipal Inspectors renamed in 2005 (HB 2018) Sec. 388.011. Certification of Municipal Building Inspectors.

Also in 2003, House Bill 3235 modified the TERP to add the new Section 388.009. In this section the Laboratory is required to develop and administer a state-wide training program for municipal building inspectors who seek to become code-certified inspectors. To accomplish this, the Laboratory will work with national code organizations to assist participants in the certification program and is allowed to collect a reasonable fee from participants in the program to pay for the costs of administering the program. This program was required to be developed no later than January 1, 2004, with state-wide training sessions starting no later than March 1, 2004.

2.2.9 (SB 20, HB 2481, HB 2129). Additional Energy-Efficiency Initiatives

The 79th Legislature (2005), through SB 20, HB 2481 and HB 2129, amended SB 5 to enhance its effectiveness by adding the following additional energy-efficiency initiatives, including requiring 5,880 MW of generating capacity from renewable energy technologies by 2015, and 500 MW from non-wind renewables.

This legislation also requires PUCT to establish a target of 10,000 MW of installed renewable capacity by 2025, and requires TCEQ to develop a methodology for computing emissions reductions from renewable energy initiatives and the associated credits. The Laboratory is to assist TCEQ in quantifying emissions reductions credits from energy-efficiency and renewable-energy programs, through a contract with the Texas Environmental Research Consortium (TERC) to develop and annually calculate creditable emissions reductions from wind and other renewable energy resources for the state's SIP.

Finally, this legislation requires the Laboratory to develop at least 3 alternative methods for achieving a 15% greater potential energy savings in residential, commercial and industrial construction. To accomplish this, the Laboratory will be using the code-compliance calculator to ascertain which measures are best suited for reducing energy use without requiring substantial investments.

2.2.10 (SB 12, HB 3693). Additional Energy-Efficiency Initiatives

The 80th Legislature (2007), through SB 12, and HB 3693 amended SB 5 to enhance its effectiveness by adding several new energy efficiency initiatives. First, it requires the Laboratory to provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC), or the International Energy Conservation Code (IECC), are equivalent to or better than the energy efficiency and air quality achievable under the editions adopted under the 2001 IRC/IECC. The laboratory shall make its recommendations not later than six months after publication of new editions at the end of each three-year code development cycle of the International Residential Code and the International Energy Conservation Code. As part of this work with SECO, the Laboratory is required to consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.

In addition, it requires the Laboratory to develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences. The form must be designed to give potential buyers information on a structure's energy performance, including: insulation; types of windows; heating and cooling equipment; water heating equipment; additional energy conserving features, if any; results of performance measurements of building tightness and forced air distribution; and an overall rating of probable energy efficiency relative to the minimum requirements of the International Energy Conservation Code or the energy efficiency chapter of the International Residential Code, as appropriate.

It also encourages the Laboratory to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of computing the energy savings and emissions reductions benefits of the home energy ratings program. Finally, it requires the Laboratory shall include information on the benefits attained from this program in an annual report to the commission.

2.2.11 (HB 1796). TERP Term & Additional Energy- Efficiency Initiatives

The 81st Legislature (2009), through HB 1796, amended sections Sec. 386.252 (a) and (b), to extend the date of the TERP to 2019 and require the TCEQ to contract with Laboratory to compute emissions reduction from wind and other renewable energy resources for the SIP.

2.2.12 (HB 51, SB 898, SB 924). Additional Energy-Efficiency Initiatives & Refinement of Ongoing Initiatives

The 82nd Legislature (2011) through HB-1, the Laboratory's responsibilities under TERP increased:

The 82nd Legislature (2011), through SB 898, amended Sec 388.005 (c), (d) and (e), which per the amendment, requires each political subdivision, institution of higher education or state agency to establish a goal to reduce the electric consumption by the entity by at least 5% each fiscal year for 10 years, beginning September 1, 2011. SB 898 further elaborated and enhanced the annual reporting requirements for those entities, and required SECO to develop a standardized form for reporting. SB 898 adds the Laboratory as the entity in charge of calculating energy savings and estimated emissions reduction for each political subdivision, institution of higher education or state agency, based on the information collected by SECO. The Laboratory shall share the analysis with the TCEQ, EPA and ERCOT.

The 82nd Legislature (2011), through SB 924, amended Sec 39.9051, Utilities Code, (f), (g) and (h), to enhance the reporting requirements by all municipally owned utilities and electric cooperatives that had retail sales of more than 500,000 MWh in 2005, regarding combined effects of their energy efficiency activities. Per the amended sections, beginning April 1, 2012, these entities must report each year to SECO, on a standardized form developed by SECO. The report of information regarding the combined effects of the energy efficiency activities of the electric cooperative/utility from the previous calendar year should include the annual goals, programs enacted to achieve those goals, and any achieved energy demand or savings goals. SB 924 adds the Laboratory as the entity in charge of calculating energy savings and estimated emissions reduction for municipally owned utilities and for electric cooperatives, based on the information collected by SECO. The Laboratory shall share the analysis with the PUCT, ERCOT, EPA and TCEQ.

The 82nd Legislature, through HB 51, required SECO to appoint a new advisory committee for selecting high-performance building design evaluation systems. The committee includes a representative from the Laboratory and meets at least once every two years.

The 82nd Legislature, through HB 51, modified Sec 388.003 (e) on the Laboratory's review of proposed local code amendments, which should be compared to the unamended code (instead of the "base" code), and added to Sec 388.007 (c) the fact that Laboratory is allowed to provide technical assistance concerning the implementation of local code amendments.

In addition, HB 51 added Sec 388.007 (d), which allows The Laboratory to conduct outreach to the real estate industry on the value of energy code compliance and above code construction.

The 83rd Legislature (2013) did not change any of the Laboratory's previously established responsibilities under TERP.

During the 84th Legislature session (2015), changes to the Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards, with the passage of HB 1736, affected the Laboratory's responsibilities under TERP:

- 2015 residential energy codes (IRC/IECC) editions are in effect starting Sept 1, 2016. 2015 commercial energy codes (IECC) are in effect starting Nov 1, 2016. The Laboratory's responsibilities of reviewing new energy codes and local code amendments remain. New codes will be reviewed no sooner than every 6 years.
- The legislation introduces a new energy rating index (ERI) as a voluntary compliance path for local code amendments. With the introduction of the ERI as another compliance path, the Laboratory is required to consider it when local amendments are reviewed, and needs to update the web-based code compliance tool and emissions reduction calculator to allow for the new optional compliance path.

3 Statewide Air Emissions Calculations from Wind and Other Renewables

The Energy Systems Laboratory, in fulfillment of its responsibilities under this Legislation, submits its tenth annual report, "Statewide Air Emissions Calculations from Wind and Other Renewables," to the Texas Commission on Environmental Quality.

The report is organized in several deliverables:

- a summary report, which details the key areas of work
- supporting documentation
- supporting data files, including weather data, and wind production data,

This executive summary provides key areas of accomplishment this year, including:

- continuation of stakeholder's meetings
- analysis of power generation from wind farms using improved method and 2016 data
- analysis of emissions reductions from wind farms
- updates on degradation analysis
- analysis of other renewables, including solar PV, solar thermal, biomass, hydroelectric, geothermal, and landfill gas
- review of electricity generation by renewable sources and transmission planning study reported by ERCOT

3.1 Analysis of wind farms using an improved method and 2016 data

In this report, the weather normalization procedures, developed together with the Stakeholders, were presented and applied to all the wind farms that reported their data to ERCOT during the 2016 measurement period, together with wind data from the nearby NOAA weather stations or the zone average wind speed provided from ERCOT.

In the previous Wind and Renewables report to the TCEQ, weather normalization analysis methods were reviewed. This report used the same analysis method as the previous reports to present the same weather normalization procedure, including:

- the processing of weather and power generation data, modeling of daily power generation versus daily wind speed using the ASHRAE Inverse Model Toolkit (IMT) for two separate periods, i.e., Ozone Season Period (OSP), from July 15 to September 15, and Non-Ozone Season Period (Non-OSP);
- predicting 2008 wind power generation as a baseline, using developed coefficients from 2016 daily OSP and Non-OSP models for all the wind farms; and
- the analysis on monthly capacity factors generated using the models.

A summary of total wind power production in the base year (2008) for all of the wind farms in the ERCOT region using the developed procedure is presented, and the twenty six new wind farms which started operation in 2015 and 2016 were added, including Javelina Ii Wind 1, Javelina Ii Wind 2, Javelina Ii Wind 3, Cotton Plains Wind, Old Settler Wind, Electra Wind 1, Electra Wind 2, Doug Colbeck'S Corner (Conway) A, Doug Colbeck'S Corner (Conway) B, Gunsight Mountain Wind, Horse Creek Wind 1, Horse Creek Wind 2, Los Vientos Iv Wind, Mariah Del Norte 1, Mariah Del Norte 2, Hidalgo & Starr Wind 11, Hidalgo & Starr Wind 12, Hidalgo & Starr Wind 21, Saltfork_Unit1, Saltfork_Unit2, San Roman Wind, South Plains Wind Ii A, South Plains Wind Ii B, Tyler Bluff Wind, Wake Wind 1, and Wake Wind 2. Figure *5* shows the measured annual wind power generation in 2016 and the estimated wind power generation in 2008 using the developed method for those wind farms in the ERCOT region. The total measured wind power generation in 2016 is 50,023,889 MWh/yr., which is 23.12% higher than what the same wind farms would have produced in 2008. Figure *6* shows the same comparison but for the Ozone Season Period. The measured wind power generation in the OSP of 2016 is 113,946 MWh/day, which is 30.12% higher than the 2008 OSP baseline wind production. For the analysis of this year, the measured 2016 wind power generation is fairly higher than the 2008 baseline wind power production.

This report also includes an uncertainty analysis that was performed on all the daily regression models for the entire year and Ozone Season Period.

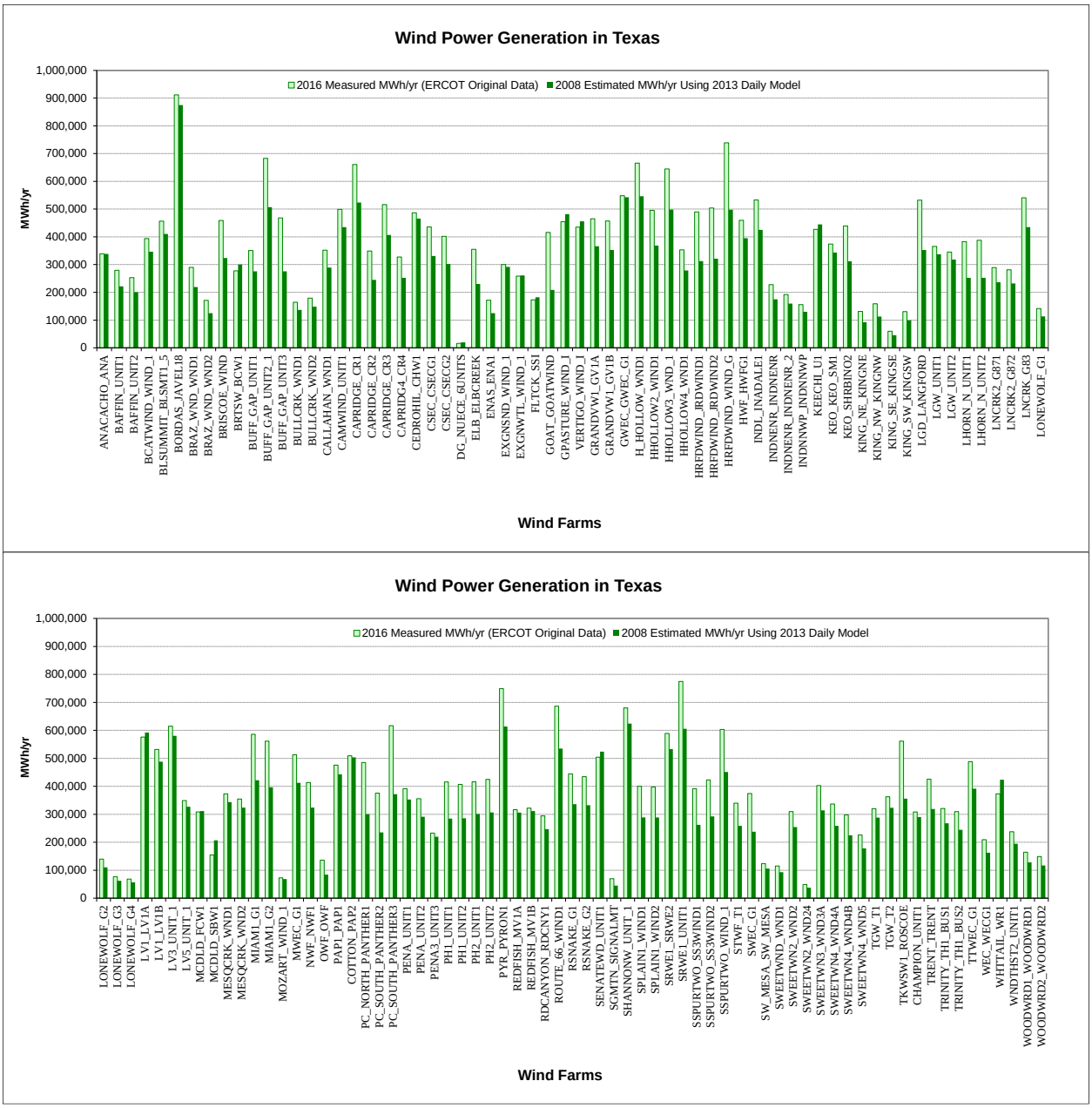


Figure 5: Comparison of 2016 Measured and 2008 Estimated Wind Power Production for Each Wind Farm

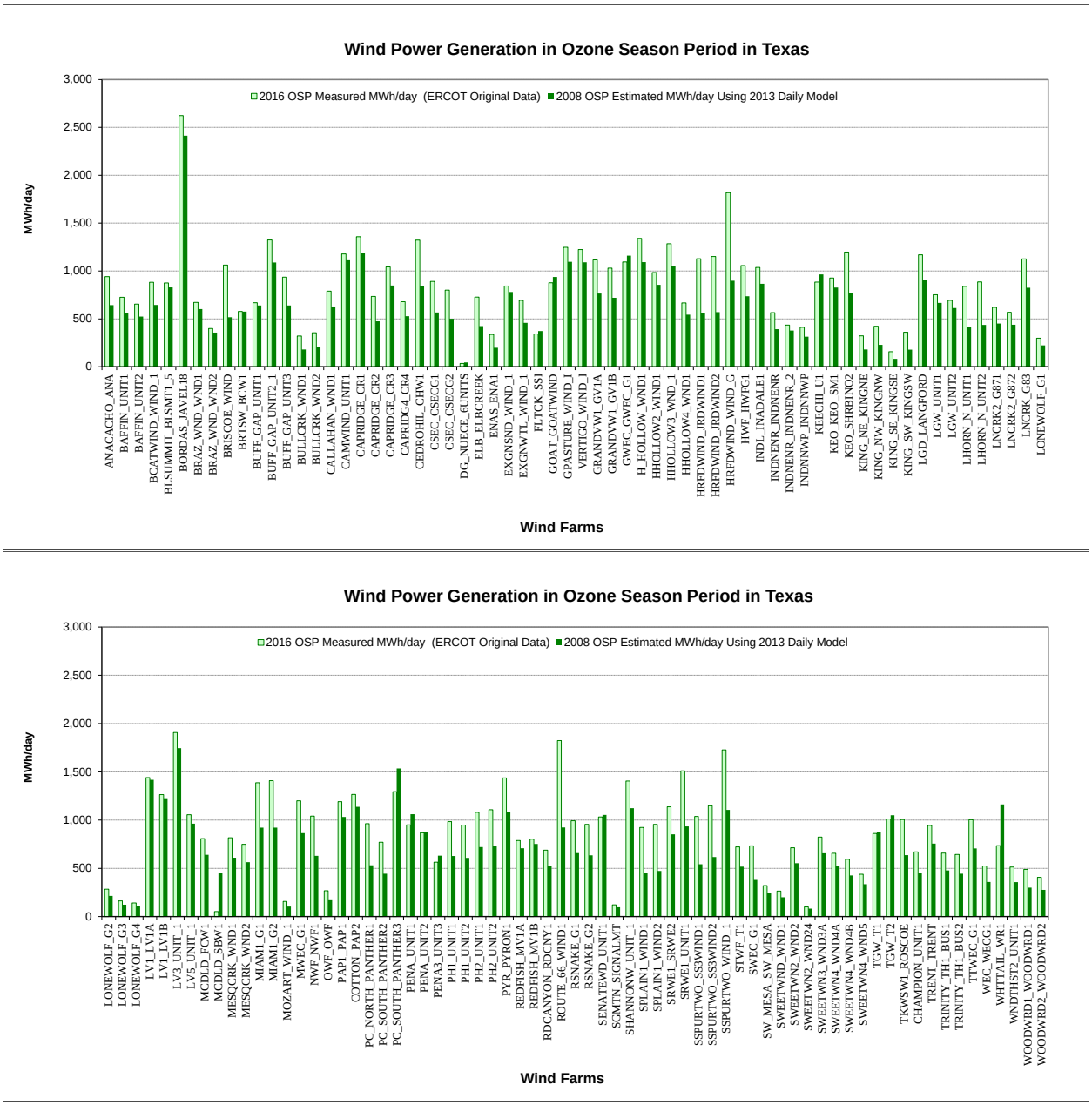


Figure 6: Comparison of 2016 OSP Measured and 2008 OSP Estimated Wind Power Production for Each Wind Farm

3.2 Analysis of emissions reductions from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NOx reductions from electricity savings from wind projects implemented in the congestion management (CM) zones in ERCOT was presented and, calculating the NOx emission reductions based on the special version of 2010 eGRID, developed by the ESL and EPA for the TCEQ. According to the developed models, the total MWh savings for all the wind farms in the base year 2008 within the ERCOT region are 40,630,248 MWh/yr and 87,571 MWh/day in the Ozone Season Period. The total NOx emissions reductions across all the counties amount are 11,259.29 tons/yr and 24.50 tons/day for the Ozone Season Period. Based on the 2016 measured ERCOT data, the total MWh savings for all the wind farms within the ERCOT region are 50,023,889 MWh/yr and 113,946 MWh/day in the Ozone Season Period. The total NOx emissions reductions in 2016 across all the counties amount are 13,796.73 tons/yr and 31.66 tons/day for the Ozone Season Period. Compared to the base year 2008, the total annual NOx emissions reductions increased by 22.54%, and the total NOx emissions reductions increase 29.22% for the Ozone Season Period.

3.3 Degradation analysis

This report contains an updated analysis to determine what degradation could be observed in the measured power from Texas wind farms. By TCEQ request on reference to the degradation of the wind farm power output, the ESL has been evaluating observed degradations from the measured data for all the Texas wind farms.

For the analysis, a statistical index was established for each site that used the 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 99^{th} percentiles of the hourly power generation over a 12-month sliding period, as well as mean, minimum and maximum hourly power generation of the same 12-month period. These indices were then displayed using one data symbol for each 12-month slide, beginning from the first 12-month period until the last 12-month period for each of the wind farms.

As shown in Table 4, of the eighty five sites[10] analyzed, fourty seven sites showed an increase when one compares the 90^{th} percentile of the whole period to the 90^{th} percentile of the first 12-month period, ranging from 0.1% to 60.5%. The remaining thirty eight sites showed a decrease from -0.4% to -27.2%. The weighted average of this increase across all wind farms is 6.5% (positive), which indicates that no degradation was observed from the aggregate energy production from these wind farms over the analyzed operation period. Similarly, the wind farms of Loraine Windpark IV (-10.5%), Papalote Creek Wind Farm (-14.5%), Big Spring Wind Power (-15.4%), Snyder Wind Project (-16.1%), and Sherbino 2 Wind (-27.2) have a decrease on production with a percentage larger than 10%, which may be caused by wind farm operations issues, the meter problems or other related issues.

[10] The eighty five sites presented in the degradation analysis section include one hundred and five individual wind farms.

Table 4: Summary of 90th Percentile Hourly Wind Power Analysis for Eighty Five Wind Farms (85 Sites) in Texas

Wind Farm	12-Month Sliding 90th Percentile Hourly Wind Report								No. of Months of Data	Capacity (MW)
	First Year		Average		Minimum		Maximum			
	First 12-mo Ending Mo.	MW	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo		
Anacacho Wind	Nov-13	83.4	86.7	4.0%	83.1	-0.4%	89.0	6.7%	38	100
Blue Summit Wind	Oct-13	121.9	121.0	-0.8%	114.9	-5.8%	128.5	5.4%	39	135
Bobcat Bluff Wind	Nov-13	115.0	114.6	-0.4%	101.5	-11.8%	127.9	11.2%	38	150
Brazos Wind Ranch	Dec-04	127.5	126.8	-0.6%	93.5	-26.7%	139.4	9.3%	133	160
Barton Chapel Wind 1	Apr-09	60.0	76.5	27.4%	43.1	-28.2%	89.1	48.5%	81	120
Buffalo Gap 1	Nov-06	100.9	98.4	-2.4%	75.4	-25.2%	105.7	4.8%	110	120
Buffalo Gap 2	Apr-08	183.4	174.1	-5.1%	104.9	-42.8%	207.6	13.2%	93	233
Buffalo Gap 3	Jun-09	86.4	136.1	57.6%	86.4	0.0%	152.1	76.0%	79	170
Bull Creek Wind Plant	Dec-09	93.9	91.5	-2.6%	41.5	-55.8%	130.4	38.9%	73	180
Big Spring Wind Power	Dec-02	27.2	23.0	-15.4%	16.3	-40.1%	27.2	0.0%	157	41
Callahan Divide Wind	Feb-06	93.3	95.1	2.0%	86.7	-7.1%	101.5	8.8%	119	114
Capricorn Ridge Wind 1&2	Aug-08	258.0	248.2	-3.8%	174.5	-32.4%	291.2	12.8%	89	364
Capricorn Ridge Wind 3	Jan-09	120.3	134.9	12.1%	97.9	-18.6%	153.5	27.6%	84	186
Capricorn Ridge Wind 4	Apr-09	85.2	84.1	-1.3%	67.6	-20.6%	92.8	9.0%	81	112.5
Camp Springs Wind Energy Center	Apr-08	111.3	106.8	-4.0%	95.0	-14.6%	120.9	8.6%	93	130
Camp Springs Energy Expension	Jan-09	94.0	97.4	3.7%	88.9	-5.4%	107.9	14.8%	84	120
Cedro Hill Wind	Dec-11	136.3	125.6	-7.8%	102.1	-25.1%	136.9	0.4%	49	150
Champion Wind Farm	Jan-09	89.4	102.8	14.9%	87.7	-1.9%	113.2	26.6%	84	126.5
Desert Sky	Dec-02	89.0	118.8	33.4%	83.1	-6.7%	134.4	50.9%	157	160.5
Elbow Creek Wind	Dec-09	94.5	97.8	3.5%	88.5	-6.4%	104.5	10.6%	73	121.9
Forest Creek Wind Farm	Dec-07	105.2	106.2	1.0%	97.3	-7.5%	111.2	5.7%	97	124.2
Goat Wind	Feb-09	61.4	94.3	53.7%	61.4	0.0%	122.6	99.8%	83	150
Gulf Wind 1	Jun-10	108.6	105.5	-2.9%	85.2	-21.6%	119.4	9.9%	79	141.6
Gulf Wind 2	Jun-10	116.5	115.4	-0.9%	89.7	-23.0%	126.3	8.4%	79	141.6
Hackberry Wind	Dec-09	138.0	125.4	-9.1%	105.8	-23.3%	140.6	1.9%	73	165.5
Harbor Wind	Jan-13	6.1	6.0	-1.5%	4.3	-29.1%	7.1	15.9%	48	9
Horse Hollow Phase 1	Jun-06	157.0	165.9	5.7%	141.3	-10.0%	185.1	17.9%	115	213
Horse Hollow Phase 2	Aug-07	145.7	137.4	-5.7%	99.0	-32.1%	151.5	4.0%	101	184
Horse Hollow Phase 3	May-07	169.2	165.8	-2.0%	123.9	-26.8%	187.7	11.0%	104	223.5
Horse Hollow Phase 4	Jun-07	88.6	88.8	0.1%	80.9	-8.7%	94.8	6.9%	103	115
Inadale Wind	Sep-10	117.9	136.8	16.0%	99.0	-16.0%	166.3	41.1%	76	197
Indian Mesa	Dec-02	48.0	58.0	20.9%	36.0	-24.9%	72.2	50.5%	157	82.5
King Mountain Wind Ranch-NE	Dec-02	41.8	46.9	12.0%	36.3	-13.2%	56.4	34.8%	157	79.3
King Mountain Wind Ranch-NW	Dec-02	44.7	55.3	23.7%	40.2	-10.1%	65.3	46.1%	157	79.3
King Mountain Wind Ranch-SE	Dec-02	21.6	23.6	9.2%	18.4	-15.0%	28.1	29.8%	157	40.3
King Mountain Wind Ranch-SW	Dec-02	41.6	46.9	12.8%	38.4	-7.7%	53.7	29.1%	157	79.3
Langford Wind	Dec-10	115.7	126.0	8.9%	114.4	-1.1%	134.3	16.0%	61	150
Lone Star - Post Oak Wind	Mar-09	149.1	155.9	4.6%	138.4	-7.2%	170.5	14.4%	94	200
Lone Star - Mesquite Wind	Sep-08	140.4	150.8	7.4%	129.9	-7.5%	168.1	19.7%	100	200
Loraine Windpark I	Dec-10	30.4	35.4	16.5%	25.9	-14.8%	42.3	39.2%	61	126
Loraine Windpark II	Dec-10	27.8	35.7	28.2%	25.7	-7.6%	43.3	55.7%	61	124.5
Loraine Windpark III	Jan-12	16.2	20.6	26.9%	16.2	0.0%	22.6	39.4%	48	26
Loraine Windpark IV	Dec-12	17.4	15.6	-10.5%	5.0	-71.5%	20.8	19.1%	37	24
Los Vientos Wind I	Oct-13	148.5	163.0	9.8%	148.5	0.0%	175.1	17.9%	39	200.1
Los Vientos Wind II	Nov-13	153.3	149.0	-2.8%	134.4	-12.3%	157.5	2.7%	38	201.6
Magic Valley Wind (Redfish) 1A	Apr-13	88.6	86.1	-2.8%	79.3	-10.5%	90.7	2.4%	45	99.8
Magic Valley Wind (Redfish) 1B	Jul-13	94.2	89.8	-4.7%	83.8	-11.1%	94.6	0.4%	42	103.5
McAdoo Wind	Dec-09	111.7	135.8	21.5%	111.7	0.0%	143.6	28.5%	73	150
Notrees Windpower	Feb-10	103.7	113.0	9.1%	103.7	0.0%	122.9	18.6%	83	153
Ocotillo Windpower	Dec-09	39.1	42.1	7.6%	36.6	-6.4%	47.2	20.7%	73	58.8
Panther Creek 1	Dec-09	114.4	120.2	5.1%	107.8	-5.8%	128.9	12.7%	73	142.5
Panther Creek 2	Dec-09	91.8	96.3	4.9%	85.2	-7.2%	104.2	13.5%	73	115.5
Panther Creek 3	Aug-10	128.5	153.3	19.3%	120.0	-6.6%	177.1	37.8%	77	199.5
Papalote Creek Wind Farm	Dec-10	150.1	128.4	-14.5%	39.6	-73.6%	157.9	5.2%	73	180
Papalote Creek Wind Farm II	Dec-11	174.2	167.7	-3.7%	155.0	-11.0%	176.4	1.2%	49	200.1
Penascal Wind 1	Feb-11	133.2	125.5	-5.8%	99.7	-25.2%	141.5	6.2%	71	161
Penascal Wind 2	Dec-09	83.3	109.1	31.0%	80.7	-3.1%	125.4	50.5%	73	142
Penascal Wind 3	May-11	87.1	78.4	-10.0%	65.7	-24.6%	88.8	2.0%	68	101
Pyron Wind Farm	Dec-09	157.2	187.2	19.1%	151.4	-3.7%	220.1	40.0%	73	249
Red Canyon 1	Aug-07	76.4	75.6	-1.0%	72.6	-4.9%	79.1	3.6%	113	84
Roscoe Wind Farm	Dec-08	169.4	153.4	-9.4%	108.1	-36.2%	179.8	6.2%	85	209
Sand Bluff Wind Farm	Nov-08	69.4	68.0	-2.0%	55.0	-20.7%	75.4	8.6%	98	90
Senate Wind	Sep-13	127.1	126.1	-0.8%	117.4	-7.6%	132.2	4.0%	49	150
Sherbino I Wind	Dec-09	104.7	112.9	7.9%	92.3	-11.8%	128.1	22.4%	73	150
Sherbino 2 Wind	Dec-12	125.7	91.6	-27.2%	38.0	-69.8%	125.7	0.0%	37	150
Silver Star Wind	Apr-09	40.6	45.9	13.0%	39.5	-2.7%	50.5	24.4%	81	60
South Trent Wind Farm	Dec-09	67.7	84.2	24.4%	65.4	-3.5%	91.0	34.4%	73	101.2
Southwest Mesa Wind	Dec-02	51.1	47.1	-7.8%	37.2	-27.1%	56.5	10.6%	157	74.6
Stanton Wind Energy	Dec-08	79.4	95.5	20.3%	79.4	0.0%	107.0	34.7%	85	120
Sweetwater Wind 1	Dec-04	34.1	33.0	-3.2%	29.9	-12.2%	34.9	2.4%	133	37.5
Sweetwater Wind 2 (unit 1)	Jan-06	71.4	81.7	14.5%	71.4	0.0%	88.0	23.3%	120	97.5
Sweetwater Wind 2 (unit 2)	Mar-08	13.1	13.8	5.1%	12.0	-8.7%	14.8	13.3%	106	16
Sweetwater Wind 3	Dec-06	99.6	101.1	1.4%	67.1	-32.7%	111.2	11.6%	109	135
Sweetwater Wind 4	Mar-08	161.0	170.4	5.8%	153.2	-4.9%	182.2	13.2%	106	240.8
Sweetwater Wind 5	Dec-08	66.5	63.3	-4.8%	56.3	-15.3%	69.3	4.3%	85	80.5
Snyder Wind Project	Dec-08	52.9	44.4	-16.1%	36.1	-31.8%	52.9	0.0%	85	63
Trent Mesa	Dec-02	108.8	119.8	10.0%	90.7	-16.7%	132.8	22.0%	157	150
Trinity Hills Wind Farm 1	Dec-12	78.8	78.4	-0.5%	62.8	-20.3%	88.1	11.8%	37	118
Trinity Hills Wind Farm 2	Dec-12	74.8	77.0	2.9%	63.5	-15.0%	88.0	17.7%	37	108
Turkey Track Wind Energy Center	Dec-09	77.4	124.2	60.5%	77.0	-0.5%	143.1	85.0%	73	169.5
Whirlwind	Dec-08	54.0	50.0	-7.4%	39.8	-26.3%	56.9	5.4%	85	60
Whitetail Wind	Oct-13	72.9	70.3	-3.5%	66.6	-8.6%	73.1	0.3%	39	92
WKN Mozart Wind	Oct-13	22.4	22.9	2.1%	20.5	-8.5%	25.8	15.0%	39	30
Wolf Ridge Wind	Dec-09	105.9	105.4	-0.5%	97.6	-7.8%	108.8	2.7%	73	112.5
Woodward Mountain Ranch	Dec-02	85.3	97.3	14.1%	80.4	-5.7%	112.4	31.8%	157	159.7
Weighted Average:				**6.5%**		**-16.2%**		**20.3%**	**Total:**	**11186.2**

3.4 Analysis of other renewable sources

Five specific renewable sources were determined: solar, biomass, hydroelectric, geothermal, and landfill gas-fired. To generate/save energy throughout the State of Texas, six types of renewable energy projects were identified: solar photovoltaic (PV) including solar power, solar thermal, biomass power, hydroelectric power, geothermal HVAC, and landfill gas-fired power projects. The solar photovoltaic project accounts for non-utility scale PV installations in Texas whereas the solar power project accounts for utility scale (solar power plant) constructions. Table 5 presents the number of newly located renewable energy projects and total renewable energy projects included in this report.

This report also presents county-wide annual/Ozone Season Day (OSD) energy savings and annual NOx emission reductions for solar photovoltaic including solar power, solar thermal, biomass, and hydroelectric projects. The annual/OSD energy savings calculation for solar photovoltaic and solar thermal was conducted using the eCalc tool. The power generation data for the other renewable energy projects (solar power, biomass, and hydroelectric), which were obtained from the ERCOT, were used to evaluate the annual/OSD energy generation. Then, the annual NOx emission reductions calculation were conducted with the special version of Texas 2010 eGrid, based on their energy savings/generation.

In 2016, the total annual/OSD energy savings from each renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale) : 127,098 MWh/yr and 386 MWh/day;
  in addition, solar power projects (utility scale) : 836,565 MWh/yr and 2,292 MWh/day,
- solar thermal projects : 232 MWh/yr and 0.6 MWh/day,
- biomass projects : 622,434 MWh/yr and 1,705 MWh/day, and
- hydroelectric projects : 1,060,418 MWh/yr and 2,905 MWh/day.

In 2016, the annual NOx emission reductions from renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 98.6 tons/yr;
  in addition, solar power projects (utility scale): 171.7 tons/yr,
- solar thermal projects: 0.1 tons/yr,
- biomass projects: 153.4 tons/yr, and
- hydroelectric projects: 157.8 tons/yr.

Table 5: Number of Identified Projects for Other Renewable Sources

Renewable Energy Projects	Number of 2016 New Projects	Total Number of Projects
Solar Photovoltaic[11]	66	4,750
(Solar Power)	(7)	(23)
Solar Thermal	0	38
Biomass[12]	New: 1, Retired:4	18
Hydroelectric[13]	0	29
Geothermal	0	286
Landfill Gas-Fired[14]	0	35

[11] The Open PV project database of National Renewable Energy Laboratory (NREL) (https://openpv.nrel.gov/), which was checked in March, 2016, provides updated PV projects for 2006, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015. Thus, the total number of PV projects until 2016, including PV projects from various websites, is now 4,750. Previously, it was 4,534.
[12] This report includes one more biomass project information which was not identified in the previous year report; however, it does not mean the State of Texas has a new biomass power plant constructed in 2016.
[13] This report includes one more hydroelectric project information which was not identified in the previous year report; however, it does not mean the State of Texas has a new hydroelectric power plant constructed in 2016.
[14] Landfill gas-fired projects information from EPA have seven sub-categories for their status: operational, candidates, potential, construction, shutdown, planned, and other. EPA rearranged/added/removed some projects information within the seven sub-categories. Operational projects were considered for the number of the projects. This report includes four more (new) and two less (shutdown) operational landfill gas-fired project information which was not identified in the previous year report; however, the new operational projects do not mean the State of Texas has new landfill gas-fired projects constructed in 2016.

3.5 Review of electricity savings and transmission planning study reported by ERCOT

In this report, the information posted on ERCOT's Renewable Energy Credit (REC) Program site www.texasrenewables.com was reviewed. In particular, information posted under the "Public Reports" tab was downloaded and assembled into an appropriate format for review. This includes ERCOT's 2001 through 2016 reports to the Legislature and information from ERCOT's listing of REC generators.

Each year ERCOT is required to compile a list of grid-connected sources that generate electricity from renewable energy and report them to the Legislature. Table 6 contains the data reported by ERCOT from 2001 to 2016. Figure 7 is included to better illustrate the annual data collected by ERCOT. Other sources present different renewable electricity generation values on biomass, wind and hydro, but those are explained in general because the numbers reported in this report are focused on the ERCOT region.

Table 6: Annual Electricity Generation by Renewable Resources (MWh, ERCOT: 2001 - 2016)

Year	Biomass (MWh)	Hydro (MWh)	Landfill gas (MWh)	Solar (MWh)	Wind (MWh)	Total (MWh)
2001	0	30,639	0	0	565,597	596,236
2002	0	312,093	29,412	87	2,451,484	2,793,076
2003	39,496	239,684	154,206	220	2,515,482	2,949,087
2004	36,940	234,791	203,443	211	3,209,630	3,685,014
2005	58,637	310,302	213,777	227	4,221,568	4,804,512
2006	60,569	210,077	306,087	470	6,530,928	7,108,131
2007	54,101	382,882	356,339	1,844	9,351,168	10,146,333
2008	70,833	445,428	387,110	3,338	16,286,440	17,193,150
2009	73,364	507,507	412,923	4,492	20,596,105	21,594,390
2010	97,535	609,257	464,904	14,449	26,828,660	28,014,805
2011	137,004	267,113	497,645	36,580	30,769,674	31,708,016
2012	288,988	389,197	549,037	139,439	32,746,534	34,113,195
2013	200,564	294,238	550,845	178,326	36,909,385	38,133,358
2014	343,469	240,792	518,580	312,757	40,644,362	42,059,961
2015	349,600	414,289	561,915	410,318	45,165,341	46,901,462
2016	247,643	393,740	518,403	847,808	57,796,161	59,803,756

NOTE: The REC Program tracks renewable generation in Texas, including non-ERCOT regions of Texas[15].

[15] https://www.texasrenewables.com/reports.asp

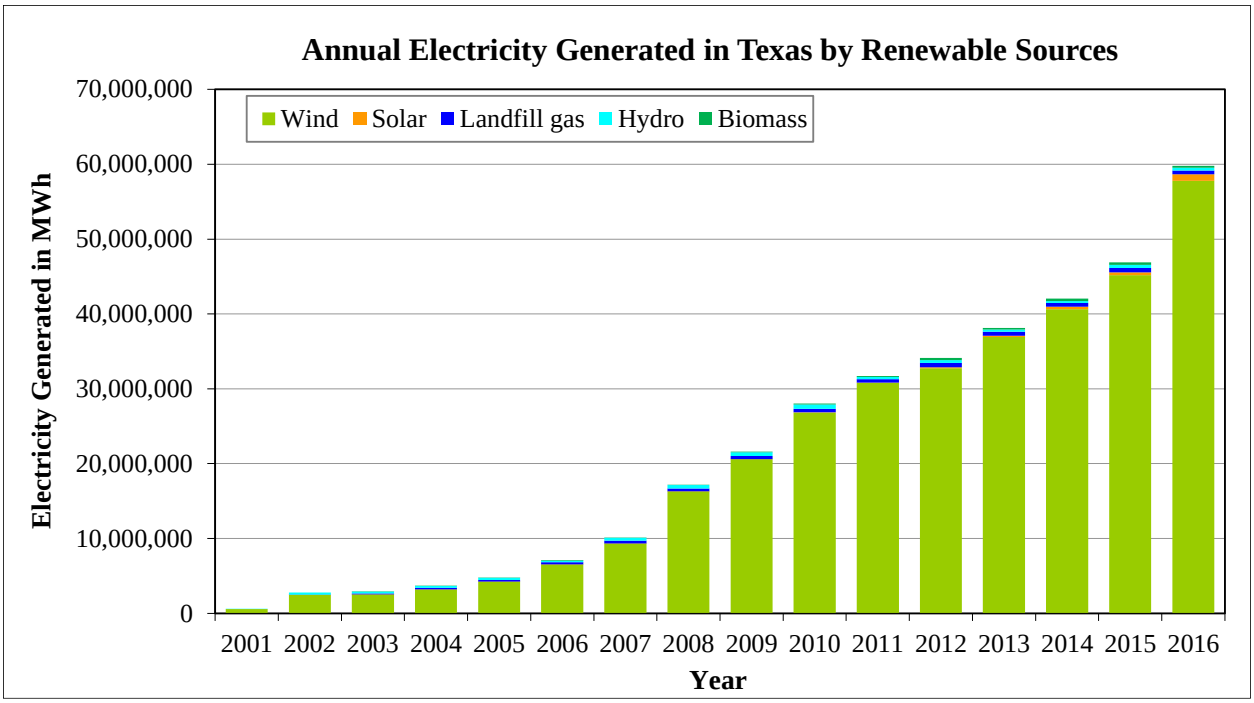


Figure 7: Electricity Generation by Renewable Resources (ERCOT: 2001–2016 Annual)

4 Calculated NOx Reductions Potential from Energy Savings of New Construction in 2016

A complete reporting of the savings, using 2008 base year (the implementation of the 2015 IECC and the ASHRAE Standard 90.1-2013), requires tracking and analyzing savings for new construction buildings that undergo a building permit. The adoption of the energy code and standard in Texas is expected to impact the following types of buildings:

- single-family residential
- multi-family residential
- commercial
- industrial

The following sections report the calculated energy savings associated with new construction activities for both residential (i.e., single-family and multi-family[16]) and commercial buildings.

4.1 2016 Results for New Single-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NOx emissions reductions in 2016 using the 2008 base year which implemented the 2015 IECC for new single-family residences in the 36 non-attainment and affected counties as well as other counties in the ERCOT region[17]. To calculate the NOx emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2016 building permits per county was obtained from the real estate center at Texas A&M University (REC 2017). Next, energy savings attributable to the 2015 IECC were calculated using the Laboratory's code-traceable, DOE-2.1e simulation, which was developed for the TERP. For the savings calculation, the 2016 Home Innovation Research Labs (HIRL) data[18] were used to determine the appropriate construction data corresponding to housing types. Then the NOx reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2010 eGRID database[19].

In Table 7[20], the 2016 new single-family and 2015 IECC code-compliant building characteristics are shown for each county. The building characteristics reflect those published by the HIRL, ARI, and GAMA for Texas. The 2015 IECC code-compliant characteristics are the minimum building code characteristics required for each county for single-family residences (i.e., Type A.1). In Table 7, the rows are first sorted by the US EPA's non-attainment, affected designation, and then other ERCOT counties alphabetically. Next, in the fourth column, the HIRL's survey classification is listed. The fifth through eighth columns show the HIRL's survey data: average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation, and wall insulation, respectively. In addition, the ninth through twelfth columns show the 2015 IECC minimum requirements for glazing U-value, SHGC, roof insulation, and wall insulation.

The corresponding values in IECC and effective regulations are applied to the air-conditioner efficiency, furnace efficiency (AFUE), and domestic water heater efficiency. The values shown in : 2016 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences represent the only changes that were made to the simulation to obtain the savings calculations. In cases where the 2016 values were more efficient than the 2015 IECC requirements, the 2016 values were used in the 2016 new

[16] The potential energy savings and NOx reductions analysis from energy savings of new single- and multi-family constructions in 2016 includes the related provisions for both *systems* and *envelope* in 2015 IECC, whereas in previous years analysis only the related provisions to the *envelope* from the corresponding code were included.
[17] The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.
[18] In 2013, the NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: http://www.homeinnovation.com
[19] This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated.
[20] Hardin, Jefferson, and Orange Counties were removed from Table 7and : 2016 Annual Electricity Savings from New Single-family Residences because since 2012 they are not in the category of "Nonattainment County" based on [http://www.tceq.texas.gov/airquality/sip/bpa/bpa-status], and these counties do not belong to ERCOT region.

single-family simulations. Otherwise, the 2015 IECC values were used in both simulations[21]. For example, in the Collin County, according to the HIRL's survey data, the roof insulation is R-25.77, which is less than the code-required insulation of R-38. Therefore, R-38 was used in the 2016 simulation.

In Table 8, the code-traceable simulation results for single-family residences are shown for each county. In a similar fashion to Table 7, Table 8 is first divided into the US EPA's non-attainment and affected classifications, followed by an alphabetical list of other ERCOT counties. In the third column, the 2015 IECC climate zone is listed followed by the number of new projected housing units[22] in the fourth column. In the fifth column, the total simulated energy use is listed if all new Construction had been built to pre-code specifications. In the sixth column, the total county-wide energy use for code-compliant Construction is shown. The values in the fifth and sixth columns come from the associated 24 simulation runs for each county, which were then distributed according to the HIRL's survey data, to account for 1 story, 2 story, slab-on-grade, crawlspace, and three different system types (i.e., central air conditioning with electric resistance heating, heat pump heating, or a natural gas-fired furnace). In the seventh column, the total annual electricity savings are shown for each county. A 7% transmission and distribution loss is used in the 2016 report, which represents a fixed 1.07 multiplier for the electricity use. In the eighth and ninth columns, the total annual pre-code and code-compliant natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Finally, in the tenth column, the total annual natural gas savings are shown for each county.

In Table 9, the Congestion Management (CM) Zones[23] assignments for each county are shown. In Table 10, the annual electricity savings are assigned to CM Zones provider(s) according to Table 9[24]. The total electricity savings for each CM Zone, as shown in Table 10, then entered into the bottom row of Table 11, which is the 2010 US EPA's eGRID database[25] for Texas. Next, the county's NOx reductions (lbs) are calculated using the assigned 2010 eGrid proportions (lbs-NOx/MWh) to each CM zone in the county. The calculated NOx reductions are presented in the columns adjacent to the corresponding CM Zone columns. By adding the NOx reductions values in each row, then, the total of the NOx reductions per county (lbs and Tons) is calculated. Counties that do not show NOx reductions represent counties that do not have power plants in eGRID's database.

[21] 2016 HIRL data and 2015 IECC are used for the 2016 new code-compliant simulations and 2008 NAHB data and 2006 IECC are used for the base-year simulations

[22] The number of the new housing units in 2016 were obtained from the Real Estate Center at Texas A&M University.

[23] ERCOT region has employed the Congestion Management (CM) since 2010, and it is currently divided into four zones: Houston (H), North (N), South (S), and West (W).

[24] Of a total of 202 counties, 138 counties are not included in this table since the corresponding providers could not be assigned for these 138 counties.

[25] This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 7%. Counties were assigned to CM Zones as indicated.

Table 7: 2016 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences

	County	Climate Zone	Division	2016 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	COLLIN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	EL PASO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ELLIS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	HARRIS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	JOHNSON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KAUFMAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	LIBERTY	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	MONTGOMERY	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	PARKER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ROCKWALL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	WALLER	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WISE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
Affected	BASTROP	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	BEXAR	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	CALDWELL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	COMAL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	GREGG	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	GUADALUPE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	HARRISON	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	NUECES	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	RUSK	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	SMITH	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	UPSHUR	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
ERCOT	ANDERSON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	ANDREWS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ANGELINA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	ARANSAS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	ARCHER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ATASCOSA	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	AUSTIN	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	BANDERA	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	BASTROP	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	BAYLOR	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	BEE	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	BELL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	BEXAR	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	BLANCO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	BORDEN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	BOSQUE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	BRAZORIA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	BRAZOS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	BREWSTER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	BRISCOE	4	West Texas	0.39	0.53	25.772	14.358	0.35	0.4	49	20
	BROOKS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	BROWN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	BURLESON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	BURNET	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CALDWELL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	CALHOUN	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	CALLAHAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CAMERON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	CHEROKEE	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	CHILDRESS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CLAY	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	COKE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	COLEMAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	COLLIN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	COLORADO	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	COMAL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	COMANCHE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CONCHO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	COOKE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CORYELL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	COTTLE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CRANE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CROCKETT	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CROSBY	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	CULBERSON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DAWSON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DE WITT	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	DELTA	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DICKENS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	DIMMIT	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	DUVAL	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	EASTLAND	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ECTOR	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	EDWARDS	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	ELLIS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ERATH	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	FALLS	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	FANNIN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	FAYETTE	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	FISHER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	FOARD	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	FRANKLIN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	FREESTONE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13

Table 7: 2016 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences (Continued)

	County	Climate Zone	Division	2016 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft²-F)	SHGC	Roof Insulation (hr-ft²-F/Btu)	Wall Insulation (hr-ft²-F/Btu)	Glazing U-value (Btu/hr-ft²-F)	SHGC	Roof Insulation (hr-ft²-F/Btu)	Wall Insulation (hr-ft²-F/Btu)
ERCOT	FRIO	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	GILLESPIE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	GLASSCOCK	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	GOLIAD	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	GONZALES	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	GRAYSON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	GREGG	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	GUADALUPE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	HALL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HAMILTON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HARDEMAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HARRIS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	HASKELL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	HENDERSON	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	HIDALGO	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	HILL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	HOOD	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HOPKINS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HOUSTON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	HOWARD	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HUDSPETH	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	HUNT	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	IRION	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	JACK	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	JACKSON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	JEFF DAVIS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	JIM HOGG	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	JIM WELLS	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	JOHNSON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	JONES	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KARNES	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	KAUFMAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KENDALL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KENEDY	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	KENT	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KERR	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KIMBLE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KING	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	KINNEY	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	KLEBERG	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	KNOX	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	LA SALLE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	LAMAR	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	LAMPASAS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	LAVACA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	LEE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	LEON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	LIMESTONE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	LIVE OAK	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	LLANO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	LOVING	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MADISON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	MARTIN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MASON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MATAGORDA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	MAVERICK	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	MCCULLOCH	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MCLENNAN	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	MCMULLEN	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	MEDINA	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	MENARD	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MIDLAND	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MILAM	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	MILLS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MITCHELL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MONTAGUE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	MONTGOMERY	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	MOTLEY	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	NACOGDOCHES	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	NAVARRO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	NOLAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	NUECES	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	PALO PINTO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	PECOS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	PRESIDIO	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	RAINS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	REAGAN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	REAL	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	RED RIVER	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	REEVES	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	REFUGIO	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	ROBERTSON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	RUNNELS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	SAN SABA	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	SCHLEICHER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	SCURRY	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	SHACKELFORD	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	SMITH	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	SOMERVELL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	STARR	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	STEPHENS	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	STERLING	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	STONEWALL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	SUTTON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	TAYLOR	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	TERRELL	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	THROCKMORTON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	TITUS	3	East Texas	0.39	0.53	25.604	13.533	0.35	0.25	38	20
	TOM GREEN	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	UPTON	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	UVALDE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	VAL VERDE	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	VAN ZANDT	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WALLER	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WARD	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	WASHINGTON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WEBB	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	WHARTON	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WICHITA	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	WILBARGER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	WILLACY	2	East Texas	0.39	0.53	25.604	13.533	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	WINKLER	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	YOUNG	3	West Texas	0.39	0.53	25.772	14.358	0.35	0.25	38	20
	ZAPATA	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13
	ZAVALA	2	West Texas	0.39	0.53	25.772	14.358	0.4	0.25	38	13

Table 8: 2016 Annual Electricity Savings from New Single-family Residences

2016 Summary TRY 2008									
	County	Climate Zone	No. of Projected Units (2014)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
Nonattain-ment County	BRAZORIA	3	2,909	52,995	47,650	5,719	509,600	478,255	31,346
	CHAMBERS	3	295	5,312	4,801	547	51,702	49,384	2,319
	COLLIN	3	8,197	146,437	128,838	18,831	2,510,414	2,358,144	152,270
	DALLAS	3	5,152	91,900	80,948	11,718	1,588,578	1,490,194	98,384
	DENTON	3	6,212	110,976	97,638	14,271	1,902,488	1,787,092	115,396
	EL PASO	2	2,219	38,923	33,957	5,313	626,868	599,495	27,373
	ELLIS	3	1,446	25,793	22,720	3,289	445,863	418,249	27,613
	FORT BEND	3	9,777	178,135	160,151	19,242	1,712,741	1,604,489	108,252
	GALVESTON	3	2,209	40,243	36,184	4,343	386,974	363,171	23,803
	HARRIS	2	15,511	282,607	254,077	30,528	2,717,226	2,545,488	171,739
	JOHNSON	2	516	9,204	8,107	1,174	159,104	149,251	9,854
	KAUFMAN	2	446	7,968	7,010	1,025	136,592	128,307	8,285
	LIBERTY	2	456	8,312	7,471	900	79,689	74,640	5,049
	MONTGOMERY	3	4,175	76,068	68,388	8,217	731,379	685,153	46,226
	PARKER	2	408	7,289	6,413	937	124,954	117,375	7,579
	ROCKWALL	2	1,116	19,937	17,541	2,564	341,786	321,055	20,731
	TARRANT	2	5,831	104,012	91,617	13,263	1,797,942	1,686,592	111,351
	WALLER	2	13	237	213	26	2,277	2,133	144
	WISE	3	70	1,251	1,100	161	21,438	20,138	1,300
Affected County	BASTROP	2	138	2,645	2,355	310	27,475	24,689	2,786
	BEXAR	2	3,283	58,608	52,196	6,861	758,406	677,023	81,383
	CALDWELL	3	322	5,782	5,155	672	77,969	70,154	7,814
	COMAL	3	1,917	34,222	30,478	4,006	442,846	395,325	47,521
	GREGG	3	157	3,017	2,688	353	36,409	36,078	332
	GUADALUPE	2	903	16,120	14,357	1,887	208,602	186,217	22,385
	HARRISON	2	40	768	685	88	9,376	9,265	112
	HAYS	2	1,895	34,044	30,341	3,962	458,852	411,879	46,973
	NUECES	3	1,212	22,225	19,845	2,547	158,494	149,464	9,031
	RUSK	2	2	37	33	4	393	385	8
	SAN PATRICIO	2	232	4,254	3,799	488	30,339	28,610	1,729
	SMITH	2	454	8,708	7,775	999	106,806	105,481	1,325
	TRAVIS	3	7,172	128,846	114,832	14,995	1,736,615	1,558,836	177,779
	UPSHUR	3	5	98	87	12	1,266	1,187	79
	VICTORIA	2	62	1,116	1,000	124	9,095	8,631	464
	WILLIAMSON	3	3,800	68,267	60,842	7,945	920,125	825,931	94,194
	WILSON	2	52	928	827	109	12,013	10,723	1,289
ERCOT	ANDERSON	2	13	238	211	29	2,555	2,501	54
	ANDREWS	3	8	155	137	19	1,809	1,706	102
	ANGELINA	2	60	1,100	976	133	11,792	11,545	247
	ARANSAS	2	187	3,429	3,062	393	24,454	23,061	1,393
	ARCHER	3	5	96	85	13	2,070	1,932	138
	ATASCOSA	2	34	607	541	71	7,862	7,029	833
	AUSTIN	2	22	401	360	43	3,854	3,610	244
	BANDERA	2	1	18	16	2	230	213	17
	BAYLOR	3	0	0	0	0	0	0	0
	BEE	2	7	126	113	14	1,027	975	52
	BELL	2	1,581	28,401	25,389	3,223	465,565	420,222	45,342
	BLANCO	3	13	234	208	27	3,148	2,826	322
	BORDEN	3	19	394	355	41	7,113	6,698	414
	BOSQUE	2	1	18	16	2	294	266	29
	BRAZOS	2	1,127	20,534	18,461	2,218	197,429	184,950	12,478
	BREWSTER	3	5	90	80	12	1,769	1,658	111
	BRISCOE	4	7	139	124	16	4,335	4,038	297
	BROOKS	2	1	34	30	4	212	196	16
	BROWN	3	85	1,527	1,365	173	25,030	22,593	2,438
	BURLESON	2	12	219	197	24	2,102	1,969	133
	BURNET	3	354	6,360	5,668	740	85,717	76,942	8,775
	CALHOUN	2	60	1,080	968	120	8,802	8,353	449
	CALLAHAN	3	2	36	32	5	706	659	47
	CAMERON	2	1,217	22,616	20,037	2,759	138,733	128,441	10,293
	CHEROKEE	2	6	110	98	13	1,179	1,154	25
	CHILDRESS	3	0	0	0	0	0	0	0
	CLAY	3	3	58	51	8	1,242	1,159	83
	COKE	3	0	0	0	0	0	0	0
	COLEMAN	3	0	0	0	0	0	0	0
	COLORADO	2	22	401	360	43	3,854	3,610	244
	COMANCHE	3	1	18	16	2	294	266	29
	CONCHO	3	1	18	16	2	354	332	22
	COOKE	3	51	910	801	117	15,699	14,725	974
	CORYELL	2	156	2,802	2,505	318	45,938	41,464	4,474
	COTTLE	3	0	0	0	0	0	0	0
	CRANE	3	13	231	204	29	4,624	4,356	268
	CROCKETT	3	19	344	302	44	6,723	6,302	421
	CROSBY	3	9	187	168	20	3,369	3,173	196
	CULBERSON	3	3	53	46	7	847	810	37
	DAWSON	3	0	0	0	0	0	0	0
	DE WITT	2	3	54	48	6	440	418	22
	DELTA	3	0	0	0	0	0	0	0
	DICKENS	3	0	0	0	0	0	0	0
	DIMMIT	2	7	125	111	14	1,185	1,068	117
	DUVAL	2	0	0	0	0	0	0	0
	EASTLAND	3	0	0	0	0	0	0	0
	ECTOR	3	448	7,963	7,014	1,016	159,129	150,125	9,005
	EDWARDS	2	0	0	0	0	0	0	0
	ERATH	3	36	655	574	87	12,707	11,863	844
	FALLS	2	3	54	48	6	883	797	86
	FANNIN	3	27	482	424	62	8,311	7,796	516
	FAYETTE	2	8	146	131	16	1,401	1,313	89
	FISHER	3	0	0	0	0	0	0	0
	FOARD	3	0	0	0	0	0	0	0
	FRANKLIN	3	0	0	0	0	0	0	0
	FREESTONE	2	6	108	96	12	1,767	1,595	172
	FRIO	2	7	125	111	15	1,619	1,447	172

Table 8: 2016 Annual Electricity Savings from New Single-family Residences (Continued)

2016 Summary TRY 2008									
	County	Climate Zone	No. of Projected Units (2014)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
ERCOT	GILLESPIE	3	49	880	785	102	11,865	10,650	1,215
	GLASSCOCK	3	0	0	0	0	0	0	0
	GOLIAD	2	3	54	48	6	440	418	22
	GONZALES	2	9	161	143	19	2,079	1,856	223
	GRAYSON	3	374	6,677	5,877	855	115,125	107,983	7,142
	GRIMES	2	39	711	639	77	6,832	6,400	432
	HALL	3	0	0	0	0	0	0	0
	HAMILTON	3	6	108	96	12	1,767	1,595	172
	HARDEMAN	3	0	0	0	0	0	0	0
	HASKELL	3	2	36	32	5	706	659	47
	HENDERSON	2	40	767	685	88	9,410	9,294	117
	HIDALGO	2	2,921	54,281	48,091	6,623	332,983	308,279	24,704
	HILL	2	8	144	128	16	2,356	2,126	229
	HOPKINS	3	10	179	157	23	3,063	2,877	186
	HOUSTON	2	0	0	0	0	0	0	0
	HOWARD	3	23	409	360	52	8,170	7,707	462
	HOOD	2	132	2,355	2,074	300	40,701	38,180	2,521
	HUDSPETH	3	0	0	0	0	0	0	0
	HUNT	2	166	2,963	2,609	380	51,098	47,928	3,170
	IRION	3	0	0	0	0	0	0	0
	JACK	3	2	36	32	5	706	659	47
	JACKSON	2	11	198	177	22	1,614	1,531	82
	JEFF DAVIS	3	0	0	0	0	0	0	0
	JIM HOGG	2	0	0	0	0	0	0	0
	JIM WELLS	2	15	275	246	32	1,962	1,850	112
	JONES	3	0	0	0	0	0	0	0
	KARNES	2	49	849	760	95	9,321	8,413	908
	KENDALL	3	245	4,371	3,805	606	56,342	52,291	4,051
	KENEDY	2	0	0	0	0	0	0	0
	KENT	3	0	0	0	0	0	0	0
	KERR	3	60	1,078	961	125	14,528	13,041	1,487
	KIMBLE	3	0	0	0	0	0	0	0
	KING	3	0	0	0	0	0	0	0
	KINNEY	2	0	0	0	0	0	0	0
	KLEBERG	2	9	165	147	19	1,177	1,110	67
	KNOX	3	0	0	0	0	0	0	0
	LA SALLE	2	3	53	48	6	508	458	50
	LAMAR	3	26	499	445	58	6,092	6,021	72
	LAMPASAS	3	45	808	723	92	13,251	11,961	1,291
	LAVACA	2	27	486	435	54	3,949	3,744	205
	LEE	2	13	233	208	27	3,148	2,832	315
	LEON	2	0	0	0	0	0	0	0
	LIMESTONE	2	3	54	48	6	883	797	86
	LIVE OAK	2	7	128	115	15	915	863	52
	LLANO	3	226	4,060	3,619	473	54,723	49,121	5,602
	LOVING	3	0	0	0	0	0	0	0
	MADISON	2	5	91	82	10	876	821	55
	MARTIN	3	4	71	63	9	1,421	1,340	80
	MASON	3	3	54	48	6	726	652	74
	MATAGORDA	2	82	1,476	1,322	164	12,029	11,416	613
	MAVERICK	2	64	1,140	1,017	131	10,834	9,766	1,068
	MCCULLOCH	3	1	18	16	2	354	332	22
	MCLENNAN	2	637	11,443	10,229	1,299	187,580	169,312	18,269
	MCMULLEN	2	0	0	0	0	0	0	0
	MEDINA	2	29	518	461	61	6,699	5,980	719
	MENARD	3	0	0	0	0	0	0	0
	MIDLAND	3	632	11,234	9,895	1,433	224,486	211,783	12,703
	MILAM	2	7	121	109	13	1,586	1,416	170
	MILLS	3	0	0	0	0	0	0	0
	MITCHELL	3	0	0	0	0	0	0	0
	MONTAGUE	3	1	18	16	2	308	289	19
	MOTLEY	3	0	0	0	0	0	0	0
	NACOGDOCHES	3	24	440	390	53	4,717	4,618	99
	NAVARRO	3	167	3,000	2,682	340	49,177	44,388	4,789
	NOLAN	3	1	18	16	2	353	330	23
	PALO PINTO	3	9	164	143	22	3,177	2,966	211
	PECOS	3	112	2,025	1,781	262	39,632	37,148	2,484
	PRESIDIO	3	11	199	175	26	3,892	3,648	244
	RAINS	3	1	18	16	2	306	288	19
	REAGAN	3	1	18	16	2	356	335	21
	REAL	2	0	0	0	0	0	0	0
	RED RIVER	3	6	115	103	13	1,406	1,389	17
	REEVES	3	3	53	47	7	1,066	1,005	60
	REFUGIO	2	7	126	113	14	1,027	975	52
	ROBERTSON	2	79	1,439	1,294	155	13,839	12,965	875
	RUNNELS	3	2	36	32	5	708	663	44
	SAN SABA	3	7	126	112	15	1,695	1,521	174
	SCHLEICHER	3	1	18	16	2	354	332	22
	SCURRY	3	8	166	150	17	2,995	2,820	175
	SHACKELFORD	3	0	0	0	0	0	0	0
	SOMERVELL	3	11	196	173	25	3,392	3,182	210
	STARR	2	4	74	66	9	456	422	34
	STEPHENS	3	2	36	32	5	706	659	47
	STERLING	3	0	0	0	0	0	0	0
	STONEWALL	3	0	0	0	0	0	0	0
	SUTTON	3	12	217	191	28	4,246	3,980	266
	TAYLOR	3	296	5,389	4,719	718	104,479	97,536	6,943
	TERRELL	3	0	0	0	0	0	0	0
	THROCKMORTON	3	0	0	0	0	0	0	0
	TITUS	3	19	365	325	42	4,452	4,400	52
	TOM GREEN	3	172	3,110	2,735	402	60,864	57,049	3,815
	UPTON	3	0	0	0	0	0	0	0
	UVALDE	2	19	339	302	40	4,389	3,918	471
	VAL VERDE	2	93	1,660	1,479	194	21,484	19,179	2,305
	VAN ZANDT	3	28	500	440	64	8,575	8,055	520
	WARD	3	3	53	47	7	1,066	1,005	60
	WASHINGTON	2	72	1,312	1,179	142	12,613	11,816	797
	WEBB	2	945	16,827	15,019	1,935	159,968	144,200	15,768
	WHARTON	2	82	1,476	1,322	164	12,029	11,416	613
	WICHITA	3	86	1,659	1,454	219	35,609	33,234	2,376
	WILBARGER	3	1	19	17	3	414	386	28
	WILLACY	2	37	688	609	84	4,218	3,905	313
	WINKLER	3	0	0	0	0	0	0	0
	WISE	3	70	1,251	1,100	161	21,438	20,138	1,300
	YOUNG	3	10	182	159	24	3,530	3,295	235
	ZAPATA	2	0	0	0	0	0	0	0
	ZAVALA	2	4	71	64	8	677	610	67
	TOTAL		102,647			217,883			1,700,624

Table 9: Allocation of CM Zones for Each of Applicable ERCOT Counties

County	Plant	CM Zones Percentage			
		H	N	W	S
Andrews	Fullerton	0.10	0.58	99.31	0.01
Atascosa	San Miguel	11.04	0.74	0.04	88.18
Bastrop	Bastrop Energy Center	11.04	0.74	0.04	88.18
	Lost Pines 1 Power Project				
	Sim Gideon 1				
	Sim Gideon 2				
	Sim Gideon 3				
Bexar	Arthur Von Rosenberg	11.04	0.74	0.04	88.18
	Covel Gardens				
	J K Spruce				
	J K Spruce 2				
	J T Deely 1				
	J T Deely 2				
	Leon Creek				
	O W Sommers 1				
	O W Sommers 2				
	University of Texas at San Antonio				
	V H Braunig 1				
	V H Braunig 2				
	V H Braunig 3				
	V H Braunig 6				
	W B Tuttle				
Bosque	Bosque County Peaking	13.35	81.87	3.95	0.84
Brazoria	BASF Freeport Works	99.06	0.01	0.00	0.93
	Chocolate Bayou Plant				
	Chocolate Bayou Works				
	Dow Chemical Texas Operation				
	Freeport Energy Center (expansion)				
	Oyster Creek Unit VIII				
	Sweeny Cogen Facility				
Brazos	Bryan 3	13.09	72.93	3.52	10.45
	Bryan 4				
	Bryan 5				
	Bryan 6				
	Bryan 7				
	Dansby 1				
	Dansby 2				
	Dansby 3				
Calhoun	Point Comfort Operations	11.04	0.74	0.04	88.18
	Seadrift Coke LP				
	Union Carbide Seadrift Cogen				
Cameron	La Palma 4	11.04	0.74	0.04	88.18
	La Palma 5				
	La Palma 6				
	La Palma 7				
	Silas Ray				
Chambers	Baytown Energy Center	99.06	0.01	0.00	0.93
	Cedar Bayou 1				
	Cedar Bayou 2				
	Enterprise Products Operating				
Cherokee	Stryker Creek 1	13.35	81.87	3.95	0.84
	Stryker Creek 2				
	Stryker Creek 3				
Coke	Jameson Gas Processing Plant	0.00	0.00	0.00	0.00
Collin	Ray Olinger 2	13.35	81.87	3.95	0.84
	Ray Olinger 3				
	Ray Olinger 4				
	Ray Olinger 5				
	University of Texas at Dallas				
Dallas	C E Newman	13.35	81.87	3.95	0.84
	Lake Hubbard 1				
	Lake Hubbard 2				
	Mountain Creek				
	State Farm Insur Support Center Central				
Denton	Spencer 4	13.35	81.87	3.95	0.84
	Spencer 5				
Ector	Odessa Ector Generating Station	0.97	0.60	91.36	7.07
	Quail Run Energy Center				
	Quail Run Energy Center				
	Quail Run Energy Center				
Ellis	Ennis Tractebel Power LP	13.35	81.87	3.95	0.84
	Midlothian Energy Facility				
Fannin	Valley	13.35	81.87	3.95	0.84
Fayette	Fayette Power Project	11.89	30.55	1.48	56.09
	Winchester Power Park				
Fort Bend	Brazos Valley Generating Facility	99.06	0.01	0.00	0.93
	W A Parish 1				
	W A Parish 2				
	W A Parish 3				
	W A Parish 4				
	W A Parish 5				
	W A Parish 7 (Uprated)				
	W A Parish 8				
	W A Parish GT1				
Freestone	Big Brown 1 (Upgrade)	13.35	81.87	3.95	0.84
	Big Brown 2				
	Freestone Power Generation LP				
Frio	Pearsall 1	0.10	0.58	99.31	0.01
	Pearsall 2				
	Pearsall 3				
Galveston	Green Power 2	99.06	0.01	0.00	0.93
	P H Robinson				
	Power Station 4				
	S&L Cogeneration				
	Texas City Plant Union Carbide				
	Texas City Power Plant				
	Valero Refining Texas City				
Goliad	Coleto Creek	0.00	0.00	0.00	0.00
Grimes	Gibbons Creek	0.00	0.00	0.00	0.00
Guadalupe	Guadalupe Generating Station	11.04	0.74	0.04	88.18
	Rio Nogales Power Project				

Table 9: Allocation of CM Zones for Each of Applicable ERCOT Counties (Continued)

County	Plant	CM Zones Percentage			
		H	N	W	S
Harris	AES Deepwater	99.06	0.01	0.00	0.93
	Altura Cogen				
	Bayou Cogen Plant				
	Cedar Bayou 4				
	Channel Energy Center				
	Channelview Cogeneration Plant				
	Clear Lake Cogeneration Ltd				
	Deepwater				
	Deer Creek Energy Center				
	Deer Park Energy Center				
	Exelon LaPorte Generating Station				
	ExxonMobil Baytown Refinery				
	ExxonMobil Baytown Turbine				
	Greens Bayou 5				
	Greens Bayou Others				
	Hiram Clarke				
	Houston Chemical Complex Battleground				
	Pasadena				
	Pasadena Cogeneration				
	Rice University				
	Sam Bertron 1				
	Sam Bertron 2				
	Sam Bertron 3				
	Sam Bertron 4				
	Sam Bertron Others				
	San Jacinto Steam Electric Station				
	Shell Deer Park				
	T H Wharton				
	Texas Medical Center				
	Texas Petrochemicals				
	Valero Refining Texas Houston				
	Webster				
	Westhollow Technology Center				
Hays	Hays Energy Project	11.04	0.74	0.04	88.18
	Southwest Texas State University				
Henderson	Trinidad	13.35	81.87	3.95	0.84
Hidalgo	Frontera Energy Center	11.04	0.74	0.04	88.18
	Hidalgo Energy Center				
	J L Bates 1				
	J L Bates 2				
	Magic Valley Generating Station				
Hood	DeCordova Steam Electric Station 1	13.35	81.87	3.95	0.84
	DeCordova Steam Electric Station CTs				
	Wolf Hollow I, L.P.				
Howard	Big Spring Carbon Plant	0.20	0.59	98.34	0.87
	C R Wing Cogen Plant				
Hunt	Engine Plant	11.08	2.24	0.11	86.57
	Greenville				
	Powerlane Plant				
Jack	Jack County Project	13.35	81.87	3.95	0.84
	Jack Energy Facility				
Johnson	Johnson County	13.35	81.87	3.95	0.84
Kaufman	Forney Energy Center	13.35	81.87	3.95	0.84
Lamar	Lamar Power Project	13.35	81.87	3.95	0.84
	Paris Generating Station				
Limestone	Limestone 1	0.00	0.00	0.00	0.00
	Limestone 2 (Uprated)				
Llano	Thomas C Ferguson	11.04	0.74	0.04	88.18
McLennan	Baylor University Cogen	13.35	81.87	3.95	0.84
	Lake Creek				
	Tradinghouse 1				
	Tradinghouse 2				
Milam	Sandow 5	11.04	0.74	0.04	88.18
	Sandow No 4				
	Sandow Station				
Mitchell	Morgan Creek	0.10	0.58	99.31	0.01
Nolan	TXU Sweetwater Generating Plant	0.10	0.58	99.31	0.01
Nueces	Barney M. Davis 1	11.04	0.74	0.04	88.18
	Barney M. Davis 2				
	Barney M. Davis Power Plant (repowering)				
	Celanese Engineering Resin				
	Corpus Christi				
	Corpus Christi Energy Center				
	Corpus Refinery				
	Nueces Bay Power Plant (repowering)				
	Valero Refinery Corpus Christi East				
	Valero Refinery Corpus Christi West				
Palo Pinto	R W Miller 1	13.35	81.87	3.95	0.84
	R W Miller 2				
	R W Miller 3				
	R W Miller Others				
Parker	North Texas	13.35	81.87	3.95	0.84
	Weatherford				
Pecos	Yates Gas Plant	0.10	0.58	99.31	0.01
Reagan	Midkiff Plant	0.10	0.58	99.31	0.01
Robertson	Oak Grove 1	11.34	11.28	0.55	76.83
	Oak Grove 2				
	Twin Oaks Power One 1				
	Twin Oaks Power One 2				
Rusk	Martin Lake	0.00	0.00	0.00	0.00
San Patricio	Gregory Power Facility	11.04	0.74	0.04	88.18
	Ingleside Cogeneration				
Scurry	EG178 Facility	0.10	0.58	99.31	0.01
Tarrant	Eagle Mountain	13.35	81.87	3.95	0.84
	Handley				
Titus	Monticello	0.00	0.00	0.00	0.00

Table 9: Allocation of CM Zones for Each of Applicable ERCOT Counties (Continued)

County	Plant	CM Zones Percentage			
		H	N	W	S
Travis	Central Utility Plant	11.04	0.74	0.04	88.18
	Decker Creek 1				
	Decker Creek 2				
	Decker Creek GT (1-4)				
	Hal C Weaver Power Plant				
	Holly Street 3				
	Holly Street 4				
	Mueller Energy Center				
	Sand Hill				
Upton	Benedum Plant	0.10	0.58	99.31	0.01
Victoria	Sam Rayburn	11.04	0.74	0.04	88.18
	Victoria (refurbish)				
	Victoria Texas Plant				
Ward	Permian Basin 5	0.10	0.58	99.31	0.01
	Permian Basin 6				
	Permian Basin Others				
Webb	Laredo 1	11.04	0.74	0.04	88.18
	Laredo 2				
	Laredo 3				
	Laredo Energy Center (refurbish)				
Wharton	Colorado Bend Energy Center	11.04	0.74	0.04	88.18
	Colorado Bend Energy Center				
	Colorado Bend Energy Center				
	New gulf Cogen				
Wichita	PPG Industries Works 4	0.10	0.58	99.31	0.01
	Signal Hill Wichita Falls Power LP				
Wilbarger	Oklaunion	13.35	81.87	3.95	0.84
Wise	Bridgeport Gas Processing Plant	13.35	81.87	3.95	0.84
	Wise County Power LP				
Young	Graham 1	13.35	81.87	3.95	0.84
	Graham 2				

Table 10: 2016 Totalized Annual Electricity Savings by CM Zone from New Single-family Residences

CM Zone	Total Electricity Savings by CM Zone (MWh) [2016-TRY 2008]
Houston (H)	73,840
North (N)	56,475
West (W)	4,246
South (S)	40,086
Total	174,648

Table 11: 2016 Annual NOx Reductions from New Single-family Residences Using 2010 eGRID

Area	County	H	NOx Reductions (lbs)	N	NOx Reductions (lbs)	W	NOx Reductions (lbs/year)	S	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.0562032	4150.05	0.0000071	0.40	0.0000003	0.00	0.0005265	21.11	4171.57	2.09
	Chambers	0.0204500	1510.03	0.0000026	0.15	0.0000001	0.00	0.0001916	7.68	1517.86	0.76
	Fort Bend	0.0313463	2314.62	0.0000040	0.22	0.0000002	0.00	0.0002937	11.77	2326.62	1.16
	Galveston	0.0226620	1673.36	0.0000029	0.16	0.0000001	0.00	0.0002123	8.51	1682.04	0.84
	Harris	0.1486911	10979.38	0.0000189	1.07	0.0000009	0.00	0.0013930	55.84	11036.29	5.52
Dallas/ Fort Worth Area	Collin	0.0012932	95.49	0.0079329	448.01	0.0003832	1.63	0.0000809	3.24	548.37	0.27
	Dallas	0.0024826	183.32	0.0152295	860.09	0.0007356	3.12	0.0001554	6.23	1052.75	0.53
	Denton	0.0001267	9.35	0.0007770	43.88	0.0000375	0.16	0.0000079	0.32	53.71	0.03
	Tarrant	0.0004742	35.01	0.0029089	164.28	0.0001405	0.60	0.0000297	1.19	201.08	0.10
	Ellis	0.0029920	220.93	0.0183544	1036.56	0.0008865	3.76	0.0001873	7.51	1268.76	0.63
	Johnson	0.0007256	53.58	0.0044512	251.38	0.0002150	0.91	0.0000454	1.82	307.69	0.15
	Kaufman	0.0059718	440.96	0.0366343	2068.92	0.0017695	7.51	0.0003738	14.98	2532.37	1.27
	Parker	0.0000012	0.09	0.0000075	0.43	0.0000004	0.00	0.0000001	0.00	0.52	0.00
	Wise	0.0010202	75.33	0.0062583	353.44	0.0003023	1.28	0.0000638	2.56	432.61	0.22
San Antonio Area	Bexar	0.0138906	1025.68	0.0009368	52.91	0.0000452	0.19	0.1109355	4446.98	5525.76	2.76
	Guadalupe	0.0032029	236.50	0.0002160	12.20	0.0000104	0.04	0.0255795	1025.38	1274.13	0.64
Austin Area	Bastrop	0.0033782	249.45	0.0002278	12.87	0.0000110	0.05	0.0269798	1081.51	1343.88	0.67
	Hays	0.0008331	61.52	0.0000562	3.17	0.0000027	0.01	0.0066537	266.72	331.42	0.17
	Travis	0.0051785	382.38	0.0003493	19.72	0.0000169	0.07	0.0413577	1657.87	2060.05	1.03
Corpus Christi Area	Nueces	0.0128578	949.42	0.0008672	48.97	0.0000419	0.18	0.1026870	4116.33	5114.90	2.56
	San Patricio	0.0015100	111.50	0.0001018	5.75	0.0000049	0.02	0.0120591	483.40	600.67	0.30
Victoria Area	Victoria	0.0021192	156.48	0.0001429	8.07	0.0000069	0.03	0.0169244	678.43	843.01	0.42
Other ERCOT counties	Andrews	0.0000037	0.28	0.0000230	1.30	0.0039003	16.56	0.0000002	0.01	18.15	0.01
	Bosque	0.0022204	163.96	0.0136212	769.25	0.0006579	2.79	0.0001390	5.57	941.58	0.47
	Brazos	0.0024089	177.87	0.0112305	634.24	0.0005425	2.30	0.0047829	191.73	1006.15	0.50
	Calhoun	0.0009466	69.90	0.0000638	3.61	0.0000031	0.01	0.0075598	303.04	376.56	0.19
	Cameron	0.0063536	469.15	0.0004285	24.20	0.0000207	0.09	0.0507425	2034.07	2527.51	1.26
	Cherokee	0.0027392	202.26	0.0168033	948.97	0.0008116	3.45	0.0001714	6.87	1161.54	0.58
	Ector	0.0019215	141.88	0.0006604	37.29	0.0911346	387.00	0.0146527	587.37	1153.55	0.58
	Fannin	0.0000041	0.30	0.0000249	1.40	0.0000012	0.01	0.0000003	0.01	1.72	0.00
	Fayette	0.0051867	382.99	0.0103217	582.92	0.0004986	2.12	0.0283993	1138.42	2106.44	1.05
	Freestone	0.0047643	351.80	0.0292268	1650.58	0.0014117	5.99	0.0002982	11.95	2020.33	1.01
	Henderson	0.0006908	51.01	0.0042376	239.32	0.0002047	0.87	0.0000432	1.73	292.93	0.15
	Hidalgo	0.0053716	396.64	0.0003623	20.46	0.0000175	0.07	0.0428994	1719.67	2136.84	1.07
	Hood	0.0050771	374.89	0.0311454	1758.93	0.0015044	6.39	0.0003178	12.74	2152.95	1.08
	Howard	0.0002411	17.80	0.0007641	43.15	0.1283942	545.22	0.0009490	38.04	644.22	0.32
	Hunt	0.0088463	653.21	0.0047066	265.81	0.0002273	0.97	0.0652823	2616.92	3536.90	1.77
	Jack	0.0030783	227.30	0.0188839	1066.47	0.0009121	3.87	0.0001927	7.72	1305.36	0.65
	Lamar	0.0040001	295.37	0.0245388	1385.83	0.0011853	5.03	0.0002504	10.04	1696.27	0.85
	Llano	0.0040314	297.68	0.0002719	15.35	0.0000131	0.06	0.0321966	1290.64	1603.73	0.80
	McLennan	0.0056576	417.76	0.0347066	1960.05	0.0016764	7.12	0.0003541	14.19	2399.13	1.20
	Milam	0.0012686	93.67	0.0000856	4.83	0.0000041	0.02	0.0101316	406.14	504.66	0.25
	Mitchell	0.0000311	2.30	0.0001910	10.78	0.0324260	137.70	0.0000019	0.08	150.86	0.08
	Nolan	0.0000293	2.16	0.0001795	10.14	0.0304745	129.41	0.0000018	0.07	141.78	0.07
	Palo Pinto	0.0036129	266.78	0.0221635	1251.68	0.0010705	4.55	0.0002261	9.06	1532.07	0.77
	Pecos	0.0000020	0.15	0.0000121	0.68	0.0020520	8.71	0.0000001	0.00	9.55	0.00
	Robertson	0.0039506	291.71	0.0055755	314.87	0.0002693	1.14	0.0246170	986.80	1594.53	0.80
	Upton	0.0000025	0.19	0.0000156	0.88	0.0026494	11.25	0.0000002	0.01	12.33	0.01
	Ward	0.0001995	14.73	0.0012239	69.12	0.2078335	882.56	0.0000125	0.50	966.91	0.48
	Webb	0.0042017	310.26	0.0002834	16.00	0.0000137	0.06	0.0335565	1345.15	1671.47	0.84
	Wharton	0.0021095	155.77	0.0001423	8.03	0.0000069	0.03	0.0168474	675.35	839.18	0.42
	Wichita	0.0000121	0.89	0.0000743	4.20	0.0126190	53.59	0.0000008	0.03	58.71	0.03
	Wilbarger	0.0179710	1326.98	0.1102430	6225.96	0.0053249	22.61	0.0011247	45.09	7620.64	3.81
	Young	0.0071054	524.66	0.0435880	2461.63	0.0021054	8.94	0.0004447	17.83	3013.06	1.51
	Total	**0.4414501**	**32596.75**	**0.4812863**	**27180.58**	**0.5345786**	**2270.07**	**0.6829349**	**27376.23**	**89423.63**	**44.71**

Energy Savings by PCA (MWh)		73,840		56,475		4,246		40,086			

4.2 2016 Results for New Multi-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NOx emissions reductions in 2016 using the 2008 base year which implemented the 2015 IECC for new multi-family residences in the 36 non-attainment and affected counties as well as other counties in the ERCOT region[26]. To calculate the NOx emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2016 building permits per county was obtained from the real estate center at Texas A&M University (REC 2017). Next, energy savings attributable to the 2015 IECC were calculated using the Laboratory's code-traceable, DOE-2.1e simulation, which was developed for the TERP. For the savings calculation, the 2016 HIRL's survey data[27] were used to determine the appropriate construction data corresponding to housing types. Then, the NOx reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2010 eGRID database[28].

In Table 12[29], the 2016 new multi-family and 2015 IECC code-compliant building characteristics are shown for each county. The 2015 IECC code-compliant characteristics are the minimum building code characteristics required for each county for multi-family residences (i.e., Type A.2). In Table 12, the rows are first sorted by the US EPA's non-attainment, affected designation, and other ERCOT counties, alphabetically. Next, in the fourth column, the HIRL's survey classification is listed. The fifth through eighth columns show the HIRL's survey data including: average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation, and wall insulation, respectively. In addition, the ninth through twelfth columns show the 2015 IECC minimum requirements for glazing U-value, SHGC, roof insulation, and wall insulation.

The corresponding values in IECC and effective regulations are applied to the air-conditioner efficiency, furnace efficiency (AFUE), and domestic water heater efficiency. The values shown in Table 12 represent the only changes that were made to the simulations to obtain the savings calculations.
In cases where the 2016 new multi-family values were more efficient than the 2015 IECC requirements, the 2016 new multi-family values were used in 2016 new multi-family simulations. Otherwise, the 2015 IECC values were used in both simulations. For the 2016 new multi-family simulations, the more efficient values from 2016 HIRL data and 2015 IECC were applied. *Similarly, for the base-year simulations,* the more efficient values from *2008 NAHB data and 2006 IECC were used.*

In Table 13, the code-traceable simulation results for multi-family residences are shown for each county. In a similar fashion to Table 12, Table 13 is first divided into the US EPA's non-attainment and affected classifications, followed by an alphabetical list of other ERCOT counties. In the third column, the 2015 IECC climate zone is listed followed by the number of new projected housing units[30] in the fourth column. In the fifth column, the total simulated energy use is listed if all new Construction had been built to pre-code specifications. In the sixth column, the total county-wide energy use for code-compliant Construction is shown. The values in the fifth and sixth columns come from the associated 144 simulation runs for each county, which were then distributed according to the HIRL's survey data to account for 1, 2 or 3 story, and 3 different fuel options (i.e., central air conditioning with electric resistance heating, heat pump heating, or a natural gas-fired furnace). In the seventh column, the total annual electricity savings are shown for each county. A 7% transmission and distribution loss is used, which represents a fixed 1.07 multiplier for the electricity use. In the eighth and ninth columns, the total annual pre-code and code-compliant natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Finally, in the tenth column, the total annual natural gas savings are shown for each county.

The annual electricity savings from Table 13 are assigned to CM Zones[31] provider(s) in a similar fashion to the single-family residential assignments. The total electricity savings for each CM Zone, as shown in Table 14, are then

[26] The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.
[27] The NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: http://www.homeinnovation.com
[28] This analysis assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated.
[29] Hardin, Jefferson, and Orange Counties were removed from Table 12 and Table 13 because since 2012 they are not in the category of "Nonattainment County" based on [http://www.tceq.texas.gov/airquality/sip/bpa/bpa-status], and these counties do not belong to ERCOT region.
[30] The number of the new housing units in 2015 were obtained from the Real Estate Center at Texas A&M University.
[31] ERCOT region has employed the Congestion Management (CM) since 2010, and it is currently divided into four zones: Houston (H), North (N), South (S), and West (W).

entered into the bottom row of Table 15, the 2010 US EPA's eGRID database for Texas. Next, the county's NOx reductions (lbs) are calculated using the assigned 2010 eGrid proportions (lbs-NOx/MWh) to each CM zone in the county. The calculated NOx reductions are presented in the columns adjacent to the corresponding CM Zone columns. By adding the NOx reductions values in each row, then, the total of the NOx reductions per county (lbs and Tons) is calculated. Counties that do not show NOx reductions represent counties that do not have power plants in eGRID's database.

Table 12: 2016 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences

	County	Climate Zone	Division	2016 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	COLLIN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	EL PASO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ELLIS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HARRIS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	JOHNSON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KAUFMAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	LIBERTY	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MONTGOMERY	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	PARKER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ROCKWALL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	WALLER	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WISE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
Affected	BASTROP	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BEXAR	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CALDWELL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	COMAL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GREGG	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	GUADALUPE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HARRISON	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	NUECES	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	RUSK	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	SMITH	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	UPSHUR	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
ERCOT	ANDERSON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ANDREWS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ANGELINA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ARANSAS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ARCHER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ATASCOSA	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	AUSTIN	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BANDERA	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BASTROP	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BAYLOR	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	BEE	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BELL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BEXAR	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BLANCO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	BORDEN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	BOSQUE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BRAZORIA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BRAZOS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BREWSTER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	BRISCOE	4	West Texas	0.39	0.53	30.703	15.172	0.35	0.4	49	20
	BROOKS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BROWN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	BURLESON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	BURNET	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CALDWELL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CALHOUN	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CALLAHAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CAMERON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CHEROKEE	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	CHILDRESS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CLAY	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	COKE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	COLEMAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	COLLIN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	COLORADO	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	COMAL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	COMANCHE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CONCHO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	COOKE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CORYELL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	COTTLE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CRANE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CROCKETT	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CROSBY	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	CULBERSON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DAWSON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DE WITT	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	DELTA	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DICKENS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	DIMMIT	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	DUVAL	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	EASTLAND	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ECTOR	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	EDWARDS	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ELLIS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ERATH	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	FALLS	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	FANNIN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	FAYETTE	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	FISHER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	FOARD	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	FRANKLIN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	FREESTONE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13

Table 12: 2016 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences (Continued)

	County	Climate Zone	Division	2016 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
ERCOT	FRIO	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GILLESPIE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	GLASSCOCK	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	GOLIAD	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GONZALES	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GRAYSON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	GRIMES	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	GUADALUPE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HALL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HAMILTON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HARDEMAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HARRIS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HASKELL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HENDERSON	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HIDALGO	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HILL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HOOD	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HOPKINS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HOUSTON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	HOWARD	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HUDSPETH	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	HUNT	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	IRION	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	JACK	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	JACKSON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	JEFF DAVIS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	JIM HOGG	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	JIM WELLS	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	JOHNSON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	JONES	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KARNES	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	KAUFMAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KENDALL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KENEDY	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	KENT	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KERR	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KIMBLE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KING	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	KINNEY	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	KLEBERG	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	KNOX	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	LA SALLE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	LAMAR	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	LAMPASAS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	LAVACA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	LEE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	LEON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	LIMESTONE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	LIVE OAK	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	LLANO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	LOVING	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MADISON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MARTIN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MASON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MATAGORDA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MAVERICK	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MCCULLOCH	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MCLENNAN	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MCMULLEN	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MEDINA	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MENARD	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MIDLAND	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MILAM	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MILLS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MITCHELL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MONTAGUE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	MONTGOMERY	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	MOTLEY	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	NACOGDOCHES	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	NAVARRO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	NOLAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	NUECES	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	PALO PINTO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	PECOS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	PRESIDIO	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	RAINS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	REAGAN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	REAL	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	RED RIVER	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	REEVES	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	REFUGIO	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ROBERTSON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	RUNNELS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	SAN SABA	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SCHLEICHER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SCURRY	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SHACKELFORD	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SMITH	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SOMERVELL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	STARR	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	STEPHENS	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	STERLING	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	STONEWALL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	SUTTON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TAYLOR	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TERRELL	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	THROCKMORTON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TITUS	3	East Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TOM GREEN	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	UPTON	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	UVALDE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	VAL VERDE	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	VAN ZANDT	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WALLER	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WARD	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	WASHINGTON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WEBB	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WHARTON	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WICHITA	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	WILBARGER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	WILLACY	2	East Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	WINKLER	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	YOUNG	3	West Texas	0.39	0.53	30.703	15.172	0.35	0.25	38	20
	ZAPATA	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13
	ZAVALA	2	West Texas	0.39	0.53	30.703	15.172	0.4	0.25	38	13

Table 13: 2016 Annual Electricity Savings from New Multi-family Residences

2016 Summary TRY 2008									
	County	Climate Zone	No. of Projected Units (2013)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
Nonattain-ment County	BRAZORIA	2	21	3,307	3,114	206.26	7,746	7,626	119.92
	CHAMBERS	2	0	0	0	0.00	0	0	0.00
	COLLIN	2	4,957	818,549	749,530	73,850.43	2,395,102	2,174,643	220,459.75
	DALLAS	2	12,907	2,129,835	1,951,368	190,959.81	6,255,803	5,677,088	578,715.16
	DENTON	2	1,216	200,798	183,867	18,116.22	587,542	533,461	54,080.91
	EL PASO	3	835	135,973	123,289	13,571.78	384,882	347,327	37,554.53
	ELLIS	3	5	825	756	73.98	2,423	2,199	224.19
	FORT BEND	2	502	79,066	74,451	4,938.13	185,171	182,304	2,866.58
	GALVESTON	2	32	5,039	4,746	314.30	11,804	11,621	182.73
	HARRIS	2	7,150	1,126,139	1,060,406	70,333.86	2,637,391	2,596,562	40,828.79
	JOHNSON	3	238	39,273	35,982	3,521.22	115,355	104,683	10,671.28
	KAUFMAN	2	4	661	605	59.59	1,933	1,755	177.90
	LIBERTY	3	0	0	0	0.00	0	0	0.00
	MONTGOMERY	3	1,362	214,518	201,996	13,397.86	502,395	494,618	7,777.46
	PARKER	2	57	9,412	8,619	849.20	27,541	25,006	2,535.04
	ROCKWALL	2	0	0	0	0.00	0	0	0.00
	TARRANT	3	6,675	1,101,468	1,009,172	98,757.01	3,235,259	2,935,970	299,289.04
	WALLER	2	292	45,991	43,306	2,872.38	107,709	106,041	1,667.41
	WISE	3	6	991	907	89.39	2,899	2,632	266.85
Affected County	BASTROP	3	30	4,898	4,524	400.79	12,695	11,429	1,265.20
	BEXAR	3	4,317	698,714	644,222	58,306.51	1,754,344	1,571,172	183,172.47
	CALDWELL	3	10	1,633	1,508	133.60	0	0	0.00
	COMAL	3	1,172	189,690	174,897	15,829.33	476,278	426,549	49,728.55
	GREGG	2	0	0	0	0.00	0	0	0.00
	GUADALUPE	3	0	0	0	0.00	0	0	0.00
	HARRISON	3	28	4,513	4,234	298.29	12,100	12,309	-209.33
	HAYS	3	546	89,164	82,336	7,305.28	230,952	207,925	23,026.71
	NUECES	2	25	3,943	3,697	263.33	7,892	7,802	90.19
	RUSK	2	0	0	0	0.00	0	0	0.00
	SAN PATRICIO	3	252	39,742	37,261	2,654.32	79,553	78,644	909.17
	SMITH	3	127	20,455	19,203	1,340.38	54,973	55,908	-934.54
	TRAVIS	3	6,331	1,033,874	954,709	84,706.47	2,677,946	2,410,945	267,000.18
	UPSHUR	3	0	0	0	0.00	0	0	0.00
	VICTORIA	2	0	0	0	0.00	0	0	0.00
	WILLIAMSON	2	1,617	264,062	243,842	21,634.87	683,974	615,779	68,194.48
	WILSON	2	0	0	0	0.00	0	0	0.00
ERCOT	ANDERSON	2	0	0	0	0.00	0	0	0.00
	ANDREWS	3	0	0	0	0.00	0	0	0.00
	ANGELINA	2	4	629	588	43.57	1,542	1,563	-21.17
	ARANSAS	2	2	315	296	21.07	631	624	7.22
	ARCHER	3	0	0	0	0.00	0	0	0.00
	ATASCOSA	2	0	0	0	0.00	0	0	0.00
	AUSTIN	2	6	945	890	59.02	2,213	2,179	34.26
	BANDERA	2	0	0	0	0.00	0	0	0.00
	BAYLOR	3	0	0	0	0.00	0	0	0.00
	BEE	2	0	0	0	0.00	0	0	0.00
	BELL	2	526	89,089	80,843	8,823.43	257,848	224,300	33,548.69
	BLANCO	3	5	817	754	66.90	2,115	1,904	210.87
	BORDEN	3	0	0	0	0.00	0	0	0.00
	BOSQUE	2	0	0	0	0.00	0	0	0.00
	BRAZOS	2	1,642	258,618	243,523	16,152.19	605,678	596,301	9,376.35
	BREWSTER	3	8	1,381	1,243	147.19	4,473	3,962	511.64
	BRISCOE	4	0	0	0	0.00	0	0	0.00
	BROOKS	2	0	0	0	0.00	0	0	0.00
	BROWN	3	3	508	461	50.32	1,471	1,279	191.34
	BURLESON	2	0	0	0	0.00	0	0	0.00
	BURNET	3	98	16,004	14,778	1,311.20	41,453	37,320	4,133.00
	CALHOUN	2	0	0	0	0.00	0	0	0.00
	CALLAHAN	3	0	0	0	0.00	0	0	0.00
	CAMERON	2	352	57,178	52,911	4,566.00	106,115	104,948	1,167.20
	CHEROKEE	2	0	0	0	0.00	0	0	0.00
	CHILDRESS	3	0	0	0	0.00	0	0	0.00
	CLAY	3	42	7,643	6,856	841.82	26,914	23,691	3,222.31
	COKE	3	0	0	0	0.00	0	0	0.00
	COLEMAN	3	0	0	0	0.00	0	0	0.00
	COLORADO	2	0	0	0	0.00	0	0	0.00
	COMANCHE	3	0	0	0	0.00	0	0	0.00
	CONCHO	3	0	0	0	0.00	0	0	0.00
	COOKE	3	0	0	0	0.00	0	0	0.00
	CORYELL	2	20	3,387	3,074	335.49	9,804	8,528	1,275.62
	COTTLE	3	0	0	0	0.00	0	0	0.00
	CRANE	3	0	0	0	0.00	0	0	0.00
	CROCKETT	3	0	0	0	0.00	0	0	0.00
	CROSBY	3	0	0	0	0.00	0	0	0.00
	CULBERSON	3	0	0	0	0.00	0	0	0.00
	DAWSON	3	0	0	0	0.00	0	0	0.00
	DEWITT	2	0	0	0	0.00	0	0	0.00
	DELTA	3	0	0	0	0.00	0	0	0.00
	DICKENS	3	0	0	0	0.00	0	0	0.00
	DIMMIT	2	0	0	0	0.00	0	0	0.00
	DUVAL	2	0	0	0	0.00	0	0	0.00
	EASTLAND	3	0	0	0	0.00	0	0	0.00
	ECTOR	3	0	0	0	0.00	0	0	0.00
	EDWARDS	2	0	0	0	0.00	0	0	0.00
	ERATH	3	185	32,241	28,939	3,532.51	104,970	92,693	12,276.87
	FALLS	2	0	0	0	0.00	0	0	0.00
	FANNIN	3	6	990	907	89.06	2,906	2,639	267.34
	FAYETTE	2	0	0	0	0.00	0	0	0.00
	FISHER	3	0	0	0	0.00	0	0	0.00
	FOARD	3	0	0	0	0.00	0	0	0.00
	FRANKLIN	3	0	0	0	0.00	0	0	0.00
	FREESTONE	2	0	0	0	0.00	0	0	0.00
	FRIO	2	0	0	0	0.00	0	0	0.00

Table 13: 2016 Annual Electricity Savings from New Multi-family Residences (Continued)

2016 Summary TRY 2008									
	County	Climate Zone	No. of Projected Units (2013)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
ERCOT	GILLESPIE	3	0	0	0	0.00	0	0	0.00
	GLASSCOCK	3	0	0	0	0.00	0	0	0.00
	GOLIAD	2	0	0	0	0.00	0	0	0.00
	GONZALES	2	0	0	0	0.00	0	0	0.00
	GRAYSON	3	356	58,766	53,827	5,284.48	172,414	156,552	15,861.98
	GRIMES	2	0	0	0	0.00	0	0	0.00
	HALL	3	0	0	0	0.00	0	0	0.00
	HAMILTON	3	0	0	0	0.00	0	0	0.00
	HARDEMAN	3	0	0	0	0.00	0	0	0.00
	HASKELL	3	0	0	0	0.00	0	0	0.00
	HENDERSON	2	54	8,698	8,165	569.93	23,374	23,772	-397.36
	HIDALGO	2	1,647	267,535	247,568	21,364.19	496,508	491,047	5,461.29
	HILL	2	0	0	0	0.00	0	0	0.00
	HOOD	3	12	1,980	1,814	177.54	5,816	5,278	538.05
	HOPKINS	3	0	0	0	0.00	0	0	0.00
	HOUSTON	2	0	0	0	0.00	0	0	0.00
	HOWARD	3	0	0	0	0.00	0	0	0.00
	HUDSPETH	3	0	0	0	0.00	0	0	0.00
	HUNT	2	0	0	0	0.00	0	0	0.00
	IRION	3	0	0	0	0.00	0	0	0.00
	JACK	3	0	0	0	0.00	0	0	0.00
	JACKSON	2	0	0	0	0.00	0	0	0.00
	JEFF DAVIS	3	0	0	0	0.00	0	0	0.00
	JIM HOGG	2	0	0	0	0.00	0	0	0.00
	JIM WELLS	2	2	315	296	21.07	631	624	7.22
	JONES	3	0	0	0	0.00	0	0	0.00
	KARNES	2	0	0	0	0.00	0	0	0.00
	KENDALL	3	288	47,608	43,008	4,922.32	118,951	107,905	11,046.13
	KENEDY	2	0	0	0	0.00	0	0	0.00
	KENT	3	0	0	0	0.00	0	0	0.00
	KERR	3	0	0	0	0.00	0	0	0.00
	KIMBLE	3	0	0	0	0.00	0	0	0.00
	KING	3	0	0	0	0.00	0	0	0.00
	KINNEY	2	0	0	0	0.00	0	0	0.00
	KLEBERG	2	0	0	0	0.00	0	0	0.00
	KNOX	3	0	0	0	0.00	0	0	0.00
	LA SALLE	2	0	0	0	0.00	0	0	0.00
	LAMAR	3	20	3,303	3,024	297.96	9,664	8,774	889.49
	LAMPASAS	3	0	0	0	0.00	0	0	0.00
	LAVACA	2	0	0	0	0.00	0	0	0.00
	LEE	2	0	0	0	0.00	0	0	0.00
	LEON	2	0	0	0	0.00	0	0	0.00
	LIMESTONE	2	0	0	0	0.00	0	0	0.00
	LIVE OAK	2	0	0	0	0.00	0	0	0.00
	LLANO	3	12	1,960	1,810	160.56	5,076	4,570	506.08
	LOVING	3	0	0	0	0.00	0	0	0.00
	MADISON	2	6	945	890	59.02	2,213	2,179	34.26
	MARTIN	3	0	0	0	0.00	0	0	0.00
	MASON	3	0	0	0	0.00	0	0	0.00
	MATAGORDA	2	0	0	0	0.00	0	0	0.00
	MAVERICK	2	12	1,892	1,774	126.40	3,788	3,745	43.29
	MCCULLOCH	3	72	12,429	11,191	1,324.73	40,260	35,656	4,604.80
	MCLENNAN	2	1,125	190,542	172,905	18,871.40	551,481	479,728	71,753.38
	MCMULLEN	2	0	0	0	0.00	0	0	0.00
	MEDINA	2	0	0	0	0.00	0	0	0.00
	MENARD	3	0	0	0	0.00	0	0	0.00
	MIDLAND	3	40	6,882	6,178	752.31	22,565	19,891	2,673.61
	MILAM	2	5	788	742	49.18	1,844	1,816	28.55
	MILLS	3	0	0	0	0.00	0	0	0.00
	MITCHELL	3	0	0	0	0.00	0	0	0.00
	MONTAGUE	3	0	0	0	0.00	0	0	0.00
	MOTLEY	3	0	0	0	0.00	0	0	0.00
	NACOGDOCHES	3	4	629	588	43.57	1,542	1,563	-21.17
	NAVARRO	3	11	1,863	1,691	184.52	5,392	4,691	701.59
	NOLAN	3	0	0	0	0.00	0	0	0.00
	PALO PINTO	3	0	0	0	0.00	0	0	0.00
	PECOS	3	0	0	0	0.00	0	0	0.00
	PRESIDIO	3	0	0	0	0.00	0	0	0.00
	RAINS	3	0	0	0	0.00	0	0	0.00
	REAGAN	3	0	0	0	0.00	0	0	0.00
	REAL	2	0	0	0	0.00	0	0	0.00
	RED RIVER	3	2	330	302	29.80	966	877	88.95
	REEVES	3	0	0	0	0.00	0	0	0.00
	REFUGIO	2	0	0	0	0.00	0	0	0.00
	ROBERTSON	2	0	0	0	0.00	0	0	0.00
	RUNNELS	3	0	0	0	0.00	0	0	0.00
	SAN SABA	3	0	0	0	0.00	0	0	0.00
	SCHLEICHER	3	0	0	0	0.00	0	0	0.00
	SCURRY	3	0	0	0	0.00	0	0	0.00
	SHACKELFORD	3	0	0	0	0.00	0	0	0.00
	SOMERVELL	3	20	3,300	3,024	295.90	9,694	8,797	896.75
	STARR	2	0	0	0	0.00	0	0	0.00
	STEPHENS	3	0	0	0	0.00	0	0	0.00
	STERLING	3	0	0	0	0.00	0	0	0.00
	STONEWALL	3	0	0	0	0.00	0	0	0.00
	SUTTON	3	0	0	0	0.00	0	0	0.00
	TAYLOR	3	8	1,394	1,251	152.76	4,539	4,008	530.89
	TERRELL	3	0	0	0	0.00	0	0	0.00
	THROCKMORTON	3	0	0	0	0.00	0	0	0.00
	TITUS	3	0	0	0	0.00	0	0	0.00
	TOM GREEN	3	0	0	0	0.00	0	0	0.00
	UPTON	3	0	0	0	0.00	0	0	0.00
	UVALDE	2	4	647	597	54.03	1,626	1,456	169.72
	VAL VERDE	2	0	0	0	0.00	0	0	0.00
	VAN ZANDT	3	0	0	0	0.00	0	0	0.00
	WARD	3	0	0	0	0.00	0	0	0.00
	WASHINGTON	2	12	1,890	1,780	118.04	4,426	4,358	68.52
	WEBB	2	213	33,591	31,495	2,243.53	67,242	66,473	768.46
	WHARTON	2	0	0	0	0.00	0	0	0.00
	WICHITA	3	90	16,377	14,691	1,803.89	57,672	50,767	6,904.94
	WILBARGER	3	0	0	0	0.00	0	0	0.00
	WILLACY	2	0	0	0	0.00	0	0	0.00
	WINKLER	3	0	0	0	0.00	0	0	0.00
	WISE	3	6	991	907	89.39	2,899	2,632	266.85
	YOUNG	3	0	0	0	0.00	0	0	0.00
	ZAPATA	2	0	0	0	0.00	0	0	0.00
	ZAVALA	2	0	0	0	0.00	0	0	0.00
	TOTAL		**57,634**			**779,821**			**2,039,288**

Table 14: 2016 Totalized Annual Electricity Savings by CM Zone from New Multi-family Residences

CM Zone	Total Electricity Savings by CM Zone (MWh) [2016-TRY 2008]
Houston (H)	151,511
North (N)	345,761
West (W)	18,492
South (S)	166,288
Total	682,052

Table 15: 2016 Annual NOx Reductions from New Multi-family Residences Using 2010 eGRID

Area	County	H	NOx Reductions (lbs)	N	NOx Reductions (lbs)	W	NOx Reductions (lbs/year)	S	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.0562032	8515.42	0.0000071	2.47	0.0000003	0.01	0.0005265	87.56	8605.45	4.30
	Chambers	0.0204500	3098.41	0.0000026	0.90	0.0000001	0.00	0.0001916	31.86	3131.17	1.57
	Fort Bend	0.0313463	4749.32	0.0000040	1.38	0.0000002	0.00	0.0002937	48.83	4799.53	2.40
	Galveston	0.0226620	3433.54	0.0000029	0.99	0.0000001	0.00	0.0002123	35.30	3469.85	1.73
	Harris	0.1486911	22528.39	0.0000189	6.52	0.0000009	0.02	0.0013930	231.64	22766.57	11.38
Dallas/ Fort Worth Area	Collin	0.0012932	195.93	0.0079329	2742.90	0.0003832	7.09	0.0000809	13.46	2959.37	1.48
	Dallas	0.0024826	376.14	0.0152295	5265.78	0.0007356	13.60	0.0001554	25.84	5681.36	2.84
	Denton	0.0001267	19.19	0.0007770	268.66	0.0000375	0.69	0.0000079	1.32	289.87	0.14
	Tarrant	0.0004742	71.84	0.0029089	1005.77	0.0001405	2.60	0.0000297	4.93	1085.15	0.54
	Ellis	0.0029920	453.32	0.0183544	6346.21	0.0008865	16.39	0.0001873	31.14	6847.07	3.42
	Johnson	0.0007256	109.94	0.0044512	1539.04	0.0002150	3.98	0.0000454	7.55	1660.51	0.83
	Kaufman	0.0059718	904.80	0.0366343	12666.69	0.0017695	32.72	0.0003738	62.15	13666.36	6.83
	Parker	0.0000012	0.19	0.0000075	2.61	0.0000004	0.01	0.0000001	0.01	2.81	0.00
	Wise	0.0010202	154.57	0.0062583	2163.87	0.0003023	5.59	0.0000638	10.62	2334.65	1.17
San Antonio Area	Bexar	0.0138906	2104.58	0.0009368	323.91	0.0000452	0.84	0.1109355	18447.21	20876.54	10.44
	Guadalupe	0.0032029	485.27	0.0002160	74.69	0.0000104	0.19	0.0255795	4253.55	4813.70	2.41
Austin Area	Bastrop	0.0033782	511.84	0.0002278	78.78	0.0000110	0.20	0.0269798	4486.40	5077.22	2.54
	Hays	0.0008331	126.23	0.0000562	19.43	0.0000027	0.05	0.0066537	1106.42	1252.13	0.63
	Travis	0.0051785	784.61	0.0003493	120.76	0.0000169	0.31	0.0413577	6877.27	7782.95	3.89
Corpus Christi Area	Nueces	0.0128578	1948.10	0.0008672	299.83	0.0000419	0.77	0.1026870	17075.58	19324.28	9.66
	San Patricio	0.0015100	228.78	0.0001018	35.21	0.0000049	0.09	0.0120591	2005.27	2269.35	1.13
Victoria Area	Victoria	0.0021192	321.08	0.0001429	49.42	0.0000069	0.13	0.0169244	2814.31	3184.93	1.59
Other ERCOT counties	Andrews	0.0000037	0.57	0.0000230	7.94	0.0039003	72.12	0.0000002	0.04	80.67	0.04
	Bosque	0.0022204	336.42	0.0136212	4709.67	0.0006579	12.17	0.0001390	23.11	5081.36	2.54
	Brazos	0.0024089	364.97	0.0112305	3883.07	0.0005425	10.03	0.0047829	795.34	5053.41	2.53
	Calhoun	0.0009466	143.42	0.0000638	22.07	0.0000031	0.06	0.0075598	1257.09	1422.64	0.71
	Cameron	0.0063536	962.65	0.0004285	148.16	0.0000207	0.38	0.0507425	8437.84	9549.03	4.77
	Cherokee	0.0027392	415.01	0.0168033	5809.93	0.0008116	15.01	0.0001714	28.51	6268.46	3.13
	Ector	0.0019215	291.13	0.0006604	228.32	0.0911346	1685.25	0.0146527	2436.56	4641.26	2.32
	Fannin	0.0000041	0.61	0.0000249	8.60	0.0000012	0.02	0.0000003	0.04	9.28	0.00
	Fayette	0.0051867	785.84	0.0103217	3568.83	0.0004986	9.22	0.0283993	4722.45	9086.35	4.54
	Freestone	0.0047643	721.85	0.0292268	10105.48	0.0014117	26.10	0.0002982	49.58	10903.02	5.45
	Henderson	0.0006908	104.66	0.0042376	1465.18	0.0002047	3.78	0.0000432	7.19	1580.82	0.79
	Hidalgo	0.0053716	813.85	0.0003623	125.26	0.0000175	0.32	0.0428994	7133.64	8073.08	4.04
	Hood	0.0050771	769.24	0.0311454	10768.86	0.0015044	27.82	0.0003178	52.84	11618.75	5.81
	Howard	0.0002411	36.53	0.0007641	264.19	0.1283942	2374.24	0.0009490	157.81	2832.77	1.42
	Hunt	0.0088463	1340.32	0.0047066	1627.37	0.0002273	4.20	0.0652823	10855.64	13827.53	6.91
	Jack	0.0030783	466.40	0.0188839	6529.31	0.0009121	16.87	0.0001927	32.04	7044.61	3.52
	Lamar	0.0040001	606.07	0.0245388	8484.57	0.0011853	21.92	0.0002504	41.63	9154.18	4.58
	Llano	0.0040314	610.81	0.0002719	94.01	0.0000131	0.24	0.0321966	5353.90	6058.96	3.03
	McLennan	0.0056576	857.19	0.0347066	12000.19	0.0016764	31.00	0.0003541	58.88	12947.27	6.47
	Milam	0.0012686	192.21	0.0000856	29.58	0.0000041	0.08	0.0101316	1684.75	1906.62	0.95
	Mitchell	0.0000311	4.72	0.0001910	66.03	0.0324260	599.62	0.0000019	0.32	670.68	0.34
	Nolan	0.0000293	4.43	0.0001795	62.05	0.0304745	563.53	0.0000018	0.30	630.32	0.32
	Palo Pinto	0.0036129	547.40	0.0221635	7663.28	0.0010705	19.80	0.0002261	37.60	8268.08	4.13
	Pecos	0.0000020	0.30	0.0000121	4.18	0.0020520	37.95	0.0000001	0.02	42.44	0.02
	Robertson	0.0039506	598.56	0.0055755	1927.78	0.0002693	4.98	0.0246170	4093.49	6624.81	3.31
	Upton	0.0000025	0.39	0.0000156	5.39	0.0026494	48.99	0.0000002	0.03	54.80	0.03
	Ward	0.0001995	30.23	0.0012239	423.19	0.2078335	3843.22	0.0000125	2.08	4298.72	2.15
	Webb	0.0042017	636.61	0.0002834	97.98	0.0000137	0.25	0.0335565	5580.04	6314.88	3.16
	Wharton	0.0021095	319.62	0.0001423	49.19	0.0000069	0.13	0.0168474	2801.51	3170.44	1.59
	Wichita	0.0000121	1.84	0.0000743	25.69	0.0126190	233.35	0.0000008	0.13	261.00	0.13
	Wilbarger	0.0179710	2722.81	0.1102430	38117.71	0.0053249	98.47	0.0011247	187.03	41126.02	20.56
	Young	0.0071054	1076.55	0.0435880	15071.03	0.0021054	38.93	0.0004447	73.95	16260.46	8.13
	Total	**0.4414501**	**66884.69**	**0.4812863**	**166409.92**	**0.5345786**	**9885.34**	**0.6829349**	**113563.60**	**356743.55**	**178.37**
Energy Savings by PCA (MWh)		151,511		345,761		18,492		166,288			

4.3 2016 Results for New Residential Construction (Single-family and Multi-family)

Table 16 presents the individual and combined annual electricity savings and NOx emissions reductions resulted from the new single-family and multi-family Construction in 2016. In addition, Table 16 includes the combined natural gas savings from the new Construction for both single-family and multi-family and the corresponding NOx emissions reductions[32].

The total NOx reductions from electricity and natural gas savings from total new single-family and multi-family Construction in 2016 are 240.27 tons NOx/year, including 44.71 tons NOx/year (18.61 %) from single-family residential electricity savings, 178.37 tons NOx/year (74.24 %) from multi-family residential electricity savings, and 17.19 tons NOx/year (7.15 %) from natural gas savings from both single-family and multi-family residences. Figure 8 through Figure 11 show the electricity savings and NOx reductions tabulated in Table 16. Figure 8 shows the annual electricity savings by county using a stacked bar chart and Figure 9 shows the spatial distribution of the electricity savings by county across the state. Figure 10 shows the annual NOx reductions by using a stacked bar chart and Figure 11 shows the spatial distribution of the NOx reductions by county across the state.

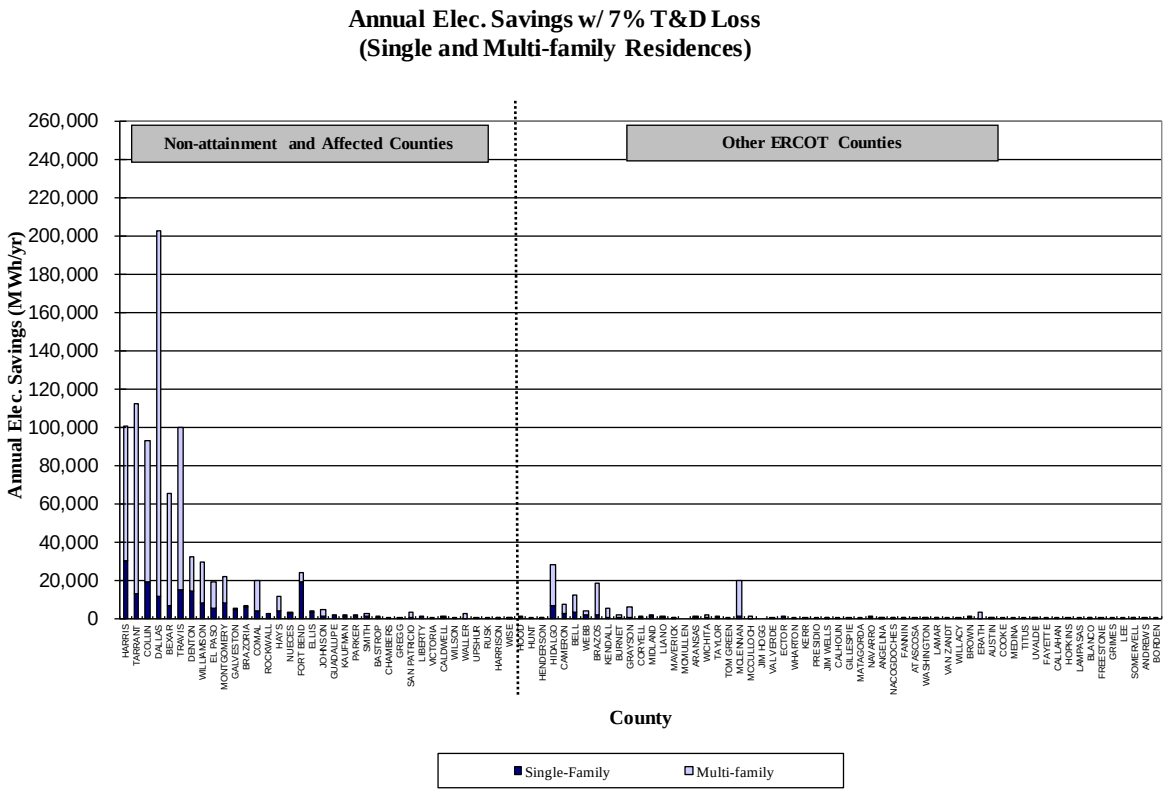
[32] 0.092 lb-NOx/MMBtu of emission rate was used for the calculation.

Table 16: 2016 Annual NOx Reductions from New Single-family and Multi-family Residences

	County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Total Electricity Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Non-attainment and Affected Counties	HARRIS	30,527.77	5.52	70,333.86	11.38	100,861.62	16.90	212,567.58	0.98	17.88
	TARRANT	13,262.92	0.10	98,757.01	0.54	112,019.93	0.64	410,639.74	1.89	2.53
	COLLIN	18,831.20	0.27	73,850.43	1.48	92,681.63	1.75	372,729.40	1.71	3.47
	DALLAS	11,718.50	0.53	190,959.81	2.84	202,678.30	3.37	677,099.45	3.11	6.48
	BEXAR	6,860.83	2.76	58,306.51	10.44	65,167.33	13.20	264,555.03	1.22	14.42
	TRAVIS	14,994.63	1.03	84,706.47	3.89	99,701.11	4.92	444,779.25	2.05	6.97
	DENTON	14,271.00	0.03	18,116.22	0.14	32,387.23	0.17	169,476.67	0.78	0.95
	WILLIAMSON	7,944.73		21,634.87		29,579.60	0.00	162,388.64	0.75	0.75
	EL PASO	5,313.43		13,571.78		18,885.20	0.00	64,927.75	0.30	0.30
	MONTGOMERY	8,216.97		13,397.86		21,614.83	0.00	54,003.33	0.25	0.25
	GALVESTON	4,343.17	0.84	314.30	1.73	4,657.47	2.58	23,985.61	0.11	2.69
	BRAZORIA	5,719.46	2.09	206.26	4.30	5,925.71	6.39	31,465.58	0.14	6.53
	COMAL	4,006.16		15,829.33		19,835.49	0.00	97,249.22	0.45	0.45
	ROCKWALL	2,563.82		0.00		2,563.82	0.00	20,731.11	0.10	0.10
	HAYS	3,961.91	0.17	7,305.28	0.63	11,267.19	0.79	69,999.85	0.32	1.11
	NUECES	2,547.30	2.56	263.33	9.66	2,810.62	12.22	9,120.76	0.04	12.26
	FORT BEND	19,242.47	1.16	4,938.13	2.40	24,180.60	3.56	111,118.16	0.51	4.07
	ELLIS	3,289.00	0.63	73.98	3.42	3,362.98	4.06	27,837.48	0.13	4.19
	JOHNSON	1,173.67	0.15	3,521.22	0.83	4,694.89	0.98	20,524.99	0.09	1.08
	GUADALUPE	1,887.09	0.64	0.00	2.41	1,887.09	3.04	22,384.54	0.10	3.15
	KAUFMAN	1,024.61	1.27	59.59	6.83	1,084.20	8.10	8,462.91	0.04	8.14
	PARKER	937.31	0.00	849.20	0.00	1,786.51	0.00	10,114.16	0.05	0.05
	SMITH	998.67		1,340.38		2,339.05	0.00	390.23	0.00	0.00
	BASTROP	309.83	0.67	400.79	2.54	710.63	3.21	4,051.33	0.02	3.23
	CHAMBERS	546.90	0.76	0.00	1.57	546.90	2.32	2,318.90	0.01	2.34
	GREGG	352.64		0.00		352.64	0.00	331.85	0.00	0.00
	SAN PATRICIO	487.60	0.30	2,654.32	1.13	3,141.92	1.44	2,637.79	0.01	1.45
	LIBERTY	900.28		0.00		900.28	0.00	5,048.86	0.02	0.02
	VICTORIA	123.92	0.42	0.00	1.59	123.92	2.01	463.60	0.00	2.02
	CALDWELL	671.66		133.60		805.26	0.00	7,814.32	0.04	0.04
	WILSON	108.67		0.00		108.67	0.00	1,289.03	0.01	0.01
	WALLER	25.59		2,872.38		2,897.96	0.00	1,811.35	0.01	0.01
	UPSHUR	11.89		0.00		11.89	0.00	78.82	0.00	0.00
	RUSK	4.43	0.00	0.00	0.00	4.43	0.00	8.24	0.00	0.00
	HARRISON	88.38		298.29		386.68	0.00	(97.70)	(0.00)	(0.00)
	WISE	160.81	0.22	89.39	1.17	250.20	1.38	1,567.19	0.01	1.39
Other ERCOT Counties	HOOD	300.24	1.08	177.54	5.81	477.78	6.89	3,058.76	0.01	6.90
	HUNT	379.63	1.77	0.00	6.91	379.63	8.68	3,169.84	0.01	8.70
	HENDERSON	87.99	0.15	569.93	0.79	657.91	0.94	(280.65)	(0.00)	0.94
	HIDALGO	6,623.22	1.07	21,364.19	4.04	27,987.41	5.10	30,165.33	0.14	5.24
	CAMERON	2,759.48	1.26	4,566.00	4.77	7,325.48	6.04	11,459.84	0.05	6.09
	BELL	3,222.81		8,823.43		12,046.24	0.00	78,890.98	0.36	0.36
	WEBB	1,934.95	0.84	2,243.53	3.16	4,178.49	3.99	16,536.60	0.08	4.07
	BRAZOS	2,218.09	0.50	16,152.19	2.53	18,370.28	3.03	21,854.56	0.10	3.13
	KENDALL	605.65		4,922.32		5,527.96	0.00	15,097.43	0.07	0.07
	BURNET	740.11		1,311.20		2,051.32	0.00	12,907.93	0.06	0.06
	GRAYSON	855.30		5,284.48		6,139.78	0.00	23,003.66	0.11	0.11
	CORYELL	318.00		335.49		653.49	0.00	5,749.62	0.03	0.03
	MIDLAND	1,432.73		752.31		2,185.04	0.00	15,376.80	0.07	0.07
	LLANO	472.50	0.80	160.56	3.03	633.06	3.83	6,108.16	0.03	3.86
	MAVERICK	131.04		126.40		257.44	0.00	1,111.19	0.01	0.01
	MCMULLEN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	ARANSAS	393.02		21.07		414.09	0.00	1,400.55	0.01	0.01
	WICHITA	219.43	0.03	1,803.89	0.13	2,023.32	0.16	9,280.77	0.04	0.20
	TAYLOR	717.50		152.76		870.26	0.00	7,473.45	0.03	0.03
	TOM GREEN	401.63		0.00		401.63	0.00	3,815.09	0.02	0.02
	MCLENNAN	1,298.50	1.20	18,871.40	6.47	20,169.91	7.67	90,022.22	0.41	8.09
	MCCULLOCH	2.34		1,324.73		1,327.06	0.00	4,626.98	0.02	0.02
	JIM HOGG	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	VAL VERDE	194.35		0.00		194.35	0.00	2,305.38	0.01	0.01
	ECTOR	1,015.61	0.58	0.00	2.32	1,015.61	2.90	9,004.79	0.04	2.94
	WHARTON	163.90	0.42	0.00	1.59	163.90	2.00	613.15	0.00	2.01
	KERR	125.44		0.00		125.44	0.00	1,487.28	0.01	0.01
	PRESIDIO	25.69		0.00		25.69	0.00	243.99	0.00	0.00
	JIM WELLS	31.53		21.07		52.59	0.00	118.98	0.00	0.00
	CALHOUN	119.93	0.19	0.00	0.71	119.93	0.90	448.64	0.00	0.90
	GILLESPIE	102.45		0.00		102.45	0.00	1,214.61	0.01	0.01
	MATAGORDA	163.90		0.00		163.90	0.00	613.15	0.00	0.00
	NAVARRO	340.42		184.52		524.94	0.00	5,491.06	0.03	0.03
	ANGELINA	132.92		43.57		176.49	0.00	226.14	0.00	0.00
	NACOGDOCHES	53.17		43.57		96.73	0.00	77.76	0.00	0.00
	FANNIN	61.75	0.00	89.06	0.00	150.81	0.01	782.91	0.00	0.01
	ATASCOSA	70.97		0.00		70.97	0.00	833.14	0.00	0.00
	WASHINGTON	141.71		118.04		259.75	0.00	865.71	0.00	0.00
	LAMAR	57.65	0.85	297.96	4.58	355.61	5.43	961.01	0.00	5.43
	VAN ZANDT	64.33		0.00		64.33	0.00	520.14	0.00	0.00
	WILLACY	83.90		0.00		83.90	0.00	312.92	0.00	0.00
	BROWN	173.27		50.32		223.59	0.00	2,629.10	0.01	0.01
	ERATH	87.26		3,532.51		3,619.77	0.00	13,121.24	0.06	0.06
	AUSTIN	43.30		59.02		102.32	0.00	277.85	0.00	0.00
	COOKE	116.63		0.00		116.63	0.00	973.87	0.00	0.00
	MEDINA	60.60		0.00		60.60	0.00	718.88	0.00	0.00
	TITUS	42.13	0.00	0.00	0.00	42.13	0.00	52.26	0.00	0.00
	UVALDE	39.71		54.03		93.73	0.00	640.71	0.00	0.00
	FAYETTE	15.75	1.05	0.00	4.54	15.75	5.60	88.58	0.00	5.60
	CALLAHAN	4.85		0.00		4.85	0.00	46.91	0.00	0.00
	HOPKINS	22.97		0.00		22.97	0.00	185.76	0.00	0.00
	LAMPASAS	91.73		0.00		91.73	0.00	0.00	0.00	0.00
	BLANCO	27.18		66.90		94.08	0.00	533.11	0.00	0.00
	FREESTONE	12.23	1.01	0.00	5.45	12.23	6.46	172.08	0.00	6.46
	GRIMES	76.76	0.00	0.00	0.00	76.76	0.00	431.81	0.00	0.00
	LEE	27.12		0.00		27.12	0.00	315.49	0.00	0.00
	SOMERVELL	25.02		295.90		320.92	0.00	1,106.81	0.01	0.01
	ANDREWS	19.14	0.01	0.00	0.04	19.14	0.05	102.16	0.00	0.05
	BORDEN	41.45		0.00		41.45	0.00	414.45	0.00	0.00

Table 16: 2016 Annual NOx Reductions from New Single-family and Multi-family Residences (Continued)

	County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Total Electricity Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Other ERCOT Counties	CHEROKEE	13.29	0.58	0.00	3.13	13.29	3.72	24.73	0.00	3.72
	DIMMIT	14.33		0.00		14.33	0.00	116.80	0.00	0.00
	FALLS	6.12		0.00		6.12	0.00	86.04	0.00	0.00
	COLORADO	43.30		0.00		43.30	0.00	243.59	0.00	0.00
	FRIO	14.61	0.00	0.00	0.00	14.61	0.00	171.53	0.00	0.00
	MILAM	13.31	0.25	49.18	0.95	62.49	1.21	198.41	0.00	1.21
	JACKSON	21.99		0.00		21.99	0.00	82.25	0.00	0.00
	ANDERSON	28.80		0.00		28.80	0.00	53.58	0.00	0.00
	HILL	16.31		0.00		16.31	0.00	229.44	0.00	0.00
	CULBERSON	7.16		0.00		7.16	0.00	37.01	0.00	0.00
	MASON	6.27		0.00		6.27	0.00	74.36	0.00	0.00
	PECOS	261.53	0.00	0.00	0.02	261.53	0.03	2,484.24	0.01	0.04
	RAINS	2.30		0.00		2.30	0.00	18.58	0.00	0.00
	LAVACA	54.19		0.00		54.19	0.00	205.07	0.00	0.00
	PALO PINTO	21.82	0.77	0.00	4.13	21.82	4.90	211.09	0.00	4.90
	KIMBLE	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	MADISON	9.84		59.02		68.86	0.00	89.62	0.00	0.00
	ARCHER	12.76		0.00		12.76	0.00	138.13	0.00	0.00
	REFUGIO	13.99		0.00		13.99	0.00	52.34	0.00	0.00
	LIMESTONE	6.12	0.00	0.00	0.00	6.12	0.00	86.04	0.00	0.00
	CLAY	7.65		841.82		849.47	0.00	3,305.19	0.02	0.02
	BEE	13.99		0.00		13.99	0.00	52.34	0.00	0.00
	MARTIN	9.07		0.00		9.07	0.00	80.40	0.00	0.00
	GONZALES	18.81		0.00		18.81	0.00	223.10	0.00	0.00
	BURLESON	23.62		0.00		23.62	0.00	132.86	0.00	0.00
	KARNES	94.89		0.00		94.89	0.00	908.16	0.00	0.00
	KLEBERG	18.91		0.00		18.91	0.00	67.06	0.00	0.00
	BREWSTER	11.68		147.19		158.87	0.00	622.55	0.00	0.00
	WINKLER	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	FRANKLIN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	YOUNG	24.24	1.51	0.00	8.13	24.24	9.64	234.55	0.00	9.64
	HOUSTON	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SCURRY	17.45		0.00		17.45	0.00	174.50	0.00	0.00
	BOSQUE	2.04	0.47	0.00	2.54	2.04	3.01	28.68	0.00	3.01
	COMANCHE	2.04		0.00		2.04	0.00	28.68	0.00	0.00
	BRISCOE	16.27		0.00		16.27	0.00	296.84	0.00	0.00
	CONCHO	2.34		0.00		2.34	0.00	22.18	0.00	0.00
	ZAVALA	8.19		0.00		8.19	0.00	66.74	0.00	0.00
	NOLAN	2.42	0.07	0.00	0.32	2.42	0.39	23.45	0.00	0.39
	BROOKS	4.19		0.00		4.19	0.00	16.25	0.00	0.00
	ROBERTSON	155.48	0.80	0.00	3.31	155.48	4.11	874.69	0.00	4.11
	LIVE OAK	14.71		0.00		14.71	0.00	52.16	0.00	0.00
	HAMILTON	12.23		0.00		12.23	0.00	172.08	0.00	0.00
	JONES	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	REAGAN	2.27		0.00		2.27	0.00	20.62	0.00	0.00
	WARD	6.80	0.48	0.00	2.15	6.80	2.63	60.30	0.00	2.63
	RED RIVER	13.30		29.80		43.10	0.00	105.45	0.00	0.00
	HASKELL	4.85		0.00		4.85	0.00	46.91	0.00	0.00
	HOWARD	52.14	0.32	0.00	1.42	52.14	1.74	462.30	0.00	1.74
	SAN SABA	14.64		0.00		14.64	0.00	173.52	0.00	0.00
	JACK	4.85	0.65	0.00	3.52	4.85	4.17	46.91	0.00	4.18
	STEPHENS	4.85		0.00		4.85	0.00	46.91	0.00	0.00
	RUNNELS	4.67		0.00		4.67	0.00	44.36	0.00	0.00
	REEVES	6.80		0.00		6.80	0.00	60.30	0.00	0.00
	DE WITT	6.00		0.00		6.00	0.00	22.43	0.00	0.00
	CHILDRESS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	CROSBY	19.63		0.00		19.63	0.00	196.32	0.00	0.00
	DAWSON	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	MITCHELL	0.00	0.08	0.00	0.34	0.00	0.41	0.00	0.00	0.41
	WILBARGER	2.55	3.81	0.00	20.56	2.55	24.37	27.63	0.00	24.37
	COLEMAN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	UPTON	0.00	0.01	0.00	0.03	0.00	0.03	0.00	0.00	0.03
	COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CROCKETT	44.37		0.00		44.37	0.00	421.43	0.00	0.00
	HARDEMAN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	BANDERA	2.47		0.00		2.47	0.00	16.54	0.00	0.00
	BAYLOR	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	COTTLE	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	CRANE	29.50		0.00		29.50	0.00	268.03	0.00	0.00
	DELTA	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	DICKENS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	DUVAL	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	EASTLAND	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	EDWARDS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	FISHER	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	FOARD	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	GLASSCOCK	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	GOLIAD	6.00		0.00		6.00	0.00	22.43	0.00	0.00
	HALL	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	HUDSPETH	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	IRION	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	JEFF DAVIS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	KENEDY	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	KENT	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	KING	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	KINNEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	KNOX	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	LA SALLE	6.14		0.00		6.14	0.00	50.06	0.00	0.00
	LEON	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	LOVING	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	MENARD	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	MILLS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	MONTAGUE	2.29		0.00		2.29	0.00	19.10	0.00	0.00
	MOTLEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	REAL	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SCHLEICHER	2.34		0.00		2.34	0.00	22.18	0.00	0.00
	SHACKELFORD	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	STARR	9.07		0.00		9.07	0.00	33.83	0.00	0.00
	STERLING	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	STONEWALL	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SUTTON	28.02		0.00		28.02	0.00	266.17	0.00	0.00
	TERRELL	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	THROCKMORTON	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	ZAPATA	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	TOTAL	**217,721.83**	**44.71**	**779,731.47**	**178.37**	**997,453.30**	**223.08**	**3,737,054.94**	**17.19**	**240.27**



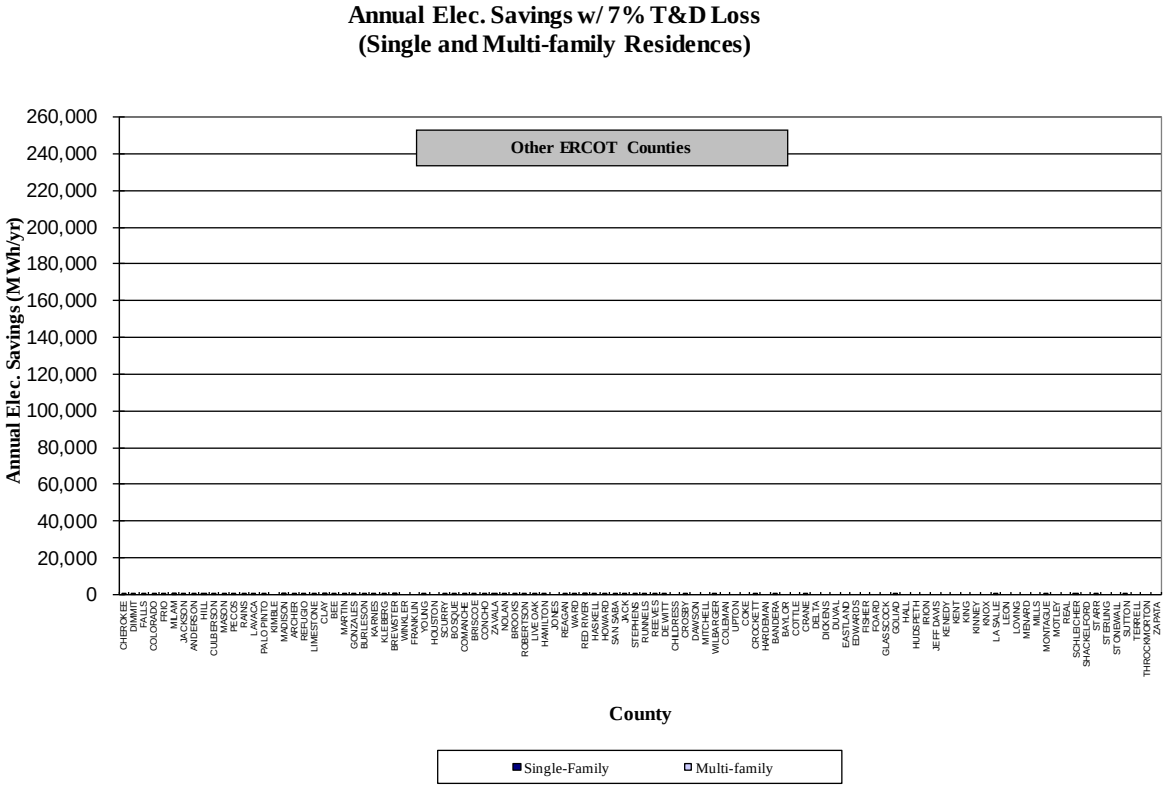


Figure 8: 2016 Annual Electricity Savings by County from New Single-family and Multi-family Residences

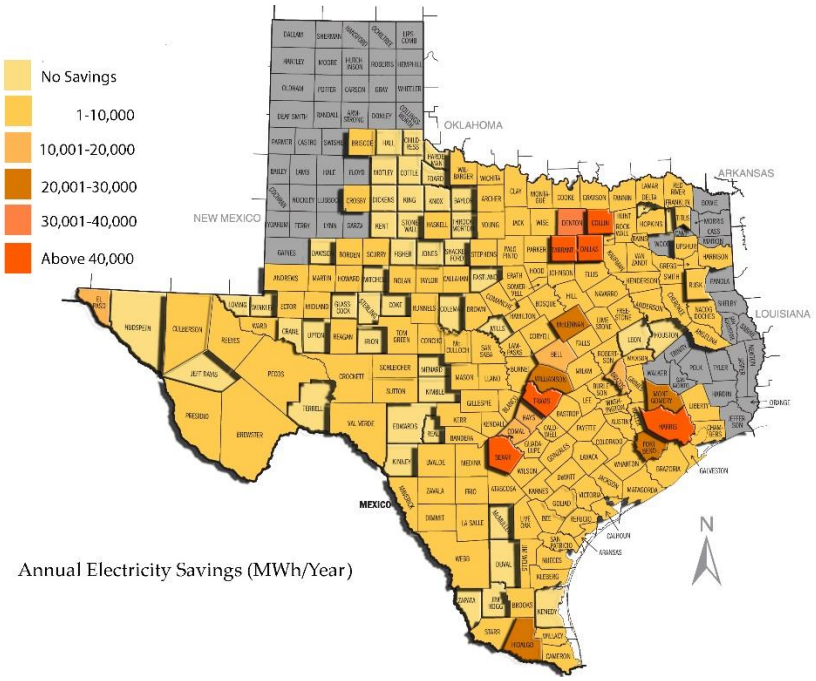


Figure 9: Map of 2016 Annual Electricity Savings by County from New Single-family and Multi-family Residences

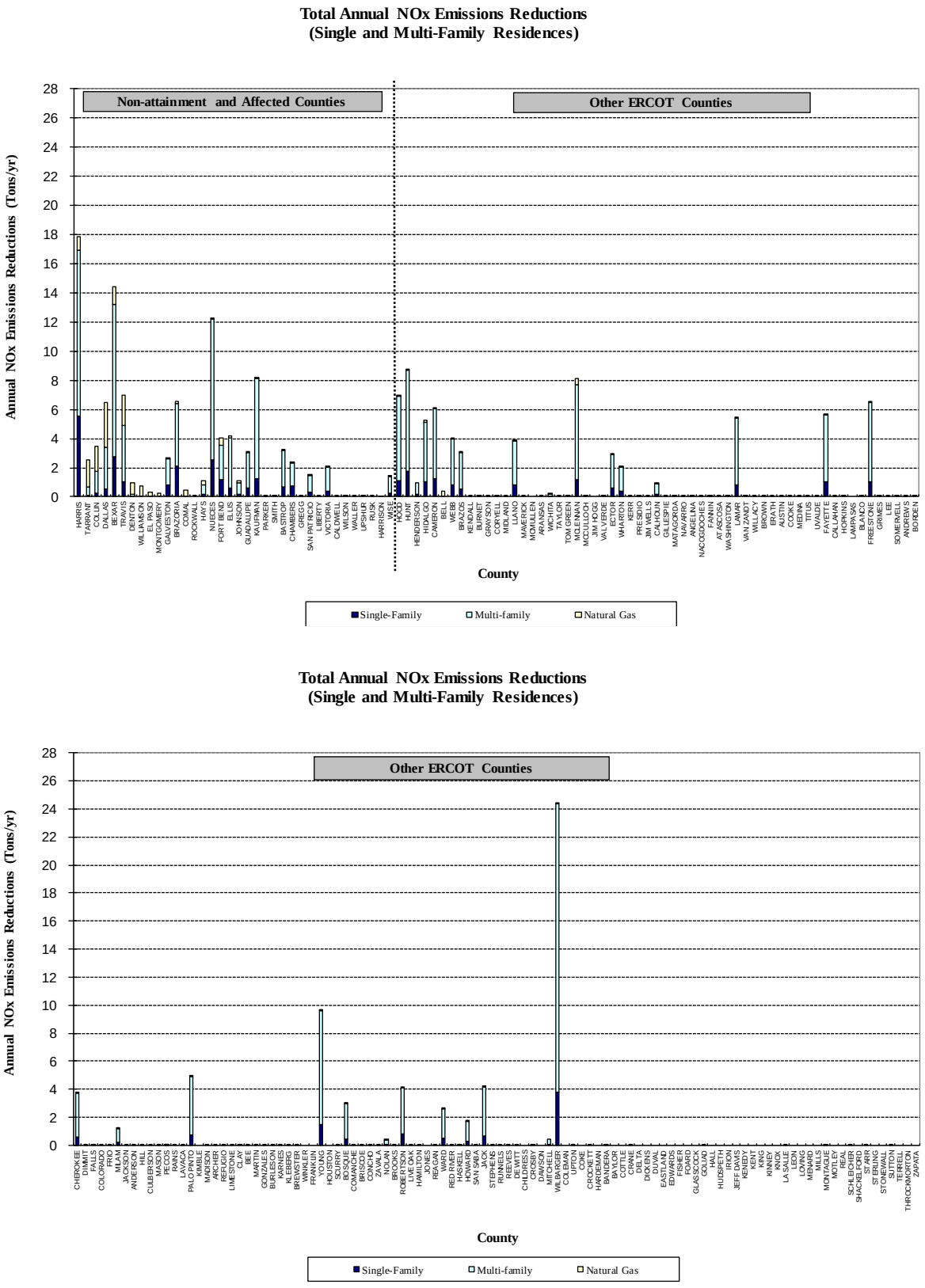


Figure 10: 2016 Annual NOx Reductions by County from New Single-family and Multi-family Residences

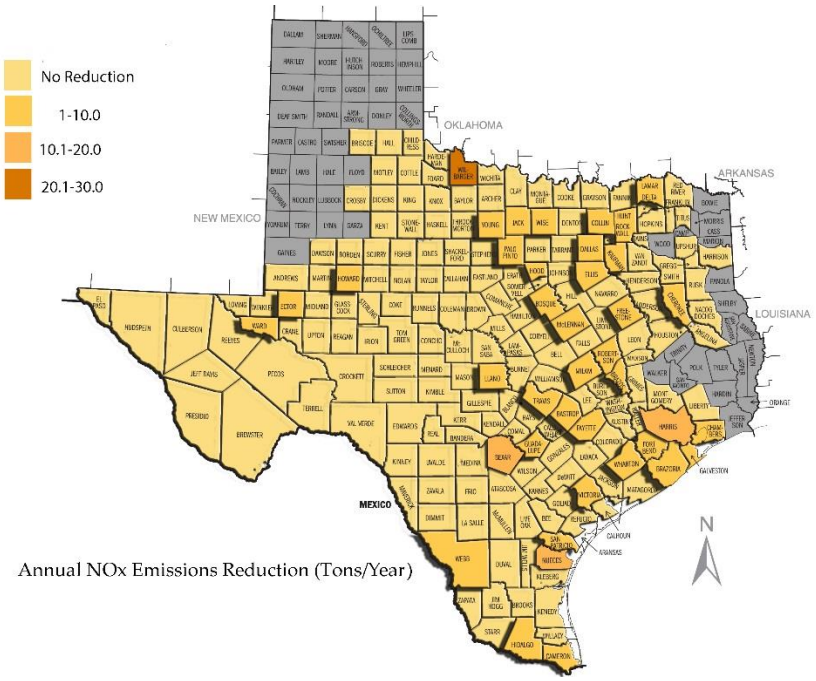


Figure 11: Map of 2016 Annual NOx Reductions by County from New Single-family and Multi-family Residences

4.4 2016 Results for Commercial Construction

This section reports the calculated energy savings and emissions reductions from new commercial Construction in 2016 that were built to meet ASHRAE Standard 90.1-2013.

To determine the energy savings and emissions reductions from new commercial Construction in all counties in the ERCOT region as well as the 36 non-attainment and affected counties, data from two sources (i.e., Dodge and USDOE) were merged into one analysis as shown in Figure 12. Beginning in the upper left of Figure 12, the Dodge database of the square footage of new commercial Construction per county in Texas (Dodge 2017) was categorized by the building types in the report published by the US Department of Energy (DOE) (USDOE 2014). This allowed for the new Construction to be tracked by county and building type. The next block in Figure 12 and Table 17 show the categories from the Dodge database and the DOE report. The Dodge "stores and restaurant" category had to be split into two categories to match the two DOE categories for "retail" and "food". To accomplish this, information published in the 2012 CBECS database by the US DOE's EIA was used to determine the percentages used to split the Dodge conditioned area for each county as shown in
Table 18 (i.e., 21.33% for food and 78.67% for retail). As a result, six Dodge building types were categorized into seven DOE building types and the resultant square footage of new commercial Construction by the seven DOE building types is shown in Figure 13 for all building types and in Figure 14 for each building type.

In the next step, the annual energy savings were calaulated. To accomplish this, this report used the resultant square footage and savings of the annual energy use intensity (EUI). The DOE report included the annual EUI values, which comply with the ASHRAE Standard 90.1-2007 and 2013, by seven building types (USDOE 2011). The annual energy use for each building type was calculated by multiplying the annual EUI value by the resultant square footage. Then, the annual energy savings were calculated by subtracting the annual energy use from ASHRAE Standard 90.1-2007 to the annual energy use from ASHRAE Standard 90.1-2013. From Table 19 to Table 21 show the annual energy use calculated for new commercial Construction, by building type, for ASHRAE Standard 90.1-2007 and ASHRAE Standard 90.1-2013. Table 22 shows the county-wide annual electricity and natural gas savings by building type[33].

[33] In this table (-) values are savings, (+) values are increased energy use.

In the next calculation step, CM Zones were assigned to each county as shown in Table 23. In the case where more than one provider was shown in a county, a percentage of electricity use was allocated.

Table 25 shows the transformation of the annual county-wide electricity and natural gas savings, along with the associated 2016 NOx emissions reductions with 7% T&D losses[34]. Figure 15 shows the bar chart of the annual electricity savings for 2016. Figure 16 presents the NOx emissions reductions resulted from the electricity and natural gas savings. The total NOx reductions from electricity and natural gas savings from new commercial Construction in 2016 are calculated to be 81.47 tons NOx/year which represents 35.78 tons NOx/year from electricity savings and 45.69 tons NOx/year from natural gas savings.

[34] 0.092 lb-NOx/MMBtu of emission rate was used for the calculation.

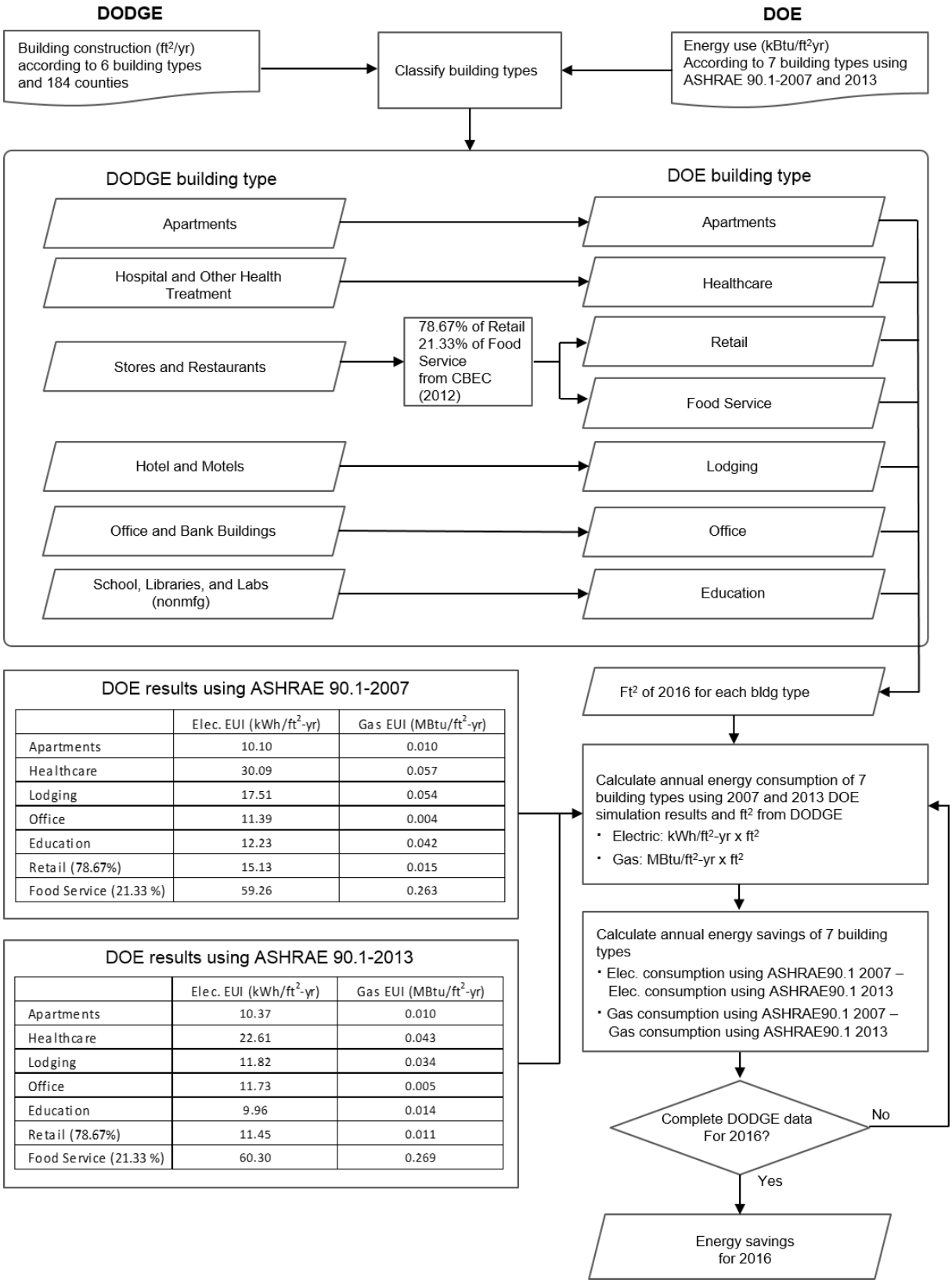


Figure 12: Calculation Method for 2016 Energy Savings from New Commercial Buildings

Table 17: Commercial Building Types in the US DOE Report and Dodge Database

No.	DOE Building Types	Dodge Building Types
1	Apartments	Apartments
2	Healthcare	Hospitals and Other Health Treatment
3	Lodging	Hotels and Motels
4	Office	Office and Bank Buildings
5	Education	Schools, Libraries, and Labs (nonmfg)
6	Retail	Stores and Restaurants
7	Food Service	

Table 18: Commercial Building Floor Area for Retail and Food Service Types from CBECS Database

		CBECS (2012)	
		Total Floor Area (million square feet)	% Distribution of Floor Area
Food	Food Sales	1,252	21.33
	Food Service	1,819	
Retail	Retail (Other Than Mall)	5,439	78.67
	Enclosed and Strip Malls	5,890	

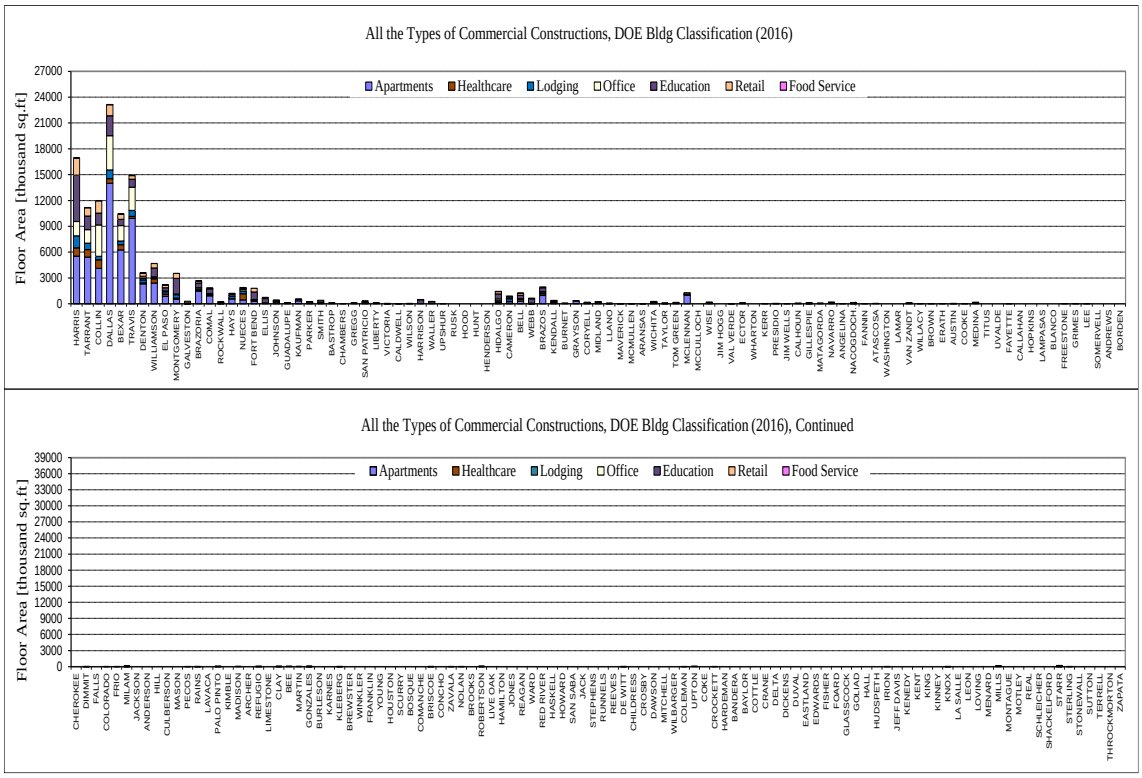


Figure 13: All the Types of 2016 New Commercial Building Construction (Dodge 2017

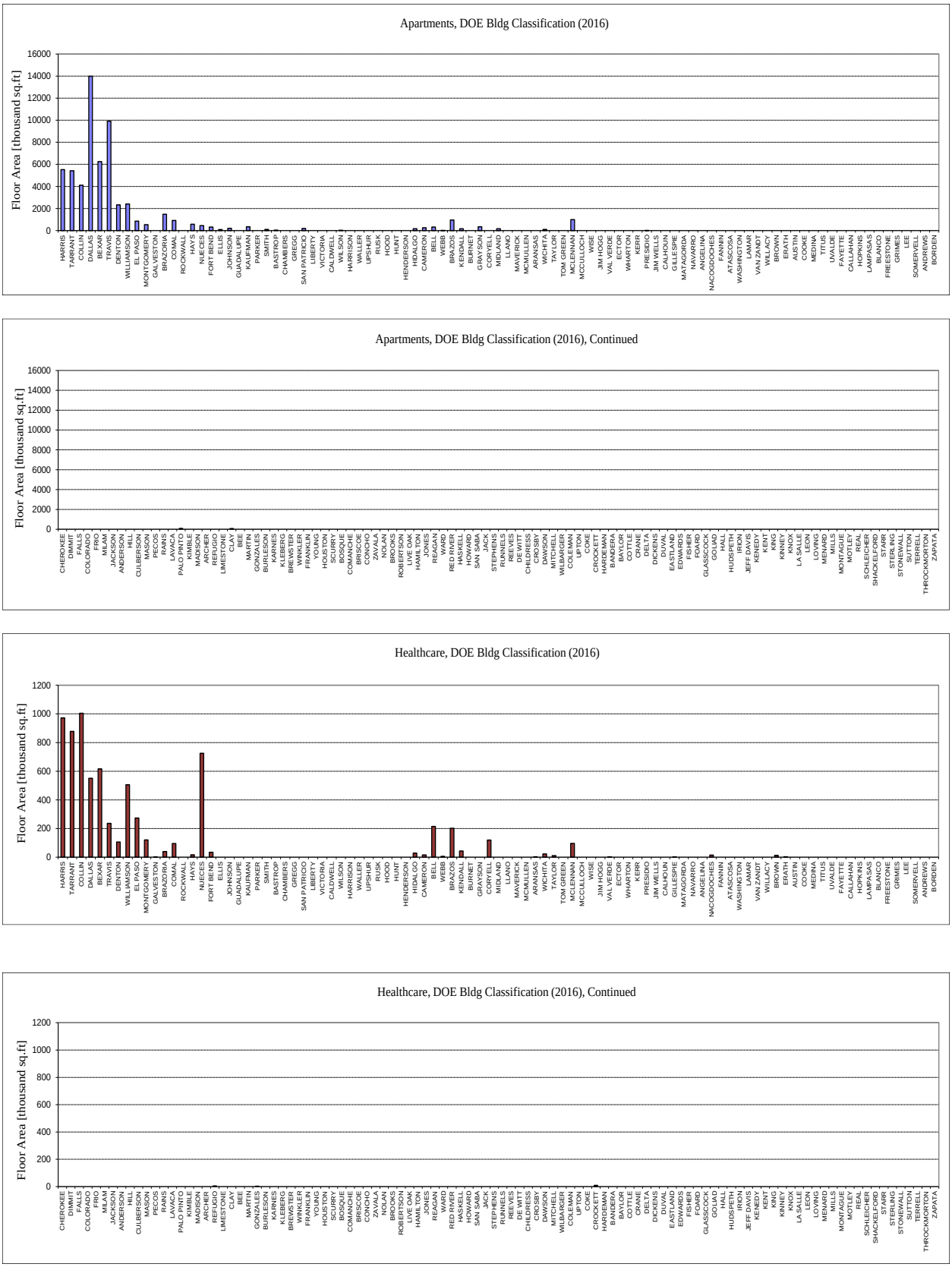
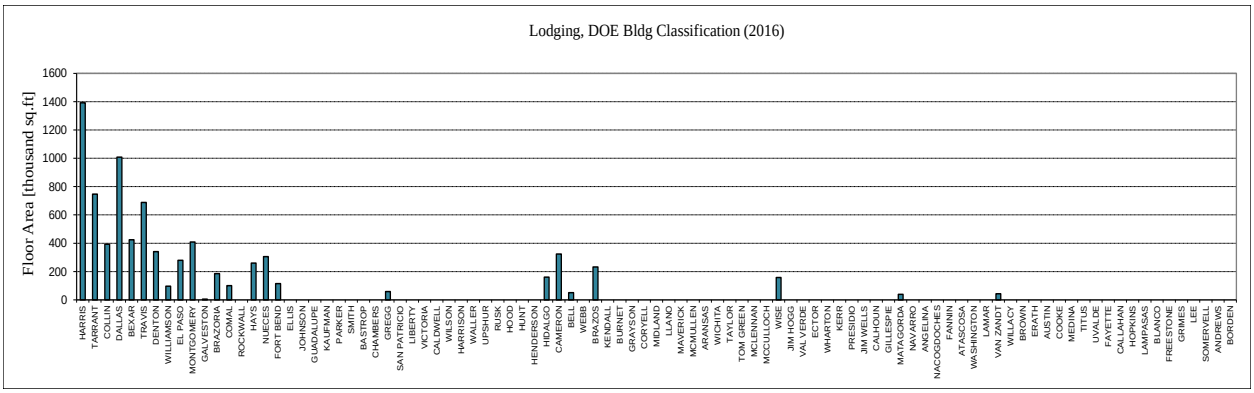
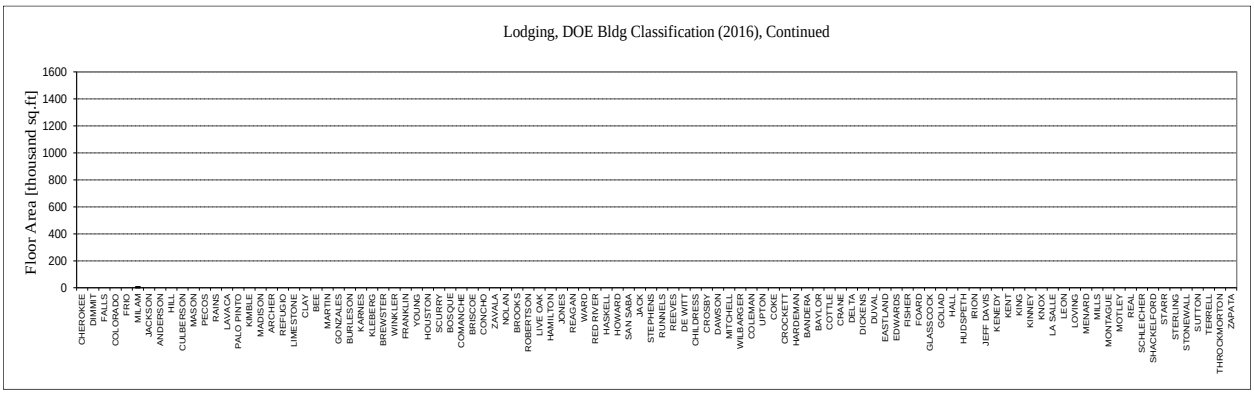
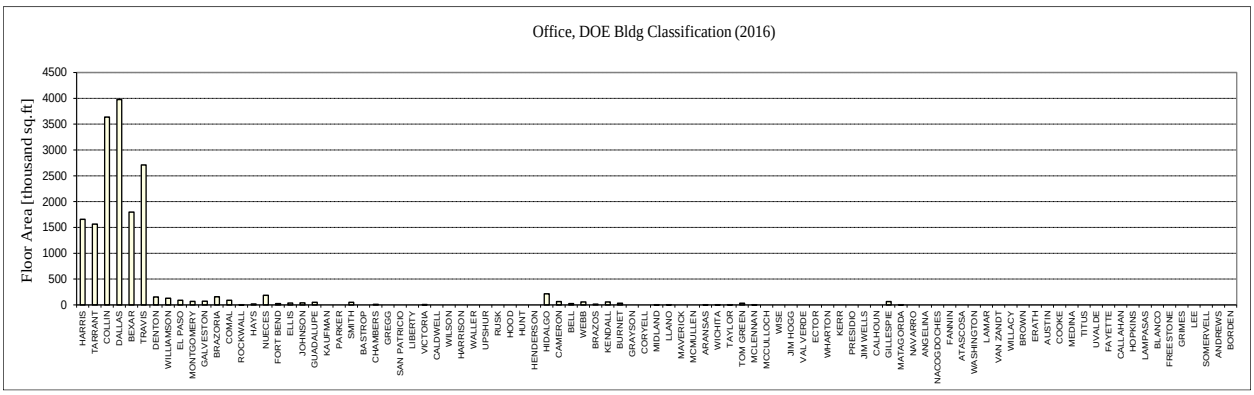


Figure 14: 2016 New Commercial Building Construction by Type (Dodge 2017)







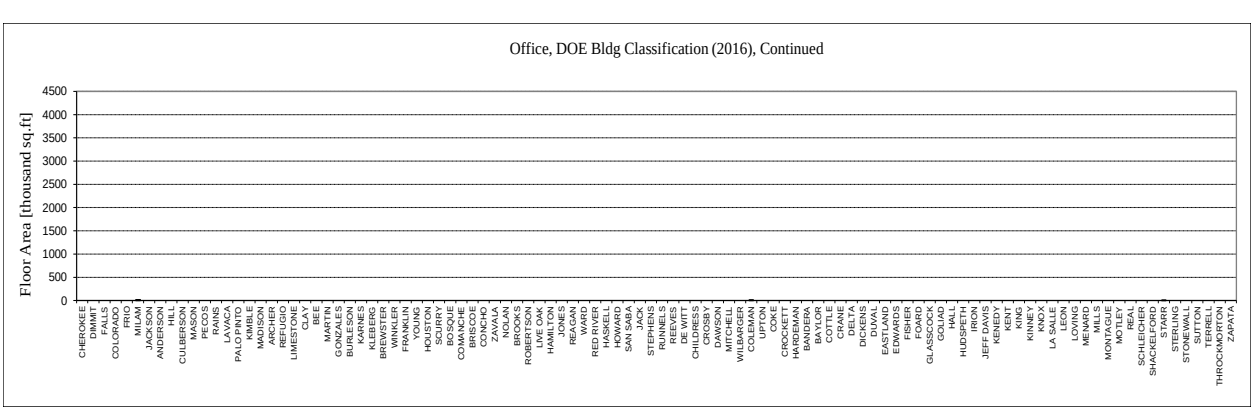


Figure 14: 2016 New Commercial Building Construction by Type (Dodge 2017) (Continued)

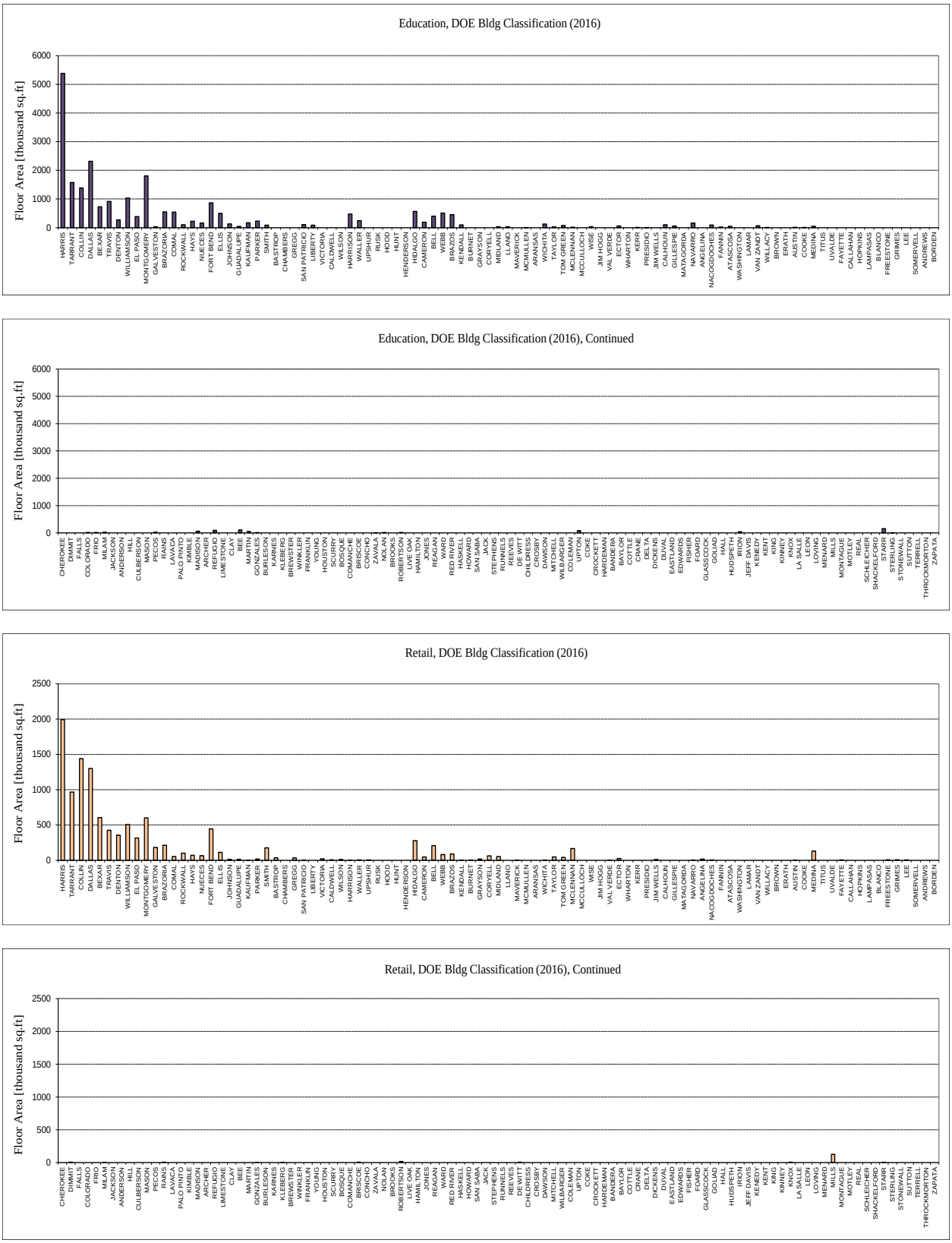


Figure 14: 2016 New Commercial Building Construction by Type (Dodge 2017) (Continued)

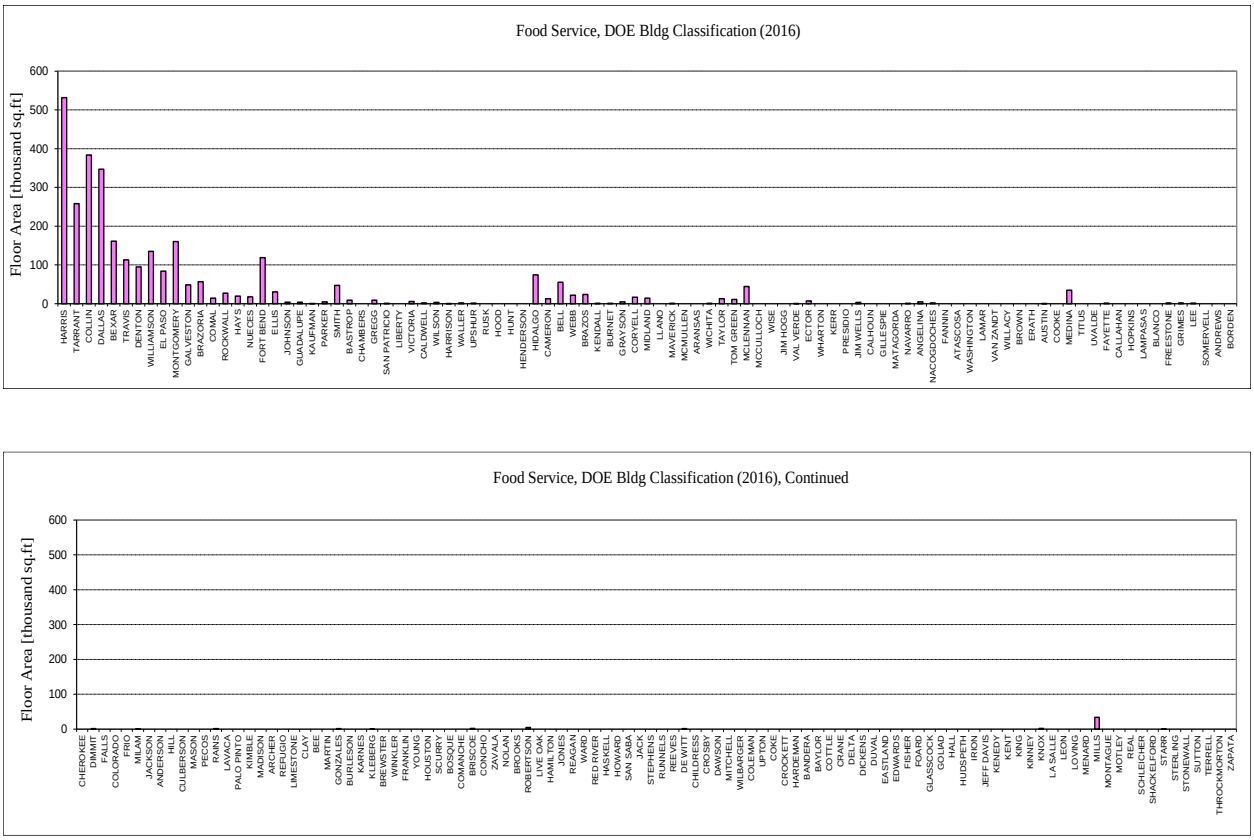


Figure 14: 2016 New Commercial Building Construction by Type (Dodge 2017) (Continued)

Table 19: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Apartment, Healthcare, and Lodging Building Types

Non-attainment Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
Brazoria	14950606	15356505	14438	14830	1188615	893063	2233	1683	3235722	2184870	10017	6313
Chambers	0	0	0	0	0	0	0	0	0	0	0	0
Collin	41479652	42605796	40057	41144	30220922	22706400	56767	42788	6882913	4647577	21308	13428
Dallas	141171559	145004272	136329	140031	16586450	12462180	31156	23483	17647642	11916288	54634	34429
Denton	23468857	24106020	22664	23279	3201739	2405617	6014	4533	5961923	4025693	18457	11631
El Paso	8541473	8773368	8249	8472	8239060	6190394	15476	11665	4886851	3299768	15129	9534
Ellis	841022	863855	812	834	0	0	0	0	0	0	0	0
Fort Bend	3221730	3309198	3111	3196	1035149	777756	1944	1466	2003066	1352538	6201	3908
Galveston	0	0	0	0	48146	36175	90	68	91048	61479	282	178
Harris	55813374	57328669	53899	55362	29236929	21967080	54918	41394	24374723	16458642	75460	47552
Johnson	2026328	2081341	1957	2010	0	0	0	0	0	0	0	0
Kaufman	3422647	3515569	3305	3395	0	0	0	0	0	0	0	0
Liberty	0	0	0	0	0	0	0	0	0	0	0	0
Montgomery	5365176	5510836	5181	5322	3632047	2728928	6822	5142	7152557	4829650	22143	13954
Parker	0	0	0	0	0	0	0	0	0	0	0	0
Rockwall	0	0	0	0	0	0	0	0	0	0	0	0
Tarrant	54764368	56251183	52886	54322	26411335	19844078	49611	37394	13067205	8823421	40454	25493
Waller	0	0	0	0	0	0	0	0	0	0	0	0
Wise	0	0	0	0	0	0	0	0	2754216	1859740	8527	5373
Affected Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
Bastrop	326111	334964	315	323	0	0	0	0	0	0	0	0
Bexar	63034250	64745587	60872	62525	18551427	13938560	34847	26266	7418698	5009357	22967	14473
Caldwell	0	0	0	0	0	0	0	0	0	0	0	0
Comal	9222973	9473370	8907	9148	2864714	2152394	5381	4056	1750932	1182289	5421	3416
Gregg	0	0	0	0	0	0	0	0	1015540	685727	3144	1981
Guadalupe	0	0	0	0	0	0	0	0	0	0	0	0
Harrison	0	0	0	0	0	0	0	0	0	0	0	0
Hays	5804365	5961949	5605	5757	496510	373051	933	703	4538415	3064492	14050	8854
Nueces	4462566	4583722	4310	4427	21819367	16393917	40985	30892	5347346	3610710	16554	10432
Rusk	0	0	0	0	0	0	0	0	0	0	0	0
San Patricio	1867816	1918526	1804	1853	0	0	0	0	0	0	0	0
Smith	959149	985189	926	951	0	0	0	0	0	0	0	0
Travis	100077586	102794625	96645	99269	7110628	5342549	13357	10067	12056917	8141240	37326	23522
Upshur	0	0	0	0	0	0	0	0	0	0	0	0
Victoria	0	0	0	0	0	0	0	0	0	0	0	0
Williamson	24218002	24875505	23387	24022	15232332	11444767	28612	21566	1680895	1134997	5204	3279
Wilson	232215	238519	224	230	0	0	0	0	0	0	0	0

Table 19: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Apartment, Healthcare, and Lodging Building Types (Continued)

Other ERCOT Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
ANDERSON	0	0	0	0	0	0	0	0	0	0	0	0
ANDREWS	0	0	0	0	0	0	0	0	0	0	0	0
ANGELINA	0	0	0	0	0	0	0	0	0	0	0	0
ARANSAS	0	0	0	0	105320	79132	198	149	0	0	0	0
ARCHER	0	0	0	0	0	0	0	0	0	0	0	0
ATASCOSA	0	0	0	0	0	0	0	0	0	0	0	0
AUSTIN	0	0	0	0	0	0	0	0	0	0	0	0
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0	0	0	0	0
BELL	3134902	3220013	3027	3110	6451624	4847408	12119	9134	875466	591144	2710	1708
BLANCO	0	0	0	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0	0	0	0
BRAZOS	9668220	9930706	9337	9590	6081498	4569315	11423	8610	4060411	2741728	12570	7921
BREWSTER	0	0	0	0	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0	0	0	0	0
BROWN	0	0	0	0	403226	302963	757	571	0	0	0	0
BURLESON	0	0	0	0	0	0	0	0	0	0	0	0
BURNET	0	0	0	0	0	0	0	0	0	0	0	0
CALHOUN	0	0	0	0	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0	0	0	0	0
CAMERON	2497825	2565640	2412	2478	481464	361747	904	682	5667766	3827069	17546	11057
CHEROKEE	0	0	0	0	0	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	673423	691706	650	668	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	0	0	0	0	0	0
COLORADO	0	0	0	0	0	0	0	0	0	0	0	0
COMANCHE	0	0	0	0	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	0	0	0	0	0	0	0	0
CORYELL	0	0	0	0	3610983	2713102	6783	5113	0	0	0	0
COTTLE	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	279851	210265	526	396	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0	0	0	0
DEWITT	0	0	0	0	0	0	0	0	0	0	0	0
DELTA	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0	0	0	0
DUVAL	0	0	0	0	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0	0	0	0	0
ECTOR	0	0	0	0	0	0	0	0	0	0	0	0
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	96293	72349	181	136	0	0	0	0
FALLS	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	0	0	0	0	0	0	0	0
FAYETTE	0	0	0	0	0	0	0	0	0	0	0	0
FISHER	0	0	0	0	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0	0	0	0	0
FRIO	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	0	0	0	0	30092	22609	57	43	0	0	0	0
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0	0	0	0
GONZALES	0	0	0	0	84256	63306	158	119	0	0	0	0
GRAYSON	3452936	3546681	3335	3425	0	0	0	0	0	0	0	0
GRIMES	0	0	0	0	0	0	0	0	0	0	0	0
HALL	0	0	0	0	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0	0	0	0	0
HENDERSON	484623	497780	468	481	947883	712189	1780	1342	0	0	0	0
HIDALGO	1686083	1731859	1628	1672	872654	655666	1639	1236	2817249	1902303	8722	5496
HILL	0	0	0	0	0	0	0	0	0	0	0	0
HOOD	0	0	0	0	0	0	0	0	0	0	0	0
HOPKINS	0	0	0	0	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0	0	0	0	0
HUNT	0	0	0	0	0	0	0	0	0	0	0	0
IRION	0	0	0	0	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0	0	0	0	0

Table 19: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Apartment, Healthcare, and Lodging Building Types (Continued)

Other ERCOT Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
JIM WELLS	0	0	0	0	0	0	0	0	0	0	0	0
JONES	0	0	0	0	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0	0	0	0	0
KENDALL	1665890	1711118	1609	1652	1293936	972195	2431	1832	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	0	0	0	0
KERR	0	0	0	0	0	0	0	0	0	0	0	0
KIMBLE	0	0	0	0	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0	0	0	0	0
KNOX	0	0	0	0	0	0	0	0	0	0	0	0
LA SALLE	0	0	0	0	0	0	0	0	0	0	0	0
LAMAR	0	0	0	0	0	0	0	0	0	0	0	0
LAMPASAS	0	0	0	0	0	0	0	0	0	0	0	0
LAVACA	0	0	0	0	0	0	0	0	0	0	0	0
LEE	0	0	0	0	0	0	0	0	0	0	0	0
LEON	0	0	0	0	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0	0	0	0	0
LLANO	0	0	0	0	0	0	0	0	0	0	0	0
LOVING	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0	0	0	0	0
MATAGORDA	0	0	0	0	0	0	0	0	682863	461093	2114	1332
MAVERICK	0	0	0	0	0	0	0	0	0	0	0	0
MCCULLOCH	0	0	0	0	0	0	0	0	0	0	0	0
MCLENNAN	10060966	10334115	9716	9980	2888787	2170481	5426	4090	0	0	0	0
MCMULLEN	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA	0	0	0	0	0	0	0	0	0	0	0	0
MENARD	0	0	0	0	0	0	0	0	0	0	0	0
MIDLAND	1625505	1669636	1570	1612	0	0	0	0	0	0	0	0
MILAM	0	0	0	0	0	0	0	0	131320	88672	407	256
MILLS	0	0	0	0	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	0	0	451373	339138	848	639	0	0	0	0
NAVARRO	0	0	0	0	0	0	0	0	0	0	0	0
NOLAN	0	0	0	0	0	0	0	0	0	0	0	0
PALO PINTO	805685	827559	778	799	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	0	0	0	0	0	0	0	0
PRESIDIO	90867	93334	88	90	0	0	0	0	0	0	0	0
RAINS	0	0	0	0	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0	0	0	0	0
RED RIVER	0	0	0	0	0	0	0	0	0	0	0	0
REEVES	0	0	0	0	0	0	0	0	0	0	0	0
REFUGIO	0	0	0	0	150458	113046	283	213	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0	0	0	0	0
RUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	0	0	0	0	0	0	0	0
SHACKELFORD	0	0	0	0	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0	0	0	0	0
STARR	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	0	0	0	0	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0	0	0	0	0
TAYLOR	0	0	0	0	346053	260006	650	490	0	0	0	0
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0	0	0	0	0
TOM GREEN	0	0	0	0	0	0	0	0	0	0	0	0
UPTON	0	0	0	0	0	0	0	0	0	0	0	0
UVALDE	0	0	0	0	0	0	0	0	0	0	0	0
VAL VERDE	0	0	0	0	75229	56523	141	107	0	0	0	0
VAN ZANDT	0	0	0	0	0	0	0	0	747648	504837	2315	1459
WARD	0	0	0	0	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0	0	0	0	0
WEBB	35337	36296	34	35	186567	140177	350	264	0	0	0	0
WHARTON	0	0	0	0	0	0	0	0	0	0	0	0
WICHITA	1037900	1066078	1002	1030	692105	520011	1300	980	0	0	0	0
WILBARGER	0	0	0	0	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	0	0	0	0	0	0	0	0	0	0	0	0
YOUNG	0	0	0	0	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0	0	0	0	0
Total	602191985	618541089	581537	597325	211405024	158838535	397100	299312	136849334	92405324	423661	266977

Table 20: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Office and Education Building Types

Non-attainment Counties	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
Brazoria	1807501	1862265	688	750	6727873	5482809	22956	7679
Chambers	127561	131426	49	53	0	0	0	0
Collin	41450645	42706527	15787	17203	16899761	13772283	57664	19288
Dallas	45288879	46661052	17248	18796	28316238	23076021	96619	32318
Denton	1739164	1791858	662	722	3336428	2718987	11384	3808
El Paso	1043271	1074880	397	433	4671489	3806981	15940	5332
Ellis	392935	404840	150	163	6086017	4959736	20766	6946
Fort Bend	290430	299230	111	121	10594902	8634204	36151	12092
Galveston	829150	854271	316	344	366775	298899	1251	419
Harris	18893904	19466356	7196	7841	65781063	53607588	224454	75078
Johnson	445326	458819	170	185	1583245	1290249	5402	1807
Kaufman	0	0	0	0	2060052	1678818	7029	2351
Liberty	0	0	0	0	1075873	876771	3671	1228
Montgomery	761952	785038	290	316	22082289	17995730	75348	25203
Parker	0	0	0	0	2811940	2291561	9595	3209
Rockwall	35307	36377	13	15	1218915	993342	4159	1391
Tarrant	17831272	18371528	6791	7400	19238562	15678264	65645	21958
Waller	0	0	0	0	2986770	2434037	10191	3409
Wise	0	0	0	0	366775	298899	1251	419
Affected Counties	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
Bastrop	0	0	0	0	0	0	0	0
Bexar	20488423	21109186	7803	8503	8875950	7233363	30286	10130
Caldwell	0	0	0	0	0	0	0	0
Comal	1023909	1054931	390	425	6593389	5373213	22498	7525
Gregg	0	0	0	0	0	0	0	0
Guadalupe	588833	606673	224	244	512262	417463	1748	585
Harrison	0	0	0	0	5760810	4694712	19657	6575
Hays	199315	205354	76	83	2752034	2242741	9390	3141
Nueces	2134377	2199045	813	886	1968358	1604093	6716	2247
Rusk	0	0	0	0	0	0	0	0
San Patricio	0	0	0	0	1260483	1027217	4301	1439
Smith	568332	585551	216	236	1020857	831936	3483	1165
Travis	30860765	31795792	11753	12808	11187854	9117425	38175	12769
Upshur	0	0	0	0	0	0	0	0
Victoria	100227	103264	38	42	0	0	0	0
Williamson	1458984	1503189	556	606	12628057	10291103	43089	14413
Wilson	0	0	0	0	0	0	0	0

Table 20: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Office and Education Building Types (Continued)

Other ERCOT Counties	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
ANDERSON	0	0	0	0	0	0	0	0
ANDREWS	0	0	0	0	0	0	0	0
ANGELINA	0	0	0	0	0	0	0	0
ARANSAS	23918	24642	9	10	0	0	0	0
ARCHER	0	0	0	0	0	0	0	0
ATASCOSA	0	0	0	0	580727	473257	1982	663
AUSTIN	0	0	0	0	171162	139486	584	195
BANDERA	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0
BEE	0	0	0	0	1344841	1095964	4589	1535
BELL	282458	291016	108	117	4864657	3964401	16599	5552
BLANCO	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0
BRAZOS	153757	158416	59	64	5554193	4526332	18952	6339
BREWSTER	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0
BROWN	0	0	0	0	0	0	0	0
BURLESON	0	0	0	0	0	0	0	0
BURNET	375851	387238	143	156	0	0	0	0
CALHOUN	0	0	0	0	1198131	976404	4088	1367
CALLAHAN	0	0	0	0	0	0	0	0
CAMERON	728923	751008	278	303	2320462	1891036	7918	2648
CHEROKEE	0	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0
COLEMAN	97949	100917	37	41	0	0	0	0
COLORADO	0	0	0	0	184610	150446	630	211
COMANCHE	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	97807	79706	334	112
CORYELL	0	0	0	0	0	0	0	0
COTTLE	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0
DEWITT	0	0	0	0	0	0	0	0
DELTA	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0
DUVAL	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0
ECTOR	0	0	0	0	712766	580861	2432	814
EDWARDS	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0
FALLS	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	264078	215207	901	301
FAYETTE	0	0	0	0	0	0	0	0
FISHER	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0
FRIO	0	0	0	0	173607	141479	592	198
GILLESPIE	742590	765089	283	308	665085	542004	2269	759
GLASSCOCK	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0
GONZALES	0	0	0	0	134484	109596	459	153
GRAYSON	0	0	0	0	0	0	0	0
GRIMES	0	0	0	0	0	0	0	0
HALL	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0
HENDERSON	0	0	0	0	0	0	0	0
HIDALGO	2438474	2512356	929	1012	6921041	5640230	23616	7899
HILL	0	0	0	0	0	0	0	0
HOOD	0	0	0	0	122258	99633	417	140
HOPKINS	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0
HUNT	0	0	0	0	257965	210226	880	294
IRION	0	0	0	0	496369	404510	1694	567
JACK	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0

Table 20: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Office and Education Building Types (Continued)

Other ERCOT Counties	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
JIM WELLS	0	0	0	0	0	0	0	0
JONES	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0
KENDALL	650336	670040	248	270	1157786	943525	3951	1321
KENEDY	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0
KERR	0	0	0	0	61129	49817	209	70
KIMBLE	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0
KNOX	0	0	0	0	0	0	0	0
LA SALLE	0	0	0	0	0	0	0	0
LAMAR	0	0	0	0	0	0	0	0
LAMPASAS	0	0	0	0	0	0	0	0
LAVACA	0	0	0	0	0	0	0	0
LEE	0	0	0	0	0	0	0	0
LEON	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0
LLANO	46697	48111	18	19	361884	294914	1235	413
LOVING	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	751888	612744	2566	858
MARTIN	0	0	0	0	612514	499162	2090	699
MASON	0	0	0	0	0	0	0	0
MATAGORDA	61503	63366	23	26	0	0	0	0
MAVERICK	0	0	0	0	0	0	0	0
MCCULLOCH	0	0	0	0	0	0	0	0
MCLENNAN	41002	42244	16	17	202949	165391	692	232
MCMULLEN	0	0	0	0	42790	34872	146	49
MEDINA	0	0	0	0	544049	443367	1856	621
MENARD	0	0	0	0	0	0	0	0
MIDLAND	56947	58672	22	24	366775	298899	1251	419
MILAM	208426	214741	79	87	311759	254064	1064	356
MILLS	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	0	0	1137002	926588	3880	1298
NAVARRO	0	0	0	0	1931681	1574203	6591	2205
NOLAN	0	0	0	0	207839	169376	709	237
PALO PINTO	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	317872	259046	1085	363
PRESIDIO	0	0	0	0	18339	14945	63	21
RAINS	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0
RED RIVER	0	0	0	0	0	0	0	0
REEVES	0	0	0	0	0	0	0	0
REFUGIO	0	0	0	0	1132112	922602	3863	1292
ROBERTSON	0	0	0	0	199281	162402	680	227
RUNNELS	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	0	0	0	0
SHACKELFORD	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0
STARR	60364	62193	23	25	1881555	1533353	6420	2147
STEPHENS	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	50126	40850	171	57
STONEWALL	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0
TAYLOR	17084	17602	7	7	311759	254064	1064	356
TERRELL	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0
TOM GREEN	378129	389585	144	157	916937	747248	3129	1047
UPTON	0	0	0	0	1023302	833929	3492	1168
UVALDE	0	0	0	0	0	0	0	0
VAL VERDE	0	0	0	0	0	0	0	0
VAN ZANDT	0	0	0	0	794679	647615	2712	907
WARD	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0
WEBB	646919	666519	246	268	6191159	5045420	21125	7066
WHARTON	0	0	0	0	0	0	0	0
WICHITA	23918	24642	9	10	1522115	1240432	5194	1737
WILBARGER	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	110032	89670	375	126
WINKLER	0	0	0	0	0	0	0	0
YOUNG	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	46458	37861	159	53
Total	195395702	201315850	74417	81095	297035028	242065582	1013525	339017

Table 21: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2014 Code-Compliant Retail and Food Service Building Types

Non-attainment Counties	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
Brazoria	3210388	2428451	3187	2429	3409039	3469011	15121	15457
Chambers	0	0	0	0	0	0	0	0
Collin	21700175	16414780	21542	16415	23042930	23448305	102207	104479
Dallas	19612292	14835432	19470	14836	20825854	21192226	92373	94427
Denton	5354218	4050120	5315	4050	5685524	5785545	25218	25779
El Paso	4755469	3597205	4721	3597	5049726	5138562	22398	22896
Ellis	1715302	1297515	1703	1298	1821441	1853484	8079	8259
Fort Bend	6707651	5073905	6659	5074	7122705	7248009	31593	32295
Galveston	2756863	2085388	2737	2085	2927451	2978951	12985	13273
Harris	30046945	22728573	29828	22729	31906179	32467478	141520	144666
Johnson	215454	162977	214	163	228786	232811	1015	1037
Kaufman	30949	23411	31	23	32864	33442	146	149
Liberty	0	0	0	0	0	0	0	0
Montgomery	9055032	6849547	8989	6850	9615336	9784490	42649	43597
Parker	269020	203496	267	204	285667	290692	1267	1295
Rockwall	1534368	1160650	1523	1161	1629311	1657974	7227	7387
Tarrant	14584232	11032029	14478	11032	15486669	15759113	68691	70218
Waller	95228	72034	95	72	101121	102900	449	458
Wise	0	0	0	0	0	0	0	0
Affected Counties	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
Bastrop	520185	393487	516	393	552373	562090	2450	2505
Bexar	9107407	6889165	9041	6889	9670952	9841085	42896	43849
Caldwell	108322	81939	108	82	115025	117049	510	522
Comal	813013	614991	807	615	863320	878508	3829	3914
Gregg	498759	377279	495	377	529621	538938	2349	2401
Guadalupe	202360	153073	201	153	214882	218662	953	974
Harrison	33330	25212	33	25	35392	36015	157	160
Hays	1089175	823891	1081	824	1156571	1176917	5130	5244
Nueces	985614	745553	978	746	1046602	1065014	4642	4745
Rusk	0	0	0	0	0	0	0	0
San Patricio	36901	27913	37	28	39184	39874	174	178
Smith	2678299	2025960	2659	2026	2844026	2894059	12615	12895
Travis	6399349	4840694	6353	4841	6795326	6914870	30141	30811
Upshur	83325	63030	83	63	88481	90037	392	401
Victoria	323777	244916	321	245	343811	349860	1525	1559
Williamson	7630177	5771736	7575	5772	8102314	8244851	35938	36737
Wilson	172601	130562	171	131	183282	186506	813	831

Table 21: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Retail and Food Service Building Types (Continued)

Other ERCOT Counties	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
ANDERSON	0	0	0	0	0	0	0	0
ANDREWS	0	0	0	0	0	0	0	0
ANGELINA	258307	195393	256	195	274291	279116	1217	1244
ARANSAS	0	0	0	0	0	0	0	0
ARCHER	0	0	0	0	0	0	0	0
ATASCOSA	0	0	0	0	0	0	0	0
AUSTIN	29759	22511	30	23	31600	32156	140	143
BANDERA	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0
BELL	3137776	2373525	3115	2374	3331934	3390550	14779	15107
BLANCO	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0
BRAZOS	1336769	1011179	1327	1011	1419485	1444457	6296	6436
BREWSTER	0	0	0	0	0	0	0	0
BRISCOE	108322	81939	108	82	115025	117049	510	522
BROOKS	0	0	0	0	0	0	0	0
BROWN	0	0	0	0	0	0	0	0
BURLESON	0	0	0	0	0	0	0	0
BURNET	52376	39619	52	40	55617	56595	247	252
CALHOUN	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0
CAMERON	717784	542957	713	543	762199	775608	3381	3456
CHEROKEE	0	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	0	0
COLORADO	0	0	0	0	0	0	0	0
COMANCHE	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	0	0	0	0
CORYELL	943952	714038	937	714	1002361	1019995	4446	4545
COTTLE	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0
DEWITT	104751	79238	104	79	111233	113190	493	504
DELTA	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0
DIMMIT	85706	64831	85	65	91009	92610	404	413
DUVAL	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0
ECTOR	391627	296240	389	296	415860	423176	1845	1886
EDWARDS	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0
FALLS	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	0	0	0	0
FAYETTE	85706	64831	85	65	91009	92610	404	413
FISHER	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0
FREESTONE	108322	81939	108	82	115025	117049	510	522
FRIO	0	0	0	0	0	0	0	0
GILLESPIE	0	0	0	0	0	0	0	0
GLASSCOCK	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0
GONZALES	77373	58528	77	59	82161	83606	364	373
GRAYSON	258307	195393	256	195	274291	279116	1217	1244
GRIMES	108322	81939	108	82	115025	117049	510	522
HALL	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0
HENDERSON	89277	67532	89	68	94801	96469	420	430
HIDALGO	4206715	3182108	4176	3182	4467017	4545601	19813	20254
HILL	0	0	0	0	0	0	0	0
HOOD	103561	78337	103	78	109969	111904	488	499
HOPKINS	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0
HUNT	1504609	1138139	1494	1138	1597711	1625818	7087	7244
IRION	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0

Table 21: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Retail and Food Service Building Types (Continued)

Other ERCOT Counties	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)	2007 (Annual)	2013 (Annual)
JIM WELLS	179744	135964	178	136	190866	194223	847	865
JONES	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0
KENDALL	39282	29714	39	30	41712	42446	185	189
KENEDY	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0
KERR	0	0	0	0	0	0	0	0
KIMBLE	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0
KLEBERG	14284	10805	14	11	15168	15435	67	69
KNOX	108322	81939	108	82	115025	117049	510	522
LA SALLE	0	0	0	0	0	0	0	0
LAMAR	0	0	0	0	0	0	0	0
LAMPASAS	0	0	0	0	0	0	0	0
LAVACA	0	0	0	0	0	0	0	0
LEE	83325	63030	83	63	88481	90037	392	401
LEON	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0
LLANO	0	0	0	0	0	0	0	0
LOVING	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0
MATAGORDA	0	0	0	0	0	0	0	0
MAVERICK	38091	28814	38	29	40448	41160	179	183
MCCULLOCH	0	0	0	0	0	0	0	0
MCLENNAN	2503317	1893598	2485	1894	2658216	2704980	11791	12053
MCMULLEN	0	0	0	0	0	0	0	0
MEDINA	1970038	1490206	1956	1490	2091939	2128741	9279	9485
MENARD	0	0	0	0	0	0	0	0
MIDLAND	792777	599684	787	600	841832	856641	3734	3817
MILAM	46424	35117	46	35	49296	50164	219	224
MILLS	1904568	1440683	1891	1441	2022418	2057997	8970	9170
MITCHELL	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0
NACOGDOCHES	91657	69333	91	69	97329	99041	432	441
NAVARRO	44043	33316	44	33	46768	47591	207	212
NOLAN	0	0	0	0	0	0	0	0
PALO PINTO	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	0	0	0	0
RAINS	85706	64831	85	65	91009	92610	404	413
REAGAN	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0
RED RIVER	0	0	0	0	0	0	0	0
REEVES	0	0	0	0	0	0	0	0
REFUGIO	0	0	0	0	0	0	0	0
ROBERTSON	258307	195393	256	195	274291	279116	1217	1244
RUNNELS	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	0	0	0	0
SHACKELFORD	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0
STARR	49995	37818	50	38	53088	54022	235	241
STEPHENS	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0
TAYLOR	721355	545659	716	546	765991	779466	3398	3473
TERRELL	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0
TOM GREEN	627317	474525	623	475	666134	677853	2955	3020
UPTON	0	0	0	0	0	0	0	0
UVALDE	0	0	0	0	0	0	0	0
VAL VERDE	30949	23411	31	23	32864	33442	146	149
VAN ZANDT	0	0	0	0	0	0	0	0
WARD	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0
WEBB	1228447	929240	1220	929	1304460	1327408	5786	5915
WHARTON	0	0	0	0	0	0	0	0
WICHITA	46424	35117	46	35	49296	50164	219	224
WILBARGER	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	0	0	0	0
WINKLER	0	0	0	0	0	0	0	0
YOUNG	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0
Total	176899872	133813324	175613	133817	187846019	191150635	833192	851713

Table 22: Annual Electricity and Natural Gas Savings from New Commercial Construction

Counties	Apartments		Healthcare		Lodging		Office		Education		Retail		Food Service		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	MWh/yr	Therm/yr
Non-attainment Counties																		
(square feet in thousands)																		
BRAZORIA	405899	392	-295553	-550	-1050853	-3705	54764	62	-1245063	-15278	-781937	-759	59972	336	-2852770	-19501	3052	208659
CHAMBERS	0	0	0	0	0	0	3865	4	0	0	0	0	0	0	3865	4	-4	-47
COLLIN	1126144	1088	-7514522	-13979	-2235336	-7881	1255882	1416	-3127478	-38376	-5285395	-5127	405375	2272	-15375330	-60587	16452	648278
DALLAS	3832712	3701	-4124270	-7672	-5731354	-20205	1372174	1548	-5240217	-64301	-4776860	-4634	366372	2053	-14301444	-89510	15303	957755
DENTON	637164	615	-796122	-1481	-1936230	-6826	52694	59	-617441	-7576	-1304098	-1265	100021	561	-3864013	-15913	4134	170270
EL PASO	231895	224	-2048667	-3811	-1587083	-5595	31609	36	-864508	-10608	-1158264	-1124	88836	498	-5306182	-20380	5678	218070
ELLIS	22833	22	0	0	0	0	11905	13	-1126281	-13820	-417787	-405	32043	180	-1477287	-14010	1581	149911
FORT BEND	87468	84	-257393	-479	-650528	-2293	8800	10	-1960698	-24059	-1633746	-1585	125304	702	-4280794	-27619	4580	295526
GALVESTON	0	0	-11972	-22	-29569	-104	25122	28	-67876	-833	-671474	-651	51500	289	-704269	-1294	754	13843
HARRIS	1515295	1463	-7269849	-13524	-7916081	-27908	572452	646	-12173475	-149376	-7318372	-7099	561299	3146	-32028732	-192652	34271	2061372
JOHNSON	55013	53	0	0	0	0	13493	15	-292996	-3595	-52477	-51	4025	23	-272942	-3555	292	38041
KAUFMAN	92923	90	0	0	0	0	0	0	-381234	-4678	-7538	-7	578	3	-295272	-4592	316	49138
LIBERTY	0	0	0	0	0	0	0	0	-199102	-2443	0	0	0	0	-199102	-2443	213	26141
MONTGOMERY	145661	141	-903119	-1680	-2322907	-8189	23086	26	-4086559	-50145	-2205485	-2139	169155	948	-9180170	-61038	9823	653112
PARKER	0	0	0	0	0	0	0	0	-520379	-6385	-65524	-64	5025	28	-580877	-6421	622	68702
ROCKWALL	0	0	0	0	0	0	1070	1	-225573	-2768	-373718	-363	28663	161	-569558	-2969	609	31764
TARRANT	1486815	1436	-6567257	-12217	-4243784	-14961	540256	609	-3560297	-43687	-3552203	-3446	272444	1527	-15624025	-70739	16718	756904
WALLER	0	0	0	0	0	0	0	0	-552733	-6782	-23194	-22	1779	10	-574148	-6795	614	72705
WISE	0	0	0	0	-894476	-3153	0	0	-67876	-833	0	0	0	0	-962351	-3986	1030	42653
Affected Counties																		
(square feet in thousands)																		
BASTROP	8854	9	0	0	0	0	0	0	0	0	-126699	-123	9717	54	-108128	-60	116	641
BEXAR	1711337	1653	-4612868	-8581	-2409341	-8494	620763	700	-1642588	-20156	-2218242	-2152	170133	954	-8380805	-36076	8967	386015
CALDWELL	0	0	0	0	0	0	0	0	0	0	-26383	-26	2024	11	-24360	-14	26	152
COMAL	250397	242	-712320	-1325	-568643	-2005	31023	35	-1220176	-14972	-198021	-192	15188	85	-2402552	-18132	2571	194015
GREGG	0	0	0	0	-329813	-1163	0	0	0	0	-121480	-118	9317	52	-441976	-1228	473	13143
GUADALUPE	0	0	0	0	0	0	17841	20	-94799	-1163	-49288	-48	3780	21	-122466	-1170	131	12516
HARRISON	0	0	0	0	0	0	0	0	-1066098	-13082	-8118	-8	623	3	-1073594	-13086	1149	140021
HAYS	157585	152	-123459	-230	-1473923	-5196	6039	7	-509293	-6249	-265284	-257	20347	114	-2187989	-11660	2341	124757
NUECES	121156	117	-5425451	-10093	-1736636	-6122	64668	73	-364265	-4470	-240061	-233	18412	103	-7562177	-20625	8092	220684
RUSK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAN PATRICIO	50710	49	0	0	0	0	0	0	-233266	-2862	-8988	-9	689	4	-190854	-2818	204	30155
SMITH	26040	25	0	0	0	0	17219	19	-188920	-2318	-652339	-633	50033	280	-747967	-2626	800	28098
TRAVIS	2717039	2624	-1768079	-3289	-3915677	-13804	935027	1055	-2070430	-25405	-1558655	-1512	119544	670	-5541230	-39662	5929	424389
UPSHUR	0	0	0	0	0	0	0	0	0	0	-20295	-20	1557	9	-18738	-11	20	117
VICTORIA	0	0	0	0	0	0	3037	3	0	0	-78861	-76	6048	34	-69775	-39	75	419
WILLIAMSON	657502	635	-3787565	-7046	-545897	-1925	44205	50	-2336954	-28676	-1858441	-1803	142537	799	-7684613	-37965	8223	406229
WILSON	6304	6	0	0	0	0	0	0	0	0	-42040	-41	3224	18	-32511	-17	35	178

Note: A decrease in energy use is negative (i.e., savings); an increase in energy use is positive (i.e., more consumption)

Table 22: Annual Electricity and Natural Gas Savings from New Commercial Construction (Continued)

Counties	Apartments		Healthcare		Lodging		Office		Education		Retail		Food Service		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	MWh/yr	Therm/yr
Other ERCOT Counties																		
(square feet in thousands)																		
ANDERSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANDREWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGELINA	0	0	0	0	0	0	0	0	0	0	-62914	-61	4825	27	-58089	-34	62	364
ARANSAS	0	0	-26188	-49	0	0	725	1	0	0	0	0	0	0	-25464	-48	27	513
ARCHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATASCOSA	0	0	0	0	0	0	0	0	-107470	-1319	0	0	0	0	-107470	-1319	115	14110
AUSTIN	0	0	0	0	0	0	0	0	-31675	-389	-7248	-7	556	3	-38368	-393	41	4201
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0	-248877	-3054	0	0	0	0	-248877	-3054	266	32676
BELL	85110	82	-1604215	-2984	-284322	-1002	8558	10	-900256	-11047	-764251	-741	58616	329	-3400760	-15354	3639	164291
BLANCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BRAZOS	262486	253	-1512183	-2813	-1318683	-4649	4659	5	-1027862	-12612	-325590	-316	24972	140	-3892201	-19992	4165	213910
BREWSTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0	0	0	-26383	-26	2024	11	-24360	-14	26	152
BROOKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROWN	0	0	-100263	-187	0	0	0	0	0	0	0	0	0	0	-100263	-187	107	1996
BURLESON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURNET	0	0	0	0	0	0	11388	13	0	0	-12757	-12	978	5	-391	6	0	-64
CALHOUN	0	0	0	0	0	0	0	0	-221727	-2721	0	0	0	0	-221727	-2721	237	29112
CALLAHAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAMERON	67814	65	-119718	-223	-1840698	-6489	22085	25	-429426	-5269	-174827	-170	13409	75	-2461360	-11985	2634	128243
CHEROKEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	18283	18	0	0	0	0	0	0	0	0	0	0	0	0	18283	18	-20	-189
COKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	2968	3	0	0	0	0	0	0	2968	3	-3	-36
COLORADO	0	0	0	0	0	0	0	0	-34164	-419	0	0	0	0	-34164	-419	37	4486
COMANCHE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	0	0	0	0	-18100	-222	0	0	0	0	-18100	-222	19	2376
CORYELL	0	0	-897882	-1670	0	0	0	0	0	0	-229913	-223	17634	99	-1110161	-1794	1188	19201
COTTLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	-69586	-129	0	0	0	0	0	0	0	0	0	0	-69586	-129	74	1385
CROSBY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEWITT	0	0	0	0	0	0	0	0	0	0	-25514	-25	1957	11	-23557	-14	25	147
DELTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0	0	-20875	-20	1601	9	-19274	-11	21	121
DUVAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECTOR	0	0	0	0	0	0	0	0	-131905	-1619	-95386	-93	7316	41	-219975	-1670	235	17870
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ERATH	0	0	-23944	-45	0	0	0	0	0	0	0	0	0	0	-23944	-45	26	477
FALLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	0	0	0	0	-48870	-600	0	0	0	0	-48870	-600	52	6416
FAYETTE	0	0	0	0	0	0	0	0	0	0	-20875	-20	1601	9	-19274	-11	21	121
FISHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0	0	0	-26383	-26	2024	11	-24360	-14	26	152
FRIO	0	0	0	0	0	0	0	0	-32128	-394	0	0	0	0	-32128	-394	34	4218
GILLESPIE	0	0	-7482	-14	0	0	22499	25	-123081	-1510	0	0	0	0	-108064	-1499	116	16037
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GONZALES	0	0	-20951	-39	0	0	0	0	-24888	-305	-18845	-18	1445	8	-63238	-355	68	3794
GRAYSON	93745	91	0	0	0	0	0	0	0	0	-62914	-61	4825	27	35656	57	-38	-605
GRIMES	0	0	0	0	0	0	0	0	0	0	-26383	-26	2024	11	-24360	-14	26	152
HALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HENDERSON	13157	13	-235694	-438	0	0	0	0	0	0	-21745	-21	1668	9	-242614	-437	260	4681
HIDALGO	45776	44	-216988	-404	-914947	-3226	73882	83	-1280811	-15716	-1024607	-994	78584	440	-3239111	-19772	3466	211555
HILL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HOOD	0	0	0	0	0	0	0	0	-22625	-278	-25224	-24	1935	11	-45914	-291	49	3116
HOPKINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUNT	0	0	0	0	0	0	0	0	-47739	-586	-366469	-355	28107	158	-386101	-784	413	8386
IRION	0	0	0	0	0	0	0	0	-91858	-1127	0	0	0	0	-91858	-1127	98	12061
JACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JIM WELLS	0	0	0	0	0	0	0	0	0	0	-43779	-42	3358	19	-40421	-24	43	253
JONES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: A decrease in energy use is negative (i.e., savings); an increase in energy use is positive (i.e., more consumption)

Table 22: Annual Electricity and Natural Gas Savings from New Commercial Construction (Continued)

Counties	Apartments		Healthcare		Lodging		Office		Education		Retail		Food Service		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	MWh/yr	Therm/yr
Other ERCOT Counties																		
(square feet in thousands)																		
KENDALL	45228	44	-321741	-599	0	0	19704	22	-214260	-2629	-9568	-9	734	4	-479903	-3167	513	33886
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KERR	0	0	0	0	0	0	0	0	-11313	-139	0	0	0	0	-11313	-139	12	1485
KIMBLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0	0	0	-3479	-3	267	1	-3212	-2	3	20
KNOX	0	0	0	0	0	0	0	0	0	0	-26383	-26	2024	11	-24360	-14	26	152
LA SALLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAMAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAMPASAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAVACA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LEE	0	0	0	0	0	0	0	0	0	0	-20295	-20	1557	9	-18738	-11	20	117
LEON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLANO	0	0	0	0	0	0	1415	2	-66971	-822	0	0	0	0	-65556	-820	70	8776
LOVING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0	-139145	-1707	0	0	0	0	-139145	-1707	149	18269
MARTIN	0	0	0	0	0	0	0	0	-113352	-1391	0	0	0	0	-113352	-1391	121	14883
MASON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MATAGORDA	0	0	0	0	-221771	-782	1863	2	0	0	0	0	0	0	-219907	-780	235	8343
MAVERICK	0	0	0	0	0	0	0	0	0	0	-9278	-9	712	4	-8566	-5	9	54
MCCULLOCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCLENNAN	273148	264	-718305	-1336	0	0	1242	1	-37558	-461	-609719	-591	46764	262	-1044428	-1861	1118	19916
MCMULLEN	0	0	0	0	0	0	0	0	-7919	-97	0	0	0	0	-7919	-97	8	1040
MEDINA	0	0	0	0	0	0	0	0	-100682	-1235	-479831	-465	36802	206	-543712	-1495	582	15993
MENARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIDLAND	44131	43	0	0	0	0	1725	2	-67876	-833	-193092	-187	14810	83	-200301	-893	214	9551
MILAM	0	0	0	0	-42648	-150	6315	7	-57694	-708	-11307	-11	867	5	-104467	-857	112	9173
MILLS	0	0	0	0	0	0	0	0	0	0	-463885	-450	35579	199	-428307	-251	458	2681
MITCHELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	-112235	-209	0	0	0	0	-210414	-2582	-22324	-22	1712	10	-343262	-2803	367	29989
NAVARRO	0	0	0	0	0	0	0	0	-357478	-4386	-10727	-10	823	5	-367382	-4392	393	46997
NOLAN	0	0	0	0	0	0	0	0	-38463	-472	0	0	0	0	-38463	-472	41	5050
PALO PINTO	21874	21	0	0	0	0	0	0	0	0	0	0	0	0	21874	21	-23	-226
PECOS	0	0	0	0	0	0	0	0	-58825	-722	0	0	0	0	-58825	-722	63	7724
PRESIDIO	2467	2	0	0	0	0	0	0	-3394	-42	0	0	0	0	-927	-39	1	420
RAINS	0	0	0	0	0	0	0	0	0	0	-20875	-20	1601	9	-19274	-11	21	121
REAGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RED RIVER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REEVES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REFUGIO	0	0	-37412	-70	0	0	0	0	-209509	-2571	0	0	0	0	-246921	-2640	264	28252
ROBERTSON	0	0	0	0	0	0	0	0	-36879	-453	-62914	-61	4825	27	-94968	-487	102	5206
RUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHACKELFORD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STARR	0	0	0	0	0	0	1829	2	-348201	-4273	-12177	-12	934	5	-357616	-4277	383	45766
STEPHENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0	-9276	-114	0	0	0	0	-9276	-114	10	1218
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAYLOR	0	0	-86047	-160	0	0	518	1	-57694	-708	-175697	-170	13475	76	-305445	-962	327	10297
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOM GREEN	0	0	0	0	0	0	11457	13	-169689	-2082	-152792	-148	11719	66	-299306	-2152	320	23024
UPTON	0	0	0	0	0	0	0	0	-189373	-2324	0	0	0	0	-189373	-2324	203	24864
UVALDE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VAL VERDE	0	0	-18706	-35	0	0	0	0	0	0	-7538	-7	578	3	-25666	-39	27	416
VAN ZANDT	0	0	0	0	-242811	-856	0	0	-147064	-1805	0	0	0	0	-389874	-2661	417	28468
WARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEBB	959	1	-46391	-86	0	0	19601	22	-1145739	-14059	-299206	-290	22948	129	-1447827	-14284	1549	152837
WHARTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICHITA	28178	27	-172094	-320	0	0	725	1	-281683	-3456	-11307	-11	867	5	-435314	-3755	466	40175
WILBARGER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	0	0	0	0	-20363	-250	0	0	0	0	-20363	-250	22	2674
WINKLER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YOUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0	-8598	-105	0	0	0	0	-8598	-105	9	1129
Total	16349104	15788	-52566489	-97788	-44444010	-156684	5920148	6677	-54969446	-674508	-43086548	-41796	3304617	18521	-169492624	-929789	181357	9948746

Note: A decrease in energy use is negative (i.e., savings); an increase in energy use is positive (i.e., more consumption)

Table 23: 2016 Totalized Annual Electricity Savings by CM Zone from New Commercial Construction

CM Zone	Total Electricity Savings by CM Zone (MWh) 2016-TRY 2008
Houston (H)	54,261
North (N)	50,490
West (W)	3,455
South (S)	31,433
Total	139,639

Table 24: 2016 Annual NOx Reductions from New Commercial Construction Using 2010 eGRID

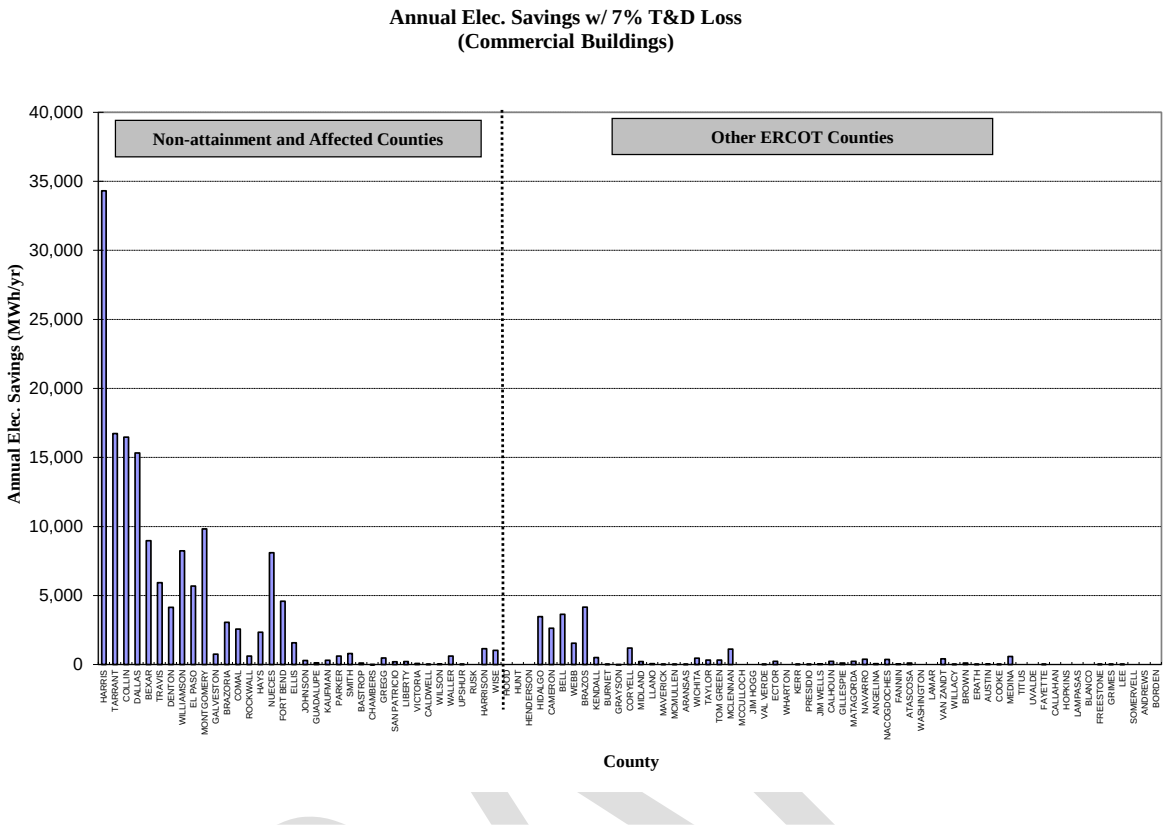
Area	County	H	NOx Reductions (lbs)	N	NOx Reductions (lbs)	W	NOx Reductions (lbs/year)	S	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.0562032	3049.66	0.0000071	0.36	0.0000003	0.00	0.0005265	16.55	3066.57	1.53
	Chambers	0.0204500	1109.64	0.0000026	0.13	0.0000001	0.00	0.0001916	6.02	1115.80	0.56
	Fort Bend	0.0313463	1700.89	0.0000040	0.20	0.0000002	0.00	0.0002937	9.23	1710.32	0.86
	Galveston	0.0226620	1229.67	0.0000029	0.15	0.0000001	0.00	0.0002123	6.67	1236.49	0.62
	Harris	0.1486911	8068.17	0.0000189	0.95	0.0000009	0.00	0.0013930	43.79	8112.92	4.06
Dallas/ Fort Worth Area	Collin	0.0012932	70.17	0.0079329	400.53	0.0003832	1.32	0.0000809	2.54	474.57	0.24
	Dallas	0.0024826	134.71	0.0152295	768.94	0.0007356	2.54	0.0001554	4.88	911.07	0.46
	Denton	0.0001267	6.87	0.0007770	39.23	0.0000375	0.13	0.0000079	0.25	46.48	0.02
	Tarrant	0.0004742	25.73	0.0029089	146.87	0.0001405	0.49	0.0000297	0.93	174.02	0.09
	Ellis	0.0029920	162.35	0.0183544	926.71	0.0008865	3.06	0.0001873	5.89	1098.01	0.55
	Johnson	0.0007256	39.37	0.0044512	224.74	0.0002150	0.74	0.0000454	1.43	266.28	0.13
	Kaufman	0.0059718	324.04	0.0366343	1849.66	0.0017695	6.11	0.0003738	11.75	2191.56	1.10
	Parker	0.0000012	0.07	0.0000075	0.38	0.0000004	0.00	0.0000001	0.00	0.45	0.00
	Wise	0.0010202	55.36	0.0062583	315.98	0.0003023	1.04	0.0000638	2.01	374.39	0.19
San Antonio Area	Bexar	0.0138906	753.72	0.0009368	47.30	0.0000452	0.16	0.1109355	3487.00	4288.17	2.14
	Guadalupe	0.0032029	173.79	0.0002160	10.91	0.0000104	0.04	0.0255795	804.03	988.77	0.49
Austin Area	Bastrop	0.0033782	183.31	0.0002278	11.50	0.0000110	0.04	0.0269798	848.04	1042.89	0.52
	Hays	0.0008331	45.21	0.0000562	2.84	0.0000027	0.01	0.0066537	209.14	257.20	0.13
	Travis	0.0051785	280.99	0.0003493	17.63	0.0000169	0.06	0.0413577	1299.98	1598.67	0.80
Corpus Christi Area	Nueces	0.0128578	697.68	0.0008672	43.78	0.0000419	0.14	0.1026870	3227.72	3969.33	1.98
	San Patricio	0.0015100	81.93	0.0001018	5.14	0.0000049	0.02	0.0120591	379.05	466.14	0.23
Victoria Area	Victoria	0.0021192	114.99	0.0001429	7.22	0.0000069	0.02	0.0169244	531.98	654.21	0.33
Other ERCOT counties	Andrews	0.0000037	0.20	0.0000230	1.16	0.0039003	13.47	0.0000002	0.01	14.85	0.01
	Bosque	0.0022204	120.48	0.0136212	687.73	0.0006579	2.27	0.0001390	4.37	814.86	0.41
	Brazos	0.0024089	130.71	0.0112305	567.03	0.0005425	1.87	0.0047829	150.34	849.95	0.42
	Calhoun	0.0009466	51.36	0.0000638	3.22	0.0000031	0.01	0.0075598	237.62	292.22	0.15
	Cameron	0.0063536	344.76	0.0004285	21.64	0.0000207	0.07	0.0507425	1594.97	1961.43	0.98
	Cherokee	0.0027392	148.63	0.0168033	848.40	0.0008116	2.80	0.0001714	5.39	1005.22	0.50
	Ector	0.0019215	104.26	0.0006604	33.34	0.0911346	314.86	0.0146527	460.57	913.03	0.46
	Fannin	0.0000041	0.22	0.0000249	1.26	0.0000012	0.00	0.0000003	0.01	1.49	0.00
	Fayette	0.0051867	281.44	0.0103217	521.14	0.0004986	1.72	0.0283993	892.66	1696.97	0.85
	Freestone	0.0047643	258.52	0.0292268	1475.66	0.0014117	4.88	0.0002982	9.37	1748.43	0.87
	Henderson	0.0006908	37.48	0.0042376	213.95	0.0002047	0.71	0.0000432	1.36	253.50	0.13
	Hidalgo	0.0053716	291.47	0.0003623	18.29	0.0000175	0.06	0.0428994	1348.44	1658.26	0.83
	Hood	0.0050771	275.49	0.0311454	1572.53	0.0015044	5.20	0.0003178	9.99	1863.21	0.93
	Howard	0.0002411	13.08	0.0007641	38.58	0.1283942	443.58	0.0009490	29.83	525.07	0.26
	Hunt	0.0088463	480.01	0.0047066	237.64	0.0002273	0.79	0.0652823	2051.99	2770.43	1.39
	Jack	0.0030783	167.03	0.0188839	953.45	0.0009121	3.15	0.0001927	6.06	1129.69	0.56
	Lamar	0.0040001	217.05	0.0245388	1238.96	0.0011853	4.09	0.0002504	7.87	1467.98	0.73
	Llano	0.0040314	218.75	0.0002719	13.73	0.0000131	0.05	0.0321966	1012.02	1244.55	0.62
	McLennan	0.0056576	306.99	0.0347066	1752.34	0.0016764	5.79	0.0003541	11.13	2076.25	1.04
	Milam	0.0012686	68.84	0.0000856	4.32	0.0000041	0.01	0.0101316	318.46	391.63	0.20
	Mitchell	0.0000311	1.69	0.0001910	9.64	0.0324260	112.03	0.0000019	0.06	123.42	0.06
	Nolan	0.0000293	1.59	0.0001795	9.06	0.0304745	105.28	0.0000018	0.06	115.99	0.06
	Palo Pinto	0.0036129	196.04	0.0221635	1119.04	0.0010705	3.70	0.0002261	7.11	1325.89	0.66
	Pecos	0.0000020	0.11	0.0000121	0.61	0.0020520	7.09	0.0000001	0.00	7.81	0.00
	Robertson	0.0039506	214.36	0.0055755	281.51	0.0002693	0.93	0.0246170	773.78	1270.57	0.64
	Upton	0.0000025	0.14	0.0000156	0.79	0.0026494	9.15	0.0000002	0.01	10.08	0.01
	Ward	0.0001995	10.83	0.0012239	61.80	0.2078335	718.03	0.0000125	0.39	791.05	0.40
	Webb	0.0042017	227.99	0.0002834	14.31	0.0000137	0.05	0.0335565	1054.77	1297.12	0.65
	Wharton	0.0021095	114.46	0.0001423	7.18	0.0000069	0.02	0.0168474	529.56	651.23	0.33
	Wichita	0.0000121	0.66	0.0000743	3.75	0.0126190	43.60	0.0000008	0.02	48.03	0.02
	Wilbarger	0.0179710	975.13	0.1102430	5566.16	0.0053249	18.40	0.0011247	35.35	6595.04	3.30
	Wise	0.0010202	55.36	0.0062583	315.98	0.0003023	1.04	0.0000638	2.01	374.39	0.19
	Young	0.0071054	385.55	0.0435880	2200.76	0.0021054	7.27	0.0004447	13.98	2607.56	1.30
	Total	**0.4414501**	**23953.66**	**0.4812863**	**24300.12**	**0.5345786**	**1846.89**	**0.6829349**	**21466.44**	**71567.11**	**35.78**
Energy Savings by PCA (MWh)		54,261		50,490		3,455		31,433			

Table 25: 2016 Annual Electricity and Natural Gas Savings and NOx Reductions from New Commercial Construction

	County	Electricity Savings and Resultant NOx Reductions (Commercial)		Total Natural Gas Savings and Resultant NOx Reductions (Commercial)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Non-attainment and Affected Counties	HARRIS	34,270.74	4.06	2,061,372.19	9.48	13.54
	TARRANT	16,717.71	0.09	756,904.12	3.48	3.57
	COLLIN	16,451.60	0.24	648,277.67	2.98	3.22
	DALLAS	15,302.54	0.46	957,755.30	4.41	4.86
	BEXAR	8,967.46	2.14	386,014.87	1.78	3.92
	TRAVIS	5,929.12	0.80	424,388.51	1.95	2.75
	DENTON	4,134.49	0.02	170,270.50	0.78	0.81
	WILLIAMSON	8,222.54		406,229.17	1.87	1.87
	EL PASO	5,677.61		218,069.62	1.00	1.00
	MONTGOMERY	9,822.78		653,111.83	3.00	3.00
	GALVESTON	753.57	0.62	13,843.44	0.06	0.68
	BRAZORIA	3,052.46	1.53	208,658.94	0.96	2.49
	COMAL	2,570.73		194,015.30	0.89	0.89
	ROCKWALL	609.43		31,763.89	0.15	0.15
	HAYS	2,341.15	0.13	124,756.80	0.57	0.70
	NUECES	8,091.53	1.98	220,684.04	1.02	3.00
	FORT BEND	4,580.45	0.86	295,526.33	1.36	2.21
	ELLIS	1,580.70	0.55	149,910.75	0.69	1.24
	JOHNSON	292.05	0.13	38,041.06	0.17	0.31
	GUADALUPE	131.04	0.49	12,516.32	0.06	0.55
	KAUFMAN	315.94	1.10	49,137.70	0.23	1.32
	PARKER	621.54	0.00	68,702.10	0.32	0.32
	SMITH	800.32		28,098.02	0.13	0.13
	BASTROP	115.70	0.52	640.84	0.00	0.52
	CHAMBERS	(4.14)	0.56	(46.64)	(0.00)	0.56
	GREGG	472.91		13,143.39	0.06	0.06
	SAN PATRICIO	204.21	0.23	30,154.66	0.14	0.37
	LIBERTY	213.04		26,141.11	0.12	0.12
	VICTORIA	74.66	0.33	419.17	0.00	0.33
	CALDWELL	26.07		152.50	0.00	0.00
	WILSON	34.79		177.85	0.00	0.00
	WALLER	614.34		72,705.36	0.33	0.33
	UPSHUR	20.05		117.31	0.00	0.00
	RUSK	0.00	0.00	0.00	0.00	0.00
	HARRISON	1,148.75		140,020.71	0.64	0.64
	WISE	1,029.72	0.19	42,653.22	0.20	0.38
Other ERCOT Counties	HOOD	0.00	0.93	0.00	0.00	0.93
	HUNT	0.00	1.39	0.00	0.00	1.39
	HENDERSON	0.00	0.13	0.00	0.00	0.13
	HIDALGO	3,465.85	0.83	211,555.07	0.97	1.80
	CAMERON	2,633.66	0.98	128,242.78	0.59	1.57
	BELL	3,638.81		164,291.02	0.76	0.76
	WEBB	1,549.18	0.65	152,836.60	0.70	1.35
	BRAZOS	4,164.66	0.42	213,910.23	0.98	1.41
	KENDALL	513.50		33,885.79	0.16	0.16
	BURNET	0.42		(63.69)	(0.00)	(0.00)
	GRAYSON	(38.15)		(605.02)	(0.00)	(0.00)
	CORYELL	1,187.87		19,201.14	0.09	0.09
	MIDLAND	214.32		9,551.00	0.04	0.04
	LLANO	70.14	0.62	8,775.85	0.04	0.66
	MAVERICK	9.17		53.63	0.00	0.00
	MCMULLEN	8.47		1,039.70	0.00	0.00
	ARANSAS	27.25		512.53	0.00	0.00
	WICHITA	465.79	0.02	40,174.69	0.18	0.21
	TAYLOR	326.83		10,297.03	0.05	0.05
	TOM GREEN	320.26		23,024.24	0.11	0.11
	MCLENNAN	1,117.54	1.04	19,915.73	0.09	1.13
	MCCULLOCH	0.00		0.00	0.00	0.00
	JIM HOGG	0.00		0.00	0.00	0.00
	VAL VERDE	27.46		415.91	0.00	0.00
	ECTOR	235.37	0.46	17,869.83	0.08	0.54
	WHARTON	0.00	0.33	0.00	0.00	0.33
	KERR	12.10		1,485.29	0.01	0.01
	PRESIDIO	0.99		420.10	0.00	0.00
	JIM WELLS	43.25		253.05	0.00	0.00
	CALHOUN	237.25	0.15	29,111.70	0.13	0.28
	GILLESPIE	115.63		16,037.37	0.07	0.07
	MATAGORDA	235.30		8,343.17	0.04	0.04
	NAVARRO	393.10		46,997.19	0.22	0.22
	ANGELINA	62.16		363.65	0.00	0.00
	NACOGDOCHES	367.29		29,989.47	0.14	0.14
	FANNIN	52.29	0.00	6,416.46	0.03	0.03
	ATASCOSA	114.99		14,110.26	0.06	0.06
	WASHINGTON	0.00		0.00	0.00	0.00
	LAMAR	0.00	0.73	0.00	0.00	0.73
	VAN ZANDT	417.17		28,468.10	0.13	0.13
	WILLACY	21.79		2,673.52	0.01	0.01
	BROWN	107.28		1,995.73	0.01	0.01
	ERATH	25.62		476.59	0.00	0.00
	AUSTIN	41.05		4,200.71	0.02	0.02
	COOKE	19.37		2,376.46	0.01	0.01
	MEDINA	581.77		15,992.54	0.07	0.07
	TITUS	0.00	0.00	0.00	0.00	0.00
	UVALDE	0.00		0.00	0.00	0.00
	FAYETTE	20.62	0.85	120.66	0.00	0.85
	CALLAHAN	0.00		0.00	0.00	0.00
	HOPKINS	0.00		0.00	0.00	0.00
	LAMPASAS	0.00		0.00	0.00	0.00
	BLANCO	0.00		0.00	0.00	0.00
	FREESTONE	26.07	0.87	152.50	0.00	0.87
	GRIMES	26.07	0.00	152.50	0.00	0.00
	LEE	20.05		117.31	0.00	0.00
	SOMERVELL	0.00		0.00	0.00	0.00
	ANDREWS	0.00	0.01	0.00	0.00	0.01
	BORDEN	0.00		0.00	0.00	0.00

Table 25: 2016 Annual Electricity and Natural Gas Savings and NOx Reductions from New Commercial Construction (Continued)

	County	Electricity Savings and Resultant NOx Reductions (Commercial)		Total Natural Gas Savings and Resultant NOx Reductions (Commercial)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Other ERCOT Counties	CHEROKEE	0.00	0.50	0.00	0.00	0.50
	DIMMIT	20.62		120.66	0.00	0.00
	FALLS	0.00		0.00	0.00	0.00
	COLORADO	36.56		4,485.58	0.02	0.02
	FRIO	34.38	0.00	4,218.23	0.02	0.02
	MILAM	111.78	0.20	9,172.91	0.04	0.24
	JACKSON	0.00		0.00	0.00	0.00
	ANDERSON	0.00		0.00	0.00	0.00
	HILL	0.00		0.00	0.00	0.00
	CULBERSON	0.00		0.00	0.00	0.00
	MASON	0.00		0.00	0.00	0.00
	PECOS	62.94	0.00	7,723.51	0.04	0.04
	RAINS	20.62		120.66	0.00	0.00
	LAVACA	0.00		0.00	0.00	0.00
	PALO PINTO	(23.40)	0.66	(226.02)	(0.00)	0.66
	KIMBLE	0.00		0.00	0.00	0.00
	MADISON	148.88		18,269.07	0.08	0.08
	ARCHER	0.00		0.00	0.00	0.00
	REFUGIO	264.21		28,252.26	0.13	0.13
	LIMESTONE	0.00	0.00	0.00	0.00	0.00
	CLAY	(19.56)		(188.92)	(0.00)	(0.00)
	BEE	266.30		32,676.39	0.15	0.15
	MARTIN	121.29		14,882.61	0.07	0.07
	GONZALES	67.66		3,793.59	0.02	0.02
	BURLESON	0.00		0.00	0.00	0.00
	KARNES	0.00		0.00	0.00	0.00
	KLEBERG	3.44		20.11	0.00	0.00
	BREWSTER	0.00		0.00	0.00	0.00
	WINKLER	0.00		0.00	0.00	0.00
	FRANKLIN	0.00		0.00	0.00	0.00
	YOUNG	0.00	1.30	0.00	0.00	1.30
	HOUSTON	0.00		0.00	0.00	0.00
	SCURRY	0.00		0.00	0.00	0.00
	BOSQUE	0.00	0.41	0.00	0.00	0.41
	COMANCHE	0.00		0.00	0.00	0.00
	BRISCOE	26.07		152.50	0.00	0.00
	CONCHO	0.00		0.00	0.00	0.00
	ZAVALA	9.20		1,128.82	0.01	0.01
	NOLAN	41.16	0.06	5,049.99	0.02	0.08
	BROOKS	0.00		0.00	0.00	0.00
	ROBERTSON	101.62	0.64	5,205.70	0.02	0.66
	LIVE OAK	0.00		0.00	0.00	0.00
	HAMILTON	0.00		0.00	0.00	0.00
	JONES	0.00		0.00	0.00	0.00
	REAGAN	0.00		0.00	0.00	0.00
	WARD	0.00	0.40	0.00	0.00	0.40
	RED RIVER	0.00		0.00	0.00	0.00
	HASKELL	0.00		0.00	0.00	0.00
	HOWARD	0.00	0.26	0.00	0.00	0.26
	SAN SABA	0.00		0.00	0.00	0.00
	JACK	0.00	0.56	0.00	0.00	0.56
	STEPHENS	0.00		0.00	0.00	0.00
	RUNNELS	0.00		0.00	0.00	0.00
	REEVES	0.00		0.00	0.00	0.00
	DEWITT	25.21		147.47	0.00	0.00
	CHILDRESS	0.00		0.00	0.00	0.00
	CROSBY	0.00		0.00	0.00	0.00
	DAWSON	0.00		0.00	0.00	0.00
	MITCHELL	0.00	0.06	0.00	0.00	0.06
	WILBARGER	0.00	3.30	0.00	0.00	3.30
	COLEMAN	(3.18)		(35.81)	(0.00)	(0.00)
	UPTON	202.63	0.01	24,863.76	0.11	0.12
	COKE	0.00	0.00	0.00	0.00	0.00
	CROCKETT	74.46		1,385.10	0.01	0.01
	HARDEMAN	0.00		0.00	0.00	0.00
	BANDERA	0.00		0.00	0.00	0.00
	BAYLOR	0.00		0.00	0.00	0.00
	COTTLE	0.00		0.00	0.00	0.00
	CRANE	0.00		0.00	0.00	0.00
	DELTA	0.00		0.00	0.00	0.00
	DICKENS	0.00		0.00	0.00	0.00
	DUVAL	0.00		0.00	0.00	0.00
	EASTLAND	0.00		0.00	0.00	0.00
	EDWARDS	0.00		0.00	0.00	0.00
	FISHER	0.00		0.00	0.00	0.00
	FOARD	0.00		0.00	0.00	0.00
	GLASSCOCK	0.00		0.00	0.00	0.00
	GOLIAD	0.00		0.00	0.00	0.00
	HALL	0.00		0.00	0.00	0.00
	HUDSPETH	0.00		0.00	0.00	0.00
	IRION	98.29		12,060.56	0.06	0.06
	JEFF DAVIS	0.00		0.00	0.00	0.00
	KENEDY	0.00		0.00	0.00	0.00
	KENT	0.00		0.00	0.00	0.00
	KING	0.00		0.00	0.00	0.00
	KINNEY	0.00		0.00	0.00	0.00
	KNOX	26.07		152.50	0.00	0.00
	LA SALLE	0.00		0.00	0.00	0.00
	LEON	0.00		0.00	0.00	0.00
	LOVING	0.00		0.00	0.00	0.00
	MENARD	0.00		0.00	0.00	0.00
	MILLS	458.29		2,681.28	0.01	0.01
	MONTAGUE	0.00		0.00	0.00	0.00
	MOTLEY	0.00		0.00	0.00	0.00
	REAL	0.00		0.00	0.00	0.00
	SCHLEICHER	0.00		0.00	0.00	0.00
	SHACKELFORD	0.00		0.00	0.00	0.00
	STARR	382.65		45,765.56	0.21	0.21
	STERLING	9.93		1,217.94	0.01	0.01
	STONEWALL	0.00		0.00	0.00	0.00
	SUTTON	0.00		0.00	0.00	0.00
	TERRELL	0.00		0.00	0.00	0.00
	THROCKMORTON	0.00		0.00	0.00	0.00
	ZAPATA	0.00		0.00	0.00	0.00
	TOTAL	**180,635.25**	**35.78**	**9,932,562.29**	**45.69**	**81.47**



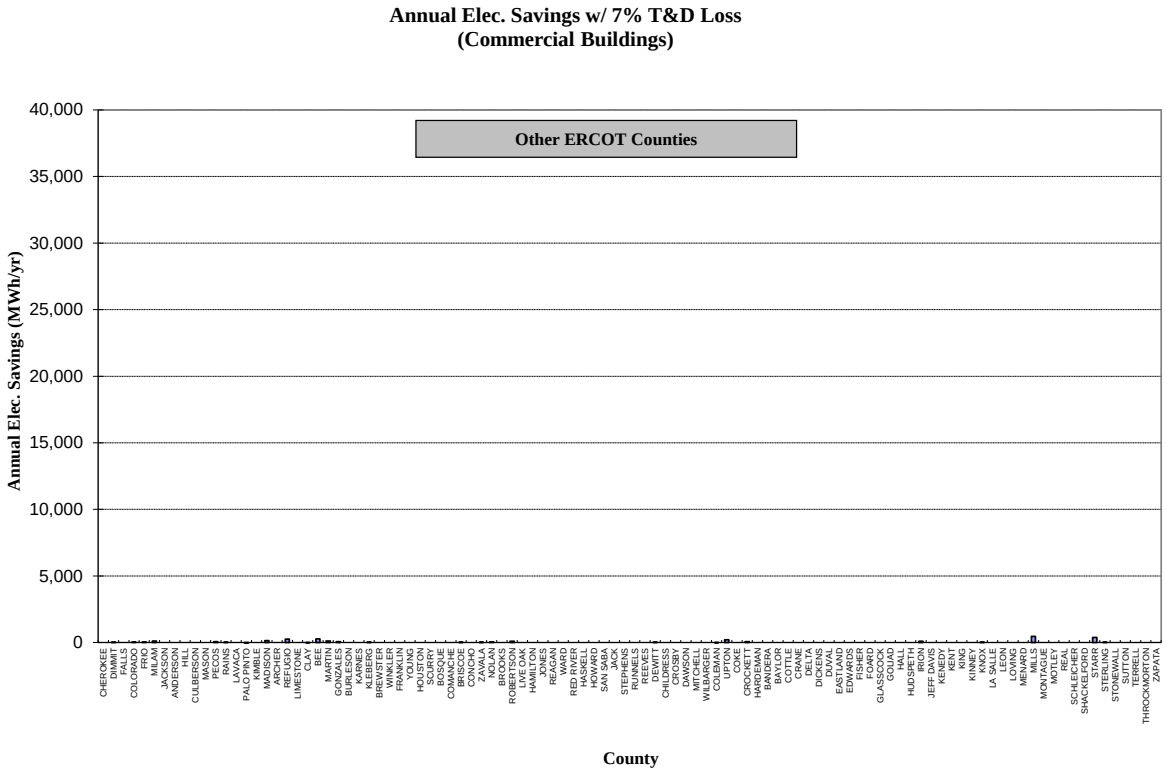


Figure 15: 2016 Annual Electricity Savings by County from New Commercial Construction

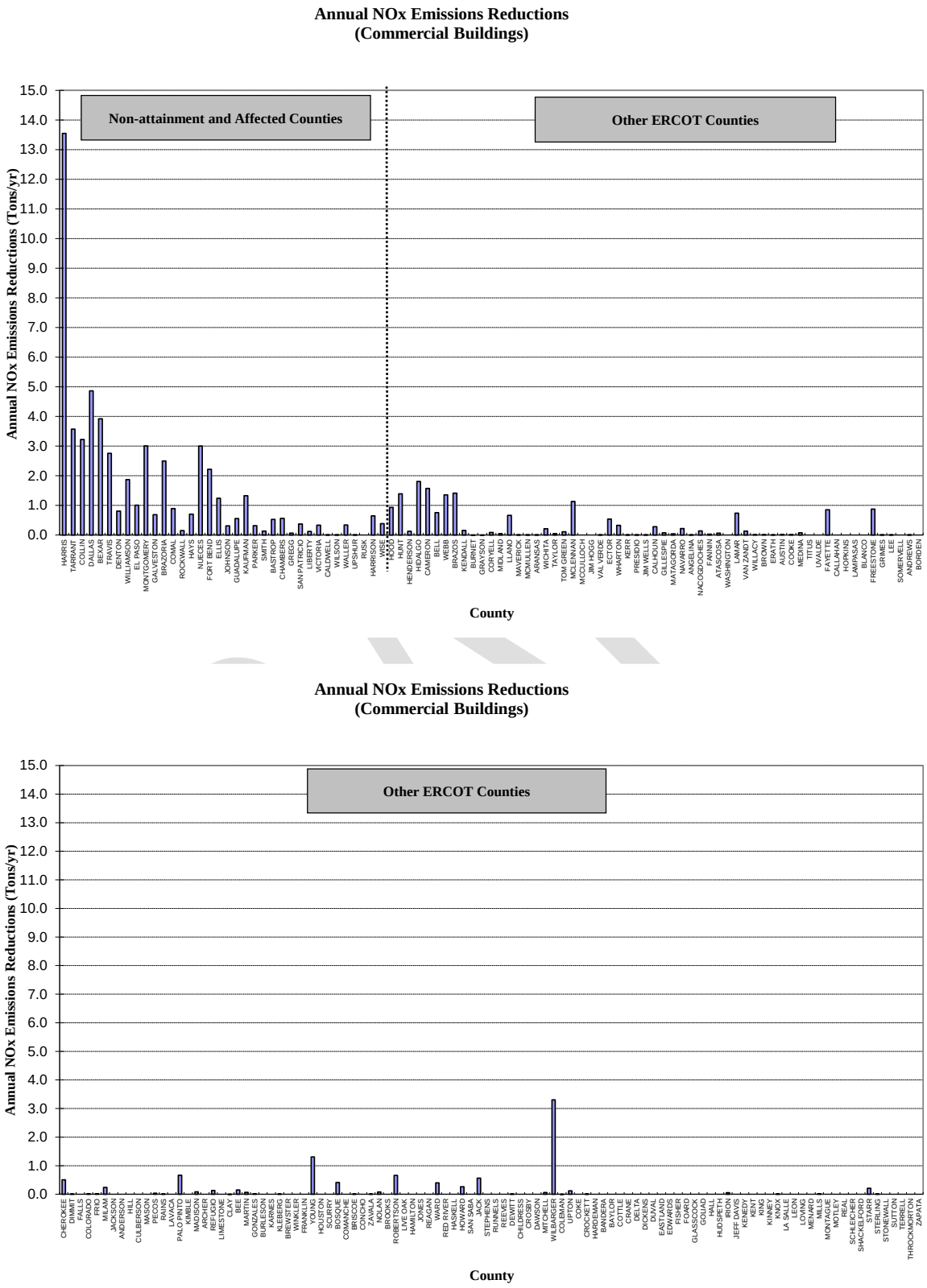


Figure 16: 2016 Annual NOx Reductions by County from New Commercial Construction

4.5 2016 Results for New Residential (Single-family and Multi-family) and Commercial Construction

Figure 17 shows the bar chart and Figure 18 shows the spatial distribution of the 2016 annual electricity savings, and Figure 19 shows the bar chart and Figure 20 shows the spatial distribution of the 2016 annual NOx reductions for new residential and commercial Construction, respectively. In general the significant increase in the annual NOx emissions reduction shown in Figure 19, compared to the previous report is due to the higher energy savings. As shown in Table 26, the total annual electricity savings in 2016 resulted in 1,178,088.55 MWh/yr which includes 217,721.83 MWh/yr (i.e., 18.48 %) for single-family buildings, 779,731.47 MWh/yr (i.e., 66.19 %) for multi-family buildings, and 180,635.25 MWh/yr (i.e., 15.33 %) for new commercial buildings. In addition, the total annual natural gas savings from new residential and commercial Construction in 2016 resulted in 1,366,764.44 MMBtu[35] (13,670,907.81 therms).

The total NOx reductions[36] from electricity and natural gas savings from new residential (single-family and multi-family) and commercial Construction in 2016 resulted in 321.75 tons NOx/year which represents 258.87 tons NOx/year from electricity savings and 62.89 tons NOx/year from natural gas savings.

[35] 1 Therm = 0.10 MMBtu, source from www.eia.gov/tools/faqs/faq.cfm?id=45&t=8
[36] 0.092 lb-NOx/MMBtu of emission rate was used for the calculation.

Table 26: 2016 Annual NOx Reductions from New Residential and Commercial Construction

	County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Electricity Savings and Resultant NOx Reductions (Commercial Buildings)		Total Electricity Savings and Resultant NOx Reductions (SF, MF and Commecial Buildings)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (SF, MF and Commecial Buildings)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Non-attainment and Affected Counties	HARRIS	30,527.77	5.52	70,333.86	11.38	34,270.74	4.06	135,132.37	20.96	212,567.58	0.98	2,273,939.77	10.46	31.42
	TARRANT	13,262.92	0.10	98,757.01	0.54	16,717.71	0.09	128,737.64	0.73	410,639.74	1.89	1,167,543.87	5.37	6.10
	COLLIN	18,831.20	0.27	73,850.43	1.48	16,451.60	0.24	109,133.24	1.99	372,729.40	1.71	1,021,007.07	4.70	6.69
	DALLAS	11,718.50	0.53	190,959.81	2.84	15,302.54	0.46	217,980.85	3.82	677,099.45	3.11	1,634,854.75	7.52	11.34
	BEXAR	6,860.83	2.76	58,306.51	10.44	8,967.46	2.14	74,134.80	15.35	264,555.03	1.22	650,569.90	2.99	18.34
	TRAVIS	14,994.63	1.03	84,706.47	3.89	5,929.12	0.80	105,630.23	5.72	444,779.25	2.05	869,167.76	4.00	9.72
	DENTON	14,271.00	0.03	18,116.22	0.14	4,134.49	0.02	36,521.72	0.20	169,476.67	0.78	339,747.17	1.56	1.76
	WILLIAMSON	7,944.73		21,634.87		8,222.54	0.00	37,802.14	0.00	162,388.64	0.75	568,617.82	2.62	2.62
	EL PASO	5,313.43		13,571.78		5,677.61	0.00	24,562.82	0.00	64,927.75	0.30	282,997.37	1.30	1.30
	MONTGOMERY	8,216.97		13,397.86		9,822.78	0.00	31,437.61	0.00	54,003.33	0.25	707,115.16	3.25	3.25
	GALVESTON	4,343.17	0.84	314.30	1.73	753.57	0.62	5,411.03	3.19	23,985.61	0.11	37,829.05	0.17	3.37
	BRAZORIA	5,719.46	2.09	206.26	4.30	3,052.46	1.53	8,978.18	7.92	31,465.58	0.14	240,124.52	1.10	9.03
	COMAL	4,006.16		15,829.33		2,570.73	0.00	22,406.22	0.00	97,249.22	0.45	291,264.52	1.34	1.34
	ROCKWALL	2,563.82		0.00		609.43	0.00	3,173.25	0.00	20,731.11	0.10	52,495.00	0.24	0.24
	HAYS	3,961.91	0.17	7,305.28	0.63	2,341.15	0.13	13,608.34	0.92	69,999.85	0.32	194,756.65	0.90	1.82
	NUECES	2,547.30	2.56	263.33	9.66	8,091.53	1.98	10,902.15	14.20	9,120.76	0.04	229,804.80	1.06	15.26
	FORT BEND	19,242.47	1.16	4,938.13	2.40	4,580.45	0.86	28,761.05	4.42	111,118.16	0.51	406,644.49	1.87	6.29
	ELLIS	3,289.00	0.63	73.98	3.42	1,580.70	0.55	4,943.68	4.61	27,837.48	0.13	177,748.23	0.82	5.42
	JOHNSON	1,173.67	0.15	3,521.22	0.83	292.05	0.13	4,986.94	1.12	20,524.99	0.09	58,566.05	0.27	1.39
	GUADALUPE	1,887.09	0.64	0.00	2.41	131.04	0.49	2,018.13	3.54	22,384.54	0.10	34,900.86	0.16	3.70
	KAUFMAN	1,024.61	1.27	59.59	6.83	315.94	1.10	1,400.14	9.20	8,462.91	0.04	57,600.61	0.26	9.46
	PARKER	937.31	0.00	849.20	0.00	621.54	0.00	2,408.05	0.00	10,114.16	0.05	78,816.26	0.36	0.36
	SMITH	998.67		1,340.38		800.32	0.00	3,139.38	0.00	390.23	0.00	28,488.25	0.13	0.13
	BASTROP	309.83	0.67	400.79	2.54	115.70	0.52	826.32	3.73	4,051.33	0.02	4,692.17	0.02	3.75
	CHAMBERS	546.90	0.76	0.00	1.57	(4.14)	0.56	542.77	2.88	2,318.90	0.01	2,272.26	0.01	2.89
	GREGG	352.64		0.00		472.91	0.00	825.55	0.00	331.85	0.00	13,475.24	0.06	0.06
	SAN PATRICIO	487.60	0.30	2,654.32	1.13	204.21	0.23	3,346.14	1.67	2,637.79	0.01	32,792.45	0.15	1.82
	LIBERTY	900.28		0.00		213.04	0.00	1,113.32	0.00	5,048.86	0.02	31,189.98	0.14	0.14
	VICTORIA	123.92	0.42	0.00	1.59	74.66	0.33	198.58	2.34	463.60	0.00	882.77	0.00	2.35
	CALDWELL	671.66		133.60		26.07	0.00	831.32	0.00	7,814.32	0.04	7,966.82	0.04	0.04
	WILSON	108.67		0.00		34.79	0.00	143.46	0.00	1,289.03	0.01	1,466.88	0.01	0.01
	WALLER	25.59		2,872.38		614.34	0.00	3,512.30	0.00	1,811.35	0.01	74,516.71	0.34	0.34
	UPSHUR	11.89		0.00		20.05	0.00	31.94	0.00	78.82	0.00	196.12	0.00	0.00
	RUSK	4.43	0.00	0.00	0.00	0.00	0.00	4.43	0.00	8.24	0.00	8.24	0.00	0.00
	HARRISON	88.38		298.29		1,148.75	0.00	1,535.42	0.00	(97.70)	(0.00)	139,923.01	0.64	0.64
	WISE	160.81	0.22	89.39	1.17	1,029.72	0.19	1,279.92	1.57	1,567.19	0.01	44,220.40	0.20	1.77
Other ERCOT Counties	HOOD	300.24	1.08	177.54	5.81	0.00	0.93	477.78	7.82	3,058.76	0.01	3,058.76	0.01	7.83
	HUNT	379.63	1.77	0.00	6.91	0.00	1.39	379.63	10.07	3,169.84	0.01	3,169.84	0.01	10.08
	HENDERSON	87.99	0.15	569.93	0.79	0.00	0.13	657.91	1.06	(280.65)	(0.00)	(280.65)	(0.00)	1.06
	HIDALGO	6,623.22	1.07	21,364.19	4.04	3,465.85	0.83	31,453.26	5.93	30,165.33	0.14	241,720.40	1.11	7.05
	CAMERON	2,759.48	1.26	4,566.00	4.77	2,633.66	0.98	9,959.14	7.02	11,459.84	0.05	139,702.63	0.64	7.66
	BELL	3,222.81		8,823.43		3,638.81	0.00	15,685.06	0.00	78,890.98	0.36	243,182.00	1.12	1.12
	WEBB	1,934.95	0.84	2,243.53	3.16	1,549.18	0.65	5,727.66	4.64	16,536.60	0.08	169,373.20	0.78	5.42
	BRAZOS	2,218.09	0.50	16,152.19	2.53	4,164.66	0.42	22,534.94	3.45	21,854.56	0.10	235,764.79	1.08	4.54
	KENDALL	605.65		4,922.32		513.50	0.00	6,041.46	0.00	15,097.43	0.07	48,983.22	0.23	0.23
	BURNET	740.11		1,311.20		0.42	0.00	2,051.74	0.00	12,907.93	0.06	12,844.23	0.06	0.06
	GRAYSON	855.30		5,284.48		(38.15)	0.00	6,101.63	0.00	23,003.66	0.11	22,398.64	0.10	0.10
	CORYELL	318.00		335.49		1,187.87	0.00	1,841.36	0.00	5,749.62	0.03	24,950.76	0.11	0.11
	MIDLAND	1,432.73		752.31		214.32	0.00	2,399.37	0.00	15,376.80	0.07	24,927.80	0.11	0.11
	LLANO	472.50	0.80	160.56	3.03	70.14	0.62	703.20	4.45	6,108.16	0.03	14,884.00	0.07	4.52
	MAVERICK	131.04		126.40		9.17	0.00	266.61	0.00	1,111.19	0.01	1,164.81	0.01	0.01
	MCMULLEN	0.00		0.00		8.47	0.00	8.47	0.00	0.00	0.00	1,039.70	0.00	0.00
	ARANSAS	393.02		21.07		27.25	0.00	441.34	0.00	1,400.55	0.01	1,913.07	0.01	0.01
	WICHITA	219.43	0.03	1,803.89	0.13	465.79	0.02	2,489.11	0.18	9,280.77	0.04	49,455.46	0.23	0.41
	TAYLOR	717.50		152.76		326.83	0.00	1,197.09	0.00	7,473.45	0.03	17,770.48	0.08	0.08
	TOM GREEN	401.63		0.00		320.26	0.00	721.89	0.00	3,815.09	0.02	26,839.33	0.12	0.12
	MCLENNAN	1,298.50	1.20	18,871.40	6.47	1,117.54	1.04	21,287.45	8.71	90,022.22	0.41	109,937.94	0.51	9.22
	MCCULLOCH	2.34		1,324.73		0.00	0.00	1,327.06	0.00	4,626.98	0.02	4,626.98	0.02	0.02
	JIM HOGG	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VAL VERDE	194.35		0.00		27.46	0.00	221.81	0.00	2,305.38	0.01	2,721.29	0.01	0.01
	ECTOR	1,015.61	0.58	0.00	2.32	235.37	0.46	1,250.98	3.35	9,004.79	0.04	26,874.62	0.12	3.48
	WHARTON	163.90	0.42	0.00	1.59	0.00	0.33	163.90	2.33	613.15	0.00	613.15	0.00	2.33
	KERR	125.44		0.00		12.10	0.00	137.55	0.00	1,487.28	0.01	2,972.57	0.01	0.01
	PRESIDIO	25.69		0.00		0.99	0.00	26.68	0.00	243.99	0.00	664.08	0.00	0.00
	JIM WELLS	31.53		21.07		43.25	0.00	95.84	0.00	118.98	0.00	372.03	0.00	0.00
	CALHOUN	119.93	0.19	0.00	0.71	237.25	0.15	357.17	1.05	448.64	0.00	29,560.34	0.14	1.18
	GILLESPIE	102.45		0.00		115.63	0.00	218.07	0.00	1,214.61	0.01	17,251.98	0.08	0.08
	MATAGORDA	163.90		0.00		235.30	0.00	399.20	0.00	613.15	0.00	8,956.31	0.04	0.04
	NAVARRO	340.42		184.52		393.10	0.00	918.04	0.00	5,491.06	0.03	52,488.25	0.24	0.24
	ANGELINA	132.92		43.57		62.16	0.00	238.64	0.00	226.14	0.00	589.79	0.00	0.00
	NACOGDOCHES	53.17		43.57		367.29	0.00	464.02	0.00	77.76	0.00	30,067.23	0.14	0.14
	FANNIN	61.75	0.00	89.06	0.00	52.29	0.00	203.10	0.01	782.91	0.00	7,199.37	0.03	0.04
	ATASCOSA	70.97		0.00		114.99	0.00	185.96	0.00	833.14	0.00	14,943.40	0.07	0.07
	WASHINGTON	141.71		118.04		0.00	0.00	259.75	0.00	865.71	0.00	865.71	0.00	0.00
	LAMAR	57.65	0.85	297.96	4.58	0.00	0.73	355.61	6.16	961.01	0.00	961.01	0.00	6.16
	VAN ZANDT	64.33		0.00		417.17	0.00	481.49	0.00	520.14	0.00	28,988.23	0.13	0.13
	WILLACY	83.90		0.00		21.79	0.00	105.68	0.00	312.92	0.00	2,986.45	0.01	0.01
	BROWN	173.27		50.32		107.28	0.00	330.88	0.00	2,629.10	0.01	4,624.83	0.02	0.02
	ERATH	87.26		3,532.51		25.62	0.00	3,645.39	0.00	13,121.24	0.06	13,597.83	0.06	0.06
	AUSTIN	43.30		59.02		41.05	0.00	143.37	0.00	277.85	0.00	4,478.56	0.02	0.02
	COOKE	116.63		0.00		19.37	0.00	136.00	0.00	973.87	0.00	3,350.33	0.02	0.02
	MEDINA	60.60		0.00		581.77	0.00	642.38	0.00	718.88	0.00	16,711.42	0.08	0.08
	TITUS	42.13	0.00	0.00	0.00	0.00	0.00	42.13	0.00	52.26	0.00	52.26	0.00	0.00
	UVALDE	39.71		54.03		0.00	0.00	93.73	0.00	640.71	0.00	640.71	0.00	0.00
	FAYETTE	15.75	1.05	0.00	4.54	20.62	0.85	36.37	6.44	88.58	0.00	209.23	0.00	6.45
	CALLAHAN	4.85		0.00		0.00	0.00	4.85	0.00	46.91	0.00	46.91	0.00	0.00
	HOPKINS	22.97		0.00		0.00	0.00	22.97	0.00	185.76	0.00	185.76	0.00	0.00
	LAMPASAS	91.73		0.00		0.00	0.00	91.73	0.00	0.00	0.00	1,290.58	0.01	0.01
	BLANCO	27.18		66.90		0.00	0.00	94.08	0.00	533.11	0.00	533.11	0.00	0.00
	FREESTONE	12.23	1.01	0.00	5.45	26.07	0.87	38.30	7.34	172.08	0.00	324.57	0.00	7.34
	GRIMES	76.76	0.00	0.00	0.00	26.07	0.00	102.82	0.00	431.81	0.00	584.31	0.00	0.00
	LEE	27.12		0.00		20.05	0.00	47.17	0.00	315.49	0.00	432.79	0.00	0.00
	SOMERVELL	25.02		295.90		0.00	0.00	320.92	0.00	1,106.81	0.01	1,106.81	0.01	0.01
	ANDREWS	19.14	0.01	0.00	0.04	0.00	0.01	19.14	0.06	102.16	0.00	102.16	0.00	0.06
	BORDEN	41.45		0.00		0.00	0.00	41.45	0.00	414.45	0.00	414.45	0.00	0.00

Table 26: 2016 Annual NOx Reductions from New Residential and Commercial Construction (Continued)

	County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Electricity Savings and Resultant NOx Reductions (Commercial Buildings)		Total Electricity Savings and Resultant NOx Reductions (SF, MF and Commecial Buildings)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (SF, MF and Commecial Buildings)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Other ERCOT Counties	CHEROKEE	13.29	0.58	0.00	3.13	0.00	0.50	13.29	4.22	24.73	0.00	24.73	0.00	4.22
	DIMMIT	14.33		0.00		20.62	0.00	34.96	0.00	116.80	0.00	237.46	0.00	0.00
	FALLS	6.12		0.00		0.00	0.00	6.12	0.00	86.04	0.00	86.04	0.00	0.00
	COLORADO	43.30		0.00		36.56	0.00	79.85	0.00	243.59	0.00	4,729.16	0.02	0.02
	FRIO	14.61	0.00	0.00	0.00	34.38	0.00	48.99	0.00	171.53	0.00	4,389.75	0.02	0.02
	MILAM	13.31	0.25	49.18	0.95	111.78	0.20	174.27	1.40	198.41	0.00	9,371.31	0.04	1.44
	JACKSON	21.99		0.00		0.00	0.00	21.99	0.00	82.25	0.00	82.25	0.00	0.00
	ANDERSON	28.80		0.00		0.00	0.00	28.80	0.00	53.58	0.00	53.58	0.00	0.00
	HILL	16.31		0.00		0.00	0.00	16.31	0.00	229.44	0.00	229.44	0.00	0.00
	CULBERSON	7.16		0.00		0.00	0.00	7.16	0.00	37.01	0.00	37.01	0.00	0.00
	MASON	6.27		0.00		0.00	0.00	6.27	0.00	74.36	0.00	74.36	0.00	0.00
	PECOS	261.53	0.00	0.00	0.02	62.94	0.00	324.47	0.03	2,484.24	0.01	10,207.76	0.05	0.08
	RAINS	2.30		0.00		20.62	0.00	22.92	0.00	18.58	0.00	139.23	0.00	0.00
	LAVACA	54.19		0.00		0.00	0.00	54.19	0.00	205.07	0.00	205.07	0.00	0.00
	PALO PINTO	21.82	0.77	0.00	4.13	(23.40)	0.66	(1.59)	5.56	211.09	0.00	(14.93)	(0.00)	5.56
	KIMBLE	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MADISON	9.84		59.02		148.88	0.00	217.75	0.00	89.62	0.00	18,358.70	0.08	0.08
	ARCHER	12.76		0.00		0.00	0.00	12.76	0.00	138.13	0.00	138.13	0.00	0.00
	REFUGIO	13.99		0.00		264.21	0.00	278.20	0.00	52.34	0.00	28,304.60	0.13	0.13
	LIMESTONE	6.12	0.00	0.00	0.00	0.00	0.00	6.12	0.00	86.04	0.00	86.04	0.00	0.00
	CLAY	7.65		841.82		(19.56)	0.00	829.91	0.00	3,305.19	0.02	3,116.27	0.01	0.01
	BEE	13.99		0.00		266.30	0.00	280.29	0.00	52.34	0.00	32,728.73	0.15	0.15
	MARTIN	9.07		0.00		121.29	0.00	130.35	0.00	80.40	0.00	14,963.01	0.07	0.07
	GONZALES	18.81		0.00		67.66	0.00	86.47	0.00	223.10	0.00	4,016.69	0.02	0.02
	BURLESON	23.62		0.00		0.00	0.00	23.62	0.00	132.86	0.00	132.86	0.00	0.00
	KARNES	94.89		0.00		0.00	0.00	94.89	0.00	908.16	0.00	908.16	0.00	0.00
	KLEBERG	18.91		0.00		3.44	0.00	22.34	0.00	67.06	0.00	87.17	0.00	0.00
	BREWSTER	11.68		147.19		0.00	0.00	158.87	0.00	622.55	0.00	622.55	0.00	0.00
	WINKLER	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	FRANKLIN	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	YOUNG	24.24	1.51	0.00	8.13	0.00	1.30	24.24	10.94	234.55	0.00	234.55	0.00	10.94
	HOUSTON	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SCURRY	17.45		0.00		0.00	0.00	17.45	0.00	174.50	0.00	174.50	0.00	0.00
	BOSQUE	2.04	0.47	0.00	2.54	0.00	0.41	2.04	3.42	28.68	0.00	28.68	0.00	3.42
	COMANCHE	2.04		0.00		0.00	0.00	2.04	0.00	28.68	0.00	28.68	0.00	0.00
	BRISCOE	16.27		0.00		26.07	0.00	42.34	0.00	296.84	0.00	449.33	0.00	0.00
	CONCHO	2.34		0.00		0.00	0.00	2.34	0.00	22.18	0.00	22.18	0.00	0.00
	ZAVALA	8.19		0.00		9.20	0.00	17.39	0.00	66.74	0.00	1,195.56	0.01	0.01
	NOLAN	2.42	0.07	0.00	0.32	41.16	0.06	43.58	0.44	23.45	0.00	5,073.44	0.02	0.47
	BROOKS	4.19		0.00		0.00	0.00	4.19	0.00	16.25	0.00	16.25	0.00	0.00
	ROBERTSON	155.48	0.80	0.00	3.31	101.62	0.64	257.10	4.74	874.69	0.00	6,080.39	0.03	4.77
	LIVE OAK	14.71		0.00		0.00	0.00	14.71	0.00	52.16	0.00	52.16	0.00	0.00
	HAMILTON	12.23		0.00		0.00	0.00	12.23	0.00	172.08	0.00	172.08	0.00	0.00
	JONES	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	REAGAN	2.27		0.00		0.00	0.00	2.27	0.00	20.62	0.00	20.62	0.00	0.00
	WARD	6.80	0.48	0.00	2.15	0.00	0.40	6.80	3.03	60.30	0.00	60.30	0.00	3.03
	RED RIVER	13.30		29.80		0.00	0.00	43.10	0.00	105.45	0.00	105.45	0.00	0.00
	HASKELL	4.85		0.00		0.00	0.00	4.85	0.00	46.91	0.00	46.91	0.00	0.00
	HOWARD	52.14	0.32	0.00	1.42	0.00	0.26	52.14	2.00	462.30	0.00	462.30	0.00	2.00
	SAN SABA	14.64		0.00		0.00	0.00	14.64	0.00	173.52	0.00	173.52	0.00	0.00
	JACK	4.85	0.65	0.00	3.52	0.00	0.56	4.85	4.74	46.91	0.00	46.91	0.00	4.74
	STEPHENS	4.85		0.00		0.00	0.00	4.85	0.00	46.91	0.00	46.91	0.00	0.00
	RUNNELS	4.67		0.00		0.00	0.00	4.67	0.00	44.36	0.00	44.36	0.00	0.00
	REEVES	6.80		0.00		0.00	0.00	6.80	0.00	60.30	0.00	60.30	0.00	0.00
	DE WITT	6.00		0.00		25.21	0.00	31.20	0.00	22.43	0.00	169.90	0.00	0.00
	CHILDRESS	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CROSBY	19.63		0.00		0.00	0.00	19.63	0.00	196.32	0.00	196.32	0.00	0.00
	DAWSON	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MITCHELL	0.00	0.08	0.00	0.34	0.00	0.06	0.00	0.47	0.00	0.00	0.00	0.00	0.47
	WILBARGER	2.55	3.81	0.00	20.56	0.00	3.30	2.55	27.67	27.63	0.00	27.63	0.00	27.67
	COLEMAN	0.00		0.00		(3.18)	0.00	(3.18)	0.00	0.00	0.00	(35.81)	(0.00)	(0.00)
	UPTON	0.00	0.01	0.00	0.03	202.63	0.01	202.63	0.04	0.00	0.00	24,863.76	0.11	0.15
	COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CROCKETT	44.37		0.00		74.46	0.00	118.82	0.00	421.43	0.00	1,806.53	0.01	0.01
	HARDEMAN	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BANDERA	2.47		0.00		0.00	0.00	2.47	0.00	16.54	0.00	16.54	0.00	0.00
	BAYLOR	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	COTTLE	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CRANE	29.50		0.00		0.00	0.00	29.50	0.00	268.03	0.00	268.03	0.00	0.00
	DELTA	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	DICKENS	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	DUVAL	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EASTLAND	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EDWARDS	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	FISHER	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	FOARD	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GLASSCOCK	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GOLIAD	6.00		0.00		0.00	0.00	6.00	0.00	22.43	0.00	22.43	0.00	0.00
	HALL	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	HUDSPETH	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	IRION	0.00		0.00		98.29	0.00	98.29	0.00	0.00	0.00	12,060.56	0.06	0.06
	JEFF DAVIS	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	KENEDY	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	KENT	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	KING	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	KINNEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	KNOX	0.00		0.00		26.07	0.00	26.07	0.00	0.00	0.00	152.50	0.00	0.00
	LA SALLE	6.14		0.00		0.00	0.00	6.14	0.00	50.06	0.00	50.06	0.00	0.00
	LEON	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LOVING	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MENARD	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MILLS	0.00		0.00		458.29	0.00	458.29	0.00	0.00	0.00	2,681.28	0.01	0.01
	MONTAGUE	2.29		0.00		0.00	0.00	2.29	0.00	19.10	0.00	19.10	0.00	0.00
	MOTLEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	REAL	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SCHLEICHER	2.34		0.00		0.00	0.00	2.34	0.00	22.18	0.00	22.18	0.00	0.00
	SHACKELFORD	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	STARR	9.07		0.00		382.65	0.00	391.72	0.00	33.83	0.00	45,799.39	0.21	0.21
	STERLING	0.00		0.00		9.93	0.00	9.93	0.00	0.00	0.00	1,217.94	0.01	0.01
	STONEWALL	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SUTTON	28.02		0.00		0.00	0.00	28.02	0.00	266.17	0.00	266.17	0.00	0.00
	TERRELL	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	THROCKMORTON	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ZAPATA	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	**217,721.83**	**44.71**	**779,731.47**	**178.37**	**180,635.25**	**35.78**	**1,178,088.55**	**258.87**	**3,737,054.94**	**17.19**	**13,670,907.81**	**62.89**	**321.75**

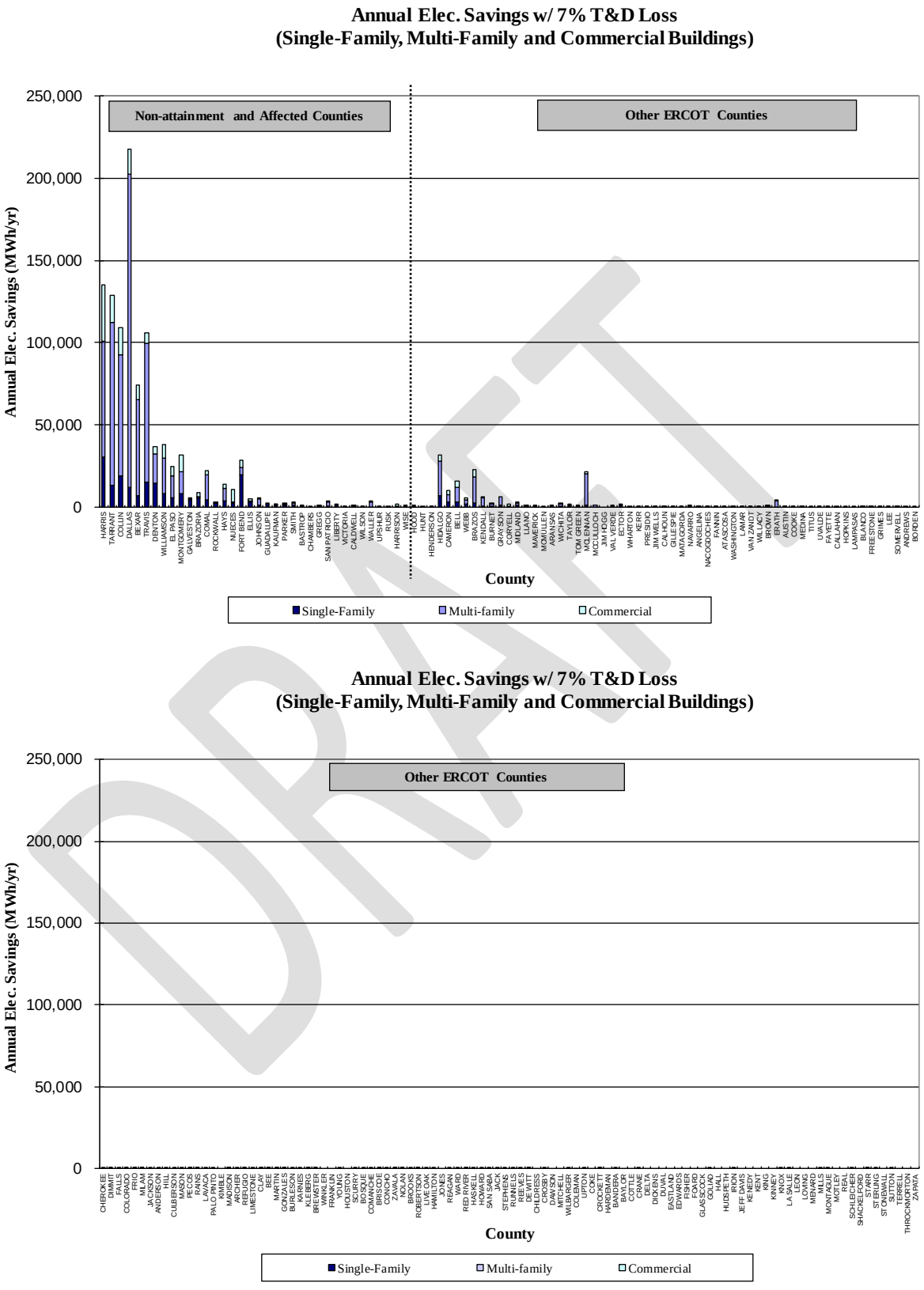


Figure 17: 2016 Annual Electricity Savings by County from New Residential and Commercial Construction

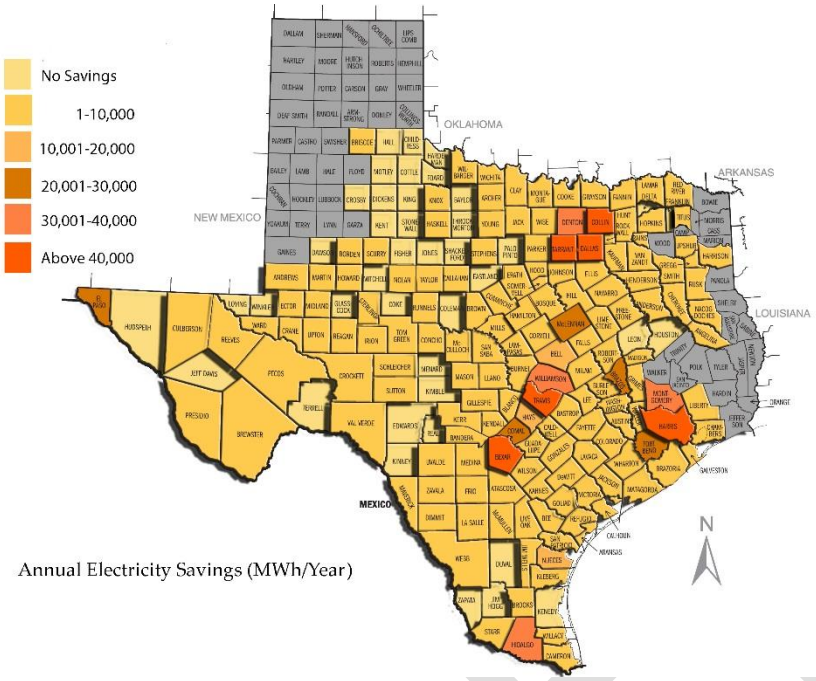


Figure 18: Map of 2016 Annual Electricity Savings by County from New Residential and Commercial Construction

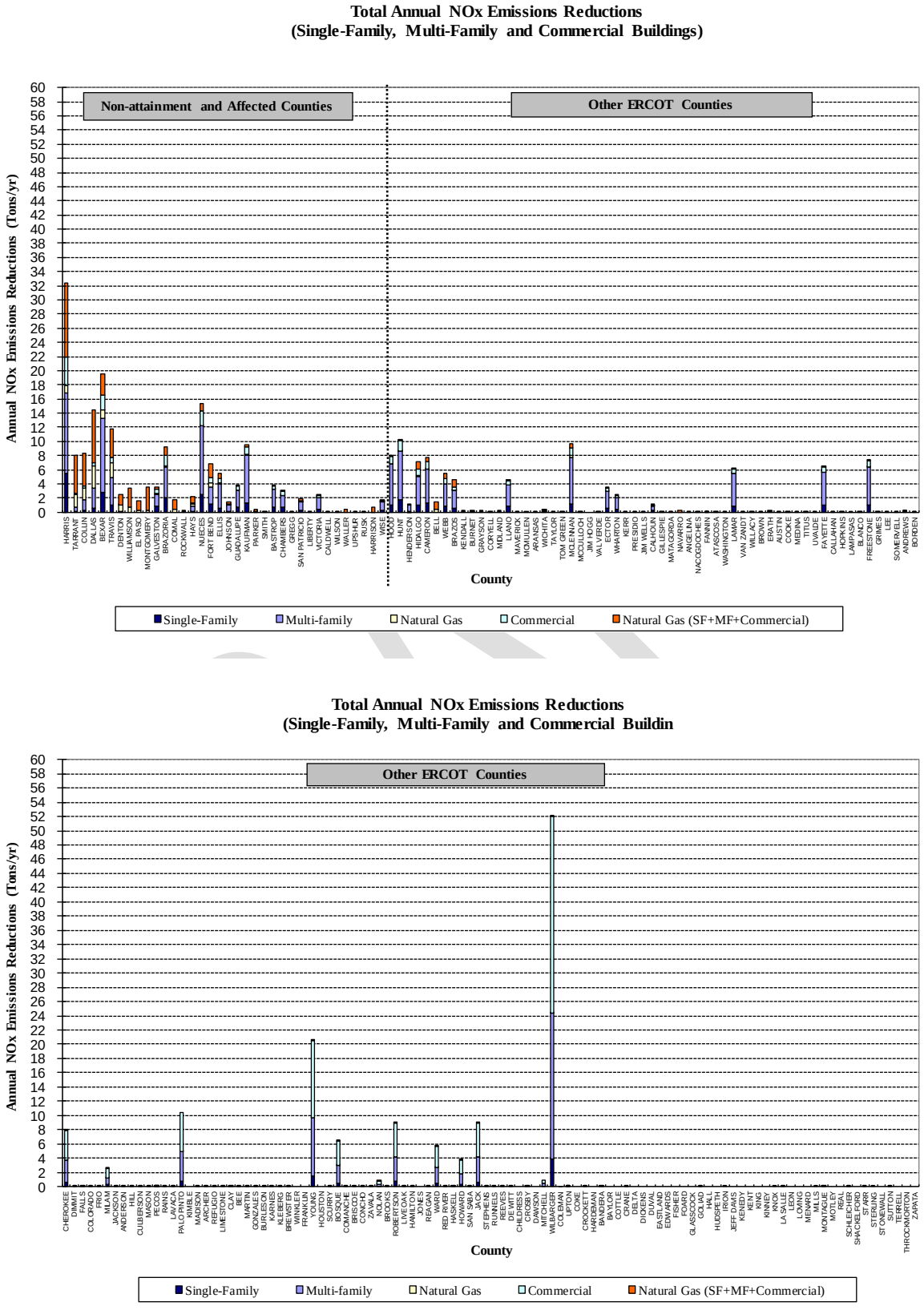


Figure 19: 2016 Annual NOx Reductions by County from New Residential and Commercial Construction

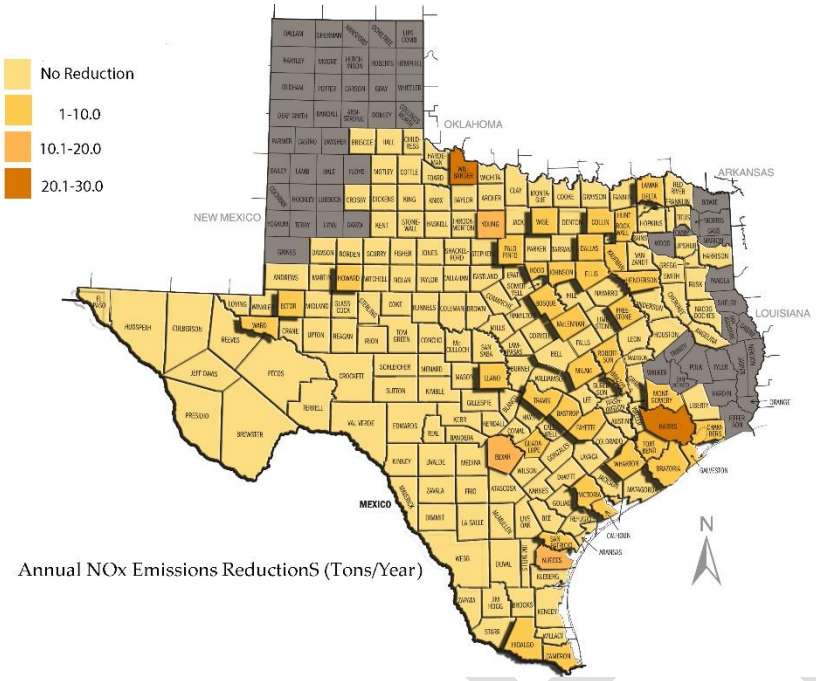


Figure 20: Map of 2016 Annual NOx Reductions by County from New Residential and Commercial Construction

5 Calculation of Integrated NOx Emissions Reductions from Multiple State Agencies Participating in the Texas Emissions Reduction Plan (TERP)

5.1 Background

In January 2005, the Laboratory was asked by the Texas Commission on Environmental Quality (TCEQ) to develop a method by which the NOx emissions reductions from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 could be reported in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the integrated savings estimation from all projects projected through 2020 for both the annual and Ozone Season Day (OSD) NOx reductions. The NOx emissions reductions from all these programs were calculated using estimated emissions factors for 2010 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose. The different programs included in this 2016 integrated analysis are:

- ESL Single-family new construction
- ESL Multi-family new construction
- ESL Commercial new construction
- PUC Senate Bill 7 Program
- SECO Senate Bill 5 Program
- Electricity generated by wind farms in Texas (ERCOT)
- SEER 13 upgrades to Single-family and Multi-family residences

The Laboratory's single-family and multi-family programs include the energy savings attained by constructing new residences in Texas. The baseline to estimate energy savings uses the published data on residential construction characteristics by the 2008 National Association of Home Builders (NAHB 2008) based on the 2006 IECC building code (2006 ICC). Annual electricity savings (MWh) are obtained from the Laboratory's Annual Reports to the TCEQ (Haberl et al., 2002 - 2016).

The Laboratory's commercial program includes the energy savings attained by constructing new commercial buildings in Texas, including office, apartment, healthcare, education, retail, food and lodging as defined by Dodge building type (Dodge 2011). Energy savings were estimated from code compliant buildings (ASHRAE Standard 90.1-2013) against pre-code buildings (ASHRAE Standard 90.1-2007) using EUI in the USDOE report and constructed square footage in Dodge data (Dodge 2017).

The Public Utility Commission of Texas (PUC) Senate Bill 7 program includes the energy efficiency programs implemented by electric utilities under the Public Utility Regulatory Act §39.905. The PUC regulated energy efficiency program was adopted pursuant to 1999 legislation (SB 7) and subsequent legislation in 2001 (SB 5), 2007 (HB 3693), and 2011 (SB 1125). The energy efficiency measures include high efficiency HVAC equipment, variable speed drives, increased insulation levels, infiltration reduction, duct sealing, Energy Star Homes, etc. Annual electricity savings claimed by the utilities were reported for the different programs completed in the years 2001 through 2016.

The Texas State Energy Conservation Office (SECO) funds energy-efficiency programs that are directed towards school districts, government agencies, city and county governments, private industries and residential energy consumers. For the 2016 reporting year SECO submitted annual energy savings values for projects funded by SECO and by Energy Service projects.

The *Electric Reliability Council of Texas (ERCOT) electricity production from currently installed green power generation (wind)* in Texas is reported. Actual measured electricity productions for 2001 through 2016 were included. For projections to 2020, the annual growth factor was estimated using the last six years installed wind power capacity.

Finally, NOx emissions reductions from *the installation of SEER 13 air conditioners in existing residences* are also reported.

5.2 Description of the Analysis Method

Annual and Ozone Season Day (OSD) NOx emissions reductions were calculated for 2016 and integrated from 2009 to 2020 using several factors to discount the potential savings. These factors include an annual degradation factor, a transmission and distribution factor, a discount factor, and growth factors as shown in Table 27 and are described as follows:

Annual degradation factor: This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from wind, an annual degradation factor of 2% was used for ESL Single-family, Multi-family, and Commercial programs and an annual degradation factor of 5% was used for all other programs . The value of the 5% degradation factor was taken from a study by Kats et al. (1996).

Transmission and distribution loss: This factor adjusts the reported savings to account for the loss in energy resulting from the transmission and distribution of the power from the electricity producers to the electricity consumers. For this calculation, the energy savings reported at the consumer level are increased by 7% to give credit for the actual power produced that is lost in the transmission and distribution system on its way to the customer. In the case of electricity generated by wind, the T&D losses were assumed to cancel out since wind energy is displacing power produced by conventional power plants; therefore, there is no net increase or decrease in T&D losses.

Initial discount factor: This factor was used to discount the reported savings for any inaccuracies in the assumptions and methods employed in the calculation procedures. For the Laboratory's single, multi-family and commercial program, the discount factor was assumed to be 20%. For PUC's Senate Bill 7 program, the discount factor was taken as 10%. For the savings in the SECO program, the discount factor was 60%. For the electricity from wind, the discount factor was taken as 5%. In addition, the discount factor for SEER 13 single-family and SEER 13 multi-family program was 20%.

Growth factor: The growth factors shown in Table 23 were used to account for several different factors. Growth factors for single-family (4.1%), multi-family residential (6.1%), and commercial (5.3%) construction are projections based on the average growth rate for these housing types from recent U.S. Census data for Texas. Growth factor for wind energy (8.5%) is a linear projection based on the installed wind power capacity for 2009 through 2016 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13 entries.

Figure 21 shows the overall information flow that was used to calculate the NOx emissions savings from the annual and OSD electricity savings (MWh) from all programs. For the Laboratory's single-family and multi-family code-implementation programs, the annual and OSD were calculated from DOE-2 hourly simulation models[37]. The base case is taken as the average characteristics of single- and multi-family residences for Texas published by the National Association of Home Builders for 2008 (NAHB 2008) and 2006 IECC. The annual electricity savings from PUC's energy efficiency programs were calculated using PUC approved demand savings calculations or tables or industry accepted measurement and verification methods (PUC 2017). The OSD consumption is the average daily consumption for the period between July 15 and September 15.

The SECO electricity savings were submitted as annual savings by project[38]. A description of the measures completed for the project was also submitted for information purposes. The electricity production from wind farms in Texas was from the actual on-site metered data measured at 15-minute intervals.

Integration of the savings from the different programs into a uniform format allowed for creditable NOx emissions to be evaluated using different criteria as shown in Table 27. These include evaluation across programs, evaluation

[37] These values are based on a performance analysis as defined by Chapter 4 of IECC 2006. This analysis is discussed in the Laboratory's annual reports to the TCEQ.
[38] The reporting requirements to the SECO did not require energy savings by project type, although for selected sites, energy savings by project type was available.

across individual counties by program, evaluation by SIP area, evaluation for all ERCOT counties except Houston/Galveston, and evaluation within a 200 km radius of Dallas/Ft.Worth.

5.3 Calculation Procedure

The electricity savings in this report was estimated based on the baseline year of 2008. In addition, the emissions estimation throughout this report was based on the 2010 eGrid database which is using the four different Congestion Management (CM) zones: Houston, North, West, and South. This report calculates the OSD emissions reductions by dividing the annual emissions reductions with 365 since the 2010 eGrid estimates the annual emissions only. However, the OSD emissions reductions from the Electricity Generated by Wind Farms were estimated by actual measured data.

ESL Single-family and Multi-family. The calculation of the annual electricity savings reported for the years 2002 through 2016 included the savings from code-compliant new housing in all 36 non-attainment and affected counties as reported in the Laboratory's annual report submitted by the Laboratory to the Texas Commission of Environmental Quality (TCEQ). From 2009 to 2016, based on year 2008, the annual electricity savings were calculated for new residential construction in all the counties in ERCOT region, which includes the 36 non-attainment and affected counties. These savings were then tabulated by county and program. Using the calculated values through 2016, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above.

In these calculations, it was assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2016 through 2020[39]. The projected energy savings through 2020, according to county, were then divided into the CM zones in the 2010 eGRID. To determine which CM zone was to be used, or in counties with multiple CM zone, the allocation to each CM zone by county was obtained from CM zone's listing published in the Laboratory's 2010 annual report[40].

For the 2016 annual NOx emissions calculations, the US EPA's 2010 eGRID were used. An example of the eGRID spreadsheet is given in the Table 28. The total electricity savings for each CM zone were used to calculate the NOx emissions reductions for each of the different counties using the emissions factors contained in eGRID. Similar calculations were performed for each year for which the analysis was required.

ESL-Commercial Buildings. The annual electricity savings for 2004 through 2016 for commercial buildings were obtained from the annual reports for 2004 through 2016 submitted by the Laboratory to TCEQ . From 2009 to 2016, based on year 2008, the annual electricity savings were also calculated for new commercial construction by county. Using the calculated savings through 2016, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above . In the projected annual electricity savings, it was assumed that the same 2016 amount of electricity savings would be achieved for each year through 2020. Similarly to the single family calculations, the projected energy saving numbers through 2020, by county, were allocated into the appropriate CM zones.

PUC-Senate Bill 7. For the PUC Senate Bill 7 program savings, the annual electricity savings for 2001 through 2016 were obtained from the Public Utility Commission of Texas. Using these values savings were projected through 2020 by incorporating the different adjustment factors mentioned above. Similar savings were assumed for each year after 2016 until 2020. The 2010 annual eGRID was also used to calculate the NOx emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each CM zone were used to calculate the NOx emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet. The integrated NOx emissions reductions for each county were then calculated.

SECO Savings. The annual electricity consumption reported by political subdivisions for 47 counties through 2016 were obtained from the State Energy Conservation Office (SECO). Using the reported consumption, the annual and

[39] This would include the appropriate discount and degradation factors for each year.
[40] Haberl et al., 2010, pp. 265.

OSD electricity savings resulted from energy conservation projects were then calculated. To achieve this, the annual energy use intensity (EUI) for each county was estimated and the county's energy savings for each year against the baseline year of 2008 were then calculated . In addition, the savings through 2020 were projected using the different adjustment factors mentioned above. In a similar fashion to the previous programs, it was assumed that the same amount of electricity savings will be achieved for each year through 2020. The 2010 annual eGRID was also used to calculate the NOx emissions savings for the SECO program.

Electricity Generated by Wind Farms. The measured electricity production from all the wind farms in Texas for 2001 through 2016 was obtained from the Energy Reliability Council of Texas (ERCOT). To obtain the annual production, the 15-minute data were summed for the 12 months. Using the reported numbers for 2016, savings through 2020 were projected incorporating the different adjustment factors mentioned above. The 2010 annual eGRID was then used to calculate the NOx emissions reductions for the electricity generated by Texas' wind farms[41]. The total electricity savings for each CM zone were used to calculate the NOx emissions reductions for each of the different counties.

SEER 13 Single-Family and Multi-Family. In January of 2006, Federal regulations mandated that the minimum efficiency for residential air conditioners be increased to SEER 13 from the previous SEER 10. Although the electricity savings from new construction reflected this change in values, the annual and OSD electricity savings from the replacement of the air conditioning units by air conditioners with an efficiency of SEER 13 in existing residences needed to be calculated. In this analysis, it was assumed that an equal number of existing houses had their air conditioners replaced, as reported for 2006, by the air conditioner manufacturers. This replacement rate continued until all the existing air conditioner stock was replaced with SEER 13 air conditioners.

In the 2016 report to the TCEQ, the annual and OSD electricity savings for all the counties in ERCOT region as well as the 36 non-attainment and affected counties were calculated. Using the numbers for 2008, the savings after 2008 until 2020 were projected by incorporating the appropriate adjustment factors[42]. The total electricity savings for each CM zone were used to calculate the NOx emissions reductions for each of the different county using the emissions factors contained in the 2010 eGRID. Integrated NOx emissions reductions for each county by SIP area were also calculated.

[41] This credited the electricity generated by the wind farm to the utility that either owned the wind farm or was associated with the wind farm owner.

[42] Additional details about this calculation are contained in the Laboratory's 2008 Annual Report to the TCEQ, available at the Senate Bill 5 web site "http://esl.tamu.edu/".

5.4 Results

The total integrated annual and OSD electricity savings for all the different programs in the integrated format were calculated for 2009 through 2020 as shown in Table 29, using the adjustment factors shown in Table 27. Annual and OSD NOx emissions reductions from the electricity savings (presented in Table 29) for all the programs in the integrated format were shown in Table 30.

In 2016, the total integrated annual savings from all programs are 44,016,581 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 3,087,080 MWh/year (7.0% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 3,498,867 MWh/year (7.9%),
- Savings from SECO's Senate Bill 5 program are 1,100,775 MWh/year (2.5%),
- Electricity savings from green power purchases (wind) are 36,069,833 MWh/year (81.9%), and
- Savings from residential air conditioner retrofits[43] are 260,026 MWh/year (0.6%).

In 2016, the total integrated OSD savings from all programs are 125,777 MWh/day, which would be a 5,241 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 8,458 MWh/day (6.7%),
- Savings from the PUC's Senate Bill 7 programs are 9,586 MWh/day (7.6%),
- Savings from SECO's Senate Bill 5 program are 3,016 MWh/day (2.4%),
- Electricity savings from green power purchases (wind) are 102,874 MWh/day (81.8%), and
- Savings from residential air conditioner retrofits are 1,844 MWh/day (1.5%).

By 2020, the total integrated annual savings from all programs will be 63,853,554 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 7,242,298 MWh/year (11.3% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 4,975,963 MWh/year (7.8%),
- Savings from SECO's Senate Bill 5 program will be 1,435,808 MWh/year (2.2%),
- Electricity savings from green power purchases (wind) will be 49,987,692 MWh/year (78.3%), and
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.3%).

By 2020, the total integrated OSD savings from all programs will be 181,479 MWh/day, which would be a 7,562 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 19,842 MWh/day (10.9%),
- Savings from the PUC's Senate Bill 7 programs will be 13,633 MWh/day (7.5%),
- Savings from SECO's Senate Bill 5 program will be 3,934 MWh/day (2.2%),
- Electricity savings from green power purchases (wind) will be 142,568 MWh/day (78.6%), and
- Savings from residential air conditioner retrofits will be 1,502 MWh/day (0.8%).

In 2016 (Table 30), the total integrated annual NOx emissions reductions from all programs are 12,142 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 769 tons-NOx/year (6.3% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 874 tons-NOx/year (7.2%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 294 tons-NOx/year (2.4%),
- NOx emissions reductions from green power purchases (wind) are 10,143 tons-NOx/year (83.5%), and
- NOx emissions reductions from residential air conditioner retrofits are 61 tons-NOx/year (0.5%).

[43] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

In 2016, the total integrated OSD NOx emissions reductions from all programs are 34.72 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 2.18 tons-NOx/day (6.3%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 2.39 tons-NOx/day (6.9 %),
- NOx emissions reductions from SECO's Senate Bill 5 program are 0.81 tons-NOx/day (2.3%),
- NOx emissions reductions from green power purchases (wind) are 28.91 tons-NOx/day (83.3%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.43 tons-NOx/day (1.2%).

By 2020, the total integrated annual NOx emissions reductions from all programs will be 17,576 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1,832 tons-NOx/year (10.4% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1,241 tons-NOx/year (7.1%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 397 tons-NOx/year (2.3%),
- NOx emissions reductions from green power purchases (wind) will be 14,057 tons-NOx/year (80.0%), and
- NOx emissions reductions from residential air conditioner retrofits will be 50 tons-NOx/year (0.3%).

By 2020, the total integrated OSD NOx emissions reductions from all programs will be 49.99 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 5.09 tons-NOx/day (10.2%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 3.40 tons-NOx/day (6.8%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 1.09 tons-NOx/day (2.2%),
- NOx emissions reductions from green power purchases (wind) will be 40.07 tons-NOx/day (80.1%), and
- NOx emissions reductions from residential air conditioner retrofits will be 0.35 tons-NOx/day (0.7%).

Table 27: Final Adjustment Factors used for the Calculation of the Annual and OSD NOx Savings for the Different Programs

	ESL-Single Family	ESL-Multifamily	ESL-Commercial	PUC (SB7)	SECO	Wind-ERCOT	SEER13 Single Family	SEER13 Multi Family
Annual Degradation Factor	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor	20.0%	20.0%	20.0%	10.0%	60.0%	5.0%	20.0%	20.0%
Growth Factor	4.1%	6.1%	5.3%	0.0%	0.0%	8.5%	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	Yes	Yes

Note: For Wind-ERCOT, the OSD energy consumption is the average daily consumption of the measured data in the months of July, August and September.

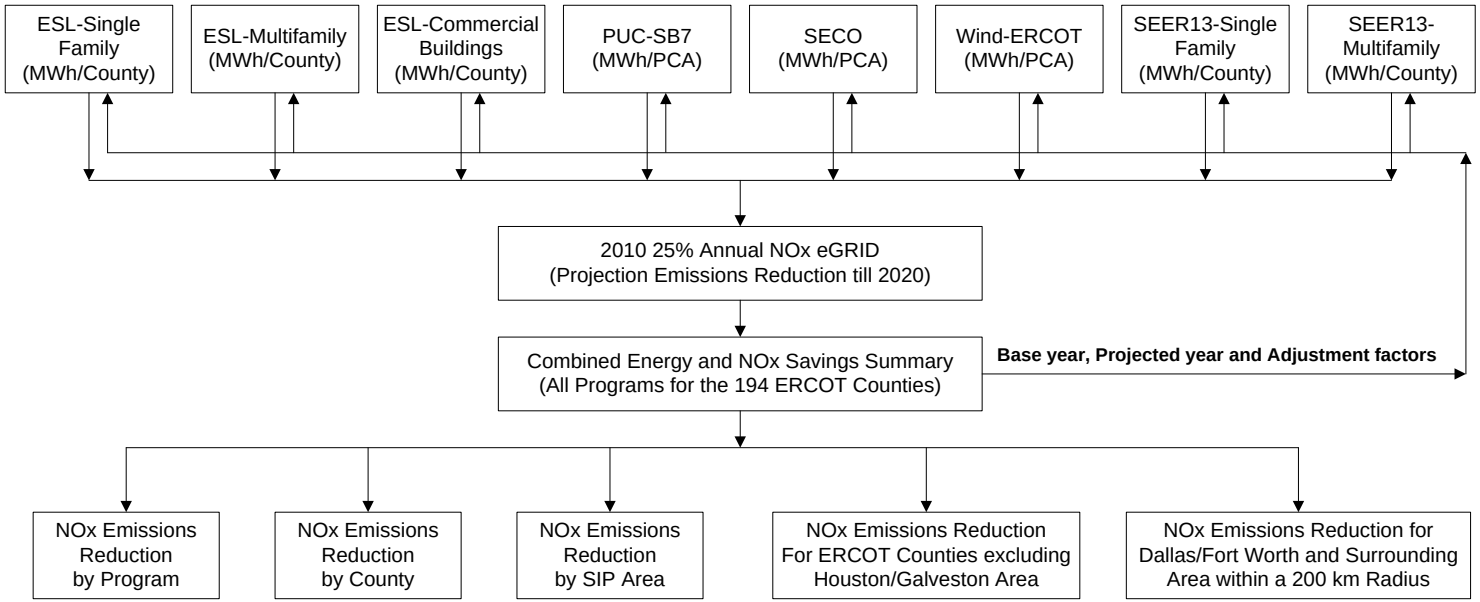


Figure 21: Process Flow Diagram of the NOx Emissions Reduction Calculations

Table 28: Example of NOx Emissions Reduction Calculations using 2010 eGRID

Area	County	CM Zones								Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
		H		N		W		S			
Houston-Galveston Area	Brazoria	0.0562032	8599.9481	0.0000071	1.3218	0.0000003	0.0039	0.0005265	73.8732	8675.15	4.34
	Chambers	0.0204500	3129.1633	0.0000026	0.4810	0.0000001	0.0014	0.0001916	26.8794	3156.53	1.58
	Fort Bend	0.0313463	4796.4664	0.0000040	0.7372	0.0000002	0.0022	0.0002937	41.2015	4838.41	2.42
	Galveston	0.0226620	3467.6271	0.0000029	0.5330	0.0000001	0.0016	0.0002123	29.7868	3497.95	1.75
	Harris	0.1486911	22752.0140	0.0000189	3.4971	0.0000009	0.0103	0.0013930	195.4389	22950.96	11.48
	Liberty	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Montgomery	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Waller	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
Beaumont/ Port Arthur Area	Hardin	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Jefferson	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Orange	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
Dallas/ Fort Worth Area	Collin	0.0012932	197.8745	0.0079329	1470.5795	0.0003832	4.3358	0.0000809	11.3550	1684.14	0.84
	Dallas	0.0024826	379.8770	0.0152295	2823.2008	0.0007356	8.3237	0.0001554	21.7993	3233.20	1.62
	Denton	0.0001267	19.3815	0.0007770	144.0407	0.0000375	0.4247	0.0000079	1.1122	164.96	0.08
	Tarrant	0.0004742	72.5572	0.0029089	539.2364	0.0001405	1.5898	0.0000297	4.1637	617.55	0.31
	Ellis	0.0029920	457.8205	0.0183544	3402.4677	0.0008865	10.0316	0.0001873	26.2721	3896.59	1.95
	Johnson	0.0007256	111.0277	0.0044512	825.1448	0.0002150	2.4328	0.0000454	6.3713	944.98	0.47
	Kaufman	0.0059718	913.7841	0.0366343	6791.1343	0.0017695	20.0225	0.0003738	52.4376	7777.38	3.89
	Parker	0.0000012	0.1881	0.0000075	1.3982	0.0000004	0.0041	0.0000001	0.0108	1.60	0.00
	Rockwall	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Henderson	0.0006908	105.6993	0.0042376	785.5448	0.0002047	2.3160	0.0000432	6.0656	899.63	0.45
	Hood	0.0050771	776.8732	0.0311454	5773.6292	0.0015044	17.0226	0.0003178	44.5809	6612.11	3.31
	Hunt	0.0088463	1353.6246	0.0047066	872.5005	0.0002273	2.5724	0.0652823	9159.0290	11387.73	5.69
El Paso Area	El Paso	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
San Antonio Area	Bexar	0.0138906	2125.4748	0.0009368	173.6634	0.0000452	0.5120	0.1109355	15564.1256	17863.78	8.93
	Comal	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Guadalupe	0.0032029	490.0910	0.0002160	40.0432	0.0000104	0.1181	0.0255795	3588.7688	4119.02	2.06
	Wilson	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
Austin Area	Bastrop	0.0033782	516.9199	0.0002278	42.2353	0.0000110	0.1245	0.0269798	3785.2277	4344.51	2.17
	Caldwell	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Hays	0.0008331	127.4814	0.0000562	10.4160	0.0000027	0.0307	0.0066537	933.5031	1071.43	0.54
	Travis	0.0051785	792.3950	0.0003493	64.7432	0.0000169	0.1909	0.0413577	5802.4379	6659.77	3.33
	Williamson	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
North East Texas Area	Gregg	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Harrison	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Rusk	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Smith	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Upshur	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
Corpus Christi Area	Nueces	0.0128578	1967.4366	0.0008672	160.7508	0.0000419	0.4739	0.1026870	14406.8657	16535.53	8.27
	San Patricio	0.0015100	231.0460	0.0001018	18.8778	0.0000049	0.0557	0.0120591	1691.8707	1941.85	0.97
Victoria Area	Victoria	0.0021192	324.2632	0.0001429	26.4942	0.0000069	0.0781	0.0169244	2374.4687	2725.30	1.36
Other ERCOT counties	Andrews	0.0000037	0.5729	0.0000230	4.2579	0.0039003	44.1330	0.0000002	0.0329	49.00	0.02
	Angelina	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Bosque	0.0022204	339.7588	0.0136212	2525.0471	0.0006579	7.4447	0.0001390	19.4971	2891.75	1.45
	Brazos	0.0024089	368.5950	0.0112305	2081.8753	0.0005425	6.1381	0.0047829	671.0365	3127.64	1.56
	Calhoun	0.0009466	144.8416	0.0000638	11.8344	0.0000031	0.0349	0.0075598	1060.6258	1217.34	0.61
	Cameron	0.0063536	972.2026	0.0004285	79.4345	0.0000207	0.2342	0.0507425	7119.1071	8170.98	4.09
	Cherokee	0.0027392	419.1326	0.0168033	3114.9437	0.0008116	9.1839	0.0001714	24.0520	3567.31	1.78
	Coke	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Coleman	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Crockett	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Ector	0.0019215	294.0201	0.0006604	122.4144	0.0911346	1031.2215	0.0146527	2055.7543	3503.41	1.75
	Fannin	0.0000041	0.6205	0.0000249	4.6112	0.0000012	0.0136	0.0000003	0.0356	5.28	0.00
	Fayette	0.0051867	793.6447	0.0103217	1913.3977	0.0004986	5.6413	0.0283993	3984.3892	6697.07	3.35
	Freestone	0.0047643	729.0166	0.0292268	5417.9649	0.0014117	15.9739	0.0002982	41.8347	6204.79	3.10
	Frio	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Grimes	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Hardeman	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Haskell	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Hidalgo	0.0053716	821.9331	0.0003623	67.1566	0.0000175	0.1980	0.0428994	6018.7354	6908.02	3.45
	Howard	0.0002411	36.8947	0.0007641	141.6408	0.1283942	1452.8266	0.0009490	133.1423	1764.50	0.88
	Jack	0.0030783	471.0290	0.0188839	3500.6313	0.0009121	10.3210	0.0001927	27.0300	4009.01	2.00
	Jones	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Lamar	0.0040001	612.0828	0.0245388	4548.9266	0.0011853	13.4117	0.0002504	35.1244	5209.55	2.60
	Limestone	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Llano	0.0040314	616.8731	0.0002719	50.4020	0.0000131	0.1486	0.0321966	4517.1506	5184.57	2.59
	McLennan	0.0056576	865.7027	0.0347066	6433.7991	0.0016764	18.9689	0.0003541	49.6784	7368.15	3.68
	Milam	0.0012686	194.1161	0.0000856	15.8604	0.0000041	0.0468	0.0101316	1421.4461	1631.47	0.82
	Mitchell	0.0000311	4.7632	0.0001910	35.3994	0.0324260	366.9116	0.0000019	0.2733	407.35	0.20
	Nolan	0.0000293	4.4765	0.0001795	33.2689	0.0304745	344.8298	0.0000018	0.2569	382.83	0.19
	Palo Pinto	0.0036129	552.8348	0.0221635	4108.6024	0.0010705	12.1135	0.0002261	31.7245	4705.28	2.35
	Pecos	0.0000020	0.3014	0.0000121	2.2402	0.0020520	23.2195	0.0000001	0.0173	25.78	0.01
	Presidio	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Red River	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Robertson	0.0039506	604.4982	0.0055755	1033.5625	0.0002693	3.0473	0.0246170	3453.7302	5094.84	2.55
	Taylor	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Titus	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Tom Green	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.00	0.00
	Upton	0.0000025	0.3892	0.0000156	2.8924	0.0026494	29.9793	0.0000002	0.0223	33.28	0.02
	Ward	0.0001995	30.5295	0.0012239	226.8915	0.2078335	2351.7118	0.0000125	1.7519	2610.88	1.31
	Webb	0.0042017	642.9283	0.0002834	52.5309	0.0000137	0.1549	0.0335565	4707.9441	5403.56	2.70
	Wharton	0.0021095	322.7877	0.0001423	26.3736	0.0000069	0.0778	0.0168474	2363.6643	2712.90	1.36
	Wichita	0.0000121	1.8537	0.0000743	13.7761	0.0126190	142.7884	0.0000008	0.1064	158.52	0.08
	Wilbarger	0.0179710	2749.8389	0.1102430	20436.4753	0.0053249	60.2534	0.0011247	157.7997	23404.37	11.70
	Wise	0.0010202	156.1032	0.0062583	1160.1405	0.0003023	3.4205	0.0000638	8.9580	1328.62	0.66
	Young	0.0071054	1087.2350	0.0435880	8080.2007	0.0021054	23.8231	0.0004447	62.3911	9253.65	4.63
	Total	**0.4414501**	**67548.6111**	**0.4812863**	**89219.2229**	**0.5345786**	**6048.9508**	**0.6829349**	**95814.9575**	258631.74	**129.32**
Energy Savings (MWh)		153,015		185,377		11,315		140,299			

Table 29: Annual and OSD Electricity Savings for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (MWh)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	25,031	47,000	74,109	153,562	215,164	275,535	360,010	533,473	710,874	892,438	1,078,398	1,268,995
ESL-Multifamily	0	50,784	108,018	200,414	332,835	527,292	774,578	1,225,617	1,856,682	2,515,116	3,202,811	3,921,770	4,674,114
ESL-Commercial	0	0	24,066	83,255	119,422	247,952	400,015	559,947	696,924	839,015	986,534	1,139,810	1,299,190
PUC (SB7)	0	538,841	976,984	1,437,883	1,831,318	2,267,414	2,675,295	3,079,759	3,498,867	3,897,019	4,275,264	4,634,597	4,975,963
SECO	0	71,910	154,786	347,175	508,375	705,060	1,004,828	1,005,713	1,100,775	1,191,083	1,276,877	1,358,380	1,435,808
Wind-ERCOT	0	3,454,992	8,587,397	11,606,284	13,774,557	16,597,064	19,905,202	24,322,675	36,069,833	39,135,769	42,462,309	46,071,605	49,987,692
SEER13-Single Family	0	343,330	326,163	309,855	294,362	279,644	265,662	252,379	239,760	227,772	216,383	205,564	195,286
SEER13-Multi Family	0	29,021	27,569	26,191	24,881	23,637	22,456	21,333	20,266	19,253	18,290	17,376	16,507
Total Annual (MWh)	**0**	**4,513,907**	**10,251,982**	**14,085,166**	**17,039,312**	**20,863,228**	**25,323,570**	**30,827,434**	**44,016,581**	**48,535,902**	**53,330,907**	**58,427,500**	**63,853,554**

PROGRAM	OZONE SEASON DAY - OSD (MWh/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	69	129	203	421	589	755	986	1,462	1,948	2,445	2,955	3,477
ESL-Multifamily	0	139	296	549	912	1,445	2,122	3,358	5,087	6,891	8,775	10,745	12,806
ESL-Commercial	0	0	66	228	327	679	1,096	1,534	1,909	2,299	2,703	3,123	3,559
PUC (SB7)	0	1,476	2,677	3,939	5,017	6,212	7,330	8,438	9,586	10,677	11,713	12,698	13,633
SECO	0	197	424	951	1,393	1,932	2,753	2,755	3,016	3,263	3,498	3,722	3,934
Wind-ERCOT	0	15,037	24,335	29,191	35,122	34,369	45,184	76,917	102,874	111,618	121,105	131,399	142,568
SEER13-Single Family	0	2,445	2,323	2,207	2,097	1,992	1,892	1,798	1,708	1,622	1,541	1,464	1,391
SEER13-Multi Family	0	195	186	176	167	159	151	144	136	130	123	117	111
Total OSD (MWh)	**0**	**19,559**	**30,435**	**37,445**	**45,456**	**47,377**	**61,283**	**95,930**	**125,777**	**138,447**	**151,904**	**166,221**	**181,479**

Table 30: Annual and OSD NOx Emissions Reduction Values for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (in tons NOx)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	3	8	15	34	50	65	86	129	174	219	265	313
ESL-Multifamily	0	4	19	43	77	127	190	305	468	639	817	1,003	1,198
ESL-Commercial	0	0	6	20	28	59	97	138	172	207	243	281	321
PUC (SB7)	0	135	246	362	460	567	669	770	874	973	1,067	1,156	1,241
SECO	0	19	43	92	133	183	264	265	294	322	348	373	397
Wind-ERCOT	0	945	2,388	3,222	3,851	4,643	5,577	6,800	10,143	11,005	11,941	12,956	14,057
SEER13-Single Family	0	81	77	73	69	66	62	59	56	53	51	48	46
SEER13-Multi Family	0	7	6	6	6	6	5	5	5	5	4	4	4
Total Annual (Tons NOx)	**0**	**1,193**	**2,792**	**3,831**	**4,659**	**5,700**	**6,930**	**8,428**	**12,142**	**13,377**	**14,690**	**16,087**	**17,576**

PROGRAM	OZONE SEASON DAY - OSD (in tons NOx/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0.00	0.01	0.02	0.04	0.09	0.14	0.18	0.24	0.35	0.48	0.60	0.73	0.86
ESL-Multifamily	0.00	0.01	0.14	0.20	0.29	0.43	0.60	0.91	1.36	1.82	2.31	2.82	3.35
ESL-Commercial	0.00	0.00	0.02	0.05	0.08	0.16	0.27	0.38	0.47	0.57	0.67	0.77	0.88
PUC (SB7)	0.00	0.37	0.67	0.99	1.26	1.55	1.83	2.11	2.39	2.67	2.92	3.17	3.40
SECO	0.00	0.05	0.12	0.25	0.37	0.50	0.72	0.73	0.81	0.88	0.95	1.02	1.09
Wind-ERCOT	0.00	4.15	6.75	8.04	9.79	9.56	12.64	21.50	28.91	31.37	34.03	36.93	40.07
SEER13-Single Family	0.00	0.57	0.54	0.51	0.49	0.46	0.44	0.42	0.40	0.38	0.36	0.34	0.32
SEER13-Multi Family	0.00	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Total OSD (Tons NOx)	**0.00**	**5.20**	**8.30**	**10.13**	**12.41**	**12.84**	**16.72**	**26.31**	**34.72**	**38.19**	**41.88**	**45.80**	**49.99**

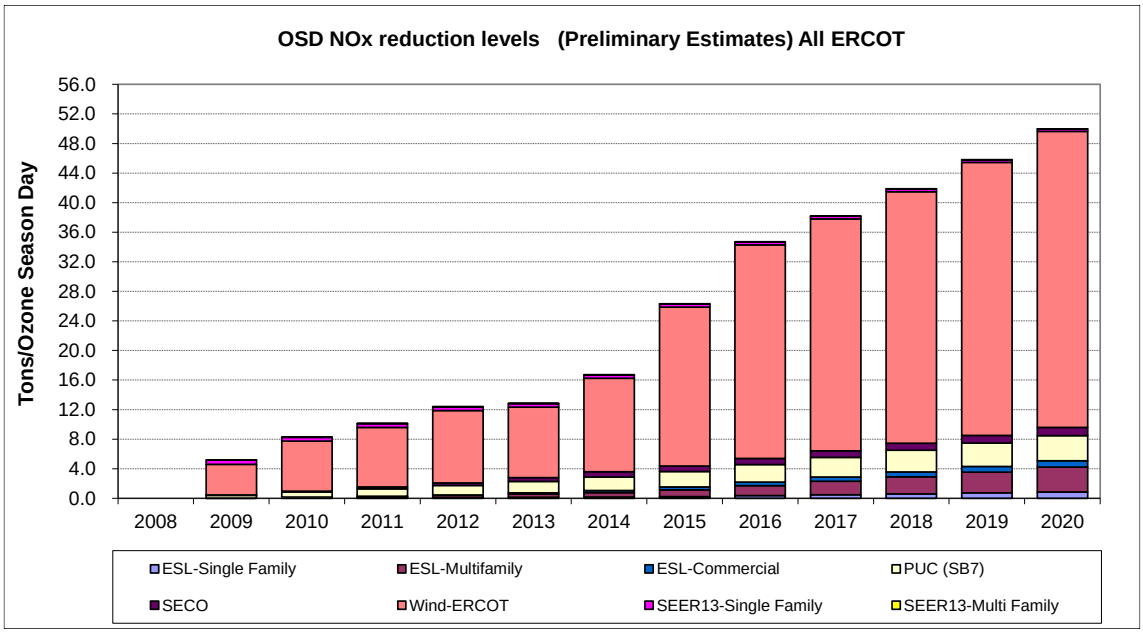


Figure 22: Integrated OSD NOx Emissions Reduction Projections through 2020 (Base Year 2008)

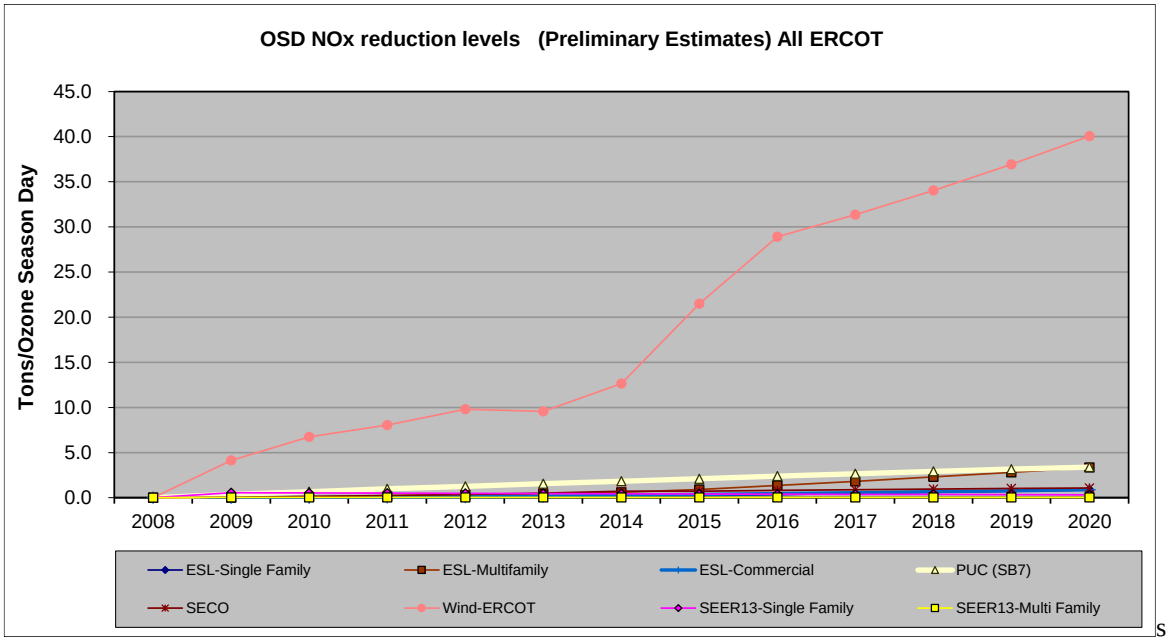


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Figure 23: Integrated OSD Individual Programs NOx Emissions Reduction Projections through 2020 (Base Year 2008)

6 2016 Year Activities of Energy Systems Laboratory (ESL) for Texas Emissions Reduction Plan

6.1 IC3 Texas Building Registry (TBR)

6.1.1 Background

In 2008, the 81st Texas Legislature amended the Texas Administrative Code (TAC .§388.008, 2009) to develop a Registry of Above-Code homes. The ESL built the first version of the Registry in 2009. This preliminary version allowed to provide basic metrics on usage of the ESL's above code calculators, *IC3*[44] and *TCV*[45]. By running reports against the calculator's databases, the ESL could determine calculator usage by month for Texas' Cities and Counties. These reports allowed a better understanding of how builders were adopting the calculators across the State, which helped to improve the calculators. In 2016, the reports continued and numbers where gathered. Figure 24 shows the projects issued each month from January to December 2016. The projects are differentiated by the basic types, IECC performance path and ERI path. Figure 25 shows the cumulative users and projects through 2016. The data are only valid for IC3 version 4, and so the counts begin from September 2015. The largest adopter of the IC3 software was the North Central Texas Council of Governments (NCTCOG) area, closely followed by the Austin-San Antonio corridor, see Figure 26. Only counties with at least 10 new projects in 2016 are included in the chart. Figure 27 shows the certifications issued by city in 2016. Only those cities with at least 30 new projects are shown on the chart.

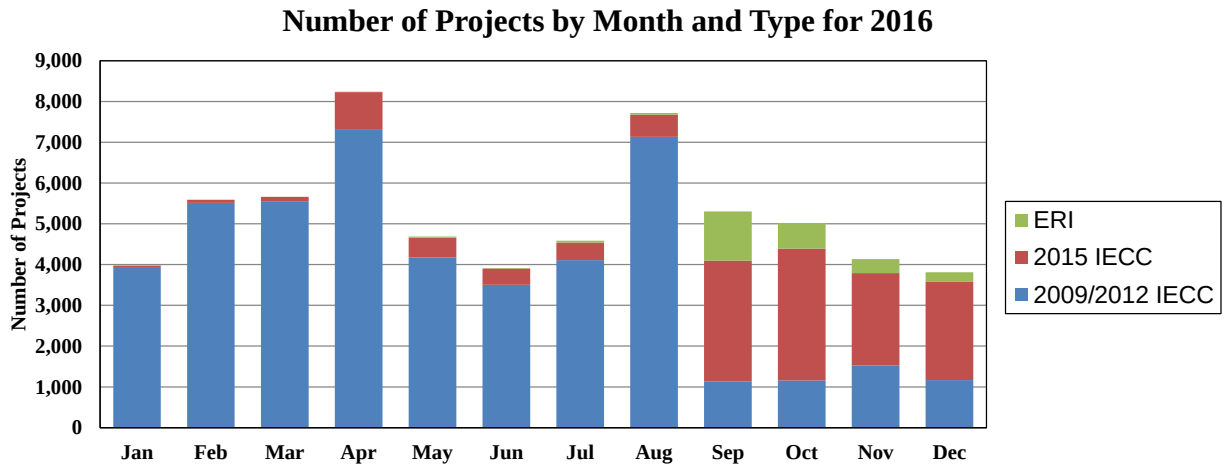


Figure 24: *IC3* 2016 Certificates and Projects

[44] International Code Compliance Calculator, a web based, above code calculator for single family, detached, new construction in Texas.
[45] Texas Climate Vision, a web based, above code calculator for single family, detached, new construction in Austin Energy's service area.

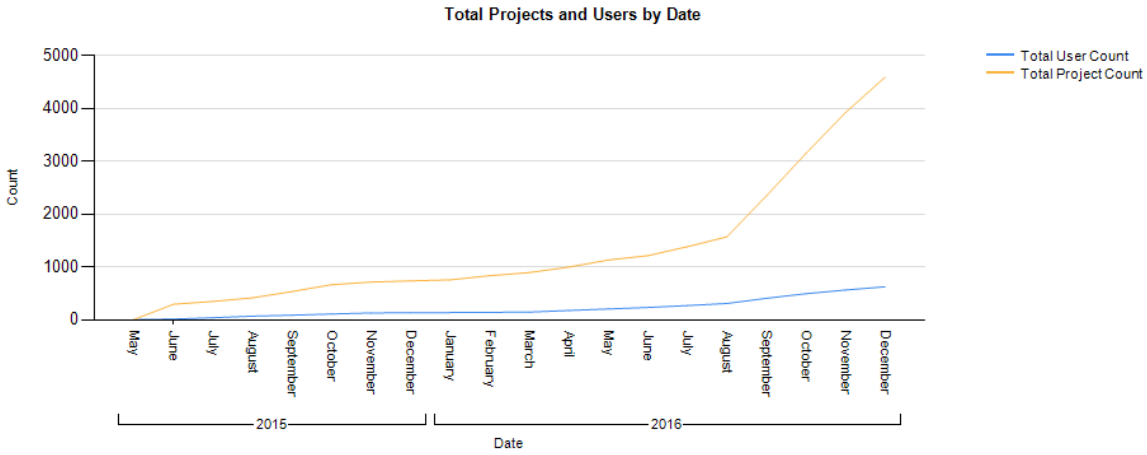


Figure 25: *IC3* 2016 Active Users and Certificates

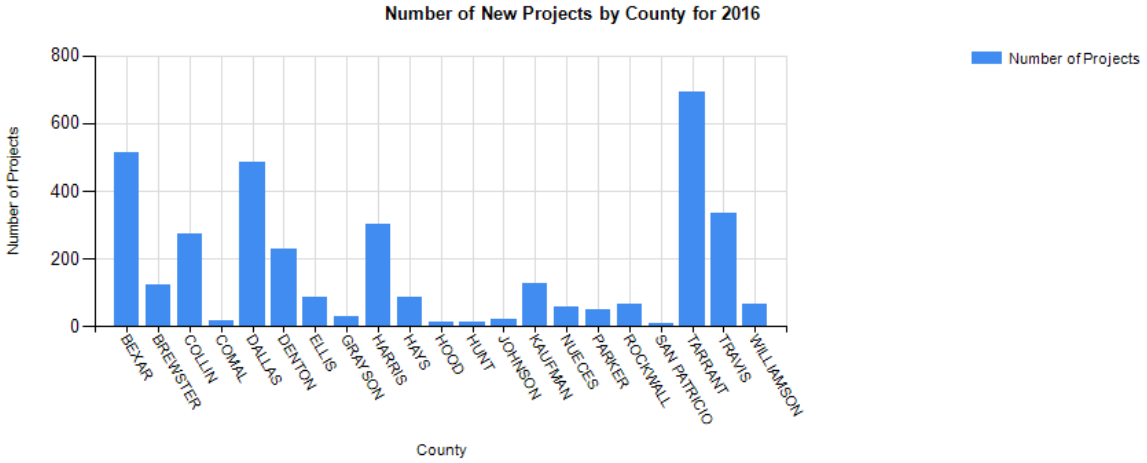


Figure 26: *IC3* 2016 Certificates – Counties with at least 10 Certificates

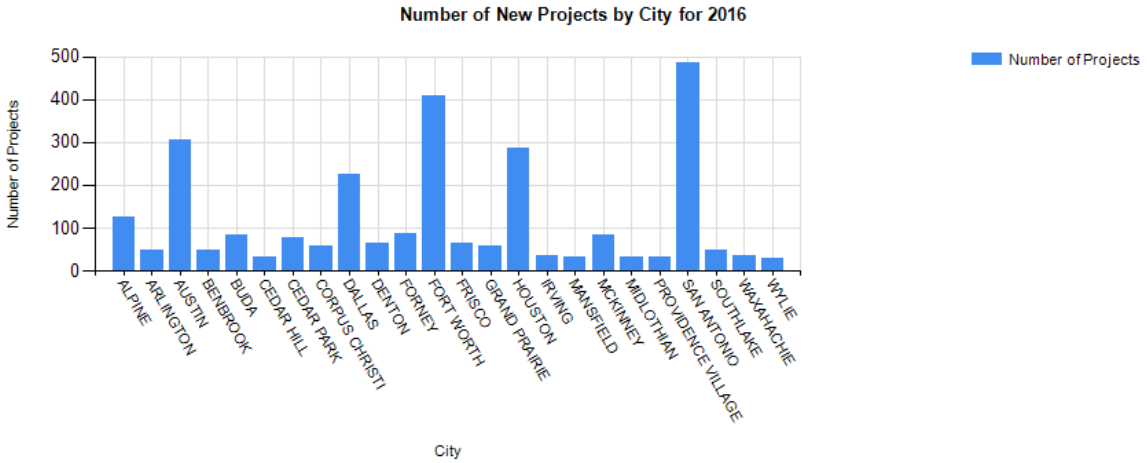


Figure 27: *IC3* 2016 Certificates – Cities with at least 200 Certificates

6.1.2 Texas Building Registry Current Version

As illustrated below and in the "*Report on the Development of the Format for a Texas Residential Registry* (Gilman, et al., 2008), the underlying database was optimized for supporting the *IC3* and *TCV* calculators and therefore needed a transformation to allow for seamless reporting. Consequently, the ESL has been steadily adding reporting capability and has been making software changes to reflect the new reporting requirements and analysis capabilities.

The underlying technology of the *IC3* and *TCV* calculators is *Microsoft SQL Server 2016*. This product offers reporting capabilities through various tools.

Figure 28 shows the "layout" of the IC3 (v3.x and above) and TCV[46] (v1.1) databases. It gives a rough overview of the different tables (called "entities") found in the *IC3* database. The center entity is the project, which is the center of the *IC3* software's abstraction of a house. The other tables include floors, walls, electrical, and systems.

[46] The *TCV* v1.1 database has different fields due to the built-in inspection module and the fact it was completed two years earlier than the described *IC3* v3.6.

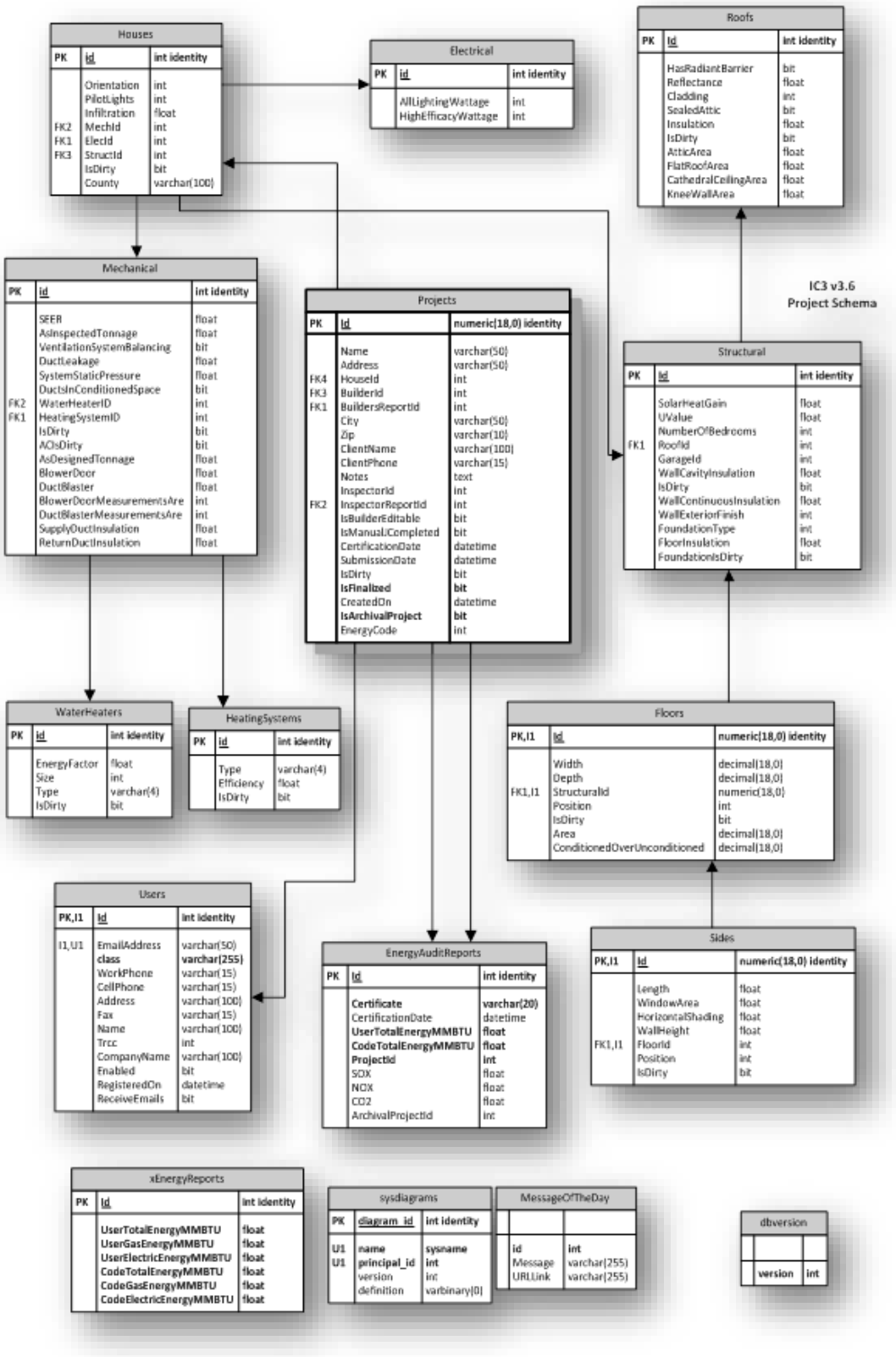


Figure 28: Database Schema

6.1.3 Usage Reports

Figure 25 in Section 6.1.1 shows the correlation between users and their successful projects (i.e. those that generate certificates). The graph shows that users were generating more projects, and were doing so at a much faster rate than the rate of adding new users.

Figure 29 and Figure 30 show where the usage was using Counties and Cities as the grouping entity. The North Central Texas Council of Governments (NCTCOG) led the way in usage during 2016.

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
ANDERSON									5			
BEXAR	9	37	33	34	78	40	92	63	58	28	19	23
BLANCO					1							
BRAZORIA									1			
BREWSTER		1	1	1	2	3	7	9	43	24	21	13
BURNET			2				1	1				
CAMERON											1	
CLAY		1										
COLLIN				3	2	5	1	12	97	61	55	36
COMAL									6	1		12
COOKE										6		
DALLAS	1	1		8	10	10	14	19	104	140	78	100
DENTON	1	1			1	2	5	4	59	67	51	36
EL PASO								1				
ELLIS								1	17	32	21	16
FANNIN										1		
FORT BEND											1	3
GALVESTON										2	1	
GRAYSON					5				12	3	5	4
GUADALUPE							1				1	
HARRIS				2	3	3	1	4	66	91	55	76
HAYS							2	1		28	37	17
HENDERSON											1	
HOOD	1				1		1		6	1	2	2
HUNT									4		5	3
JEFFERSON												1
JOHNSON							1	2	1	2	7	9
KAUFMAN				5			1		23	12	57	29
KENDALL							1					
KERR										1	3	1
LLANO			3								1	
MCLENNAN										1		

Figure 29: Counties Generating Single-Family Homes IC3 Certificates in 2016

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
MONTAGUE											1	
MONTGOMERY										2		1
NAVARRO									1		1	
NUECES		1							19	21	13	6
PALO PINTO												1
PARKER			1	2	2		2		13	5	15	9
ROCKWALL				17	1		1	2	11	16	11	6
RUSK											1	
SAN PATRICIO									5	4	1	1
TARRANT	2	1	3	6	8	12	13	27	134	153	160	175
TRAVIS		1		4	8	6	21	12	84	77	86	36
VAL VERDE										1		
VAN ZANDT									1			
VICTORIA							1					
WICHITA					1		1		1			1
WILLIAMSON										18	38	9
WISE								1		1	2	3

Figure 29: Counties Generating Single-Family Homes IC3 Certificates in 2016 (Continued)

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
ADDISON									1	2	6	
ALAMO HEIGHTS					1							
ALEDO							1		4	3	8	4
ALLEN										1		1
ALPINE		1	1	1	2	3	7	9	43	24	21	13
ALVARADO											1	2
ANGLETON									1			
ANNA									1			2
ARGYLE									1		1	
ARLINGTON									11	17	11	10
AUBREY									2	6	7	3
AURORA											1	
AUSTIN				3	8	6	21	12	84	60	76	36
AZLE				1	1		1		3	2	3	2
BEAUMONT												1
BEDFORD					1				1			
BENBROOK								1	11	16	9	12
BLANCO					1							
BLUE RIDGE									8		3	
BOERNE							1					
BONHAM										1		
BOWIE											1	
BOYD											1	2
BRIDGEPORT												1
BUDA										28	37	17
BURLESON								2	1	2	4	10
CADDO MILLS											1	
CANTON									1			
CARROLLTON	1	1		1	1		1	1	1		3	
CAYUGA									5			
CEDAR HILL				1					13	6	6	7
CEDAR PARK										21	47	9
CELINA												1
CLEBURNE							1			2	1	
COLLEYVILLE	1				1					2	2	2
COMBINE										1		1
CONROE										2		1
COPPELL										1	2	1
COPPER CANYON										1		
CORINTH										2		

Figure 30: Cities Generating Multi-Family Homes IC3 Certificates in 2016

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
CORPUS CHRISTI									19	21	13	6
CROSBY												1
CROSS ROADS										2		2
CROSS TIMBER											1	
CROWLEY		1	3	1		2	1	3	1			
DALLAS				1	2		1	5	47	86	43	40
DALWORTHINGTON GARDENS												1
DECATUR								1		1		
DEL RIO										1		
DENISON					1					1	2	
DENTON					1	1		1	17	19	13	12
DESOTO									4			16
DUNCANVILLE									1		1	1
EL PASO								1				
ENNIS											1	4
EULESS						1	3	2	2	1	2	1
EVERMAN												1
FAIR OAKS RANCH					2		1		1			
FARMERS BRANCH									2	4	1	
FARMERSVILLE									1		1	
FATE				17								
FERRIS												1
FLOWER MOUND						1	4	2	6	9	5	2
FOREST HILL								1			1	1
FORNEY				4					9	4	54	17
FORT WORTH				3	3	4	5	9	81	88	103	112
FRISCO								1	25	20	12	6
GAINESVILLE										6		
GALVESTON										1		
GARLAND				2		1		1	5	7	4	9
GLENN HEIGHTS												1
GORDON												1
GRANBURY	1				1		1		6	1	2	2
GRAND PRAIRIE	2			3	5	9	12	2	2	12	7	4
GRAPEVINE											1	
GREENVILLE									4		4	
HARLINGEN											1	
HASLET										4	2	
HEARTLAND									3	6	3	10

Figure 30: Cities Generating Multi-Family Homes IC3 Certificates in 2016 (Continued)

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
HEATH									4	7	2	
HELOTES			2	8	2	4	1	2	3	2		1
HENDERSON											1	
HENRIETTA		1										
HICKORY CREEK											1	
HIGHLAND PARK					1			7	6	3		3
HIGHLAND VILLAGE									1			
HORSESHOE BAY											1	
HOUSTON					3	3	1	3	63	87	52	75
HOWE					4				1			
HUDSON OAKS			1	1	1				2			
HUMBLE									1		1	
HURST											1	
IRVING					1		2	1	12	9	6	3
JAMAICA BEACH											1	
JOSEPHINE									9	1		1
KATY										1	1	
KAUFMAN				1			1					1
KELLER								4	1		2	
KENNEDALE									1		1	
KERRVILLE										1	3	1
KYLE							2	1				
LAKE WORTH											1	1
LAKEWOOD VILLAGE										3		
LANCASTER								2	4		2	1
LAVON											1	
LEAGUE CITY										1		
LEANDER										4		
LEWISVILLE									10		14	
LITTLE ELM								1	15	5	1	7
LUCAS									1			
MALAKOFF											1	
MANCHACA				1						10	1	
MANSFIELD									10	4	6	12
MARBLE FALLS			2				1	1				
MARION							1					
MCKINNEY									27	24	13	18
MELISSA									5	4	3	
MESQUITE												1
MIDLOTHIAN								1	4	17	7	3

Figure 30: Cities Generating Multi-Family Homes IC3 Certificates in 2016 (Continued)

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
NASSAU BAY										1		
NEEDVILLE												1
NEW BRAUNFELS									6	1		12
NORTH RICHLAND HILLS									7	3	2	10
NORTHLAKE		1								1		
OAK LEAF											9	1
OVILLA									2			
PASADENA										1		
PLANO				1	2	5	1	7	3	2	2	1
PORT ARANSAS		1										
PORTLAND									5	4	1	1
PRINCETON									4		2	4
PROSPER									2		1	
PROVIDENCE VILLAGE										16	6	9
QUINLAN												2
RED OAK										1		
RICE									1		1	
RICHARDSON										2		
RICHLAND HILLS								1				
ROANOKE											1	
ROCKWALL					1		1	2	3	3	9	4
ROSENBERG												1
ROWLETT				1					2	2	1	4
ROYSE CITY									3	9	6	2
SACHSE										1		
SAGINAW										2		
SAN ANTONIO	9	37	31	26	73	36	90	61	54	26	19	22
SANGER									2	2	1	1
SEAGOVILLE									4	4		10
SEGUIN											1	
SHERMAN									5			3
SHOREACRES											1	
SOUTHLAKE				1	3	4	3	6	6	11	11	3
SPRING VALLEY									2			
SPRINGTOWN												1
SUGAR LAND											1	1
SUNNYVALE										2		
TERRELL									10	1		
TIOGA										1		
TOMBALL				2								

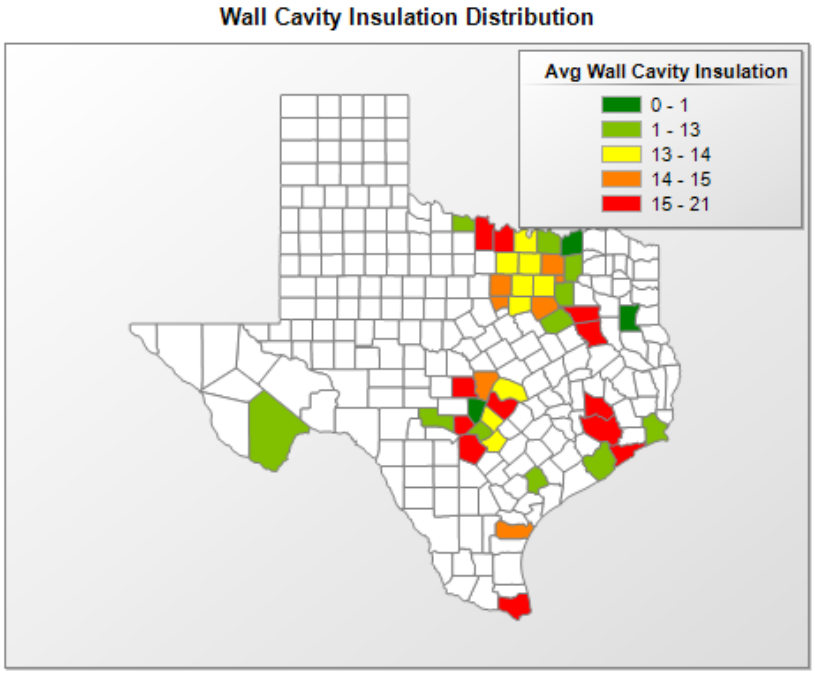
Figure 30: Cities Generating Multi-Family Homes IC3 Certificates in 2016 (Continued)

County Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
TROPHY CLUB									1			
UNINCOPORATED		1	3	2		1		3	9			
UNION VALLEY												1
UNIVERSITY PARK											1	1
VAN ALSTYNE									6		3	
VICTORIA							1					
WACO										1		
WATAUGA												1
WAXAHACHIE									11	14	3	6
WEATHERFORD									4	2	5	2
WEST UNIVERSITY PLACE								1		1		
WESTLAKE									1			1
WESTOVER HILLS												1
WHITEWRIGHT										1		1
WICHITA FALLS					1		1		1			1
WILLOW PARK											1	2
WYLIE								1	9	7	11	2

Figure 30: Cities Generating Multi-Family Homes IC3 Certificates in 2016 (Continued)

6.1.4 Parameter Reports

A unique and valuable use of the Registry is to look at building trends across the state. This report shows the yearly average wall cavity insulation distribution in Texas for 2016. Yellow, Orange, and Red in the figure show the relevant insulation values.



County	Avg Wall Insulation	House Count
Anderson	19.0	5
Bexar	15.7	514
Blanco	0.0	1
Brazoria	13.0	1
Brewster	2.0	125
Burnet	14.5	4
Cameron	19.0	1
Clay	16.0	1
Collin	14.9	272
Comal	13.0	19
Cooke	14.0	6
Dallas	13.9	485
Denton	13.9	227
El paso	13.0	1
Ellis	14.1	87
Fannin	0.0	1
Fort bend	20.5	4
Galveston	18.3	3

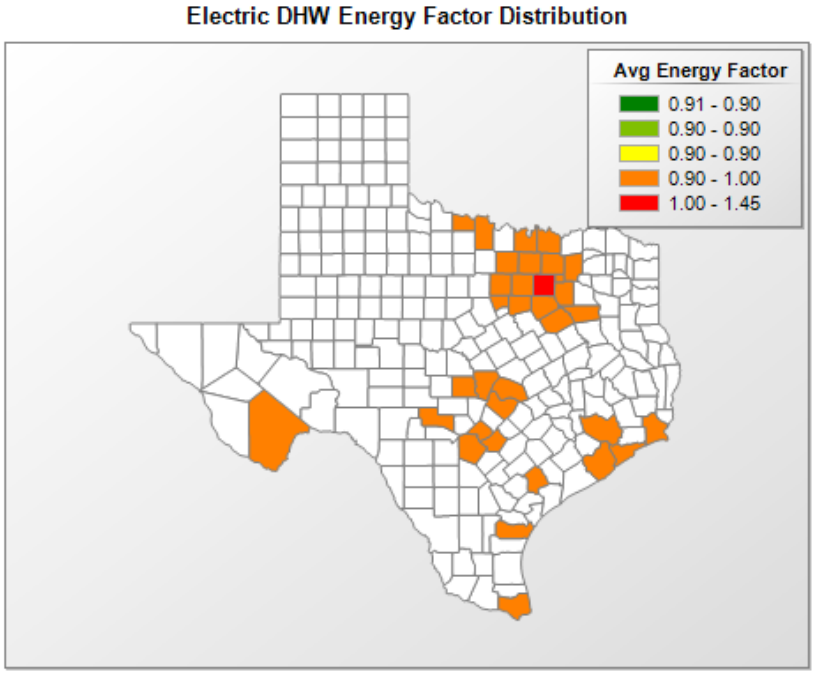
County	Avg Wall Insulation	House Count
Grayson	12.9	29
Guadalupe	14.0	2
Harris	15.4	301
Hays	13.1	85
Henderson	19.0	1
Hood	14.2	14
Hunt	13.0	12
Jefferson	13.0	1
Johnson	14.0	22
Kaufman	12.8	127
Kendall	19.0	1
Kerr	11.6	5
Llano	17.8	4
Mclennan	19.0	1
Montague	19.0	1
Montgomery	17.7	3
Navarro	13.0	2
Nueces	14.4	60

County	Avg Wall Insulation	House Count
Palo pinto	13.0	1
Parker	14.2	49
Rockwall	14.2	65
Rusk	0.0	1
San patricio	15.0	11
Tarrant	13.8	694
Travis	15.3	335

County	Avg Wall Insulation	House Count
Val verde	0.0	1
Van zandt	20.0	1
Victoria	13.0	1
Wichita	11.5	4
Williamson	13.8	65
Wise	13.4	7

Figure 31: Yearly Average Wall Cavity Insulation Distribution by County for Single-Family Homes in 2016

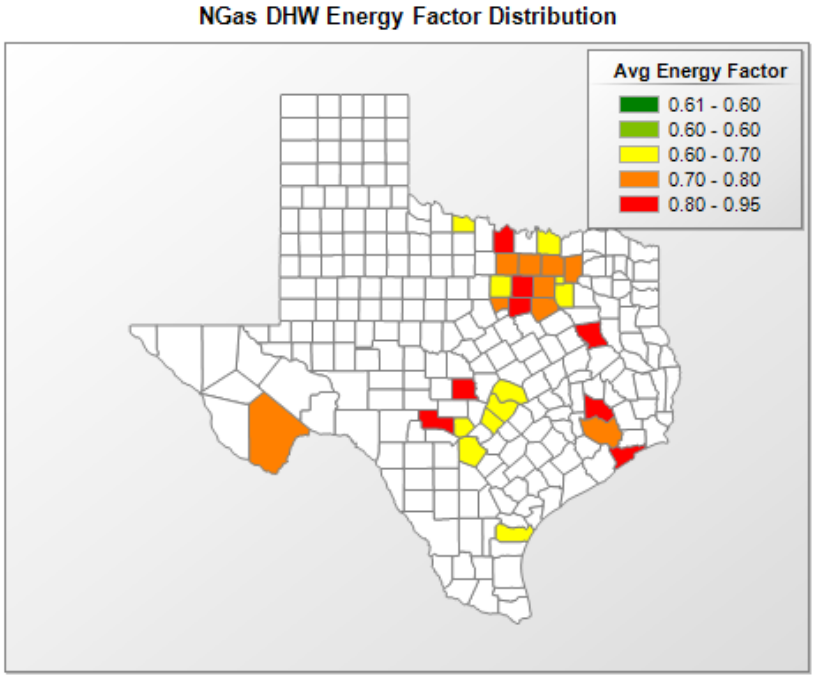
This report shows heater efficiencies across Texas in 2016.



County	Avg Electric Energy Factor	House Count
Bexar	0.9	54
Brazoria	0.9	1
Brewster	0.9	7
Burnet	1.0	4
Cameron	0.9	1
Clay	0.9	1
Collin	0.9	63
Comal	0.9	19
Cooke	0.9	6
Dallas	1.4	168
Denton	0.9	106
Ellis	0.9	60
Navarro	0.9	2
Nueces	0.9	5
Palo pinto	0.9	1
Parker	0.9	42
Rockwall	0.9	23
San patricio	1.0	11

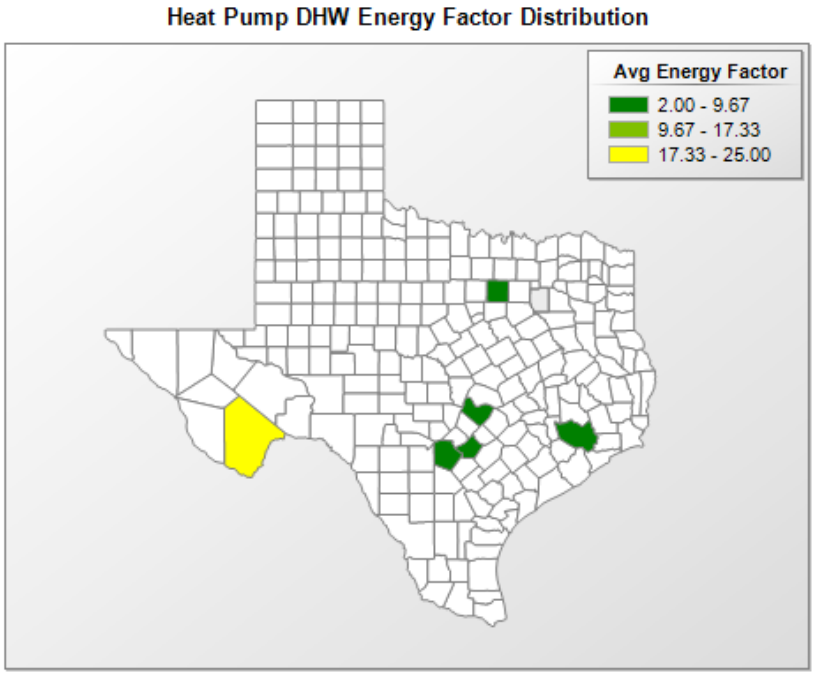
Fort bend	0.9	1
Galveston	1.0	1
Grayson	0.9	20
Guadalupe	0.9	1
Harris	0.9	15
Henderson	1.0	1
Hood	0.9	10
Hunt	0.9	9
Jefferson	1.0	1
Johnson	1.0	15
Kaufman	0.9	37
Kerr	0.9	3
Llano	0.9	3
Tarrant	0.9	350
Travis	0.9	59
Victoria	0.9	1
Wichita	1.0	2
Williamson	0.9	8
Wise	0.9	5

Figure 32: Yearly Average Water Heater Energy Factor Distribution by County for Single-Family Homes in 2016



County	Avg NGas Energy Factor	House Count
Anderson	0.8	5
Bexar	0.6	450
Brewster	0.7	6
Collin	0.7	199
Dallas	0.8	295
Denton	0.7	118
Hood	0.7	3
Hunt	0.8	3
Johnson	0.9	6
Kaufman	0.6	86
Kendall	0.6	1
Kerr	0.9	1
Llano	0.9	1
Mclennan	0.9	1
Montague	0.9	1
Montgomery	0.8	3
El paso	0.7	1
Ellis	0.7	24
Fort bend	0.9	3
Galveston	0.9	2
Grayson	0.6	7
Harris	0.8	264
Hays	0.6	85
Nueces	0.7	53
Parker	0.6	4
Rockwall	0.7	42
Tarrant	0.8	301
Travis	0.7	242
Van zandt	0.9	1
Wichita	0.6	1
Williamson	0.6	57
Wise	0.8	2

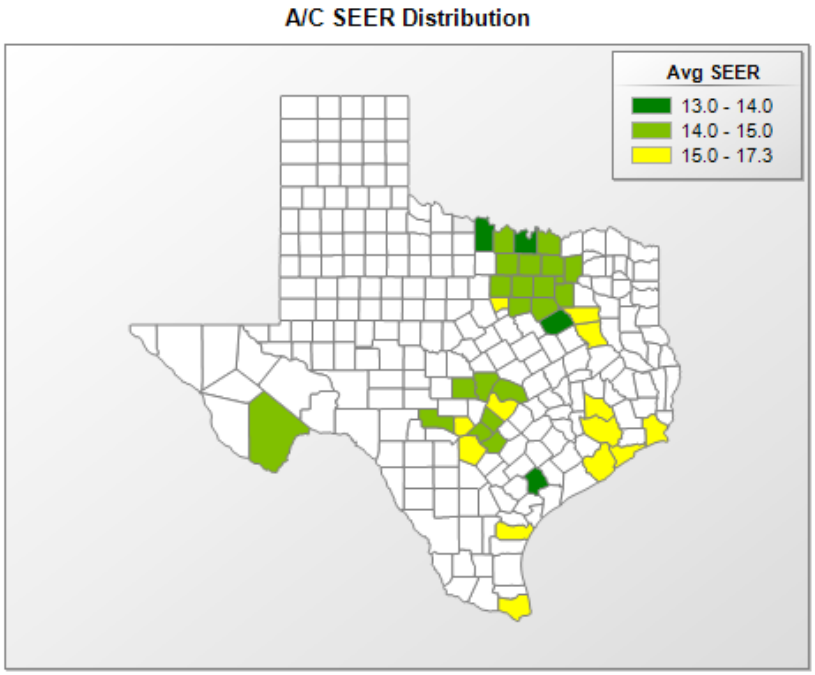
Figure 33: Yearly Average Water Heater Energy Factor Distribution by County for Single-Family Homes in 2016



County	Avg Heat Pump WH Energy Factor	House Count
Bexar	2.3	1
Brewster	25.0	1
Tarrant	2.0	5
Guadalupe	2.3	1
Harris	2.3	1
Kaufman	2.0	1
Travis	2.5	15

Figure 34: Yearly Average Water Heater Energy Factor Distribution for Single-Family Homes in 2016

This report shows the average A/C SEER across Texas in 2016. The efficiency (and sizing) of air conditioning is a vital component of energy efficiency in Texas.

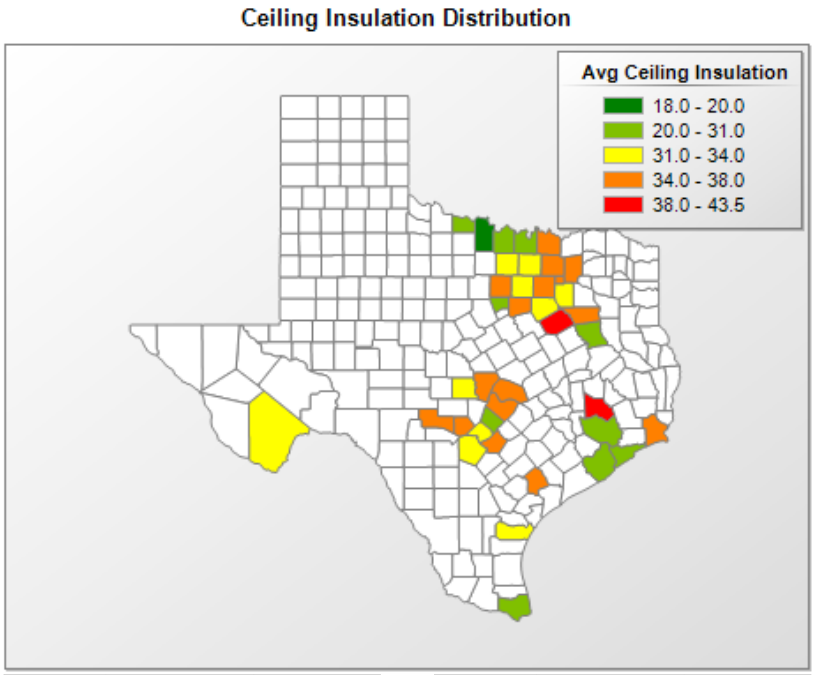


County	Avg A/C SEER	House Count
Anderson	16.0	5
Bexar	15.6	505
Brazoria	16.0	1
Brewster	14.9	17
Burnet	14.8	4
Cameron	16.0	1
Clay	13.0	1
Collin	15.0	263
Comal	15.0	19
Cooke	14.0	6
Dallas	14.9	464
Denton	14.6	223
El paso	14.5	1
Ellis	14.2	85
Fort bend	15.0	4
Montgomery	16.0	3
Navarro	14.0	2
Nueces	15.8	57
Palo pinto	15.0	1
Parker	15.0	46
Rockwall	14.7	65
San patricio	16.0	11

Galveston	15.3	3
Grayson	14.8	26
Guadalupe	14.8	2
Harris	15.1	283
Hays	14.5	85
Henderson	16.0	1
Hood	15.2	13
Hunt	14.3	12
Jefferson	16.0	1
Johnson	14.3	21
Kaufman	14.0	123
Kendall	16.0	1
Kerr	14.5	4
Llano	14.5	4
Mclennan	14.0	1
Montague	15.0	1
Tarrant	14.8	656
Travis	15.1	317
Van zandt	16.0	1
Victoria	14.0	1
Wichita	17.3	3
Williamson	14.5	65
Wise	15.0	7

Figure 35: Average A/C SEER across Counties for Single-Family Homes in 2016

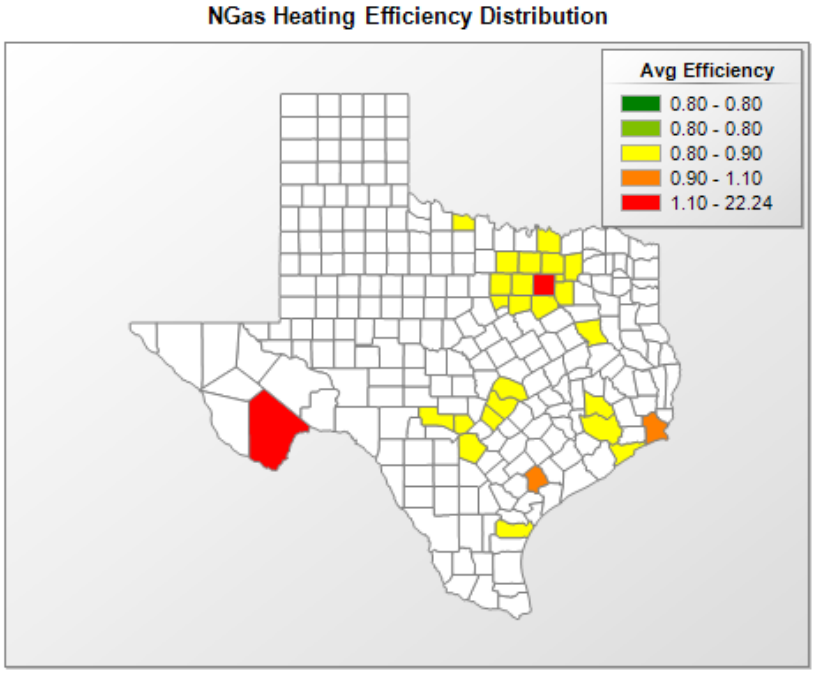
This report shows the average ceiling insulation across Texas in 2016.



County	Avg Ceiling Insulation	House Count
Anderson	28.5	5
Bexar	33.7	507
Brazoria	30.0	1
Brewster	33.1	12
Burnet	38.0	4
El paso	38.0	1
Ellis	31.4	86
Fort bend	30.0	4
Galveston	30.0	3
Grayson	37.4	27
Guadalupe	38.0	2
Harris	29.1	284
Hays	30.8	85
Henderson	38.0	1
Hood	31.0	13
Hunt	37.3	12
Jefferson	38.0	1
Johnson	36.3	21
Kaufman	32.0	124
Kendall	38.0	1
Kerr	38.0	4
Llano	33.3	4
Cameron	22.0	1
Clay	18.0	1
Collin	35.7	263
Comal	32.1	19
Cooke	30.0	6
Dallas	35.4	462
Denton	33.4	225
Mclennan	30.0	1
Montague	30.0	1
Montgomery	42.7	3
Navarro	43.5	2
Nueces	32.8	58
Palo pinto	35.0	1
Parker	34.8	45
Rockwall	37.6	65
San patricio	30.7	11
Tarrant	32.7	661
Travis	37.3	323
Van zandt	38.0	1
Victoria	38.0	1
Wichita	30.0	3
Williamson	37.6	65
Wise	33.8	6

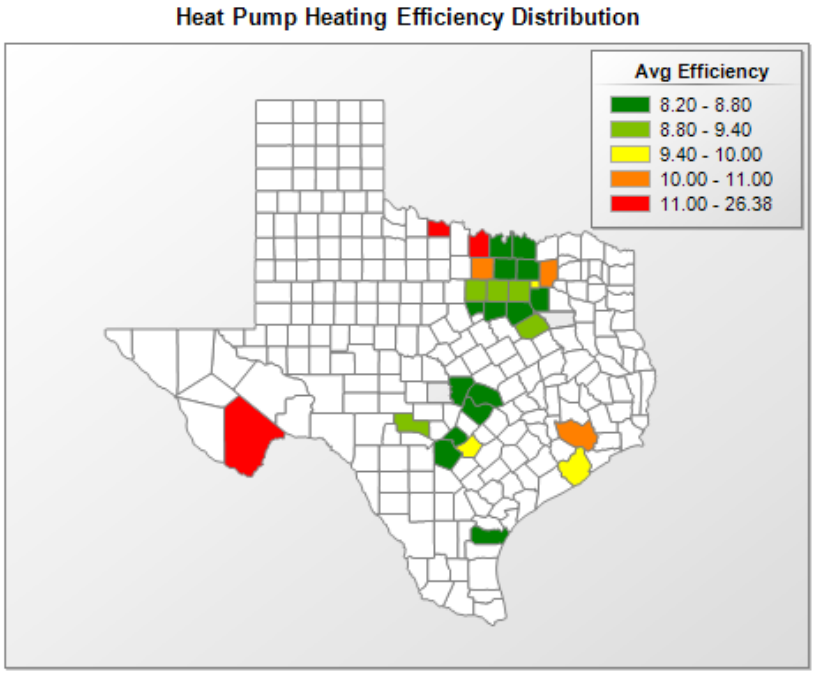
Figure 36: Average Ceiling Insulation across Counties for Single-Family Homes in 2016

This report shows the average heating efficiency across Texas in 2016.



County	Avg NGas Efficiency	House Count
Anderson	0.8	5
Bexar	0.8	448
Brewster	22.2	8
Collin	0.9	202
Dallas	1.2	294
Denton	0.8	119
El paso	0.9	1
Ellis	0.8	20
Fort bend	0.9	3
Galveston	0.9	3
Grayson	0.8	11
Harris	0.8	270
Tarrant	0.8	340
Travis	0.8	229
Van zandt	0.9	1
Victoria	1.0	1
Hays	0.8	85
Hood	0.9	3
Hunt	0.9	2
Jefferson	1.0	1
Johnson	0.8	5
Kaufman	0.8	84
Kendall	0.8	1
Kerr	0.8	2
Mclennan	0.9	1
Montgomery	0.9	3
Nueces	0.8	2
Parker	0.8	14
Rockwall	0.8	45
Wichita	0.9	1
Williamson	0.8	57
Wise	0.8	1

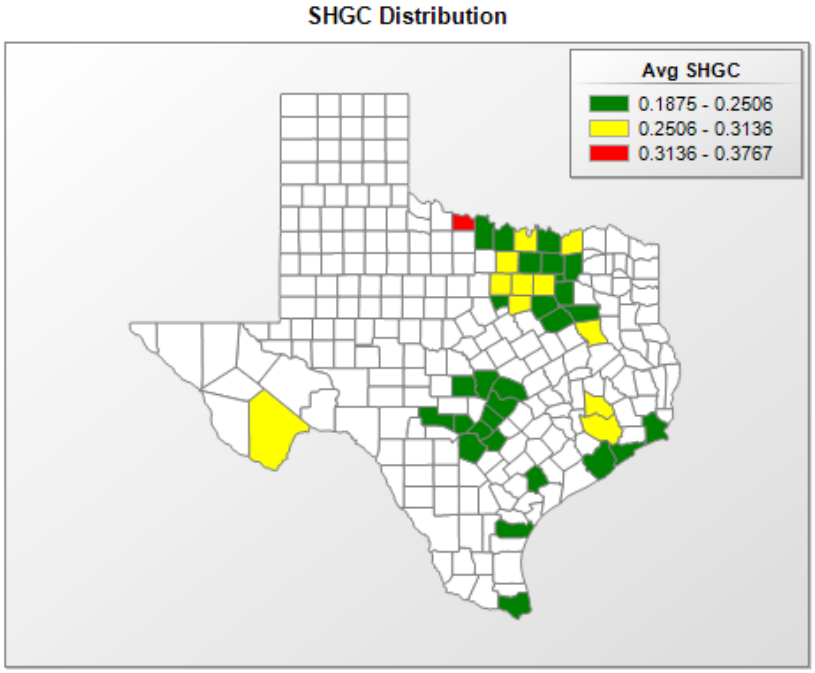
Figure 37: Average Heating Efficiency across Counties for Multi-Family Homes in 2016



County	Avg Heat Pump Efficiency	House Count
Bexar	8.4	55
Brazoria	9.5	1
Brewster	26.4	5
Burnet	8.4	4
Collin	8.6	61
Comal	8.5	19
Cooke	8.5	6
Dallas	9.2	168
Denton	8.7	104
Ellis	8.5	64
Fort bend	13.0	1
Grayson	8.3	15
Guadalupe	9.8	2
Harris	10.0	8
Henderson	8.2	1
Hood	8.3	10
Hunt	10.1	10
Johnson	8.7	16
Kaufman	8.7	39
Kerr	9.1	2
Llano	8.2	4
Montague	12.0	1
Navarro	9.3	2
Nueces	8.8	56
Palo pinto	9.0	1
Parker	8.8	32
Rockwall	9.4	20
San patricio	8.7	11
Tarrant	8.8	314
Travis	8.6	86
Wichita	11.5	2
Williamson	8.4	8
Wise	10.4	6

Figure 38: Average Heat Pump Heating Efficiency across Counties for Multi-Family Homes in 2016

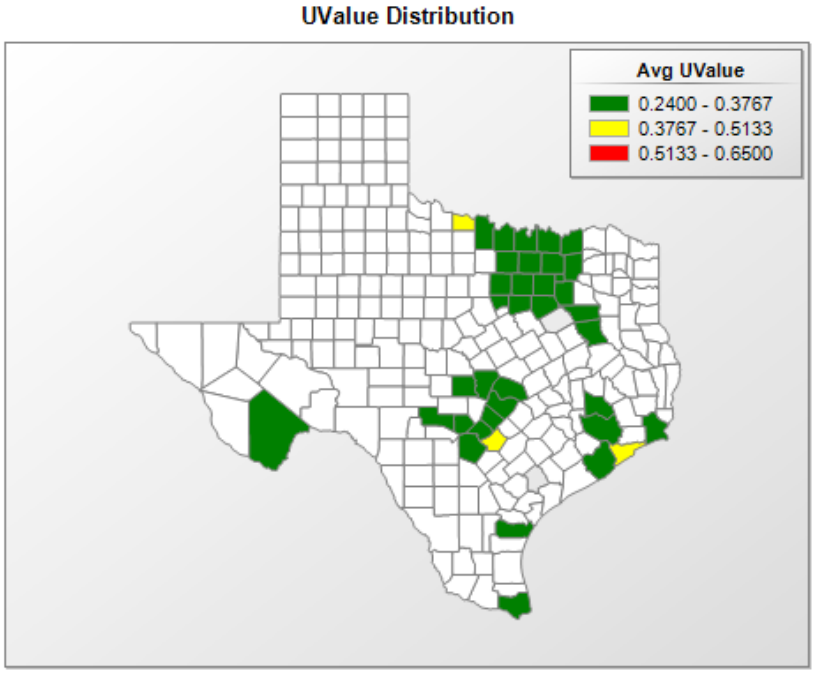
This report shows the average SHGC across Texas in 2016.



County	Avg SHGC	House Count
Anderson	0.2700	5
Bexar	0.2325	505
Brazoria	0.2500	1
Brewster	0.2953	17
Cooke	0.2800	6
Dallas	0.2560	466
Denton	0.2495	223
El paso	0.3500	1
Ellis	0.2358	86
Fannin	0.3000	1
Fort bend	0.2550	4
Galveston	0.2367	3
Grayson	0.2400	27
Guadalupe	0.1900	2
Harris	0.2790	283
Hays	0.2214	85
Henderson	0.2500	1
Hood	0.2285	13
Hunt	0.2158	12
Jefferson	0.2200	1
Johnson	0.2695	20
Kaufman	0.2448	125
Kendall	0.2300	1
Burnet	0.2500	4
Cameron	0.2100	1
Clay	0.1900	1
Collin	0.2457	265
Comal	0.2500	19
Kerr	0.2200	4
Llano	0.1875	4
Mclennan	0.2500	1
Montague	0.2500	1
Montgomery	0.2967	3
Navarro	0.2400	2
Nueces	0.2328	58
Palo pinto	0.2200	1
Parker	0.2577	47
Rockwall	0.2369	65
San patricio	0.2300	11
Tarrant	0.2545	667
Travis	0.2338	329
Van zandt	0.2500	1
Victoria	0.2500	1
Wichita	0.3767	3
Williamson	0.2202	65
Wise	0.2733	6

Figure 39: Average SHGC across Counties for Single-Family Homes in 2016

This report shows the average U Factor acorss Texas is 2016. The U Factor applies to the heat transfer of a window caused by temperature, no direct solar radiation.



County	Avg UValue	House Count
Anderson	0.2800	5
Bexar	0.3235	506
Brazoria	0.3500	1
Brewster	0.3171	17
Burnet	0.3500	4
Cameron	0.3000	1
Clay	0.3200	1
Collin	0.3324	265
Comal	0.3500	19
Cooke	0.3500	6
Dallas	0.3180	465
Denton	0.3382	223
El paso	0.2500	1
Ellis	0.3335	86
Fannin	0.3000	1
Montague	0.3000	1
Montgomery	0.2967	3
Navarro	0.2400	2
Nueces	0.3340	58
Palo pinto	0.3000	1
Parker	0.3500	47
Rockwall	0.3151	65
San patricio	0.3200	11

Fort bend	0.3150	4
Galveston	0.3833	3
Grayson	0.3415	27
Guadalupe	0.4750	2
Harris	0.3422	283
Hays	0.3553	85
Henderson	0.3500	1
Hood	0.3369	13
Hunt	0.3125	12
Jefferson	0.3500	1
Johnson	0.3475	20
Kaufman	0.3444	125
Kendall	0.3300	1
Kerr	0.3325	4
Llano	0.2700	4
Mclennan	0.2500	1
Tarrant	0.3283	666
Travis	0.3429	329
Van zandt	0.3500	1
Victoria	0.6500	1
Wichita	0.3833	3
Williamson	0.3500	65
Wise	0.3533	6

Figure 40: Average U Factor across Counties for Single-Family Homes in 2016

6.2 IC3 Enhancements

IC3 is continuously being enhanced since 2009 released Version 3.5.2 to 2013 released Version 3.13.x. Numerous enhancements have been made and are detailed out in section 6.2.1.

6.2.1 History of IC3 Enhancements

Most of the enhancements that are being added to IC3 in the recent years are summarized next:

In Version 3.5.2 (November 2009)

- Three code choices: IECC 2009, IECC 2006 (with Houston Amendments) and IECC 2000/2001.
- Duct insulation values
- Improved input of overhang values to allow for just inches

In Version 3.6.1 (December 2009)

- Foundations
- Opt out of emails
- Copy a project
- Moved orientation from Floors tab to Project Information

In Version 3.6.2 (April 2010)

- Fixed defect in 2nd Floor, Back Window issue
- Reference A\C tonnage matches the proposed A\C tonnage.
- Updated model
- Updated illustrations

In Version 3.7.x (June 2010)

- Simple multi-family code compliance
- Updated model
  a. Floor Insulation R-Value
  b. Four foundation types
- Updated illustrations
- Updated manual

In Version 3.8.x (September 2010)

- Fixed default of Multi-family Units to be “Ducts in Conditioned Space” to YES
- Fixed wrong IECC code version on certificate
- Enhanced input screens by moving several fields from Units to Floor
- Plans

In Version 3.9.x (October 2010)

- Added slab insulation
- Updated the manual

In Version 3.10 (September 2011)

- Three IECC 2009 compliant reports (i.e. energy, inspection list, and certificate)
- Paging enhancements on “My Page” to help organize large quantities of projects.
- Multi-family usability increased with Plan/Unit information being displayed on pages.
- Elimination of flash animation (so we will become iPad compatible).

- Updated/expanded help text.
- Updated illustrations.
- Tweaked min/max values on duct insulation, water heaters.

In Version 3.11 (December 2011)

- Added support for IECC 2009 Austin Amendments

In version 3.12.x (January 2012)

- Deprecated 2000/2001 and 2006 Houston Code.
- Added a button to generate Energy Report w/ a signature line. The original energy report still exists
- Improvements in the algorithm
- Help images/ text updated
- Updated manual

In version 3.13.x (August 2013)

- Added Manual J.
- Added 2009 NCTCOG code. This is the 2012 IECC w/ NCTCOG amendments. It is slightly less stringent than the base 2012 code and is optimized for climate zone 3.

In version 3.14.x (March 2015)

- Added 2012 AE Code.
- Added heat-pump water heater option
- Added sealed attic option.
- Revised energy report to make it clearer

6.2.2 History of IC3 version 4 Enhancements

Version 4.0 (June 2015)

- Initial release
- Originally has only 2015 IECC single-family

Version 4.0.1 (July 2015)

- The original version (4.0) printed the logged in user's name, phone number, and email address in the builder's fields on the certificate and energy report. These can now be overridden on a project-by-project basis. The new input fields on the left side of the screen are now the values that will be printed on the certificate and energy reports.
- The project notes will now appear on the Energy Report. Due to spacing issues, only the first 60 characters will be printed. If the project notes are longer, they will be truncated in the energy report.
- On a user's main user screen (the one immediately after login that lists all of your projects), a button has been added to the top: 'Edit User Information'. This button allows you to edit the logged in user's contact information that you entered when registering on the site.
- On a user's main user screen (the one immediately after login that lists all of your projects), a button has been added to the top: 'Import Project from IC3 version 3.x '. Several users have requested the ability to 'import' projects from the old version of IC3. This is now possible. o Users will be prompted to enter their IC3 version 3.x credentials and the select a project to import. Only single-family project import is available at this time.
    - The user will be prompted for a new project name, project address, and orientation (just as when you are copying an existing project from version 4.x).
    - Aside from these fields, the project is copied without alteration except that the code is changed to IECC 2015. Of course, there is no guarantee that a project that passes 2009 or 2012 will still pass 2015 without some modifications.
- Some rounding issues on the energy Report have been fixed.

In version 4.0.2 (April 2016)

- Clean up of some error messages
- Revised attic model to give better results
- Webpage will now check that the house meets the minimum fresh air standards as given by the IRC and will post an error message upon submission if it does not meet the minimum standards.

In version 4.1 (September 2016)

- Added ERI calculation mode

In version 4.1.1 (September 2016)

- Some bug fixes

In version 4.1.2 (October 2016)

- Altered appliance energy calculation for ERI

In version 4.2 (October 2016)

- Added NCTCOG 2015 IECC amendment to list of codes

6.2.3 Changes in Single-Family Input File

There have been two major version changes according to the changes in the Single-Family Input file since the 2012 annual simulations. Table 31 presents the summarized description of the changes in Single-Family Input file since the 2012 annual simulation.

Table 31: Changes in Single-Family Input file

BDL Version	Description	Date Modified
4.01.08	BDL used for the 2012 annual report.	03/10/2011
4.01.09	Added sensible and latent components for equipment heat gain.	07/31/2013
4.01.10	Added special construction for knee wall. Corrected plywood layers for floor. Corrected construction for floor-over-ambient conditions. Added heat-pump water heater module. Corrected layers for cathedral ceiling.	08/27/2013 10/20/2013 12/11/2013
4.01.11	Added option to include attic volume in conditioned space in case of sealed attic. Added option for roof insulation to go over roof studs.	05/29/2014 04/09/2014

Added sensible and latent components for equipment heat gain
In order to incorporate the HERS Index calculations in IC3, it became necessary to elaborate the input for lighting, equipment and occupants[47]. Equipment loads were now divided into sensible and latent components. Two new parameters were added in Version 4.01.09 to incorporate the sensible and latent components of the equipment load.

Added special construction for knee wall
In BDL Version 4.01.10 specifications were added to represent knee wall construction. Previous versions of the BDL did not have a separate entry for knee wall construction. Specifications for exterior wall construction was used to represent construction for knee walls.

Corrected plywood layers for floor
In BDL Version 4.01.10 specifications for floor construction was modified to better account for standard practice. Previous versions of the BDL had thinner layer of plywood specified. The current version specifies a more appropriate thickness of plywood used in the construction of floors, which include floors over basements and crawl spaces.

Corrected construction for floor over ambient
In BDL Version 4.01.10 specifications for floor-over-ambient construction was created. Previous versions of the BDL used specifications for ceiling insulation for floor-over-ambient conditions. The current version appropriately incorporates floor insulation in floor-over-ambient construction. The specification in the BDL limits the thickness of floor insulation to the thickness of floor studs input in the model.

Added heat-pump water heater module
In BDL Version 4.01.10 specifications for heat-pump water heaters were added. These specifications include the addition of the heat-pump option as an option available in the BDL to be modeled as a DHW type. When the heat-pump option is selected, several inputs are now modified by the software team. These includevalues for energy input

[47] It should be noted that loads from occupants were included in the loads for equipment.

ratio (DHW-EIR) and heat rate (DHW-HEAT-RATE). The equation for converting EF to COP is adopted from the specifications in EnergyGauge USA (Version 3.1.02).

$$\text{DHW-EIR} = 1/\text{COP} = 0.781/(\text{EF})$$

The heat rate values of 7,700 Btu/hr are adopted from EnergyGauge regardless of the size of the tank[48].
In addition, the curves used for energy input ratio as a function of part load ratio are the same curves that are used for heat pump space heating obtained from Henderson et al. (2000)[49].

Corrected layers for cathedral ceiling
In BDL Version 4.01.10 specifications for cathedral ceiling were added to the BDL. The modification included providing a separate entry in the BDL for cathedral ceiling insulation that is restricted size of ceiling stud. Previous versions of the BDL used ceiling insulation for cathedral ceilings.

Added option to include attic volume in conditioned space in case of sealed attic
In BDL Version 4.01.11 modifications were made to include attic volume in conditioned space in the case of sealed attic was simulated. The modifications were made to 'ROOM' space conditions.

[48] Email correspondence with Jeff Myron, EnergyGauge Technical Support (10/18/2013).
[49] Henderson, H., D. Parker, Huang, Y. (2000). Improving DOE-2's RESYS Routine: User Defined Functions to Provide More Accurate Part Load Energy Use and Humidity Predictions. Presented at the 2000 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA.

6.3 Laboratory's TERP Web Site "esl.tamu.edu/terp"

Since the fall of 2001, the Laboratory has maintained a TERP webpage, where information is provided to builders, code officials, the design community and homeowners about TERP. In 2016, the Laboratory redesigned its website to make navigation easier. On the navigation bar is a tab that links to the TERP homepage (Figure 41). The homepage contains the following items:

- Definition of the Texas Emissions Reduction Plan
- Texas Work
  - TERP Objectives
  - TERP Elements
  - ESL's TERP Responsibilities
  - The CATEE Conference
  - Links to
    - Texas Legislative Testimony by the ESL
    - TERP Legislative History
- National Work
  - National Center of Excellence on Displaced Emission Reductions (CEDER)
  - Links to
    - CEDER Program
    - EPA Recognizes ESL and Dallas Partners
- Latest articles and news on the right sidebar

The TERP tab also contains a dropdown menu which provides links to the following sections

- Code Compliance Calculator
  - IC3
    - Help and Support – contains IC3 Help Resources including
      - Supplemental Release Notes
      - What's New in this Version?
      - Manual
      - Detailed Release Notes for current release of IC3
      - Aggregate Reports from IC3 – Location, parameters and maps.
      - Contact information
      - Workshops
      - FAQ
      - RESNET Certification Resources
        - Report
    - News – includes information about improvements and fixes to IC3 Workshops – description of IC3 Workshops, including contact information
    - FAQs
    - IC3 Reports – contains data from ESL's research and software projects
      - IC3 – Registry House Parameters (updated monthly)
        - Envelope
        - Systems
        - Mixed
      - Texas Building Registry Demographics
        - Texas

        - Counties
        - Cities
        - TCV (Travis County & Austin)
    - Weather Data
  - TCV
    - Help & Support – contains TCV Help & Support and contact information
    - News – includes TCV News including
      - What's New in Version 1.1
      - What is the Difference between TCV v1.1 and IC3 v3.x?
    - FAQs
  - Other Legacy calculators
    - AIM Calculator
    - eCalc 1.x Calculator
  - Credits
- Letters and Reports
  - Legislative Documents
  - Builders Information
  - EPA/CEDER Work
    - Background
    - Reports provided to US EPA as part of CEDER Program
  - Reports – listed by year from 2002-2016
- About
  - Legislative Testimony
  - Legislative Documents
  - Legislative History
- TERP Data Sets
  - Weather Data
  - Texas Building Registry
    - IC3/TCV Usage Reports
    - IC3 House Construction Trends
- TERP Links
  - eCalc Emissions & Energy Calculator
  - International Code Compliance Calculator (ICCC)
  - Public Utility Commission of Texas (PUC)
  - U.S. Department of Energy (DOE)
  - Texas State Energy Conservation Office (SECO)
  - U.S. Environmental Protection Agency (EPA)
  - International Code Council (ICC)
  - American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - North Central Texas Council of Governments (NCTCOG)
  - Alamo Area Council of Governments (AACOG)
  - Circle of Ten
  - Texas Home Energy Rating Organization (HERO)
- Other Publications
  - Builders Information
  - Digital Library
  - Presentations
  - Proceedings
    - Air Quality (CATEE)

    - Hot & Humid
    - IBPSA
    - ICEBO
    - IETC
- Workshops
    - IC3
    - IECC Residential
    - IECC Commercial
    - ASHRAE

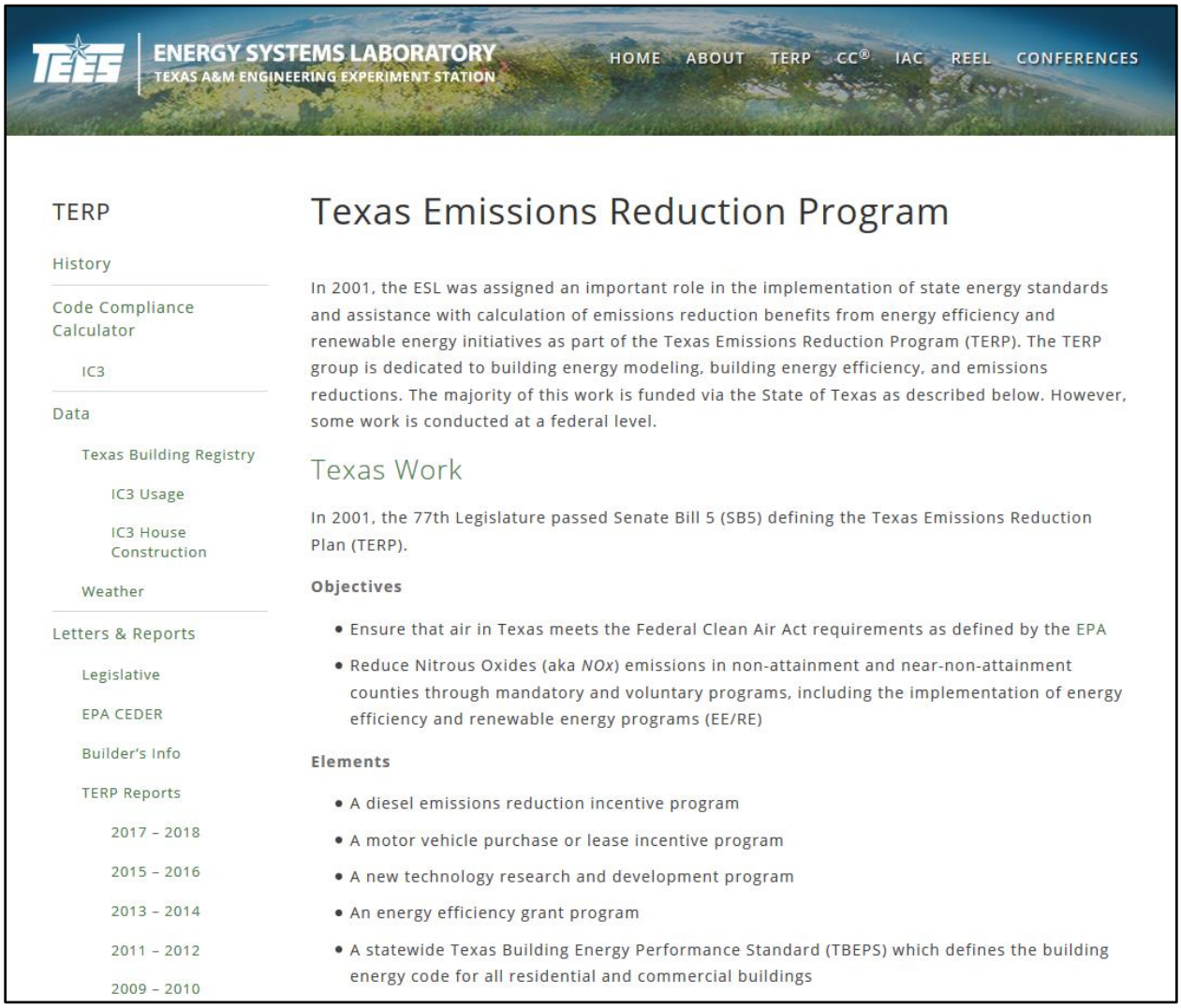


Figure 41. TERP Home Page

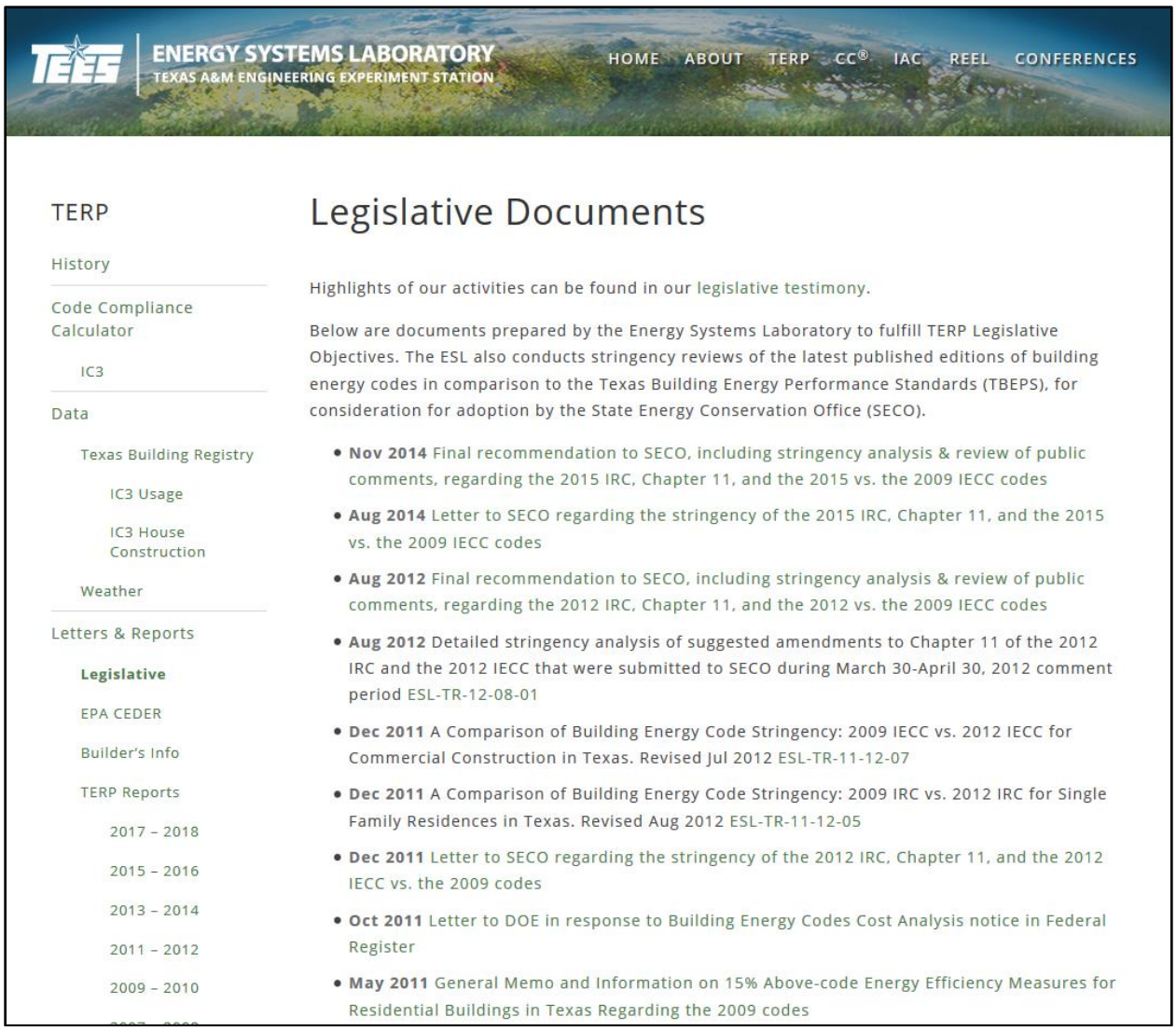


Figure 42: TERP –Letters and Reports

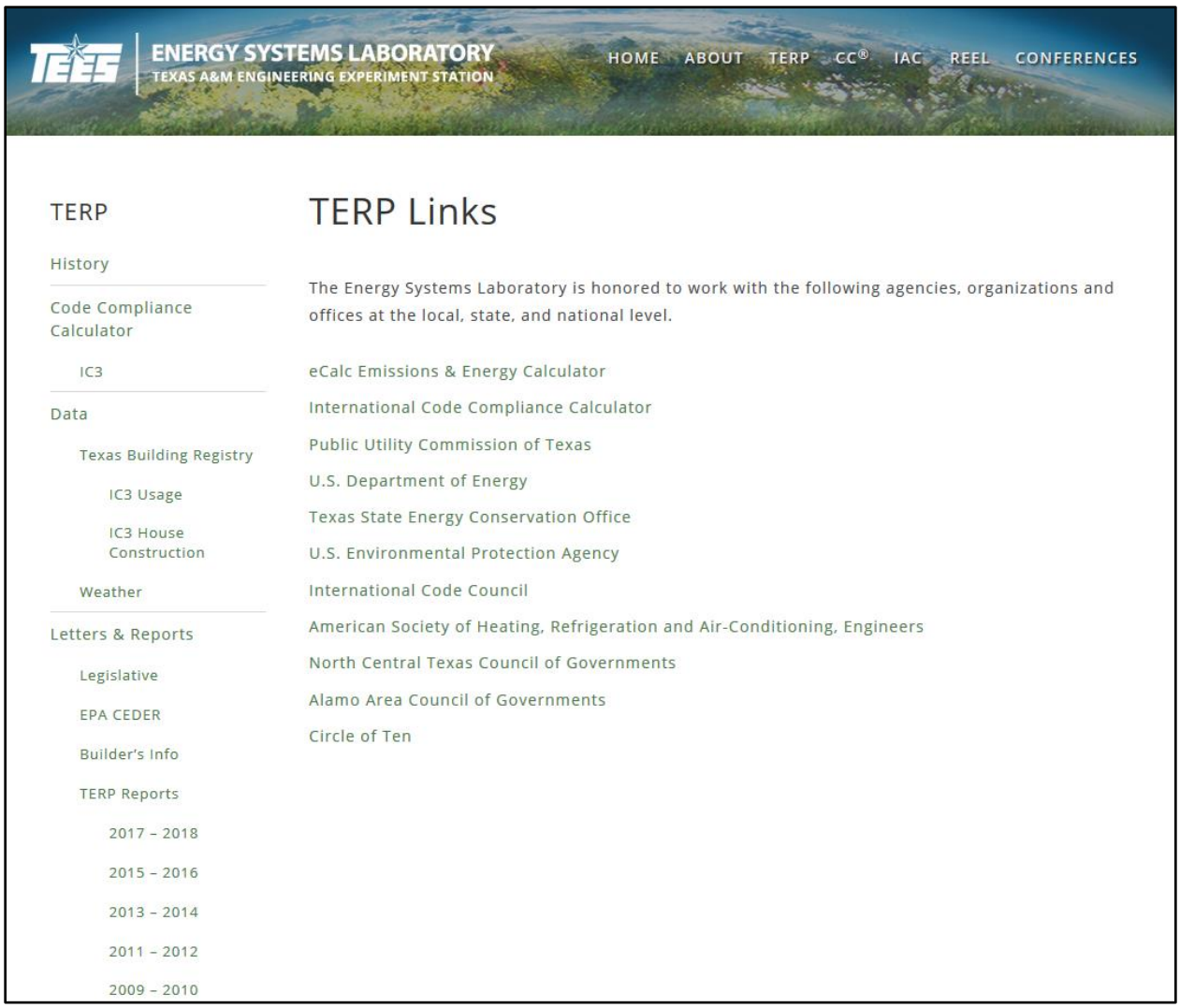


Figure 43: TERP Links

In addition, the Energy Systems Lab. (ESL) also hosted the Clear Air Through Energy Efficiency Conference (CATEE). The CATEE website and information are linked in the dropdown menu of the Conference tab in the ESL website.

6.4 Activities of Technical Transfer

6.4.1 Technical Assistance to the TCEQ

The Laboratory received dozens of calls per week from code officials, builders, home owners and municipal officials regarding the building code and emissions calculations. A complete file of these transactions is maintained at the Laboratory.

The Laboratory provides technical assistance to the TCEQ, the PUC, SECO and ERCOT, as well as Stakeholders participating in a number of conferences and presentations. In 2011, the Laboratory continued to work closely with the TCEQ to develop an integrated emissions calculation, which provided the TCEQ with a creditable NOx emissions reduction from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, and 2016 by the Laboratory, PUC, SECO, and Wind-ERCOT.

The Laboratory has also enhanced the previously developed emissions calculator by: expanding the capabilities to include all counties in ERCOT, including the collection and assembly of weather from 1999 to the present from 17 NOAA weather stations, and enhancing the underlying computer platform for the calculator.

The Laboratory has and will continue to provide leading edge technical assistance to counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering the emissions and improving the air for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP.

6.4.2 Code Training

Section 388.009 of HB 3235 requires the Laboratory to develop and administer a state-wide training program for municipal building inspectors who seek to become code-certified inspectors. To accomplish this, the Laboratory originally developed the Energy Code Workshops which were based on the 2006 International Energy Conservation Code (IECC) as published by the International Code Council (ICC) for residential and commercial buildings, with amendments. Since then, the Laboratory has updated the workshops to the 2009 IECC, and developed 2012 code workshops.

6.4.3 Other Meetings

6.4.3.1 North Central Texas Council Government (NCTCG) Meetings from 2016.

The following pages are meeting notes, agendas, and summaries from the NCTCG meetings from 2016.

AGENDA

Energy and Green Advisory Board
Thursday, January 21, 2016
9:00 AM – 12:00 PM Metroplex Conference Room
NCTCOG Offices, CPII
616 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas
Vice Chair: Evan Roberts, City of Fort Worth

1. **Welcome and Introductions.**

ACTION ITEM

2. **Discussion of specific proposed amendment language to Table R402.1.2, Table R402.1.4 and Section R402.4.1.2 of the 2015 Edition of the IECC that include the expiration of the amendment. This action item will require a vote.**

DISCUSSION

3. **Continuing review and discussion of the 2015 IgCC.** The board will continue reviewing the 2015 Edition of the IgCC and incorporate previous work as applicable.

OTHER BUSINESS AND ROUNDTABLE DISCUSSION

4. **Future Agenda Items**. Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.

4. **Roundtable Topics/Other Business**. EGAB members and NCTCOG staff may share additional items of interest as time allows.

5. **Schedule for the Next EGAB Meeting**. Future EGAB meetings will occur on the following Thursdays, from 9:00 AM to 12:00 PM:

February 18, 2016	Tejas Conference Room, CPIII (3rd floor)
March 17, 2016	Tejas Conference Room, CPIII (3rd floor)
Additional meeting dates forthcoming	

6. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or sbarba@nctcog.org. If you plan to attend this public meeting and you have a disability that requires special arrangements

North Central Texas Council of Governments

AGENDA

Regional Codes Coordinating Committee
Monday, January 25, 2016
9:30 AM, William J. Pitstick Executive Board Room
NCTCOG Offices, CPII
616 Six Flags Drive, Arlington, Texas 76011

Chair: David Kerr, City of Plano
Vice-Chair: Jack Thompson, City of DeSoto

1. **Welcome and Introductions**.

ACTION/PRESENTATIONS

2. **Summary of the August 4, 2015 Meeting**. The August 4, 2015 draft meeting summary is available online for your review and consideration.

3. **Approval sought for Appointment of Advisory Board Members.** Advisory Board Chair(s) will seek approval of advisory board member appointments.

4. **Consideration of recommendation from EGAB regarding recommended amendments to the 2015 Edition of the IECC.** Ed Dryden, Chair of the EGAB will present discussion regarding amendments to 2015 Edition of the IECC. This item may require a vote.

DISCUSSION

- **Discuss Building Standards in light of recent tornados.**

INFORMATION ITEMS

OTHER BUSINESS AND ROUNDTABLE DISCUSSION

5. **Future Agenda Items**.

6. **Roundtable Topics/Other Business**. RCCC members and NCTCOG staff may share additional items of interest as time allows.

7. **Schedule for the Next RCCC Meeting**. The upcoming RCCC meetings are scheduled for the following dates at the NCTCOG Offices, CPII.

April 12, 2016; June 14, 2016

616 Six Flags Drive, Centerpoint Two
P.O. Box 5888, Arlington, Texas 76005-5888
(817) 640-3300 FAX: 817-608-2372
www.nctcog.org

North Central Texas Council of Governments

AGENDA

Energy and Green Advisory Board
Thursday, February 18, 2016
9:00 AM – 12:00 PM Tejas Conference Room
NCTCOG Offices, CPIII
600 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas
Vice Chair: Evan Roberts, City of Fort Worth

1. **Welcome and Introductions.**

DISCUSSION

2. **Continuing review and discussion of the 2015 IgCC.** The board will continue reviewing the 2015 Edition of the IgCC and incorporate previous work as applicable.
   a. Reconsideration of recommended deletion of Section 611.
   b. Discussion of various templates and checklists.
   c. Other as necessary.

ACTION ITEM

3. **Final vote on recommended amendments to the 2015 IgCC.**

OTHER BUSINESS AND ROUNDTABLE DISCUSSION

4. **Future Agenda Items**. Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.

5. **Roundtable Topics/Other Business**. EGAB members and NCTCOG staff may share additional items of interest as time allows.

6. **Schedule for the Next EGAB Meeting**. Future EGAB meetings will occur on the following Thursdays, from 9:00 AM to 12:00 PM:

March 17, 2016 (meeting needed only if business not completed at February 18, 2016 EGAB meeting.)	Tejas Conference Room, CPIII (3rd floor)
~~April 21, 2016~~	~~Tejas Conference Room, CPIII (3rd floor)~~
~~May 19, 2016~~	~~Tejas Conference Room, CPIII (3rd floor)~~
~~June 16, 2016~~	~~Metroplex Conference Room, CPII~~

616 Six Flags Drive, Centerpoint Two
P.O. Box 5888, Arlington, Texas 76005-5888
(817) 640-3300 FAX: 817-608-2372
www.nctcog.org

6.4.3.2 State Agency Energy Advisory Group (SAEAG)

The following pages are meeting notes, agendas, and summaries from the SAEAG meetings from 2016.

Tammy Persky

Subject:	SAEAG Meeting
Location:	LBJ Building (17th and Brazos) - Room 212C
Start:	Wed 1/20/2016 9:00 AM
End:	Wed 1/20/2016 11:30 AM
Show Time As:	Tentative
Recurrence:	(none)
Organizer:	Eddy Trevino

State Agency Energy Advisory Group

Wednesday, January 20, 2016
9:00 a.m. – 11:15 a.m.
LBJ Office Building
17th and Brazos
Room 212C
Austin, Texas 78711

AGENDA

Case Update from OAG

SECO Report

BREAK

Discussion on Future Presenters

Guest speaker: Greg Tinkler, KCI Technologies; Houston, TX
The Path to a ZeroNet Energy Building and Geothermal

Q&A

General discussion

***If you are attending in person, be sure to bring a picture I.D. to gain entry to the LBJ Building.**

Register now if you will be attending remotely!

Registration URL: https://attendee.gotowebinar.com/register/1403499476961338881
Webinar ID: 139-059-811

After registering, you will receive a confirmation email containing information about joining the webinar.

State Agency Energy Advisory Group

Wednesday, May 18, 2016
9:00 a.m. – 10:45 a.m.
LBJ Office Building
17th and Brazos
Room 305
Austin, Texas 78711

AGENDA

9:00 a.m. – 9:20 a.m.	Case Update from OAG (not open to public)
9:20 a.m. – 9:30 a.m.	Networking
9:30 a.m. – 10:15 a.m.	Guest speaker: Melissa Brogan (CPA Tax Policy) (Presentation and Q&A) **Water-Efficient Products sales tax holiday**
10:15 a.m. – 10:30 a.m.	SECO Update
10:30 a.m. – 10:45 a.m.	General discussion

*If you are attending in person, be sure to bring a picture I.D. to gain entry to the LBJ Building.

Registration

Please register for SAEAG meeting on May 18, 2016 9:00 AM CDT at:

https://attendee.gotowebinar.com/register/4815025675455355396

After registering, you will receive a confirmation email containing information about joining the webinar.

SAEAG MEETING

State Agency Energy Advisory Group

Wednesday, August 17, 2016
9:00 a.m. – 11:00 a.m.
Office of the Attorney General
William Clements Building
NW Corner of 15th and Lavaca
12th Floor Large Conference Room by Receptionist Area
Austin, Texas 78701

AGENDA

9:00 a.m. – 9:15 a.m.	Introductions
9:15 a.m. – 9:45 a.m.	Case Update from OAG
9:45 a.m. – 10:00 a.m.	BREAK
10:00 a.m. – 11:00 a.m.	Energy Reporting Requirements for State Agencies and Universities, presented by Alison Huxel, SECO

Webinar Registration: https://attendee.gotowebinar.com/rt/7495588846236999171

If you are attending in person, be sure to bring a picture I.D. to gain entry to the Clements Building.

You may pre-register to obtain unescorted clearance (you will still need to bring a picture I.D.) to our floor by emailing or calling before our meeting is scheduled nancy.villarreal@texasattorneygeneral.gov [512-475-4164] or colleen.minor@texasattorneygeneral.gov [512-475-4157].

State Agency Energy Advisory Group

LBJ Office Building- 111 E. 17th Street, Austin

September 21, 2016

AGENDA

9:00– 9:15 am Case Update from OAG (not open to public)

9:15– 9:30 am SECO Update

9:30– 10:30 am Presentation on Eproject Builder by Elizabeth Stuart, Lawrence Berkeley National Laboratory

10:30– 10:45 am Questions and General discussion

6.4.3.3 Clean Air Through Energy Efficiency (CATEE 2016)

The Clean Air Through Energy Efficiency (CATEE) Conference is a premiere educational conference and business exhibition connecting public and private decision makers and thought leaders. Its purpose is to help communities improve decisions that determine the energy and water intensity of the built environment, learn from examples and seek alternative renewable energy sources – and reduce related emissions. CATEE is hosted by the Energy Systems Laboratory (ESL) of the Texas A&M Engineering Experiment Station (TEES).
The following pages are conference program and list of sponsors from the CATEE 2016.

CATEE 2016 Program

Monday, Dec. 19 – Pre-Conference Workshops	
9:00am – 12:00pm	Continuous Commissioning® Workshop – Hosted by Texas A&M Energy Systems Laboratory • *The trademarked Continuous Commissioning® (CC®) process, developed by the ESL, focuses on the optimization of public, commercial, and institutional building operations. The CC® process has been implemented in hundreds of buildings around the world in various climates.*
	Solar for Local and State Governments Workshop – Sponsored by Performance Services • *A plain English discussion about solar energy for government, business leaders and owners, fire & code officials, energy engineers & managers .. and others.*
1:00pm – 4:00pm	ERI, IC3, and IECC 2015 Workshop – Hosted by Texas A&M Energy Systems Laboratory • *This workshop provides a detailed overview into the use of the IC3 calculator to demonstrate compliance with the 2015 International Energy Conservation Code.*
	Energy Efficiency Workshop for Local Government – Sponsored by McKinstry • *This workshop will provide city, county administrators, facility managers, energy managers and other public sector officials with some of the latest strategies, methodologies, and benchmarks that lead* towards a "best-in-class" 2020 Vision for local government facilities.
	Solar Tour – Mission Solar and Alamo 1 Solar Farm & Grid Storage Battery
Tuesday, Dec. 20 – Day One of Conference	
7:00am	Registration & Information Desk Open
8:00am – 6:30pm	**Expo Arena Open**
8:30am – 10:00am	**CATEE 2016 Opening General Session** • Welcome – *Betin Santos, CATEE Executive Director* • Welcome – *City of San Antonio, Invited* • Host Utility – *Ricardo Luna, CPS Energy* • Opening Keynote: When Making a Difference, Really Makes a Difference – *John Tooley, Advanced Energy*
10:00am – 10:30am	Networking Break
10:30am – 11:45pm	**Concurrent Breakout Sessions:**
	Emerging Technologies Showcase – *Panel Chair: Eddy Trevino, SECO* • UTSA Flow Battery Testing and Demonstration Project – *Dr. Juan Gomez, UTSA-TSERI*

	• 1MW Grid-Scale Solar Storage Project – *Byungwook Lee, OCI Solar* • Geothermal Power and Desalination – *James Jackson, Thermal Energy Partners LLC*
10:30am – 11:45pm	**Energy and Water – Two Sides of the Same Coin** – *Panel Chair: Kate Zerrenner, EDF* • Why Does the Energy-Water Nexus Matter? – *Kate Zerrenner* • Data-driven Insights on Customer Water Use – *Brewster McCracken, Pecan Street Inc.* • Water/Energy Resources – *Karen Guz, San Antonio Water System (SAWs)* • *CPS Energy's Generation Strategy – Municipal Utility Perspective – Kim Stoker, CPS Energy*
	Overview of Renewable Energy in Texas – *Panel Chair: Melissa Miller, President, TREIA* • Overview of Wind Energy in Texas – *Susan Sloan, American Wind Energy Association* • Overview of Solar Energy in Texas – Texas Solar Market Update – *Charlie Hemmeline, Texas Solar Power Association* • Overview of Geothermal Energy in Texas – Geothermal Technology and Spotlight Projects – *Dustin Gregoire, Bosch Thermotechnology* • Overview of Energy from Landfill Gas in Texas – *Paul Pabor, Waste Management*
11:45pm – 1:00pm	**Lunch Presentation – State of the State** • SECO Update – *Dub Taylor, State Energy Conservation Office (SECO)* • State of the State – *Dr. Jeff Haberl, Energy Systems Laboratory, TEES & College of Architecture, TAMU*
1:00pm – 2:15pm	**Concurrent Breakout Sessions:**
	Regional and Community Programs – *Panel Chair: Nicholas Jones, AACOG* • SA Tomorrow Sustainability Plan: A Vision for a Sustainable San Antonio – *Doug Melnick, City of San Antonio* • Austin Energy's Energy Efficiency Programs – *Denise Kuehn, Austin Energy* • 2030 Districts in Texas – *Elizabeth Kertesz, SPEER* • SECO Regional Benchmarking Tool – *Jennifer Ronk, HARC*
	Texas Energy Manager's Association: Defining Sustainability to Develop a Sustainability Management – *Panel Chair: Ashley Williams, City of Temple* • Paul Buckner, *Bryan ISD* • Paul Raabe, *Northeast ISD* • Keith Ordeneaux, *City of Pearland & Pearland ISD*
	Utility Perspectives on Renewable Energy – *Panel Chair: Steve Wiese, Frontier Associates* • Transmission and Distribution Utilities and Retail Electricity Providers – Solar Costs, Incentives, and Trends – *Steve Wiese, Frontier Associates* • The Perspective of an Electric Cooperative on Renewable Energy – *Ingmar Sterzing, Pedernales Electric Cooperative*

	• Municipal Utilities' Engagement with Renewable Energy – Georgetown Utility Systems – *Chris Foster, Georgetown Utilities Systems* • Municipal Utilities' Engagement with Renewable Energy – Austin Energy – *Danielle Murray, Austin Energy*
2:15pm – 2:45pm	Networking Break
2:45pm – 4:00pm	**Concurrent Breakout Sessions:**
	Central Texas Corridor – *Panel Chair: Ana Sandoval, Air and Health Collaborative of San Antonio* • Andrew Hoekzema, *CAPCOG* • Allie Blazosky, *Alamo Area MPO* • Mario Bravo, *EDF* • Nicholas Jones, *Clean Cities, AACOG*
	Research and Compliance Tools for Energy Codes – *Panel Chair: Fred Yebra, SECO* • Introduction of the TX A&M IC3 Energy Code Compliance Tool & Other Code Compliance Tools – *Shirley Ellis, Energy Systems Laboratory* • Texas Field Study – Implementing Targeted Education and Outreach – *Richard Morgan, SPEER*
	Distributed Use of Solar Energy: Multiple Perspectives – *Panel Chair: Ross Pumfrey. Texas Solar Energy Society* • Rooftop Solar – An Installer Perspective – *D.J. Rosebaugh, Lighthouse Solar* • Community Solar in Texas – Current State of the State – *Lori Clark, Principal Air Quality Planner, NCTCOG* • Municipal Utility Case Study – *Shannon M. Wagner, CPS Energy* • SolSmart Designation and Soft Cost Reduction Strategies – *Chad Laurent, Meister Consultant Groups, Inc.*
4:00pm – 4:15pm	Networking Break
4:15pm – 5:30pm	**Clean Air Act Policy and Legislative Panel** – *Panel Chair: Cyrus Reed, Ph.D., Conservation Director, The Sierra Club, Lone Star Chapter* • Councilman Ron Nirenberg, *City of San Antonio* • Senator Menendez, Invited • Andrew Hoekzema, CAPCOG
5:30pm – 7:30pm	CATEE Welcome Reception – Sponsored by METCO Engineering
Wednesday, Dec. 21 – Day Two of Conference	
8:00am	Registration & Information Desk Open
8:00am – 2:30pm	Expo Arena Open
9:00am – 10:30am	**Energy Efficient & Sustainable Airport Facilities** – *Panel Chair: Dr. Morad Atif, Texas A&M University* • **Houston Airport's IAH Initiatives Project** – *Robert Barker, City of Houston, Houston Airport System* • **Benchmarking and Profiling Airport Terminal Energy End Uses** – *Juan-Carlos Baltazar, Texas A&M University* • **Toronto Pearson Airport** – *Ronak Patel, Greater Toronto Airport Authority (GTAA)*
10:30am – 11:00am	Networking Break

11:00am – 12:00pm	**Concurrent Breakout Sessions:**
	Malcolm Verdict Memorial Student Poster Session – *Poster Session Chair: Dr. Jeff Haberl, Energy Systems Laboratory*
	Energy Efficiency for Education Facilities – *Panel Chair: Dr. Gavin Dillingham, HARC* • **Energy Management at Alamo Colleges** – *John Strybos, Alamo Colleges* • **History of Energy Management at Judson ISD,** *David Oehler and Marcelo Jimenez, Judson ISD* • **When Hail Breaks Loose** – *Marcia Coker, Wylie ISD*
12:00pm – 1:30pm	**CATEE Awards Luncheon** • **Luncheon Keynote: International & National Perspective on Energy Efficiency and Clean Air in Buildings** – *Dr. Morad Atif, Architectural Engineering, TAMU* • **CATEE & Poster Awards** – *Betin Santos*
1:30pm – 2:45pm	**Concurrent Breakout Sessions:**
	Texas Metro Area Roundtable: Energy Initiatives and Ozone Attainment/Maintenance Efforts – *Panel Chair: Tamara Cook and Lori Clark, NCTCOG* • Nicholas Jones, AACOG • Andrew Hoekzema, CAPCOG • Shelley Whitworth, HGAC
	Industrial Energy Efficiency Efforts – *Panel Chair: Erik Fowler, SPEER* • **Tracking the Multiple Benefits of Industrial Energy Efficiency** – *Dr. Bryan Rasmussen, ESL* • **Industrial Energy Efficiency and Combined Heat and Power** – *Jennifer Ronk, HAR***C** • **PACE: Financing for Efficiency Projects** – *Jonathon Blackburn, Texas PACE Authority*
2:45pm	**Conference Adjourns**

6.4.4 Papers, Theses, etc.

6.4.4.1 Theses and Dissertations.

The following theses and dissertations were published in 2016 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Chunliu Mao, "Analysis of Building Peak Cooling Load Calculation Method for Commercial Buildings in The United States,"Phd., Department of Architecture, May 2016.

  In This study aims to provide valid comparisons of the peak cooling load methods that were published in the ASHRAE Handbook of Fundamentals, including the Heat Balance Method (HBM), the Radiant Time Series Method (RTSM), the Transfer Function Method (TFM), the Total Equivalent Temperature Difference/ Time Averaging Method (TETD/TA), and the Cooling Load Temperature Difference/Solar Cooling Load /Cooling Load Factor Method (CLTD/SCL/CLF), and propose a new procedure that could be adopted to update the SCL tables in the CLTD/SCL/CLF Method to make the results more accurate.

  To accomplish the peak cooling load method comparisons, three steps were taken.
  First, survey and phone interviews were performed on selected field professionals after an IRB approval was obtained. The results showed that the CLTD/SCL/CLF Method was the most popular method used by the HVAC design engineers in the field due to the reduced complexity of applying the method while still providing an acceptable cooling load prediction accuracy, compared to the other methods.

  Next, a base-case comparison analysis was performed using the published data provided with the ASHRAE RP-1117 report. The current study successfully reproduced the HBM results in the RP-1117 report. However, the RTSM cooling load calculation showed an over-prediction compared to the RTSM results in the report. In addition, analyses of the TFM, the TETD/TA Method and the CLTD/SCL/CLF Method were compared to the base-case cooling load. The comparisons showed the HBM provided the most accurate analysis compared to the measured data from the RP-1117 research project, and the RTSM performed the best among the simplified methods. The TFM estimated a value very close to the peak cooling load value compared to the RTSM. The CLTD/SCL/CLF Method behaved the worst among all methods.

  Finally, additional case studies were analyzed to further study the impact of fenestration area and glazing type on the peak cooling load. In these additional comparisons, the HBM was regarded as the baseline for comparison task. Beside the base case, fifteen additional cases were analyzed by assigning different window areas and glazing types. The results of the additional tests showed the RTSM performed well followed by the TFM. The TETD/TA Method behaved somewhere in between the TFM and CLTD/SCL/CLF Method. In a similar fashion as the base-case comparisons, the CLTD/SCL/CLF Method performed the worst among all methods.

6.4.4.2 Papers

6.4.4.2.1 Published Papers in 2016

The following papers were published in 2016 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Oh, S.; Haberl, J.S., 2016. "Origins of analysis methods used to design high-performance commercial buildings: Whole-building energy simulation." Science and Technology for the Built Environment.

  Many commercial buildings today do not perform the way they were simulated. One potential reason for this discrepancy is that designers using building energy simulation programs do not fully understand the analysis methods that the programs are based on and may therefore have unreasonable expectations about the actual system performance or energy use. Therefore, the purpose of this study is to trace the origins of the most widely used building energy simulation programs and the analysis methods of thermal envelope loads used in the software to analyze high-performance commercial buildings in the United States. Such an analysis is important to better understand the capabilities of building energy simulation programs so they can be used more accurately to simulate the performance of an intended design. In this study, a new comprehensive genealogy chart was developed to support the explanations for the origins of the analysis methods of thermal envelope loads used in whole-building energy simulation programs. Two other works explained the origins of the analysis methods of solar photovoltaic, solar thermal, passive solar, and daylighting simulation programs.

  Link:
  http://www.tandfonline.com/doi/full/10.1080/23744731.2015.1063958?scroll=top&needAccess=true&

- Oh, S.; Haberl, J.S., 2016. "Origins of analysis methods used to design high-performance commercial buildings: Daylighting Simulation." Science and Technology for the Built Environment.

  This study presents a review of the origins of the analysis methods used to design high-performance commercial buildings. This study includes the origins of the analysis methods used in daylighting analysis software developed in the United States. The analysis of this study can help readers better understand and identify the analysis methods used in daylighting simulation programs. In other works, the origins of the analysis methods of whole-building energy and solar energy analysis software were reviewed.

  Link: http://www.tandfonline.com/doi/full/10.1080/23744731.2015.1090278

- Oh, S.; Haberl, J.S., 2016. "Origins of analysis methods used to design high-performance commercial buildings: Solar energy analysis." Science and Technology for the Built Environment.

  This study reviews the origins of the analysis methods used to design high-performance commercial buildings. This study focuses on the origins of the analysis methods used in solar thermal, passive solar, and solar photovoltaic analysis software, developed in the United States and Canada, using a new comprehensive genealogy chart. This historical analysis is important because it gives readers a better understanding of the fundamentals of the analysis methods. The origins of the analysis methods of whole-building energy and daylighting simulation programs were reviewed in other works.

  Link: http://www.tandfonline.com/doi/full/10.1080/23744731.2015.1090277

- Do, S.L.; Haberl, J.S. ,2016. " Development and validation of a custom-built ground heat exchanger model for a case study building." Energy and Buildings.

  Use of a ground-source heat pump (GSHP) system is becoming widespread in energy savings applications. A typical GSHP system is equipped with one of three ground heat exchanger (GHX) configurations: vertical, horizontal, or surface-water. Due to site characteristics/limitations, however, some residential/commercial buildings utilize a combination of different GHX configurations for their GSHP systems; in this research, we will refer to such a system as a custom-built GHX. A residential building utilizing a custom-built GHX combining two different GHX types (horizontal and surface-water) was selected to be the case study for this research. This research developed a custom-built GHX model to calculate the entering water temperatures (EWTs) circulated from the custom-built GHX to the GSHP system. In order to validate the developed model, the measured EWTs from the case-study house were referenced and compared to the calculated EWTs. The comparison showed that the average EWT differences resulted in about 1.2 °C (2.1 °F) and 1.6 °C (2.8 °F) for the full heating and cooling seasons, respectively.

  Link: http://www.sciencedirect.com/science/article/pii/S0378778816302031

- Kim, H., Oldham, E., Haberl, J., 2016. "Field Investigation of Occupancy-Based Climate Control Technology: IEQ Performance during the Cooling Season", Indoor Air 2016.

  Link: http://www.indoorair2016.org/

- Do, S.L.; Haberl, J.S. ,2016. " Development procedure of an air-source heat pump base-case simulation model for a code-compliant residential building." Energy and Buildings.

  Computer simulation is widely used for analyzing building energy performance. A building simulation model is often verified by comparing the simulation results of the same building using different simulation programs, and thus developing a same building simulation model for different programs is inevitable for the comparative verification. This study proposed a step-by-step input parameter change procedure to develop a residential building model that complies with the 2009 International Energy Conservation Code (IECC). By implementing the procedure, this study developed the code-compliant residential air-source heat pump base-case model using two whole-building simulation programs: DOE-2.1e and eQUEST. The simulation results from DOE-2.1e and eQUEST at each step in the procedure were compared. To evaluate the accuracy and comparability of the final base-case model developed with the procedure, this study compared the simulation results of the same base-case model using Residential Energy Services Network (RESNET) accredited programs. The comparison showed that the differences in the annual total site energy use among the simulation programs were well-matched within 4.7%.

  Link: http://www.sciencedirect.com/science/article/pii/S0378778815301900

- Chen, W.J., Claridge, D., Liao, J., 2016. "Modeling to Predict Positive Pressurization Required to Control Mold Growth from Infiltration in Buildings in a Hot and Humid Climate", Building and Environment.

  Commercial buildings in humid regions of the United State are generally designed to operate at a positive pressure to limit mold growth, material deterioration and other condensation related problems from infiltration in hot and humid climates. This paper combines existing models of infiltration and mold growth to predict the influence of pressurization level on the risk of mold growth. Walls are treated differently depending on their height and the direction they face. Local weather data are utilized

to generate the outside pressure field. Temperature measurements performed on an actual building are applied to a multi-layer envelope temperature prediction model, used to simulate the performance of three different envelope constructions. Annual change in mold index is calculated for three humid locations for one construction type and for two other construction types in one location. The simulated results indicate that for a 22 °C indoor temperature set-point, 3 m high walls facing all directions in an unpressurized building in College Station, TX, will experience an annual increase in mold index. However, 1.5 Pa positive pressurization results in a negative annual change in mold index for all walls that should theoretically eliminate the long-term risk of an increasing mold index on all walls. The model also indicates that only 1 Pa pressurization is required to produce negative annual change in mold index if the same building is moved to Fort Worth, TX and no pressurization is required in Atlanta, GA with a 22 °C indoor temperature set-point.

Link: http://www.sciencedirect.com/science/article/pii/S0360132316301536

- Gangisetti, K., Claridge, D., Srebric, J., Paulus, M., 2016. "Influence of Reduced VAV Flow Settings on Indoor Thermal Comfort in an Office Space", Building Simulation.

  The air temperature distribution in a space with reduced diffuser flow rates and heat loads was studied using simulation. Computational fluid dynamics (CFD) was used to analyze the room air distribution from a side wall diffuser at the design flow rate, and the results were validated with experimental data. CFD was used to predict occupant discomfort under a range of reduced diffuser flow rates. It was found for diffuser flow rates above 30% of the design flow rate that the temperature influence from the jet was minimal. At these flow rates, there was nearly a uniform temperature distribution in the occupied zone. The predicted maximum value of percentage of dissatisfied occupants within the space began to increase for diffuser flow rates below 30% of the design flow rate. The percent dissatisfaction at 1 m room height was greater than 25% for the lowest diffuser flow rate tested (15% of the design flow rate) directly under the diffuser, which was the highest of the test cases, but was 5% or less throughout more than 90% of the room. In contrast, at the higher flow rates, the percent dissatisfied index was 5% or less in only 60%–80% of the room due to increased velocity. Evidence of dumping was already found at the traditional minimum flow rate setting of 30% of design, and so there would be little harm in reducing the minimum flow rate further. Reducing the flow rate below 30% of design just moved the location of the dumping closer to the diffuser. For very low diffuser flow rates (below 30% of the design flow rate), it is recommended that desks be placed away from the supply diffuser to avoid discomfort. Overall, the simulation results indicate that uniform temperatures are maintained in the room at flow rates as low as 15% of design except immediately under the diffuser. This suggests that the VAV minimum flow rates can be set below 30% of design flow as long as the diffuser is at least 1 m from an occupant's position.

  Link: https://link.springer.com/article/10.1007/s12273-015-0254-3

6.5 Solar Test Bench (STB)

This section introduces the activities that were carried out using the Solar Test Bench (STB) during the calendar year of 2016, and the activities summary is listed as follow:

- Regular maintenance
- Weekly report.

6.5.1 Solar Test Bench Setup

Figure 44 shows the exterior view of the STB. In addition, the whole STB setup comprises the sensors indicated in Table 32, which includes the sensor name, make, model and serial number along with the multiplier, offset and unit.

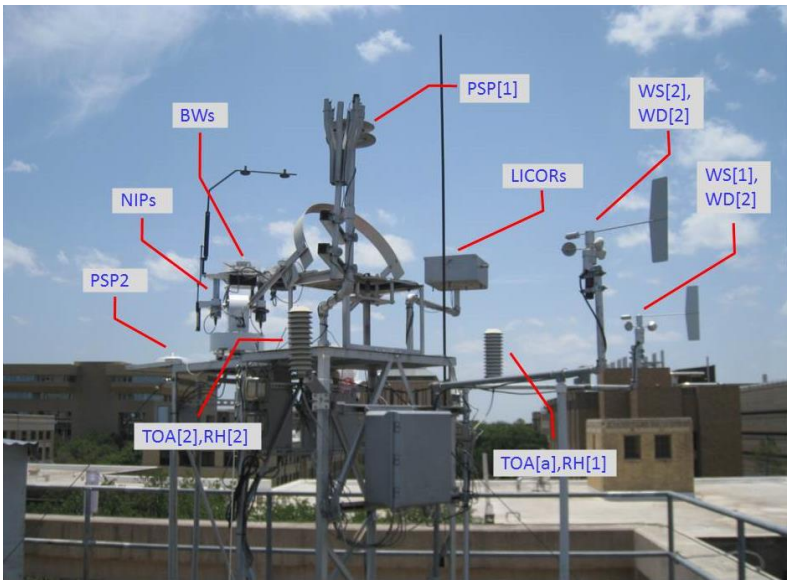


Figure 44. Exterior View of the Solar Test Bench

Table 32. List of the sensors updated to the end of 2016

Index Number	Sensor Name	Make	Model	Serial Number	Multiplier	Offset	Unit
1	TOA/RH[1]	Vaisala	HMP45A	D2430006	0.18 0.10	-40 NA	° F %
2	TOA/RH[2]	Vaisala	HMP155A	G3220004	0.18 0.10	-40 NA	° F %
3	WS/WD[1]	Met One	034B	H4735	1.79 712	0.629 NA	MPH Degree
4	WS/WD[2]	Met One	034B	M5048	1.79 712	0.629 NA	MPH Degree
5	LICOR[3]	Licor	Li-cor	PY15L25	75.59	NA	W/m^2
6	LICOR[4]	Licor	Li-cor	PY49745	75.03	NA	W/m^2
7	LICOR[5]	Licor	Li-cor	PY 74409	200	NA	W/m^2
8	LICOR[6]	Licor	Li-cor	PY 74438	200	NA	W/m^2
9	LICOR[7]	Licor	Li-cor	PY 74439	200	NA	W/m^2
10	LICOR[8]	Licor	Li-cor	PY 474450	200	NA	W/m^2
11	PSP[1]	Eppley	PSP	13673F3	125.63	NA	W/m^2
12	PSP[2]	Eppley	PSP	16881F3	103.09	NA	W/m^2
13	PSP[3]	Eppley	PSP	35417F3	112.74	NA	W/m^2
14	NIP[1]	Eppley	NIP	14851E6	118.06	NA	W/m^2
15	NIP[2]	Eppley	NIP	16620E6	117.79	NA	W/m^2
16	BW[1]	Eppley	8-48	20226	96.99	NA	W/m^2
17	BW[2]	Eppley	8-48	33886	98.62	NA	W/m^2

6.5.2 2016 STB Activities

6.5.2.1 Regular Maintenance

The solar test bench regular maintenance is carried out every two weeks, the desiccants for PSPs, B&Ws and the junction boxes are replaced, and the used one are recycled. The alignment for the solar tracker and the covers for the B&Ws are checked, and the occurred problems were fixed by restarting the solar tracker and manually adjusting the devices. The sensor wiring connections are checked and fixed as needed.

6.5.2.2 Weekly Report

The data logger downloaded data have been checked every week, and the STB data was compared with NOAA data in STB weekly report. Figure 45 shows the example plots comparing the STB data with the NOAA data.

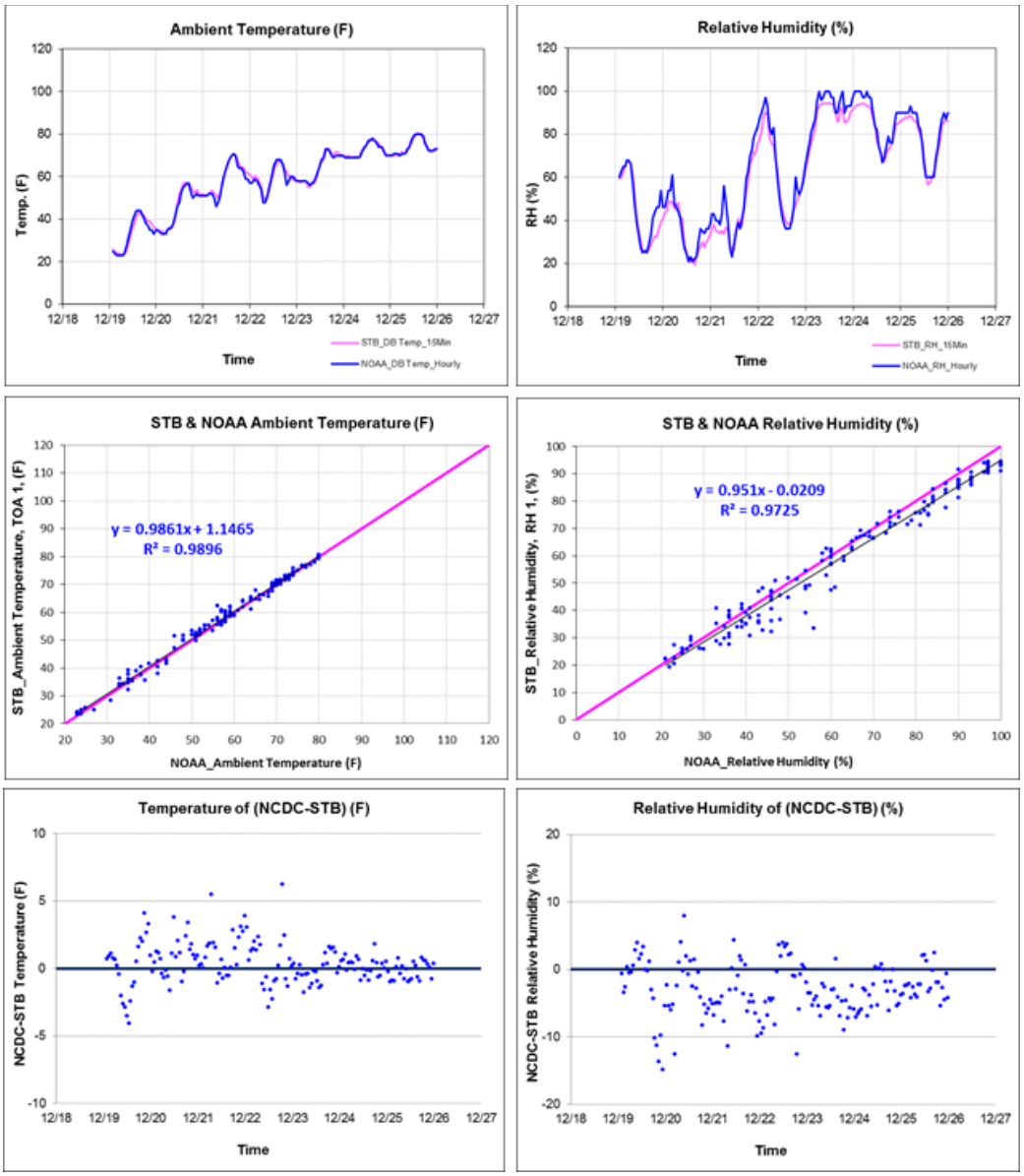


Figure 45: Comparisons of the STB Data with the NOAA Data

6.5.3 Future work Plan

6.5.3.1 Camera Installation

It is required to install a monitoring camera close enough for clear observation of the solar tracker, but avoiding any shading on the bench.

6.5.3.2 Wire Protection in Mechanical Room

In the mechanical room, some wires were outside the junction boxes. It is still necessary to install conduits for wires.

6.5.4 Acknowledgements

This task could not be completed without the help of many students/staffs among another Mr. Sukjoon Oh, Mr. Minjae Shin, Mr. Farshad Kheiri, Mr. Sungkyun Jung, Ms. Qinbo Li, from ESL, TAMU.

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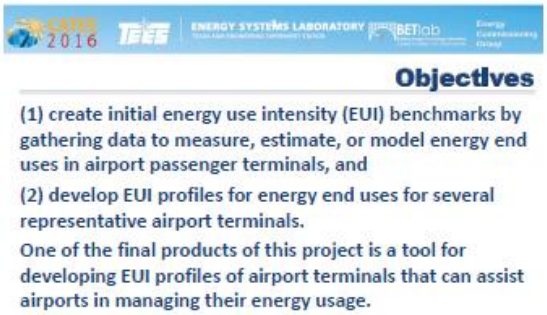
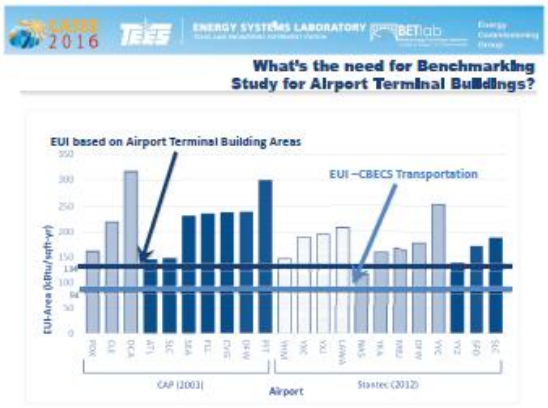
Appendix: Presentations to Various Entities at Conferences and Workshops in 2016

The Energy Systems Laboratory made presentations at several conferences and workshops about ways to save energy, and the appendix shows the presentation slides.

- "Benchmarking and Profiling Airport Terminal Energy End Uses", CATEE conference San Antonio, TX Dec 2016, presented by Juan-Carlos Baltazar.

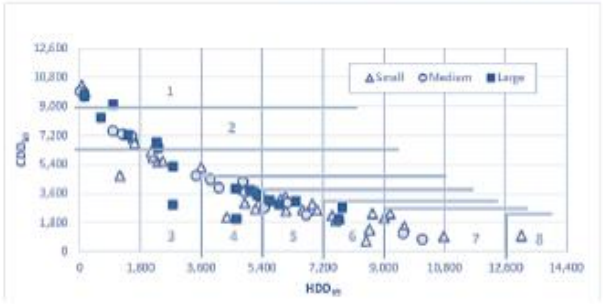




Participating Sample of Airport Terminal Buildings (ATBs)

Participating Sample of Airport Terminal Buildings (ATBs)

Participating Sample of Airport Terminal Buildings (ATBs)



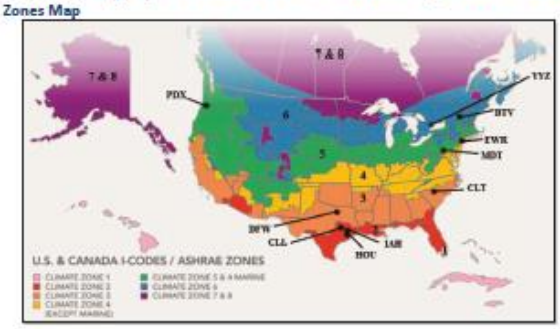
Participating Sample of Airport Terminal Buildings (ATBs)

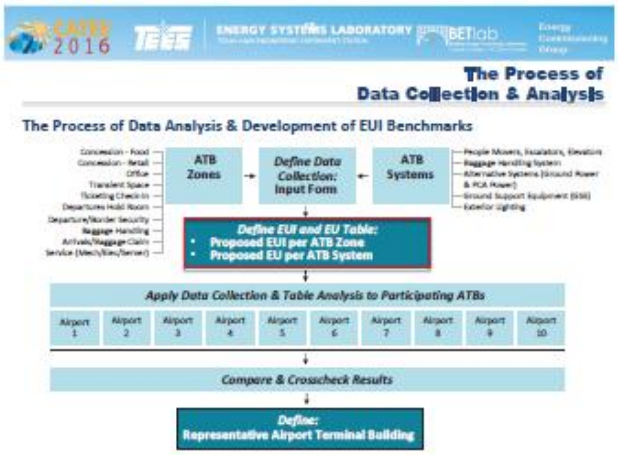
Participating Sample of Airport Terminal Buildings (ATBs)

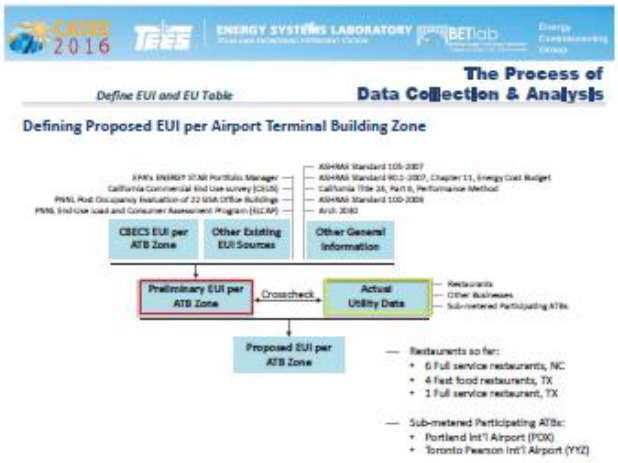
Airport Name	Code	City	State/ Province	Airport Size	Climate Zone
George Bush Int'ctl Airport	IAH	Houston	TX	L	2
William P. Hobby Airport	HOU	Houston	TX	M	2
Easterwood Airport	CLL	College Station	TX	Noshub	2
Charlotte Douglas International Airport	CLT	Charlotte	NC	L	3
Dallas/Fort Worth International Airport	DFW	Dallas/Fort Worth	TX	L	3
Newark Liberty International Airport	EWR	Newark	NJ	L	4
Portland International Airport	PDX	Portland	OR	M	4
Harrisburg International Airport	MDT	Middletown	PA	S	5
Toronto Pearson International Airport	YYZ	Mississauga	Ontario-Canada	L	6
Burlington International Airport	BTV	Burlington	VT	S	6

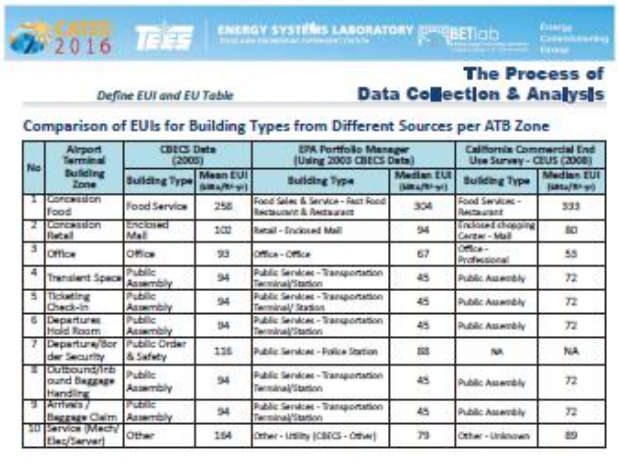
Participating Sample of Airport Terminal Buildings (ATBs)

The Participating Airports Identified on U.S & Canada I-Codes / ASHRAE Climate Zones Map

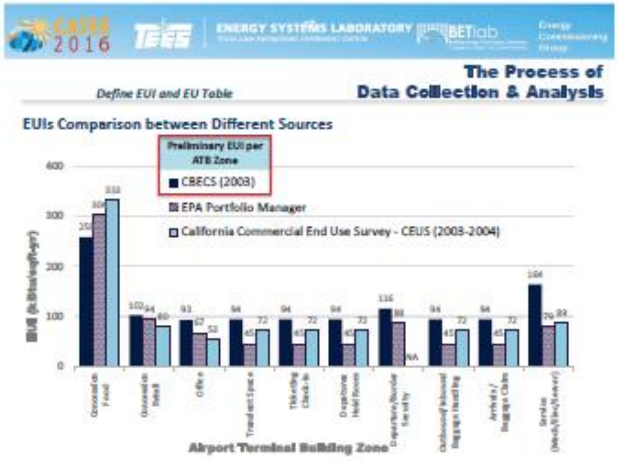








No	Airport Terminal Building Zone	CBECS Data (2003)		EPA Portfolio Manager (Using 2003 CBECS Data)		California Commercial End Use Survey - CEUS (2008)	
		Building Type	Mean EUI (kBtu/ft²-yr)	Building Type	Median EUI (kBtu/ft²-yr)	Building Type	Median EUI (kBtu/ft²-yr)
1	Concession Food	Food Service	258	Food Sales & Service - Fast Food Restaurant & Restaurant	304	Food Service - Restaurant	333
2	Concession Retail	Enclosed Mall	102	Retail - Enclosed Mall	94	Enclosed shopping Center - Mall	80
3	Office	Office	93	Office - Office	67	Office - Professional	53
4	Transient Space	Public Assembly	94	Public Services - Transportation Terminal/Station	45	Public Assembly	72
5	Ticketing Check-in	Public Assembly	94	Public Services - Transportation Terminal/ Station	45	Public Assembly	72
6	Departures Hold Room	Public Assembly	94	Public Services - Transportation Terminal/Station	45	Public Assembly	72
7	Departure/Border Security	Public Order & Safety	116	Public Services - Police Station	88	NA	NA
8	Outbound/Inbound Baggage Handling	Public Assembly	94	Public Services - Transportation Terminal/Station	45	Public Assembly	72
9	Arrivals / Baggage Claim	Public Assembly	94	Public Services - Transportation Terminal/Station	45	Public Assembly	72
10	Service (Mech/ Elec/Server)	Other	164	Other - Utility (CBECS - Other)	79	Other - Unknown	89



Define EUI and EU Table

The Process of Data Collection & Analysis

$$EUI_{ATB,\ total}\ (kBtu/sqft\text{-}yr) = EUI_{all\ ATB\ Zones,\ total}\ (kBtu/sqft\text{-}yr) + EU_{all\text{-}systems,\ total}\ (kBtu/yr) / \text{Terminal Gross Area (sqft)}$$

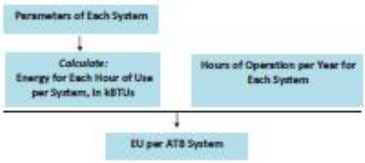
ATB EUI Table

		Airport Terminal Building (ATB) Zones / Systems	Proposed EUI per Zone (kBtu/sqft-yr)	Floor Area (sqft)	Energy Use (kBtu/yr)	Total Energy Use Index (kBtu/sqft-yr)
ATB Zones	1	Concession - Food	250.0			
	2	Concession - Retail	75.0			
	3	Office	82.0			
	4	Transient Space	90.0			
	5	Ticketing/ Check-in	90.0			
	6	Departures Hold Room	90.0			
	7	Departures/Border Security	113.0			
	8	Outbound/Inbound Baggage Handling	90.0			
	9	Arrivals/Baggage Claim	90.0			
	10	Service (Maint/Gas/Servers)	164.0			
		Subtotal for all ATB Zones				
ATB Systems	11	People Movers, Escalators, Elevators				
	12	Baggage Handling Systems				
	13	Alternative Systems (Ground Power & PCA Power)				
	14	Airport Ground Support Equipment (GSE) Electricity Use				
	15	External Lighting, Parking Lighting				
		Subtotal for all ATB Systems				
		Total for ATB Zones & Systems				
		Total for ATB based on Utility Bills				

Define EUI and EU Table

The Process of Data Collection & Analysis

Defining EU per Airport Terminal Building System

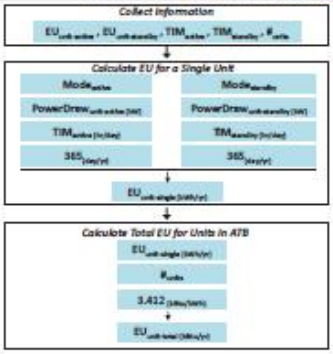


$$EU_{all\text{-}systems,\ total} = EU_{escalator\text{-}total} + EU_{people\text{-}mover\text{-}total} + EU_{baggage\ handling\text{-}total} + EU_{elevator\text{-}total} + EU_{alternative\ systems\text{-}total} + EU_{ground\ support\ equipment\text{-}total} + EU_{exterior\ lighting} + EU_{other}$$

Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU for Escalators, People Movers (Moving Walkways), and Baggage Handling Systems in ATB



Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU for Escalators in the ATB

$$EU_{escalator\text{-}total} = \{(EU_{escalator\text{-}active} \times TIM_{active} \times 365) + (EU_{escalator\text{-}standby} \times TIM_{standby} \times 365)\} \times \#_{units} \times 3.412$$

Where:

$EU_{escalator\text{-}total}$ = Annual electricity use of all units in the ATB (kBtu/yr),
$EU_{escalator\text{-}active}$ = Power Draw per Unit in mode; active (kW),
TIM_{active} = Time in mode; active (hr/day),
$EU_{escalator\text{-}standby}$ = Power Draw per Unit in mode; standby (kW),
$TIM_{standby}$ = Time in mode; standby (hr/day),
$\#_{units}$ = Number of Escalators in Airport Terminal Building.
1 kWh = 3.412 kBtu

Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU for People Movers in the ATB

$$EU_{people\ mover\text{-}total} = \{(EU_{people\ mover\text{-}active} \times TIM_{active} \times 365) + (EU_{people\ mover\text{-}standby} \times TIM_{standby} \times 365)\} \times \#_{units} \times 3.412$$

Where:

$EU_{people\ mover\text{-}total}$ = Annual electricity use of all units in the ATB (kBtu/yr),
$EU_{people\ mover\text{-}active}$ = Power Draw per Unit in mode; active (kW),
TIM_{active} = Time in mode; active (hr/day),
$EU_{people\ mover\text{-}standby}$ = Power Draw per Unit in mode; standby (kW),
$TIM_{standby}$ = Time in mode; standby (hr/day),
$\#_{units}$ = Number of Units in Airport Terminal Building.
1 kWh = 3.412 kBtu

Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU for Baggage Handling Systems in the ATB

$$EU_{baggage\ handling\text{-}total} = \{(EU_{baggage\ handling\text{-}active} \times TIM_{active} \times 365) + (EU_{baggage\ handling\text{-}standby} \times TIM_{standby} \times 365)\} \times \#_{units} \times 3.412$$

Where:

$EU_{baggage\ handling\text{-}total}$ = Annual electricity use of all units in the ATB (kBtu/yr),
$EU_{baggage\ handling\text{-}active}$ = Power Draw per Unit in mode; active (kW),
TIM_{active} = Time in mode; active (hr/day),
$EU_{baggage\ handling\text{-}standby}$ = Power Draw per Unit in mode; standby (kW),
$TIM_{standby}$ = Time in mode; standby (hr/day),
$\#_{units}$ = Number of Units in Airport Terminal Building.
1 kWh = 3.412 kBtu

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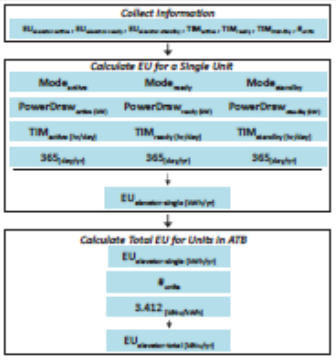
Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU for Elevators in ATB



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Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU for Elevators in ATB

$$EU_{elevator\text{-}total} = \{(EU_{elevator\text{-}active} \times TIM_{active} \times 365) + (EU_{elevator\text{-}ready} \times TIM_{ready} \times 365) + (EU_{elevator\text{-}standby} \times TIM_{standby} \times 365)\} \times \#_{units} \times 3.412$$

Where:

$EU_{elevator\text{-}total}$ = Annual electrical energy use of all elevators in the ATB (kBtu/yr),
$EU_{elevator\text{-}active}$ = Power Draw per Unit in mode; active (kW),
TIM_{active} = Time in mode; active (hr/day),
$EU_{elevator\text{-}ready}$ = Power Draw per Unit in mode; ready (kW),
TIM_{ready} = Time in mode; ready (hr/day),
$EU_{elevator\text{-}standby}$ = Power Draw per Unit in mode; standby (kW),
$TIM_{standby}$ = Time in mode; standby (hr/day),
$\#_{units}$ = Number of elevator Units in the ATB.
1 kWh = 3.412 kBtu

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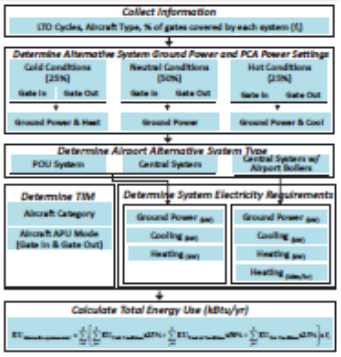
Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU of Alternative Systems in ATB



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Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU of Alternative Systems in ATB

$$EU_{Alternative\ systems\text{-}total} = \sum_{i=1}^{3}\left[\sum_{j=1}^{5} EU_{Cold\ Conditions} \times 25\% + \sum_{j=1}^{5} EU_{Neutral\ Conditions} \times 50\% + \sum_{j=1}^{5} EU_{Hot\ Conditions} \times 25\%\right] \times f_i$$

Where:

$EU_{Alternative\ systems\text{-}total}$ = Annual electrical EU of all Alternative System units in the ATB (kBtu/yr),
$EU_{Cold\ Conditions}$ = $EU_{ground\ power} + EU_{heating}$,
$EU_{Neutral\ Conditions}$ = $EU_{ground\ power}$,
$EU_{Hot\ Conditions}$ = $EU_{ground\ power} + EU_{cooling}$,
i = 1,2,3, representing three alternative system types, including POU system, Central system, and Central system with Airport Boilers,
j = 1,2,3,4,5, representing up to five aircraft types, including narrow body, wide body, jumbo-wide body, regional jet, and turbo prop,
f_i = Percentage of gates using this system to deliver ground power, heating and cooling.

$$EU_{Alternative\ systems\text{-}total} = \sum_{i=1}^{3}\left[\sum_{j=1}^{5} EU_{ground\ power} + \sum_{j=1}^{5} EU_{heating} \times 25\% + \sum_{j=1}^{5} EU_{cooling} \times 25\%\right] \times f_i$$

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Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU of Ground Support Equipment (GSE) in ATB

$$EU_{Ground\ Support\ Equipment} = \sum_{k=1}^{N}(GS \times TIM_{active} + EU_{Standby} \times TIM_{standby}) \times 365 \times 3.412$$

Where:

$EU_{Ground\ Support\ Equipment}$ = Annual energy use of the ground support equipment (kBtu/yr),
GS = Ground Support power (kW),
TIM_{active} = Time in mode, active (hr/day),
$EU_{Standby}$ = Electric power in standby mode (kW),
$TIM_{standby}$ = Time in mode, standby (hr/day),
k=1,2,...,N, representing N types of ground support equipment.

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Define EUI and EU Table

The Process of Data Collection & Analysis

Calculating Total Annual EU of Exterior Lighting

$$EU_{exterior\ lighting} = EU_{exposed\ lighting} + EU_{covered\ lighting}$$

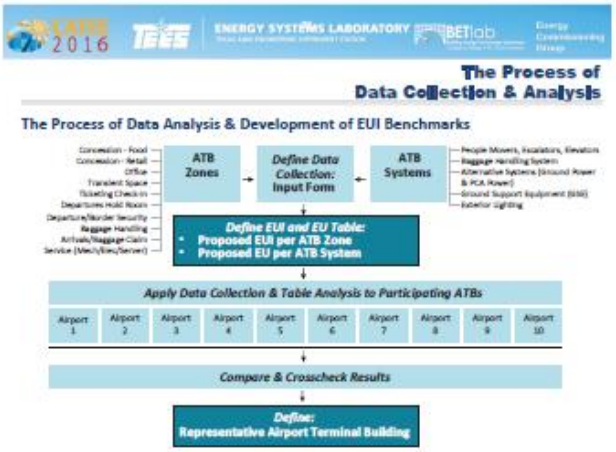
Where:

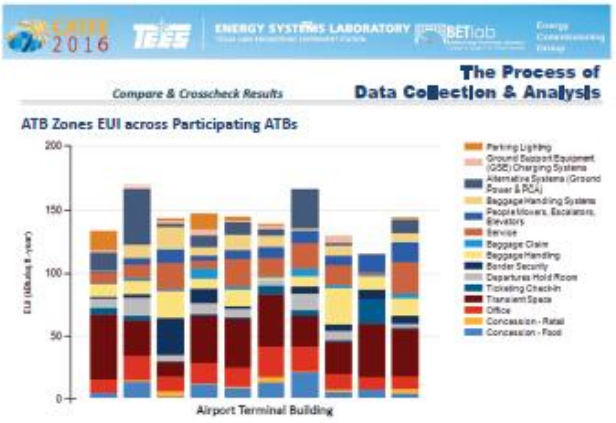
$EU_{exposed\ lighting}$ (kBtu) = (LPD/1000) x A ft^2 x 12 hr/day x 365 day/yr x 3.412 kBtu/kWh

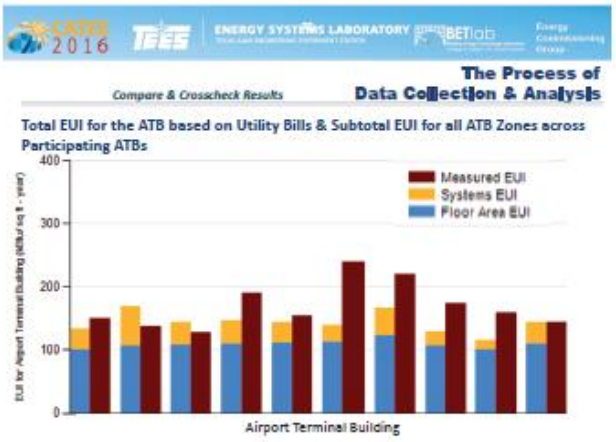
$EU_{covered\ lighting}$ (kBtu) = (LPD/1000) x A ft^2 x 24 hr/day x 365 day/yr x 3.412 kBtu/kWh

Where:

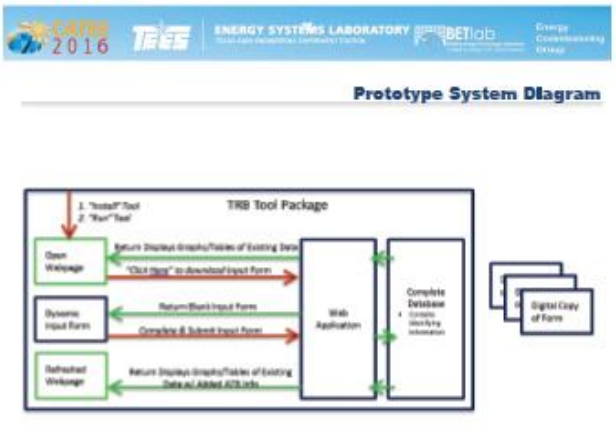
LPD = Lighting Power Density (W/ft^2),
A= Area illuminated (ft^2).


The Process of Data Collection & Analysis
The Process of Data Analysis & Development of EUI Benchmarks
ATB Zones
Define Data Collection: Input Form
ATB Systems
Define EUI and EU Table:
Proposed EUI per ATB Zone
Proposed EU per ATB System
Apply Data Collection & Table Analysis to Participating ATBs
Airport 1
Airport 2
Airport 3
Airport 4
Airport 5
Airport 6
Airport 7
Airport 8
Airport 9
Airport 10
Compare & Crosscheck Results
Define:
Representative Airport Terminal Building


Compare & Crosscheck Results
The Process of Data Collection & Analysis
ATB Zones EUI across Participating ATBs
Airport Terminal Building


Compare & Crosscheck Results
The Process of Data Collection & Analysis
Total EUI for the ATB based on Utility Bills & Subtotal EUI for all ATB Zones across Participating ATBs
Measured EUI
Systems EUI
Floor Area EUI
Airport Terminal Building


Benchmarking Tool
Airport Cooperative Research Program
Airport Terminal Building Energy Use Intensity (ATB-EUI) Benchmarking Tool


Prototype System Diagram
TRB Tool Package
Open Webpage
Systems Input Form
Refreshed Webpage
Web Application
Complete Database
Digital Copy of Form


Input Form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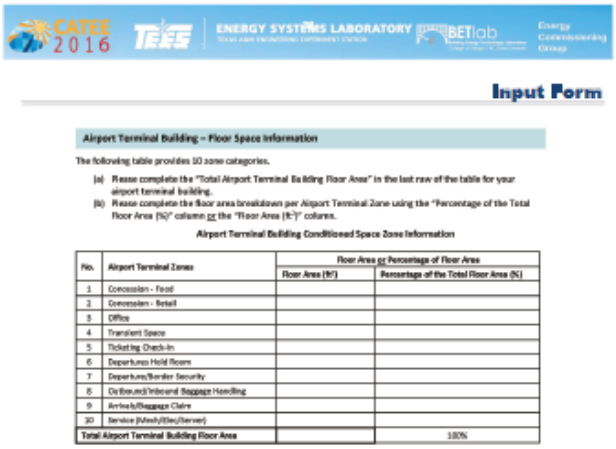
Input Form
Date of Survey: ___/___/____ Airport Name:_____ Airport Code:_____
Contact Information
Name: _____
Title: _____
Phone number: _____
Email: _____
Airport Terminal Building - General Information
Terminal name: _____
Terminal construction year: _____
Terminal renovation year: _____
No. of gates: _____
No. of floors: _____
Operating Hours: Weekdays: _____ a.m. to _____ p.m.
Weekends: _____ a.m. to _____ p.m.
Holidays: _____ a.m. to _____ p.m.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Input Form
Airport Terminal Building – Floor Space Information
The following table provides 10 zone categories.
(a) Please complete the "Total Airport Terminal Building Floor Area" in the last row of the table for your airport terminal building.
(b) Please complete the floor area breakdown per Airport Terminal Zone using the "Percentage of the Total Floor Area (%)" column or the "Floor Area (ft²)" column.
Airport Terminal Building Conditioned Space Zone Information
No.
Airport Terminal Zones
Floor Area or Percentage of Floor Area
Floor Area (ft²)
Percentage of the Total Floor Area (%)
1 Concession - Food
2 Concession - Retail
3 Office
4 Transient Space
5 Ticketing Check-in
6 Departures Hold Room
7 Departures/Border Security
8 Outbound/Inbound Baggage Handling
9 Arrivals/Baggage Claim
10 Service (Maint/Elec/Server)
Total Airport Terminal Building Floor Area
100%


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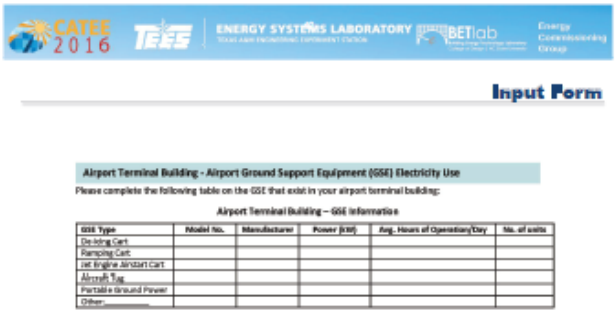
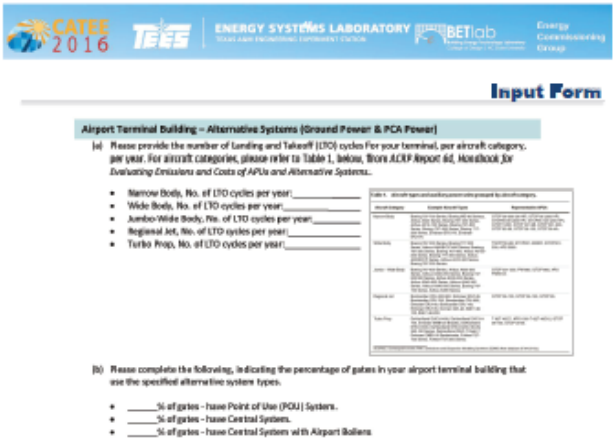
Energy Commissioning Group
Input Form
Airport Terminal Building - Mechanical Systems
Please complete the following tables on the mechanical systems that exist in your airport terminal building:
Airport Terminal Building - Baggage Handling Systems Information
Type
Model No.
Manufacturer
Power (kW)
Avg. Hours of Operation /Day
No. of Units
1
2
3
4
5
Airport Terminal Building - People Mover Systems Information
Type
Model No.
Manufacturer
Power (kW)
Avg. Hours of Operation /Day
No. of Units
1
2
3
4
5
Airport Terminal Building - Escalators Information
Type
Model No.
Manufacturer
Power (kW)
Avg. Hours of Operation /Day
No. of Units
1
2
3
4
5
Airport Terminal Building - Elevators Information
Type
Model No.
Manufacturer
Power (kW)
Avg. Hours of Operation /Day
No. of Units
1
2
3
4
5


CATEE 2016
ENERGY SYSTEMS LABORATORY
BETlab
Energy Commissioning Group
Input Form
Airport Terminal Building - Airport Ground Support Equipment (GSE) Electricity Use
Please complete the following table on the GSE that exist in your airport terminal building:
Airport Terminal Building – GSE Information
GSE Type
Model No.
Manufacturer
Power (kW)
Avg. Hours of Operation/Day
No. of units
De-Icing Cart
Ramping Cart
Jet Engine Jetstart Cart
Aircraft Tug
Portable Ground Power
Other: _____

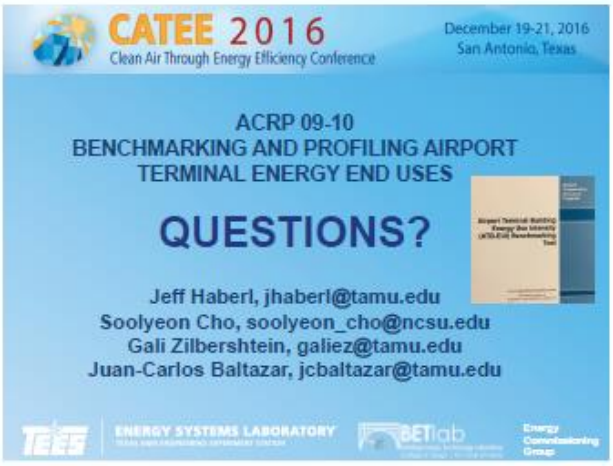

CATEE 2016
ENERGY SYSTEMS LABORATORY
BETlab
Energy Commissioning Group
Input Form
Airport Terminal Building – Alternative Systems (Ground Power & PCA Power)
(a) Please provide the number of Landing and Takeoff (LTO) cycles for your terminal, per aircraft category, per year. For aircraft categories, please refer to Table 1, below, from ACRP Report 66, Handbook for Evaluating Emissions and Costs of APUs and Alternative Systems.
Narrow Body, No. of LTO cycles per year: _____
Wide Body, No. of LTO cycles per year: _____
Jumbo-Wide Body, No. of LTO cycles per year: _____
Regional Jet, No. of LTO cycles per year: _____
Turbo Prop, No. of LTO cycles per year: _____
(b) Please complete the following, indicating the percentage of gates in your airport terminal building that use the specified alternative system types.
_____% of gates - have Point of Use (POU) Systems.
_____% of gates - have Central Systems.
_____% of gates - have Central Systems with Airport Boilers.


CATEE 2016
ENERGY SYSTEMS LABORATORY
BETlab
Energy Commissioning Group
Input Form
Airport Terminal Building - External Lighting / Parking Lighting
Is energy consumption of external lighting/parking lighting included in the airport terminal building utility bill?
☐ Yes ☐ No
If "Yes", please provide the following information: ☐ Covered illuminated area (ft²): _____
☐ None-covered illuminated area (ft²): _____
(i.e., open to the sky)


ENERGY SYSTEMS LABORATORY
Input Form
Airport Terminal Building - Performance and Utilities Information
Please provide 12-month metered utility data if available for the airport terminal building. If monthly utility information is not available, please provide the Total Annual energy use.
Airport Terminal Building – Utility Information
For the Period: _____(m/d/year-m/d/year)
Date of Utility Bill (m/d/year-m/d/year)
Electricity (kWh/month)
Natural Gas
Other: _____
1
2
3
4
5
6
7
8
9
10
11
12
Total Annual
Is monthly sub-metered utility data available for the airport terminal building?
☐ Yes ☐ No
If "Yes", please check all that apply:
☐ Electricity ☐ Natural gas ☐ Other (please specify): _____


ENERGY SYSTEMS LABORATORY
Benchmarking Tool


Airport Terminal Building Energy Use Intensity (ATB-EUI) Benchmarking Tool
Airport Cooperative Research Program


CATEE 2016
Clean Air Through Energy Efficiency Conference
December 19-21, 2016
San Antonio, Texas
ACRP 09-10
BENCHMARKING AND PROFILING AIRPORT TERMINAL ENERGY END USES
QUESTIONS?
Jeff Haberl, jhaberl@tamu.edu
Soolyeon Cho, soolyeon_cho@ncsu.edu
Gali Zilbershtein, galiez@tamu.edu
Juan-Carlos Baltazar, jcbaltazar@tamu.edu
ENERGY SYSTEMS LABORATORY

- "Introduction of the TX A&M IC3 Energy Code Compliance Tool and Other Code Compliance Tools" CATEE conference San Antonio, TX Dec 2016, presented by Shirley Ellis.

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

Introduction of the IC3 and Other Compliance Tools

Shirley Ellis
Energy Code Specialist

Agenda

- IC3 – What is it?
- IC3 – History
- Getting Started
- ERI Simulation Path
- Other Compliance Tools

IC3 – What is it?

- The International Code Compliant Calculator is a performance-based residential energy code compliance tool
- Publicly accessible energy code compliance software
- Based on the Texas Building Energy Performance Standards
- RESNET certified
  - Verification Procedures No. 07-003
- Satisfies the EPA guidelines
  - Demonstrates air quality improvements/emission reductions with adequate certainty

IC3 – History

- Created in response to the 77th Texas Legislature's Senate Bill 5 (2001)
- Assigned the ESL responsibilities
  - Calculation of emissions reduction
    - Energy efficiency
    - Renewable energy programs
  - Providing state-wide technical assistance
- Web-based energy efficiency and emissions reduction calculators
  - Texas Climate Vision (Austin, TX)
  - Legacy calculators
    - eCalc
    - AIM

User Login

Project List

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ERI SIMULATION PATH

ENERGY SYSTEMS LABORATORY

Testing

ENERGY SYSTEMS LABORATORY

Roof

ENERGY SYSTEMS LABORATORY

Foundation

ENERGY SYSTEMS LABORATORY

Heating

ENERGY SYSTEMS LABORATORY

A/C

ENERGY SYSTEMS LABORATORY

Water Heater

ENERGY SYSTEMS LABORATORY

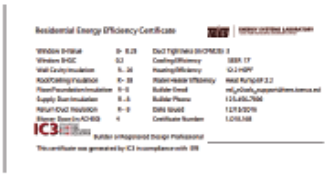
Appliance

ENERGY SYSTEMS LABORATORY

Project Results

ENERGY SYSTEMS LABORATORY

Certificate



ENERGY SYSTEMS LABORATORY

Energy Report

ENERGY SYSTEMS LABORATORY

Energy Report – Page 2

ENERGY SYSTEMS LABORATORY

Energy Report – Page 3

ENERGY SYSTEMS LABORATORY

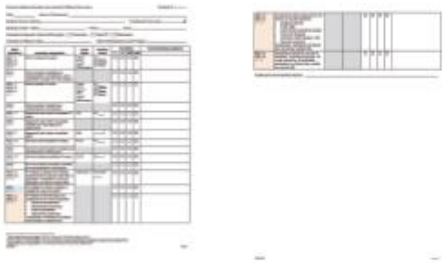
Inspection Report

ENERGY SYSTEMS LABORATORY

Inspection Report

ENERGY SYSTEMS LABORATORY

Inspection Report



ENERGY SYSTEMS LABORATORY

Inspection Report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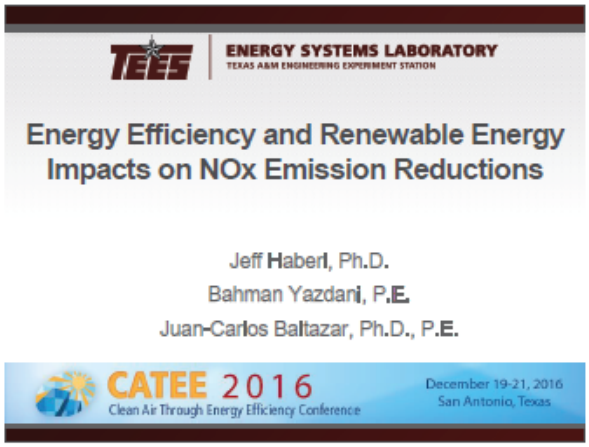
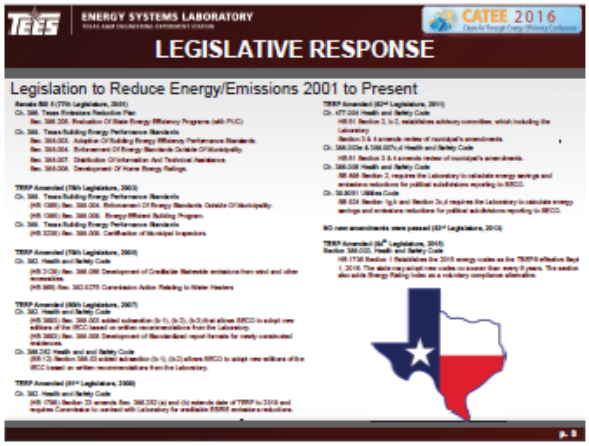
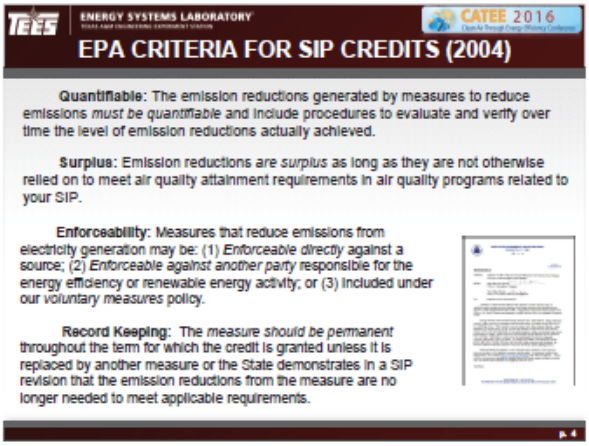
Other Software Tools – ERI
• Accredited Rating Software
– ANSI/RESNET/ICC 301-2014 Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index
• First published March 2014
• Repudiated January 2015
• Software Providers
– National Registry of Accredited Rating Software Programs www.resnet.us
– EnergyGauge, REM/Rate, Right-Energy HERS, Ekotrope, HERS Module, ICF International Beacon Residential

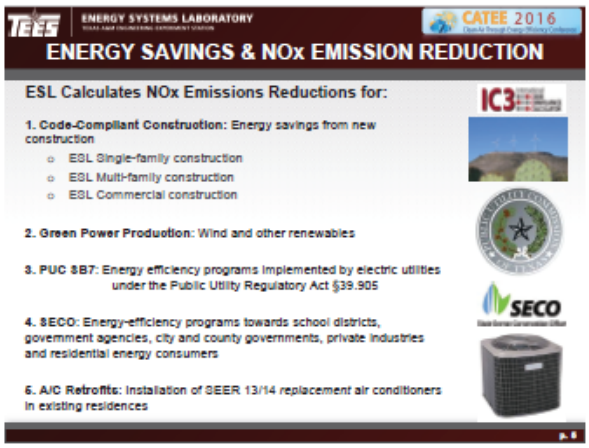

ENERGY SYSTEMS LABORATORY
Thank You
Patrick Parker
– Senior Software Applications Developer
– patparker@exchange.tamu.edu

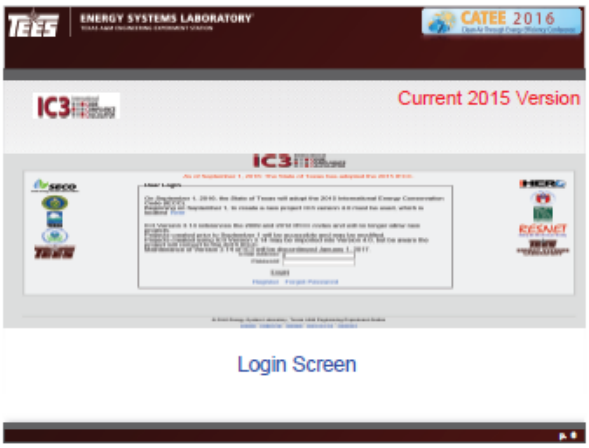
- "Energy Efficiency and Renewable Energy Impacts on Emission Reductions" CATEE conference San Antonio, TX Dec 2016, presented by Jeff Haberl.

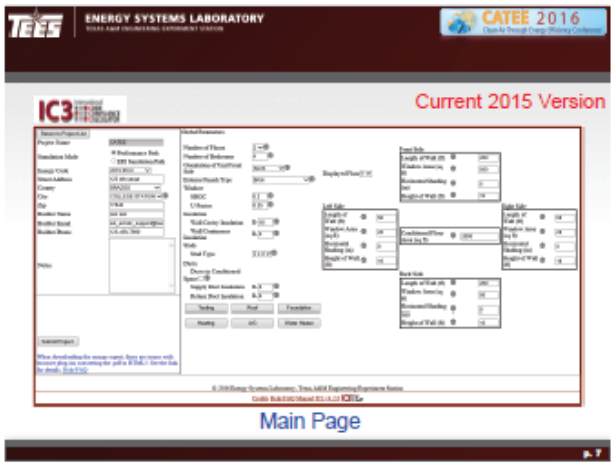


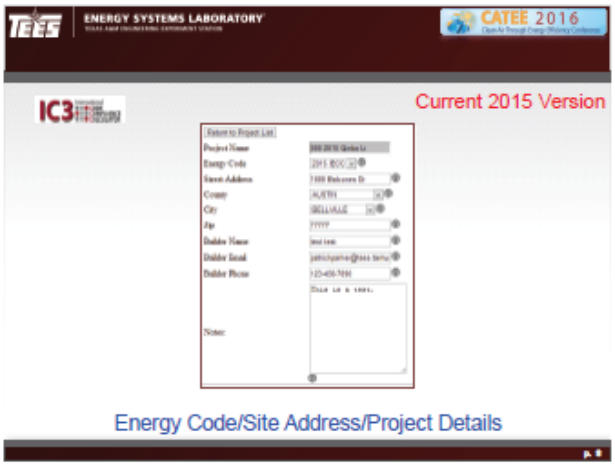


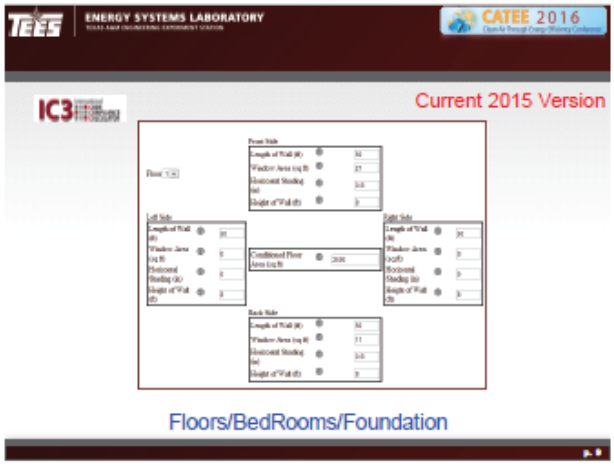




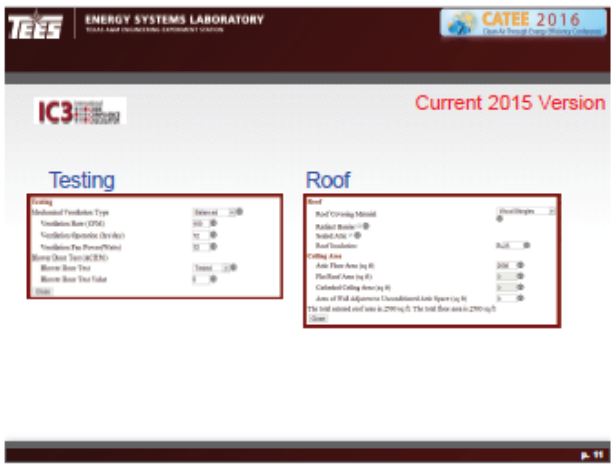


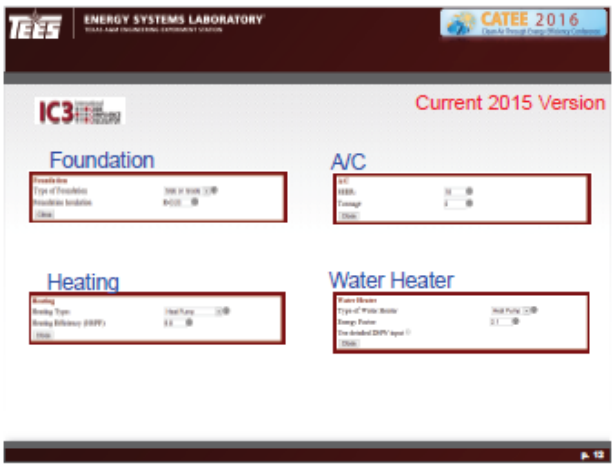

ENERGY SYSTEMS LABORATORY
CATEE 2016
IC3
Current 2015 Version
Main Page


ENERGY SYSTEMS LABORATORY
CATEE 2016
IC3
Current 2015 Version
Energy Code/Site Address/Project Details


ENERGY SYSTEMS LABORATORY
CATEE 2016
IC3
Current 2015 Version
Floors/BedRooms/Foundation


ENERGY SYSTEMS LABORATORY
CATEE 2016
IC3
Current 2015 Version
Global Parameters
Number of Floors
Number of Bedrooms
Orientation of Unit Front Side
Exterior Finish Type
Window
SHGC
U-Value
Insulation
Wall Cavity Insulation
Wall Continuous Insulation
Studs
Stud Type
Ducts
Ducts in Conditioned Space


ENERGY SYSTEMS LABORATORY
CATEE 2016
IC3
Current 2015 Version
Testing
Roof


ENERGY SYSTEMS LABORATORY
CATEE 2016
IC3
Current 2015 Version
Foundation
A/C
Heating
Water Heater

ENERGY SYSTEMS LABORATORY

CATEE 2016

Current 2015 Version

Certificate

ENERGY SYSTEMS LABORATORY

CATEE 2016

Current 2015 Version

Certificate on Electrical Panel

ENERGY SYSTEMS LABORATORY

CATEE 2016

SAVINGS FROM CODE COMPLIANT CONSTRUCTION

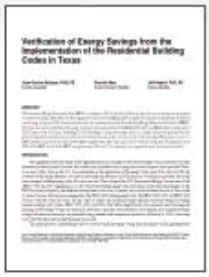
IC3 International CODE COMPLIANCE CALCULATOR

Has an analysis been performed to determine actual measured energy savings (i.e., real utility bills)?

ENERGY SYSTEMS LABORATORY

CATEE 2016

IC3 International CODE COMPLIANCE CALCULATOR



Yes!

Calculated savings compared with utility bills

*Results published in the 2014 ASHRAE Transactions.

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CATEE 2016

Developed API for IC3

IC3

IC3 Web:
http://ic3-2015.tamu.edu

Benefits from API:

- Single screen allowing access to the same DOE-2 model used by the IC3 webpage
- Tablet/iPad/iPhone friendly
- XML input/output
- Easily integrated into existing *third party software*

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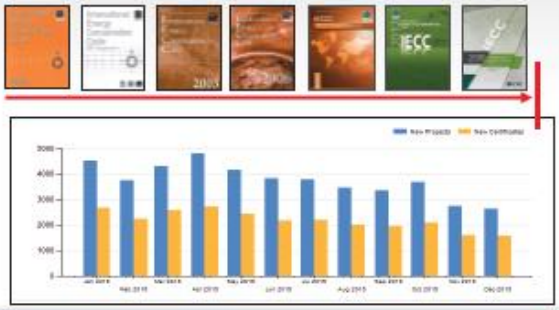
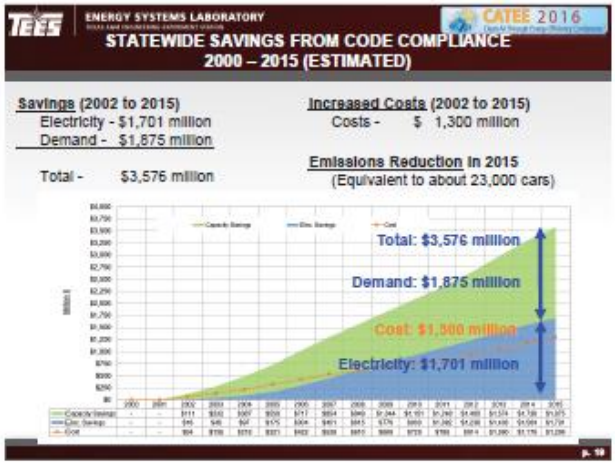
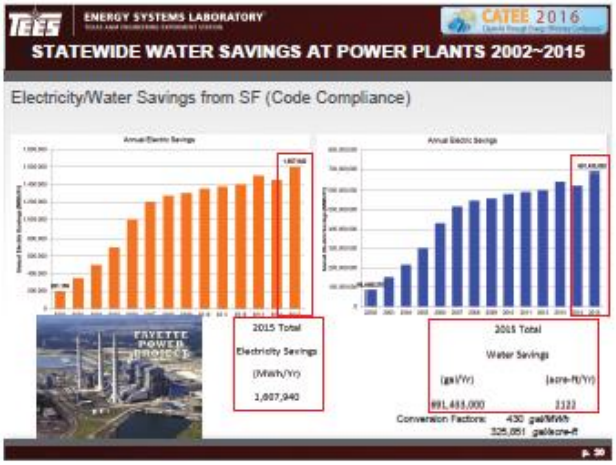
CATEE 2016

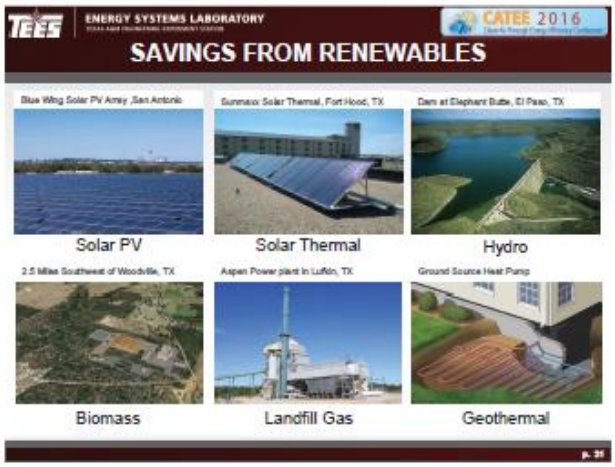
STATEWIDE SAVINGS FROM CODE COMPLIANCE (2000 – 2014)

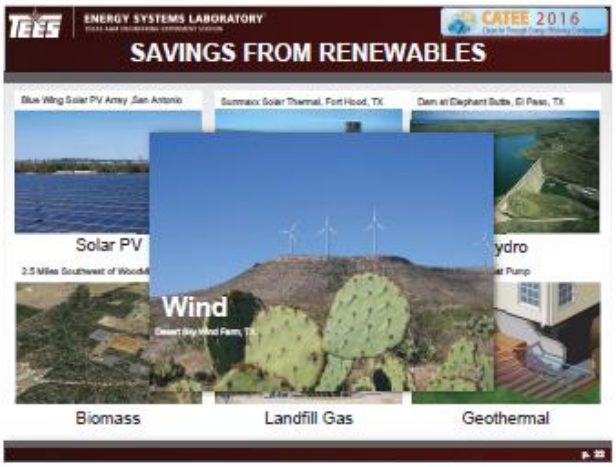
How much electricity has been saved from residential code compliance for all single-family housing 2000-2015?

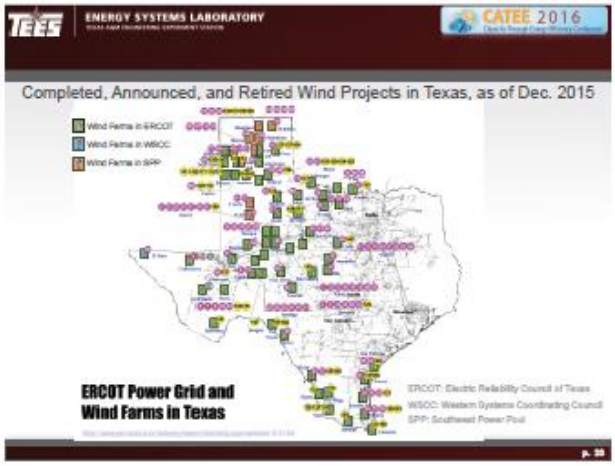


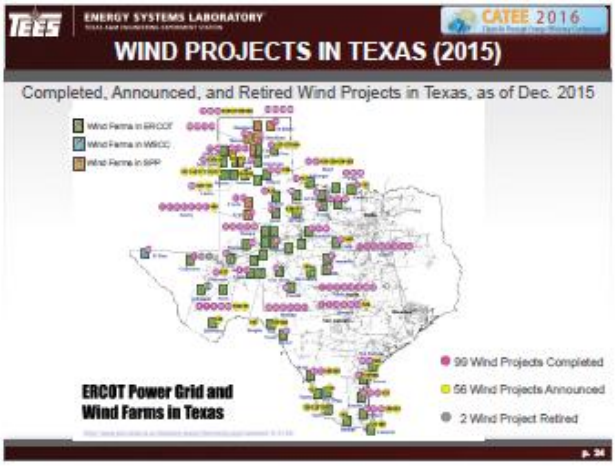

ENERGY SYSTEMS LABORATORY
CATEE 2016
STATEWIDE SAVINGS FROM CODE COMPLIANCE
2000 – 2015 (ESTIMATED)
Savings (2002 to 2015)
Electricity - $1,701 million
Demand - $1,875 million
Total - $3,576 million
Increased Costs (2002 to 2015)
Costs - $ 1,300 million
Emissions Reduction in 2015
(Equivalent to about 23,000 cars)
Total: $3,576 million
Demand: $1,875 million
Cost: $1,300 million
Electricity: $1,701 million

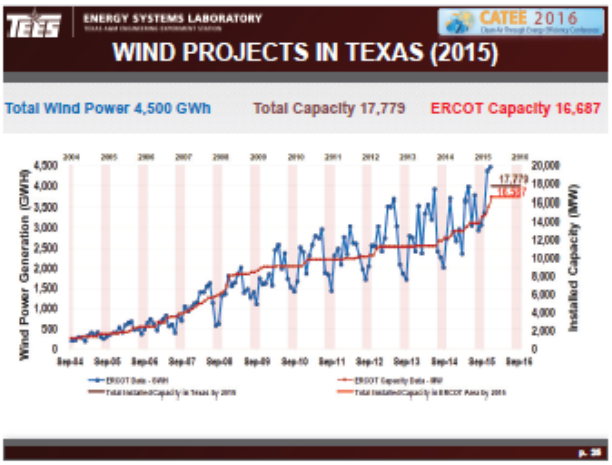

ENERGY SYSTEMS LABORATORY
CATEE 2016
STATEWIDE WATER SAVINGS AT POWER PLANTS 2002~2015
Electricity/Water Savings from SF (Code Compliance)
2015 Total
Electricity Savings
(MWh/Yr)
1,007,940
2015 Total
Water Savings
(gal/Yr)
(acre-ft/Yr)
991,483,000
3122
Conversion Factors: 430 gal/MWh
325,851 gal/acre-ft

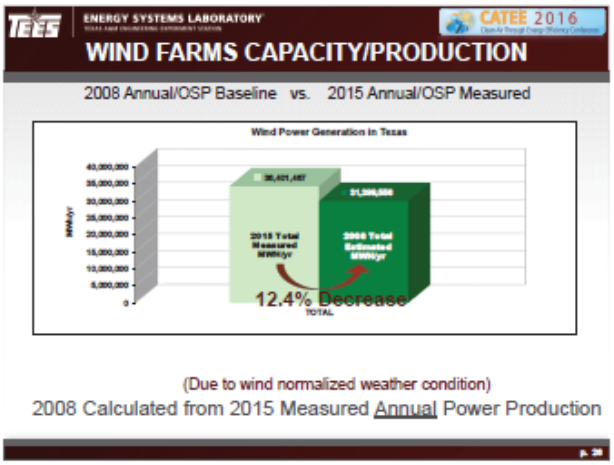

ENERGY SYSTEMS LABORATORY
CATEE 2016
SAVINGS FROM RENEWABLES
Solar PV
Solar Thermal
Hydro
Biomass
Landfill Gas
Geothermal

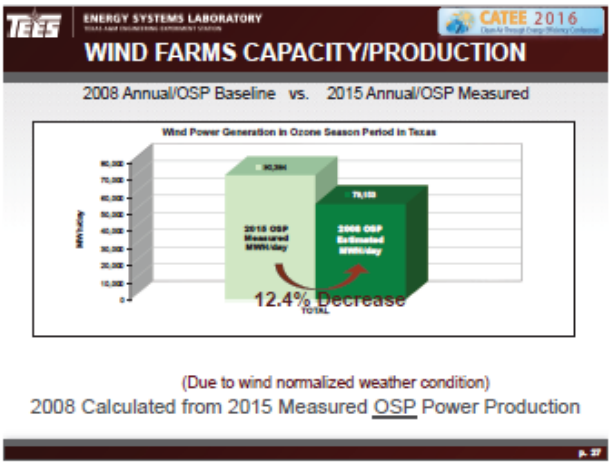

ENERGY SYSTEMS LABORATORY
CATEE 2016
SAVINGS FROM RENEWABLES
Solar PV
Wind
Biomass
Landfill Gas
Geothermal

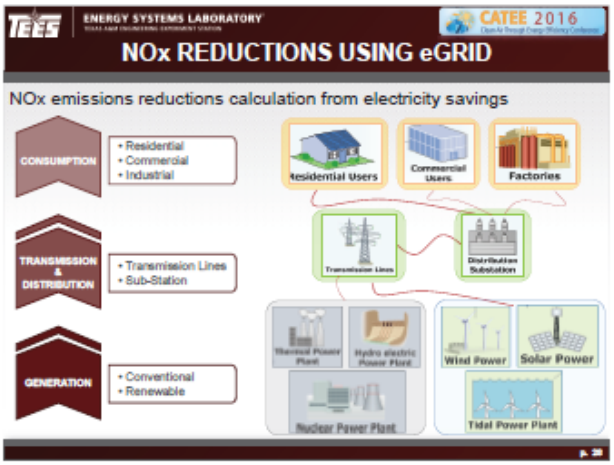

ENERGY SYSTEMS LABORATORY
CATEE 2016
Completed, Announced, and Retired Wind Projects in Texas, as of Dec. 2015
ERCOT Power Grid and
Wind Farms in Texas

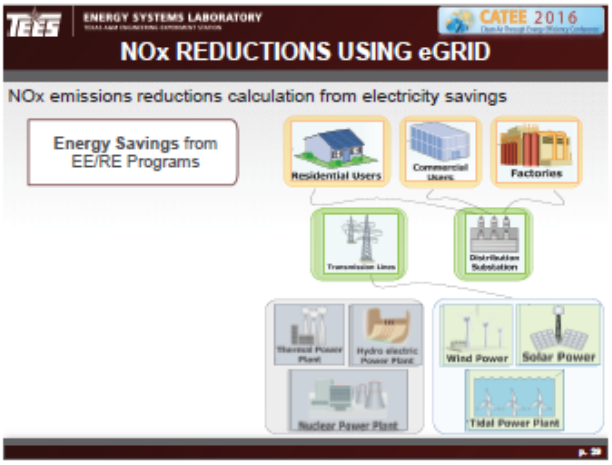

ENERGY SYSTEMS LABORATORY
CATEE 2016
WIND PROJECTS IN TEXAS (2015)
Completed, Announced, and Retired Wind Projects in Texas, as of Dec. 2015
ERCOT Power Grid and
Wind Farms in Texas
99 Wind Projects Completed
56 Wind Projects Announced
2 Wind Project Retired

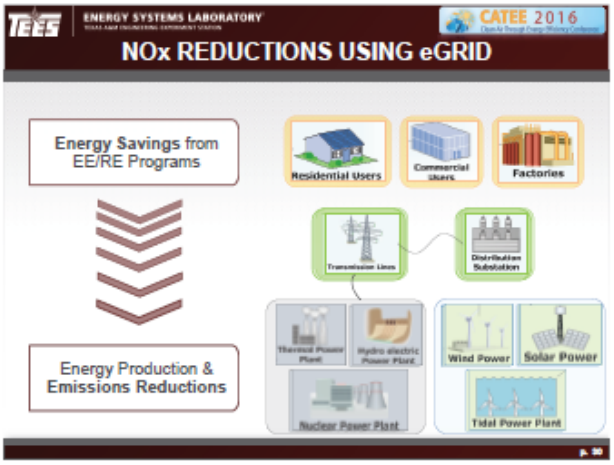

ENERGY SYSTEMS LABORATORY
CATEE 2016
WIND PROJECTS IN TEXAS (2015)
Total Wind Power 4,500 GWh
Total Capacity 17,779
ERCOT Capacity 16,687
Wind Power Generation (GWH)
Installed Capacity (MW)
17,779
16,687

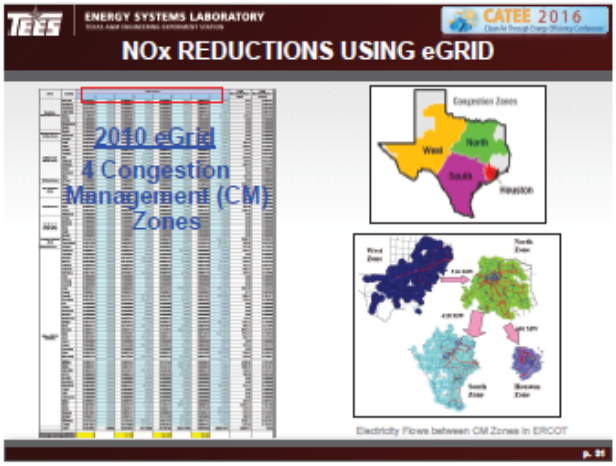

ENERGY SYSTEMS LABORATORY
CATEE 2016
WIND FARMS CAPACITY/PRODUCTION
2008 Annual/OSP Baseline vs. 2015 Annual/OSP Measured
Wind Power Generation in Texas
12.4% Decrease
TOTAL
(Due to wind normalized weather condition)
2008 Calculated from 2015 Measured Annual Power Production

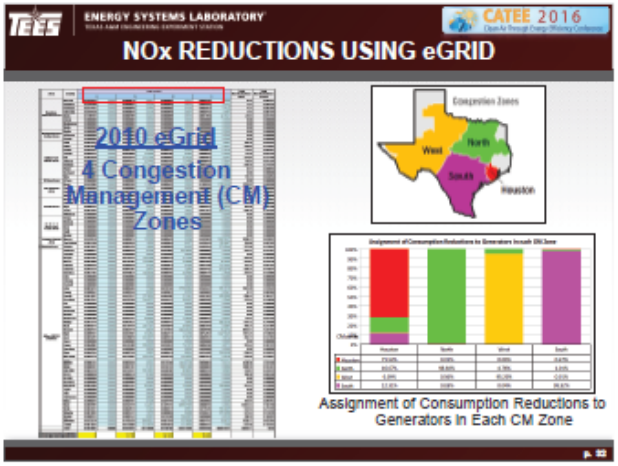

ENERGY SYSTEMS LABORATORY
CATEE 2016
WIND FARMS CAPACITY/PRODUCTION
2008 Annual/OSP Baseline vs. 2015 Annual/OSP Measured
Wind Power Generation in Ozone Season Period in Texas
12.4% Decrease
TOTAL
(Due to wind normalized weather condition)
2008 Calculated from 2015 Measured OSP Power Production

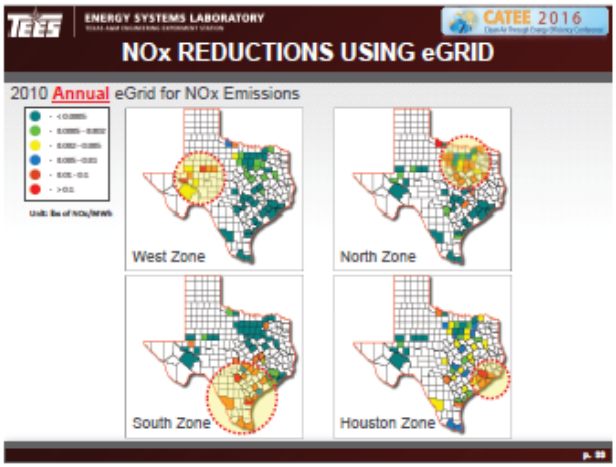

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
NOx emissions reductions calculation from electricity savings
CONSUMPTION
• Residential
• Commercial
• Industrial
TRANSMISSION & DISTRIBUTION
• Transmission Lines
• Sub-Station
GENERATION
• Conventional
• Renewable
Residential Users
Commercial Users
Factories
Transmission Lines
Distribution Substation
Thermal Power Plant
Hydro electric Power Plant
Wind Power
Solar Power
Nuclear Power Plant
Tidal Power Plant

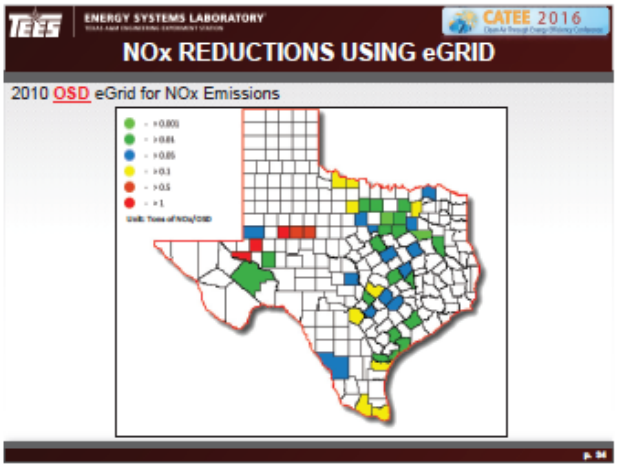

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
NOx emissions reductions calculation from electricity savings
Energy Savings from EE/RE Programs
Residential Users
Commercial Users
Factories
Transmission Lines
Distribution Substation
Thermal Power Plant
Hydro electric Power Plant
Wind Power
Solar Power
Nuclear Power Plant
Tidal Power Plant

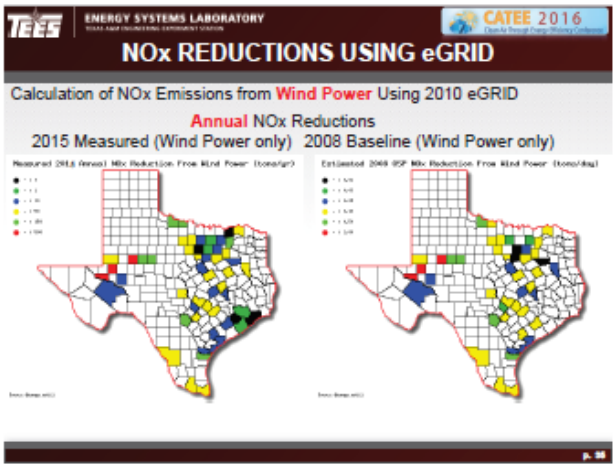

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
Energy Savings from EE/RE Programs
Energy Production & Emissions Reductions
Residential Users
Commercial Users
Factories
Transmission Lines
Distribution Substation
Thermal Power Plant
Hydro electric Power Plant
Wind Power
Solar Power
Nuclear Power Plant
Tidal Power Plant

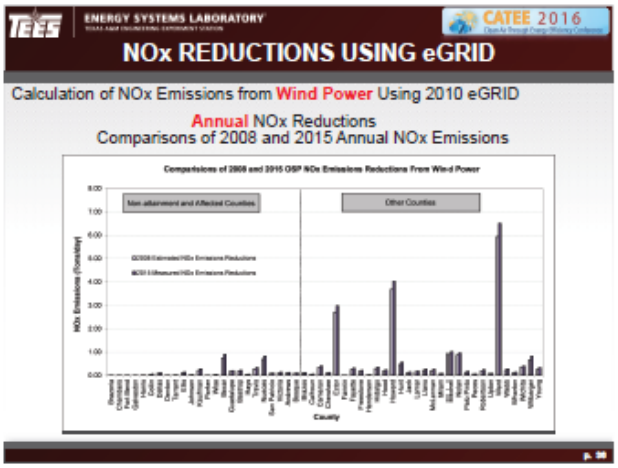

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
2010 eGrid
4 Congestion Management (CM) Zones
Congestion Zones
West
North
South
Houston
Electricity Flows between CM Zones in ERCOT

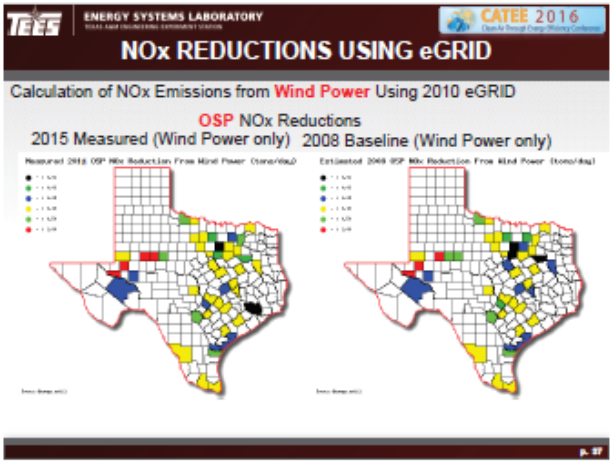

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
2010 eGrid
4 Congestion Management (CM) Zones
Congestion Zones
West
North
South
Houston
Assignment of Consumption Reductions to Generators in Each CM Zone

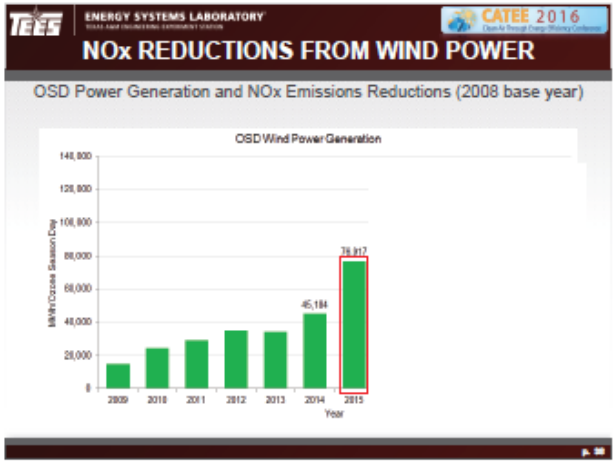

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
2010 Annual eGrid for NOx Emissions
West Zone
North Zone
South Zone
Houston Zone

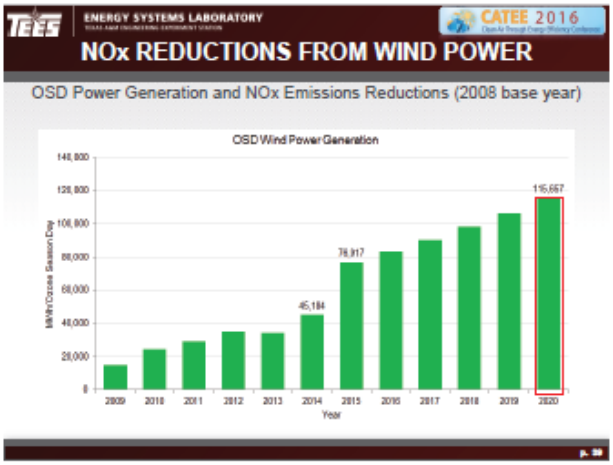

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
2010 OSD eGrid for NOx Emissions

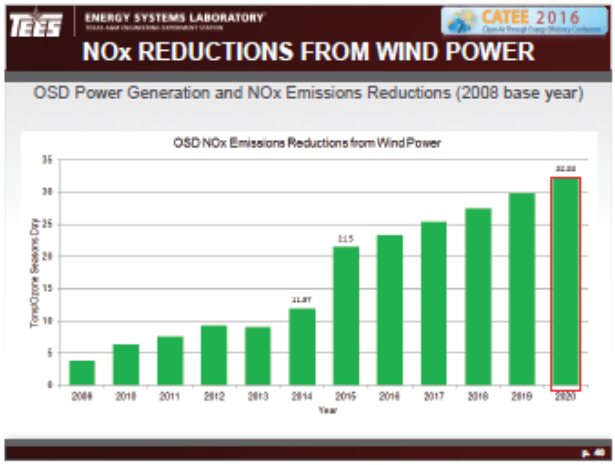

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
Calculation of NOx Emissions from Wind Power Using 2010 eGRID
Annual NOx Reductions
2015 Measured (Wind Power only)
2008 Baseline (Wind Power only)

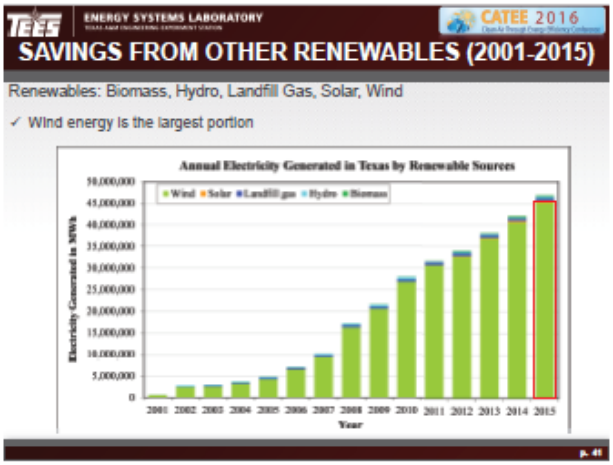

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
Calculation of NOx Emissions from Wind Power Using 2010 eGRID
Annual NOx Reductions
Comparisons of 2008 and 2015 Annual NOx Emissions
Non attainment and Affected Counties
Other Counties
NOx Emissions (Tons/day)
County

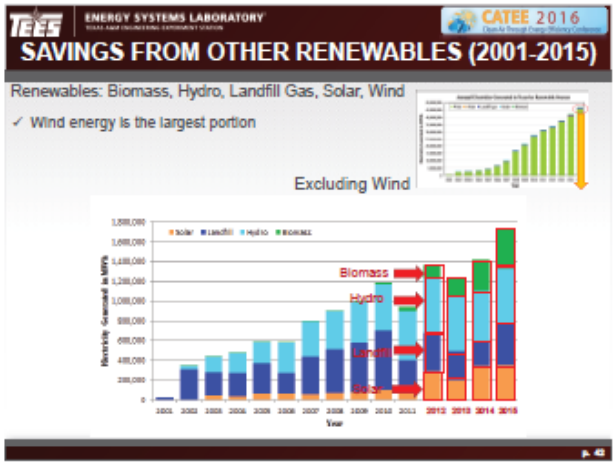

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS USING eGRID
Calculation of NOx Emissions from Wind Power Using 2010 eGRID
OSP NOx Reductions
2015 Measured (Wind Power only)
2008 Baseline (Wind Power only)

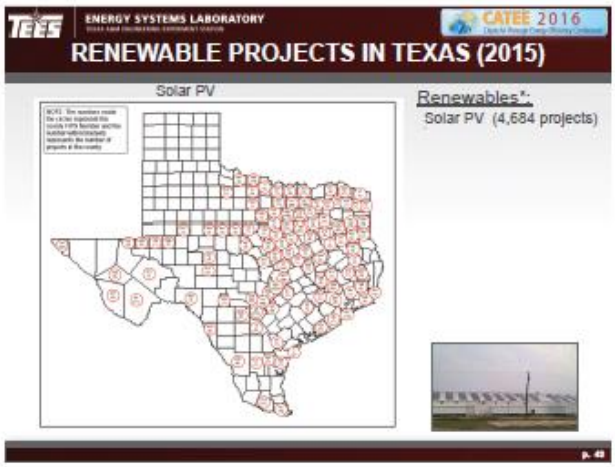

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS FROM WIND POWER
OSD Power Generation and NOx Emissions Reductions (2008 base year)
OSD Wind Power Generation
MWh/Ozone Season Day
Year
45,184
78,917

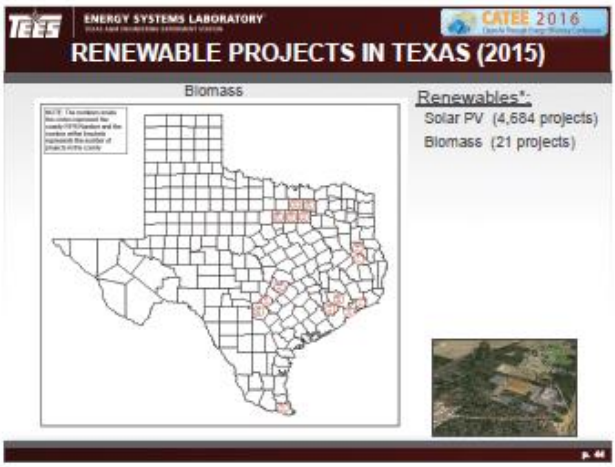

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS FROM WIND POWER
OSD Power Generation and NOx Emissions Reductions (2008 base year)
OSD Wind Power Generation
MWh/Ozone Season Day
Year
45,184
78,917
115,667

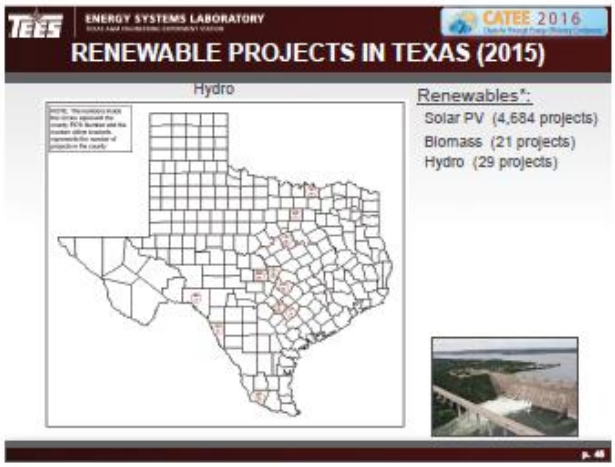

ENERGY SYSTEMS LABORATORY
CATEE 2016
NOx REDUCTIONS FROM WIND POWER
OSD Power Generation and NOx Emissions Reductions (2008 base year)
OSD NOx Emissions Reductions from Wind Power
Tons/Ozone Seasons Day
Year

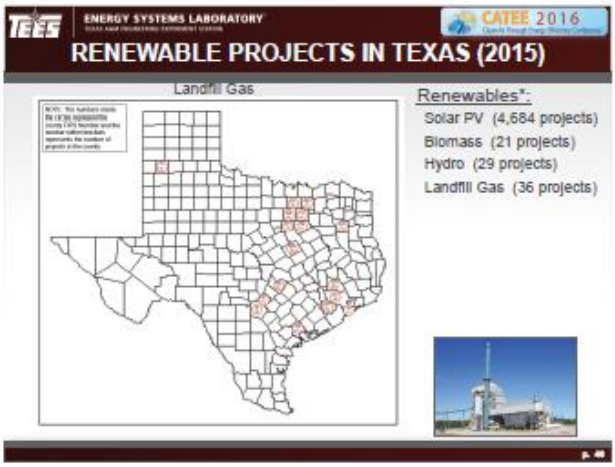

ENERGY SYSTEMS LABORATORY
CATEE 2016
SAVINGS FROM OTHER RENEWABLES (2001-2015)
Renewables: Biomass, Hydro, Landfill Gas, Solar, Wind
✓ Wind energy is the largest portion
Annual Electricity Generated in Texas by Renewable Sources
Wind
Solar
Landfill gas
Hydro
Biomass
Electricity Generated in MWh
Year

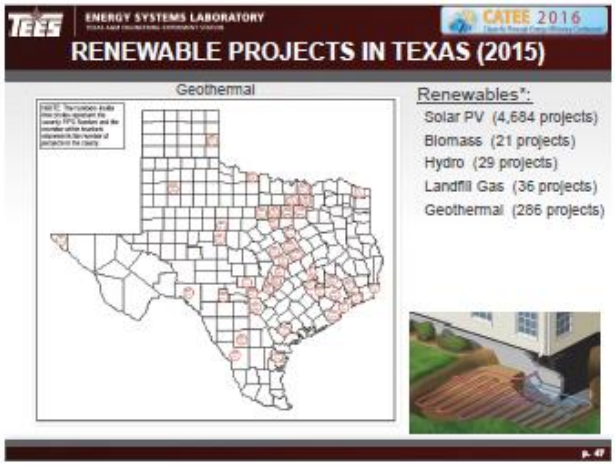

ENERGY SYSTEMS LABORATORY
CATEE 2016
SAVINGS FROM OTHER RENEWABLES (2001-2015)
Renewables: Biomass, Hydro, Landfill Gas, Solar, Wind
✓ Wind energy is the largest portion
Excluding Wind
Biomass
Hydro
Landfill
Solar
Year

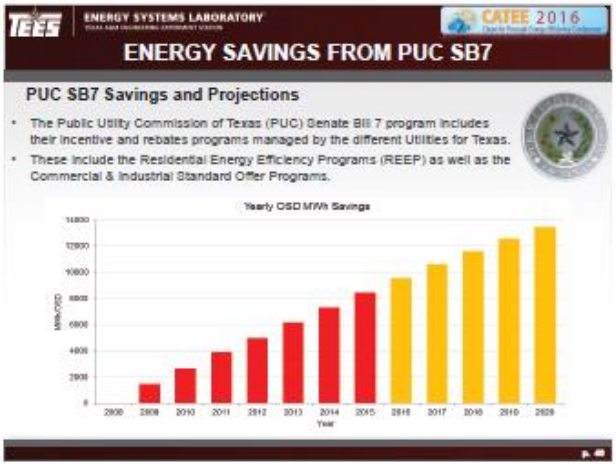

ENERGY SYSTEMS LABORATORY
CATEE 2016
RENEWABLE PROJECTS IN TEXAS (2015)
Solar PV
Renewables*:
Solar PV (4,684 projects)


ENERGY SYSTEMS LABORATORY
CATEE 2016
RENEWABLE PROJECTS IN TEXAS (2015)
Biomass
Renewables*:
Solar PV (4,684 projects)
Biomass (21 projects)


ENERGY SYSTEMS LABORATORY
CATEE 2016
RENEWABLE PROJECTS IN TEXAS (2015)
Hydro
Renewables*:
Solar PV (4,684 projects)
Biomass (21 projects)
Hydro (29 projects)


ENERGY SYSTEMS LABORATORY
CATEE 2016
RENEWABLE PROJECTS IN TEXAS (2015)
Landfill Gas
Renewables*:
Solar PV (4,684 projects)
Biomass (21 projects)
Hydro (29 projects)
Landfill Gas (36 projects)


ENERGY SYSTEMS LABORATORY
CATEE 2016
RENEWABLE PROJECTS IN TEXAS (2015)
Geothermal
Renewables*:
Solar PV (4,684 projects)
Biomass (21 projects)
Hydro (29 projects)
Landfill Gas (36 projects)
Geothermal (286 projects)


ENERGY SYSTEMS LABORATORY
CATEE 2016
ENERGY SAVINGS FROM PUC SB7
PUC SB7 Savings and Projections
The Public Utility Commission of Texas (PUC) Senate Bill 7 program includes their incentive and rebates programs managed by the different Utilities for Texas.
These include the Residential Energy Efficiency Programs (REEP) as well as the Commercial & Industrial Standard Offer Programs.
Yearly DSD MWh Savings

ENERGY SYSTEMS LABORATORY

CATEE 2016

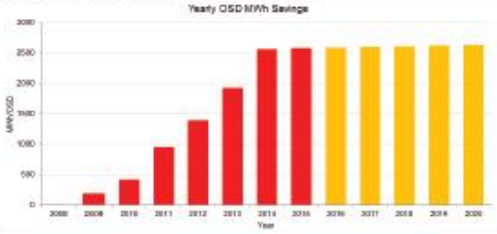
ENERGY SAVINGS FROM SECO

SECO Savings and Projections

- The Texas State Energy Conservation Office (SECO) funds energy-efficiency programs directed towards school districts, government agencies, city and county governments, private industries and residential energy consumers.
- The annual electricity savings are obtained from SECO's energy conservation projects reported by political subdivisions for 47 counties.

SECO

Yearly OSD MWh Savings



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CATEE 2016

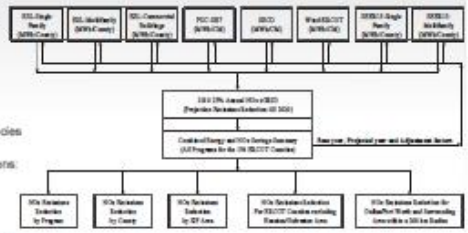
INTEGRATED NOx EMISSIONS REDUCTION

Integrated Emissions Savings Across Agencies To Report Savings To TCEQ and EPA

State agencies included:
- TEES/ESL
- PUC
- SECO
- ERCOT/Wind
- SEER 13/14 Single/Multifamily

Total savings across agencies

Annual emissions reductions:
- By program
- By county
- By SIP area
- By ERCOT counties
- By City and Surrounding Area within a 200km Radius



TCEQ SECO ERCOT

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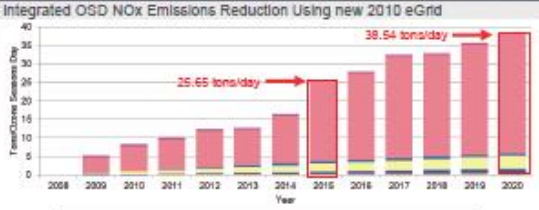
CATEE 2016

INTEGRATED NOx EMISSIONS REDUTION (2008 Baseyear)

2015 Integrated OSD NOx Emissions Reduction Using new 2010 eGrid



2015 Integrated OSD NOx Emissions Reduction		2020 Integrated OSD NOx emissions reduction	
ESL Code Compliance	(0.92 tons/day)	ESL Code Compliance	(1.80 tons/day)
PUC SB7 programs	(2.12 tons/day)	PUC SB7 programs	(3.37 tons/day)
SECO Political Sub.	(0.87 tons/day)	SECO Political Sub.	(0.89 tons/day)
Green Power (Wind)	(21.50 tons/day)	Green Power (Wind)	(32.33 tons/day)
Residential AC Retrofits	(0.45 tons/day)	Residential AC Retrofits	(0.35 tons/day)
Total (2015)	(25.65 tons/day)	Total (2020)	(38.54 tons/day)

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REPORTS AND PAPERS: TERP

ESL Homepage:
http://esl.tamu.edu/terp/documents/terp-reports/

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REPORTS AND PAPERS: TERP

Reports: 2002 through 2016

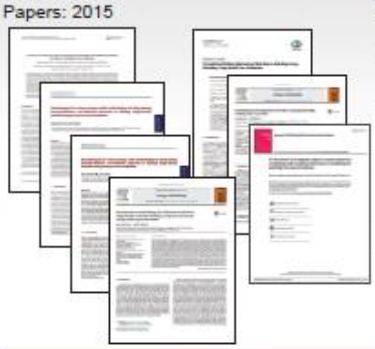
2015 Reports:
- TCEQ 2015Annual Preliminary Report: Integrated NOx Emissions Savings from EE/RE Programs Statewide
- TCEQ 2015Annual Report Volume I: Technical Report
- TCEQ 2015 Annual Report Volume II: Technical Appendix
- Statewide 2015 Air Emission Calculations from Wind and Other Renewables

ENERGY SYSTEMS LABORATORY

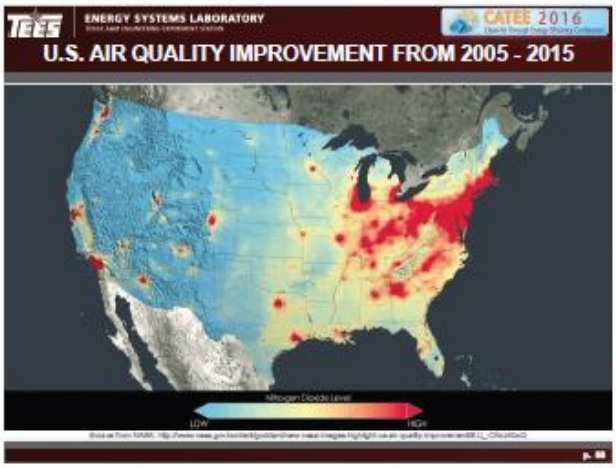
CATEE 2016

REPORTS AND PAPERS: TERP

Papers: 2015



Papers 2015:
- A Framework to Integrate Object-Oriented Physical Modelling with Building Information Modelling for Building Thermal Simulation.
- Development of Methodology for Calibrated Simulation in Single-family Residential Buildings using Three-parameter Change-point Regression Model
- Development of a Home Energy Audit Methodology for Determining Energy-Efficient, Cost-Efficient Measures in Existing Single-Family Homes Using an Easy-to-use Simulation
- Enhanced Opportunities for Energy Savings in Industrial Facilities through Long-Term Monitoring
- Qualifying Efficiency Gains of Refrigeration Systems Using Advanced Expansion Valve Technology
- Improving Monthly Weather-Normalized Energy Use Model: Building Energy Use Classification Based on Occupancy
- Development of Methodology for Calibrated Simulation in Single-family Residential Buildings
- Development of a Home Energy Audit Methodology for Determining Energy-Efficient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U.S. AIR QUALITY IMPROVEMENT FROM 2005 - 2015
Nitrogen Dioxide Level
LOW
HIGH


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