

# **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 2019-December 2019**



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**ENERGY SYSTEMS LABORATORY**  
TEXAS A&M ENGINEERING EXPERIMENT STATION



**TEXAS A&M ENGINEERING  
EXPERIMENT STATION**

**Energy Systems Laboratory**

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November 08, 2020

Mr. Robert Gifford  
Air Quality Division  
Texas Commission on Environmental Quality  
Austin, TX 78711-3087

Dear Mr. Gifford:

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,

A handwritten signature in black ink that reads "David E. Claridge".

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

Enclosure

### **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 counties in Texas. A new version of eGRID was developed and presented in this 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 2015 IECC and the ASHRAE Standards 90.1-2013. 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 NO<sub>x</sub> emissions reduction calculation procedures that provide the TCEQ with a standardized, creditable NO<sub>x</sub> 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 NO<sub>x</sub> 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. NO<sub>x</sub> 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 NO<sub>x</sub> emissions reduction through 2024 for the electricity and natural gas savings from the various EE/RE programs.

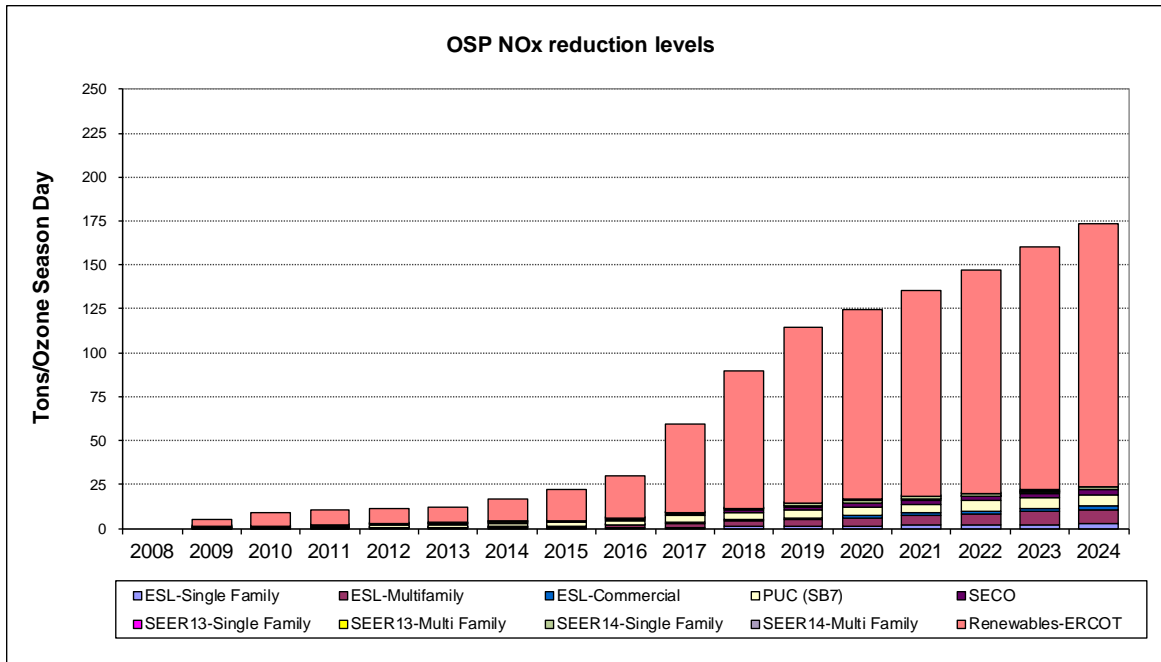


Figure 1: Integrated OSP NOx Emissions Reduction Projections through 2024 (Base Year 2008)

In 2019 (Table 1), the total integrated annual savings from all programs are 75,802,813 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 6,279,626 MWh/year (8.3% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 4,628,168 MWh/year (6.1%),
- Savings from SECO's Senate Bill 5 program are 1,691,059 MWh/year (2.2%),
- Electricity savings from renewable power generation are 62,168,032 MWh/year (82.0%), and
- Savings from residential air conditioner retrofits<sup>1</sup> are 1,035,928 MWh/year (1.4%).

By 2024, the total integrated annual savings from all programs will be 116,515,731 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 12,872,105 MWh/year (11.0% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 6,429,358 MWh/year (5.5%),
- Savings from SECO's Senate Bill 5 program will be 2,933,310 MWh/year (2.5%),
- Electricity savings from renewable power generation will be 93,479,378 MWh/year (80.2%), and
- Savings from residential air conditioner retrofits will be 801,581 MWh/year (0.7%).

In 2019 (Table 2), the total integrated annual NOx emissions reductions from all programs are 32,291 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 2,099 tons-NOx/year (6.5% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 1,547 tons-NOx/year (4.8%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 546 tons-NOx/year (1.7%),
- NOx emissions reductions from renewable power generation are 27,757 tons-NOx/year (86.0%), and
- NOx emissions reductions from residential air conditioner retrofits are 342 tons-NOx/year (1.1%).

<sup>1</sup> 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. SEER 14 calculations for existing homes were added from 2019-2024.

By 2024, the total integrated annual NOx emissions reductions from all programs will be 49,470 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 4,363 tons-NOx/year (8.8% of the total NOx savings),
- NOx emissions reductions from the PUC’s Senate Bill 7 programs will be 2,136 tons-NOx/year (4.3%),
- NOx emissions reductions from SECO’s Senate Bill 5 program will be 969 tons-NOx/year (2.0%),
- NOx emissions reductions from renewable power generation will be 41,738 tons-NOx/year (84.4%), and
- NOx emissions reductions from residential air conditioner retrofits will be 265 tons-NOx/year (0.5%).

Table 1: Annual and OSP 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	2021	2022	2023	2024
ESL-Single Family	0	25,031	47,000	74,109	153,562	215,164	275,535	360,010	533,473	722,595	967,082	1,212,227	1,463,313	1,720,666	1,984,624	2,255,535	2,533,763
ESL-Multifamily	0	50,784	108,018	200,414	332,835	527,292	774,578	1,225,617	1,856,682	2,472,527	3,151,036	3,962,565	4,811,210	5,699,485	6,630,048	7,605,717	8,629,478
ESL-Commercial	0	0	24,066	83,255	119,422	247,952	400,015	559,947	696,924	850,020	983,858	1,104,834	1,215,437	1,330,862	1,451,373	1,577,272	1,708,863
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	3,844,949	4,209,108	4,628,168	5,026,276	5,404,478	5,763,770	6,105,097	6,429,358
SECO	0	74,198	157,524	349,845	512,539	713,477	1,015,815	1,019,507	1,117,717	1,296,153	1,402,040	1,691,059	1,965,627	2,226,467	2,474,265	2,709,672	2,933,310
Renewables-ERCOT	0	3,454,992	8,351,369	12,158,649	13,392,752	17,028,343	18,753,002	20,885,590	34,193,486	47,055,032	49,700,002	62,168,032	67,452,315	73,185,762	79,406,551	86,156,108	93,479,378
SEER13-Single Family	0	363,440	345,268	328,005	311,605	296,024	281,223	267,162	253,804	241,114	229,058	217,605	206,725	196,389	186,569	177,241	168,379
SEER13-Multi Family	0	30,765	29,227	27,766	26,377	25,059	23,806	22,615	21,485	20,410	19,390	18,420	17,499	16,624	15,793	15,003	14,253
SEER14-Single Family	0	0	0	0	0	0	0	0	0	0	0	663,523	630,347	598,830	568,888	540,444	513,421
SEER14-Multi Family	0	0	0	0	0	0	0	0	0	0	0	136,379	129,560	123,082	116,928	111,082	105,528
Total Annual (MWh)	0	4,538,051	10,039,456	14,659,925	16,680,410	21,320,725	24,199,269	27,418,208	42,172,438	56,502,800	60,661,574	75,802,812	82,918,310	90,502,644	98,598,809	107,253,171	116,515,731

PROGRAM	OZONE SEASON PERIOD - OSP (MWh/day)																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ESL-Single Family	0	69	129	203	421	589	755	986	1,462	1,980	2,650	3,321	4,009	4,714	5,437	6,180	6,942
ESL-Multifamily	0	139	296	549	912	1,445	2,122	3,358	5,087	6,774	8,633	10,856	13,181	15,615	18,165	20,838	23,642
ESL-Commercial	0	0	66	228	327	679	1,096	1,534	1,909	2,329	2,696	3,027	3,330	3,640	3,976	4,321	4,682
PUC (SB7)	0	1,476	2,677	3,939	5,017	6,212	7,330	8,438	9,586	10,534	11,532	12,680	13,771	14,807	15,791	16,726	17,615
SECO	0	203	432	958	1,404	1,955	2,783	2,793	3,062	3,551	3,841	4,633	5,385	6,100	6,779	7,424	8,036
Renewables-ERCOT	0	15,037	26,234	30,736	32,528	31,695	46,338	63,604	86,957	96,446	145,063	187,283	203,202	220,474	239,214	259,548	281,609
SEER13-Single Family	0	2,582	2,453	2,330	2,214	2,103	1,998	1,898	1,803	1,713	1,627	1,546	1,468	1,395	1,325	1,259	1,196
SEER13-Multi Family	0	207	196	187	177	168	160	152	144	137	130	124	118	112	106	101	96
SEER14-Single Family	0	0	0	0	0	0	0	0	0	0	0	4,337	4,120	3,914	3,718	3,532	3,356
SEER14-Multi Family	0	0	0	0	0	0	0	0	0	0	0	891	847	804	764	726	690
Total OSP (MWh)	0	19,713	32,482	39,130	43,000	44,846	62,581	82,763	110,011	123,464	176,172	228,698	249,431	271,581	295,276	320,654	347,864

Table 2: Annual and OSP 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	2021	2022	2023	2024
ESL-Single Family	0	3	8	15	34	50	65	86	129	224	320	403	489	577	668	761	856
ESL-Multifamily	0	4	19	43	77	127	190	305	468	810	1,061	1,333	1,617	1,914	2,226	2,553	2,896
ESL-Commercial	0	0	5	16	22	47	79	114	141	229	310	363	411	461	509	559	611
PUC (SB7)	0	135	246	362	460	567	669	770	874	1,326	1,410	1,547	1,677	1,801	1,918	2,030	2,136
SECO	0	20	44	92	134	185	267	269	298	407	447	546	639	728	812	892	969
Renewables-ERCOT	0	951	2,645	3,258	3,561	4,693	5,116	5,683	9,359	24,054	22,408	27,757	30,117	32,677	35,454	38,468	41,738
SEER13-Single Family	0	86	81	77	73	70	66	63	60	72	77	73	69	66	63	60	57
SEER13-Multi Family	0	7	7	7	6	6	6	5	5	6	6	6	6	5	5	5	5
SEER14-Single Family	0	0	0	0	0	0	0	0	0	0	0	219	208	198	188	178	169
SEER14-Multi Family	0	0	0	0	0	0	0	0	0	0	0	44	42	40	38	36	34
Total Annual (Tons NOx)	0	1,205	3,054	3,870	4,369	5,744	6,457	7,294	11,335	27,127	26,039	32,291	35,275	38,467	41,881	45,541	49,470

PROGRAM	OZONE SEASON PERIOD - OSP (in tons NOx/day)																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ESL-Single Family	0.00	0.01	0.02	0.04	0.09	0.14	0.18	0.24	0.35	0.62	0.93	1.18	1.43	1.68	1.94	2.21	2.49
ESL-Multifamily	0.00	0.01	0.05	0.12	0.21	0.35	0.52	0.83	1.28	2.24	3.09	3.88	4.70	5.57	6.47	7.42	8.42
ESL-Commercial	0.00	0.00	0.01	0.04	0.06	0.13	0.22	0.31	0.39	0.64	0.91	1.07	1.22	1.38	1.54	1.70	1.87
PUC (SB7)	0.00	0.37	0.67	0.99	1.26	1.55	1.83	2.11	2.39	3.75	4.21	4.62	5.01	5.38	5.73	6.07	6.38
SECO	0.00	0.05	0.12	0.25	0.37	0.51	0.73	0.74	0.82	1.14	1.30	1.58	1.85	2.11	2.35	2.58	2.81
Renewables-ERCOT	0.00	4.15	7.53	8.42	8.91	9.03	12.87	17.55	24.11	50.25	78.80	99.65	108.13	117.32	127.29	138.11	149.85
SEER13-Single Family	0.00	0.60	0.57	0.54	0.52	0.49	0.47	0.44	0.42	0.52	0.59	0.56	0.53	0.50	0.48	0.45	0.43
SEER13-Multi Family	0.00	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.03
SEER14-Single Family	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	1.45	1.38	1.31	1.24	1.18
SEER14-Multi Family	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.29	0.28	0.26	0.25	0.24
Total OSP (Tons NOx)	0.00	5.24	9.03	10.45	11.46	12.23	16.85	22.26	29.80	59.21	89.87	114.42	124.65	135.63	147.41	160.07	173.69

#### d. Technology Transfer

In 2019, The Laboratory, hosted the 2019 Texas Energy Summit (formerly called the 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 2019 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 continuously 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 the 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.

## Acknowledgments

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. Robert Gifford, TCEQ.

Numerous additional individuals at the Laboratory contributed significantly to this report, including, Mr. Sungkyun Jung, Mr. Farshad Kheiri, Mr. Chul Kim, Ms. Qinbo Li, and Mr. Jounghwan Ahn.



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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 NO<sub>x</sub> 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 NO<sub>x</sub> 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 77<sup>th</sup> 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 NO<sub>x</sub> 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 the 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 78<sup>th</sup> 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 to 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 the enforcement of energy codes.

Senate Bill 5 was again amended during the 79<sup>th</sup> 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 a 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 80<sup>th</sup> 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 81<sup>st</sup> 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 82<sup>nd</sup> 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 annually 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 83<sup>rd</sup> 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.

The 85<sup>th</sup> Legislature (2017) did not change any of the Laboratory's previously established responsibilities under TERP.

The 86<sup>th</sup> Legislature (2019) did not change any of the Laboratory's previously established responsibilities under TERP.

## 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 FY 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; \$454,571.79 in FY 2015; \$459,845.41 in FY 2016; \$460,409.98 in FY 2017; and \$440,558.76 in FY 2018. In FY 2019 the Laboratory expended \$443,310.85.

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, R-2, R-3 and R-4 multi-family 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 not defined as Residential.

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 the 2003 and 2006 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. Although several individual jurisdictions did adopt the newer editions.

In the time frame of 2002-2012, the laboratory provided recommendations and considered additional input from stakeholder meetings and public comment periods on the 2009 edition of the IRC/IECC energy efficiency codes. With the laboratory's recommendation, SECO updated the TBEPS energy efficiency codes to the 2009 IRC/IECC.

In the timeframe of 2013-2015, the laboratory provided recommendations and considered additional input from stakeholder meetings and public comment periods on the 2012 and 2015 editions of the IRC/IECC energy efficiency codes. The State of Texas did not adopt the 2012 edition of the energy efficiency codes as the TBEPS. During this time, several individual jurisdictions did adopt the 2012 and the 2015 editions of the IRC/IECC.

During the 84th Legislature session (2015), the legislature adopted the 2015 residential energy codes (IRC/IECC) editions effective September 1, 2016. The 2015 IECC – Commercial (IECC-C) were effective November 1, 2016. The Legislation also included statues providing the Laboratory's responsibilities of reviewing new energy codes and local code amendments remain. New codes residential codes and provisions will be reviewed no sooner than every 6 years (next review will be of 2021 code editions). The 2015 residential energy codes also established a new energy rating index (ERI) as a voluntary compliance path and the legislation amended the index values published in the IECC. With the introduction of the ERI as another compliance path, the Laboratory is required to consider it when local amendments are reviewed.

In the timeframe of 2016-2019, the laboratory provided recommendations and considered additional input from stakeholder meetings and public comment periods on the 2018 edition of the IRC/IECC energy efficiency codes as requested by several jurisdictions. The Laboratory updated the IC3 web-based code compliance tool and emissions reduction calculator to allow for the new optional compliance path and for compliance with the latest adopted editions of the IECC.

#### 1.4 Accomplishments since January 2019

Since January 2019, the Laboratory has accomplished the following:

- Calculated energy and resultant NO<sub>x</sub> 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 and commercial IECC/IRC sessions at the 27th Building Professional Institute (BPI), UT Arlington.;
- Provided energy code training workshops, including: residential and commercial IECC/IRC sessions to the following local jurisdictions: Killeen, Victoria, and Amarillo;
- Provided energy code training workshops, including: residential and commercial IECC/IRC sessions to the following institutes of higher education: Austin Community College, University of Texas Project Management and Construction Services and Stephen F. Austin State University;
- Provided energy code training workshops, including: residential and commercial IECC/IRC sessions to Texas Association of Professional Real Estate Inspectors and the North Central Texas Council of Governments;
- 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 Texas Energy Summit (previously Clear Air Through Energy Efficiency Conference (CATEE)) in November 2019, in Austin, 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: Evolution of the Grid- High Renewables and DERS, Low Cost; Clean Air and Clean Energy in Texas; Increasing Grid Resiliency with Distributed Resources; Improving Public Health and Resilience in Energy Corridors; State Agency Energy Leadership; The Permian Boom- Making High Production and Clean Air Coexist; Clean Energy as an Economic Development Tool; Electrifying Transportation; Public Sector Energy Efficiency Requirements; Political Movements and Climate Change; Innovation for Industrial Emissions Reductions; Big Renewables- Procuring Cheap, Clean Energy.
- Provided technical assistance to the TCEQ regarding specific issues, including:
  - Enhancement of the standardized, integrated NO<sub>x</sub> emissions reduction reporting procedures to the TCEQ for EE/RE projects, and
  - Enhancement of the procedures for weather normalizing NO<sub>x</sub> emissions reduction from renewable projects.
- Participated as exhibitors at several conferences, including at the Texas Energy Summit in Houston, 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 work 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.

One presentation to the Texas Energy Summit held in Austin, Texas, November 2019.

- Haberl, J.; Yazdani, B.; Baltazar, J., 2019 “Energy Efficiency and Renewable Energy Impacts on NO<sub>x</sub> Emission Reductions in Texas” *Texas Energy Summit*, Austin, Texas, November 2019

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 NO<sub>x</sub> 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 NO<sub>x</sub> 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, 78<sup>th</sup> 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 2019, the following savings were calculated:

- In 2019, the annual electricity savings from code-compliant residential and commercial construction are 6,279,626 MWh/year (8.3% of the total electricity savings),
- Savings from residential air conditioner retrofits<sup>2</sup> are 1,035,928 MWh/year (1.4%).
- In 2019, the OSP electricity savings from code-compliant residential and commercial construction are 17,204 MWh/day (7.5%),
- Savings from residential air conditioner retrofits are 6,898 MWh/day (3.0%).
- By 2024, the annual electricity savings from code-compliant residential and commercial construction will be 12,872,105 MWh/year (11.0% of the total electricity savings),
- Savings from residential air conditioner retrofits will be 801,581 MWh/year (0.7%).
- By 2024, the OSP electricity savings from code-compliant residential and commercial construction will be 35,266 MWh/day (10.1%),
- Savings from residential air conditioner retrofits will be 5,337 MWh/day (1.5%).
- In 2019, the annual NO<sub>x</sub> emissions reduction from code-compliant residential and commercial construction are 2,099 tons-NO<sub>x</sub>/year (6.5% of the total NO<sub>x</sub> savings),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits are 342 tons-NO<sub>x</sub>/year (1.1%).
- In 2019, the OSP NO<sub>x</sub> emissions reduction from code-compliant residential and commercial construction are 6.13 tons-NO<sub>x</sub>/day (5.4%),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits are 2.43 tons-NO<sub>x</sub>/day (2.1%).
- By 2024, the NO<sub>x</sub> emissions reduction from code-compliant residential and commercial construction will be 4,363 tons-NO<sub>x</sub>/year (8.8% of the total NO<sub>x</sub> savings),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits will be 265 tons-NO<sub>x</sub>/year (0.5%).
- By 2024, the OSP NO<sub>x</sub> emissions reduction from code-compliant residential and commercial Construction will be 12.77 tons-NO<sub>x</sub>/day (7.4%),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits will be 1.88 tons-NO<sub>x</sub>/day (1.1%).

<sup>2</sup> 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. SEER 14 calculations for existing homes were applied from 2019-2024.

## 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 2019, the total integrated annual savings from all programs are 75,802,813 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 6,279,626 MWh/year (8.3% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 4,628,168 MWh/year (6.1%),
- Savings from SECO's Senate Bill 5 program are 1,691,059 MWh/year (2.2%),
- Electricity savings from renewable power generation are 62,168,032 MWh/year (82.0%), and
- Savings from residential air conditioner retrofits<sup>3</sup> are 1,035,928 MWh/year (1.4%).

In 2019, the total integrated OSP savings from all programs are 228,698 MWh/day, which would be a 9,529 MW average hourly load reduction during the OSP. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 17,204 MWh/day (7.5%),
- Savings from the PUC's Senate Bill 7 programs are 12,680 MWh/day (5.5%),
- Savings from SECO's Senate Bill 5 program are 4,633 MWh/day (2.0%),
- Electricity savings from renewable power generation are 187,283 MWh/day (81.9%), and
- Savings from residential air conditioner retrofits are 6,898 MWh/day (3.0%).

By 2024, the total integrated annual savings from all programs will be 116,515,731 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 12,872,105 MWh/year (11.0% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 6,429,358 MWh/year (5.5%),
- Savings from SECO's Senate Bill 5 program will be 2,933,310 MWh/year (2.5%),
- Electricity savings from renewable power generation will be 93,479,378 MWh/year (80.2%), and
- Savings from residential air conditioner retrofits will be 801,581 MWh/year (0.7%).

By 2024, the total integrated OSP savings from all programs will be 347,864 MWh/day, which would be 14,494 MW average hourly load reduction during the OSP. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 35,266 MWh/day (10.1%),
- Savings from the PUC's Senate Bill 7 programs will be 17,615 MWh/day (5.1%),
- Savings from SECO's Senate Bill 5 program will be 8,036 MWh/day (2.3%),
- Electricity savings from renewable power generation will be 281,609 MWh/day (81.0%), and
- Savings from residential air conditioner retrofits will be 5,337 MWh/day (1.5%).

In 2019 (Table 31), the total integrated annual NOx emissions reductions from all programs are 32,291 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

<sup>3</sup> 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. SEER 14 calculations for existing homes were added from 2019-2024.

- NOx emissions reductions from code-compliant residential and commercial construction are 2,099 tons-NOx/year (6.5% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 1,547 tons-NOx/year (4.8%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 546 tons-NOx/year (1.7%),
- NOx emissions reductions from renewable power generation are 27,757 tons-NOx/year (86.0%), and
- NOx emissions reductions from residential air conditioner retrofits are 342 tons-NOx/year (1.1%).

In 2019, the total integrated OSP NOx emissions reductions from all programs are 114.42 tons-NOx/day. The integrated OSP NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 6.13 tons-NOx/day (5.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 4.62 tons-NOx/day (4.0%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 1.58 tons-NOx/day (1.4%),
- NOx emissions reductions from renewable power generation are 99.65 tons-NOx/day (87.1%), and
- NOx emissions reductions from residential air conditioner retrofits are 2.43 tons-NOx/day (2.1%).

By 2024, the total integrated annual NOx emissions reductions from all programs will be 49,470 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 4,363 tons-NOx/year (8.8% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 2,136 tons-NOx/year (4.3%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 969 tons-NOx/year (2.0%),
- NOx emissions reductions from renewable power generation will be 41,738 tons-NOx/year (84.4%), and
- NOx emissions reductions from residential air conditioner retrofits will be 265 tons-NOx/year (0.5%).

By 2024, the total integrated OSP NOx emissions reductions from all programs will be 173.69 tons-NOx/day. The integrated OSP NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 12.77 tons-NOx/day (7.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 6.38 tons-NOx/day (3.7%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 2.81 tons-NOx/day (1.6%),
- NOx emissions reductions from renewable power generation will be 149.85 tons-NOx/day (86.3%), and
- NOx emissions reductions from residential air conditioner retrofits will be 1.88 tons-NOx/day (1.1%).

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

	ESL-Single Family <sup>16</sup>	ESL <sup>16</sup> -Multifamily	ESL <sup>16</sup> -Commercial	PUC (SB7) <sup>15</sup>	SECO <sup>15</sup>	Renewables-ERCOT <sup>8</sup>	SEER13/14 Single Family	SEER/1314 Multi Family
Annual Degradation Factor <sup>11</sup>	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss <sup>9</sup>	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor <sup>12</sup>	20.0%	20.0%	20.0%	10.0%	60% / 30%	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 Renewables-ERCOT, the OSP energy consumption is the average daily consumption of the measured data from May 1 to September 30. In the SECO calculations, a 30% initial discount factor is used from 2019 and before 2019, a 60% initial discount factor was used for the estimations. SEER 14 calculations were added for 2019-2024 projections. Before 2019, SEER 13 calculations were only applied.

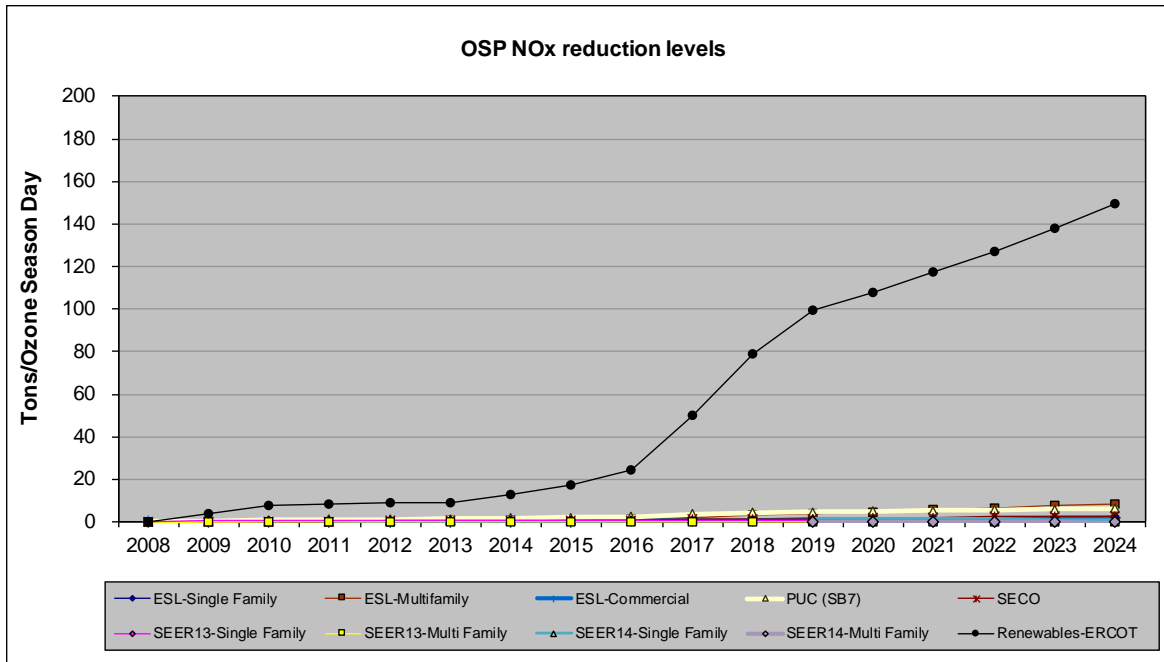


Figure 2: Integrated OSP Individual Programs NOx Emissions Reduction Projections through 2024 (Base Year 2008)

### 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.<sup>4</sup> 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-Family building 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.

<sup>4</sup> *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 – Single Family version of IC3 version 4, implementing IECC 2015
  - Version 4.0.1 – Added builder information. Changed format of energy report

The 2016 software updates include:

- IC3
  - Version 4.0.2 – Clarified some error messages. Revised model of attic. Added check for fresh air standards,
  - Version 4.1 – Added ERI
  - Version 4.1.1 – Some bug fixes
  - Version 4.1.2 – Altered appliance energy calculation in ERI to improve accuracy
  - Version 4.2 – Added NCTCOG 2015 IECC amendment

The 2017 software updates include:

- IC3
  - Version 4.3 – Added Austin Energy IECC 2015 amendment. Improved accuracy of duct model
  - Version 4.3.1 – Added NCTCOG 2015 ERI amendment

The 2018 software updates include:

- IC3
  - Bug fixes only
- CEXIS API
  - Rewrote the CEXIS API to properly interface with the new Poller API (see below)
- Poller API
  - Rewrote the polling software (the client software that actually performs the DOE2 runs) as a web-based service. This solved several ongoing maintenance and security issues we were having.

The 2019 software updates include:

- IC3
  - Bug fixes
  - Added 2018 IECC
  - Added support for tankless water heater equipment
- CEXIS API
  - Updated all weather information
  - Major revision of ERI calculation
- POLLER API
  - Improved Performance

## 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 2019, the Laboratory continued to work with the TCEQ to develop an integrated NO<sub>x</sub> emissions reductions calculation that provided the TCEQ with a creditable NO<sub>x</sub> emissions reductions from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2018 by the Laboratory, PUCT, SECO, and ERCOT (i.e., renewables).
- At the request of the TCEQ, the Laboratory has continued the development of procedures for quantifying NO<sub>x</sub> emissions reductions from renewables and the quantification of NO<sub>x</sub> emissions reductions from the new Federal regulations for SEER 14 air conditioners.

## 1.10 Planned Focus for 2019

In FY 2020, 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 NO<sub>x</sub> emissions reductions from green renewable technologies, including wind power, solar energy and geothermal energy systems.
- Continue development of well-documented, integrated NO<sub>x</sub> emissions reductions methodologies for calculating and reporting NO<sub>x</sub> 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 the 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 rating 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.
- Complete RESNET certification for the ERI path in IC3.
- Release version 2018 AE IECC (Austin Energy Amendments). This is not mandated by the State but has been requested by Austin Energy
- Continue to update all websites managed by the lab to meet the evolving TEES standards.

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.

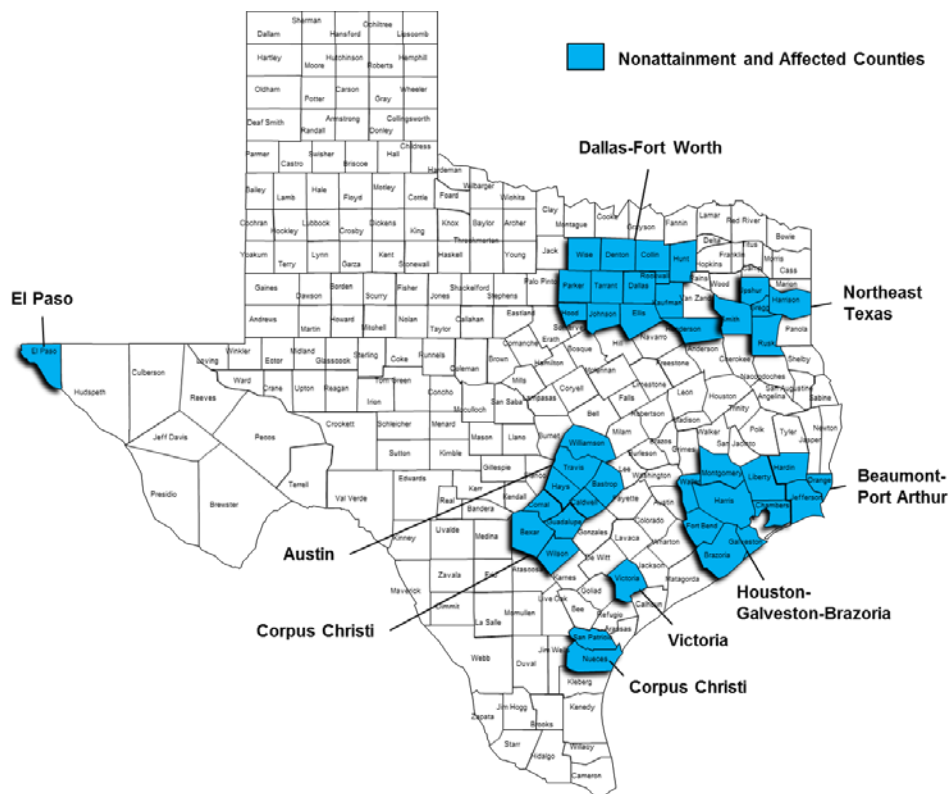
If any questions arise, please contact us by phone at 979-845-9213.

## 2 Introduction

### 2.1 Background

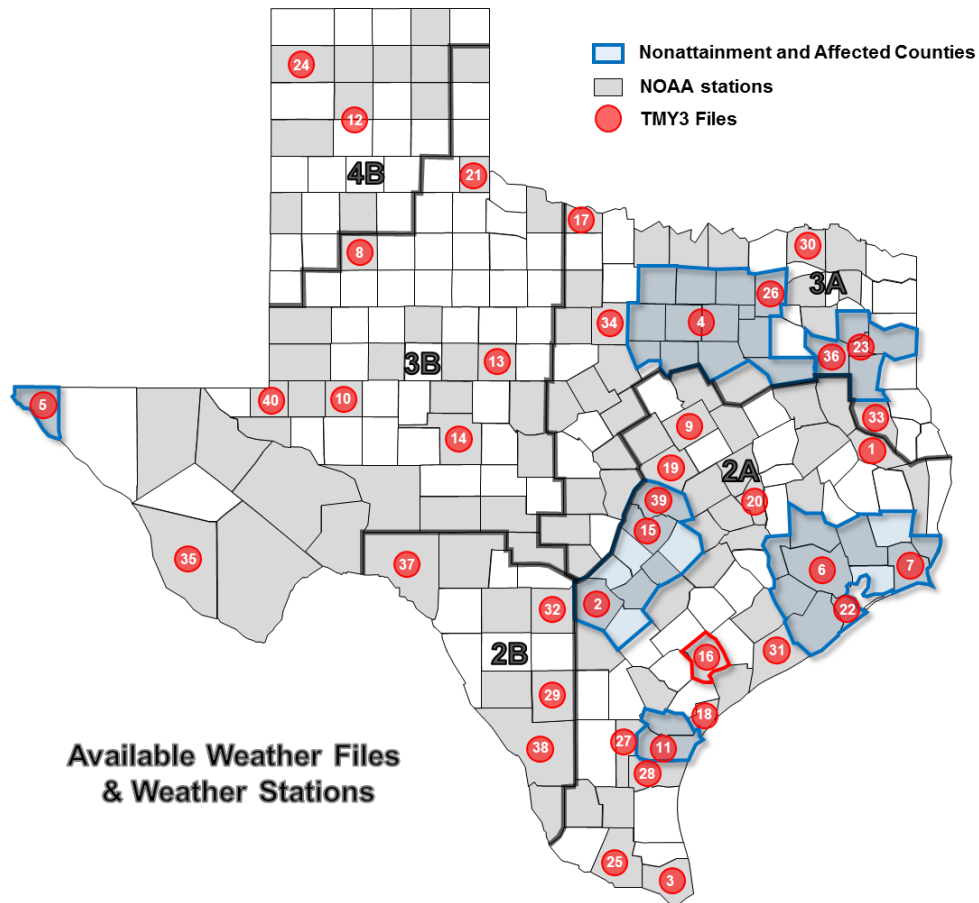
In 2001, the Texas Legislature adopted the Texas Emissions Reduction Plan, identifying thirty-eight counties in Texas where a focus on air quality improvements was deemed critical to public health and economic growth. In 2008, twenty counties were designated as non-attainment counties that include: Brazoria, Chambers, Collin, Dallas, Denton, Ellis, Fort Bend, Hardin, Harris, Jefferson, Galveston, Johnson, Kaufman, Liberty, Montgomery, Orange, Parker, Rockwall, Tarrant, and Waller. There were also 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. By 2017, forty-two counties are designated as non-attainment counties that include: Bastrop, Bexar, Brazoria, Caldwell, Chambers, Collin, Comal, Dallas, Denton, El Paso, Ellis, Fort Bend, Galveston, Gregg, Guadalupe, Hardin, Harris, Harrison, Hays, Henderson, Hood, Hunt, Jefferson, Kaufman, Liberty, Montgomery, Nueces, Orange, Parker, Rockwall, Rusk, San Patricio, Smith, Tarrant, Travis, Upshur, Victoria, Waller, Williamson, Wilson, and Wise (TCEQ 2016). These areas are shown on the map in Figure 3 as non-attainment and near non-attainment.

These counties represent several geographic areas of the state, which have been assigned to different climate zones by the 2015 IECC<sup>5</sup> as shown in Figure 4, based primarily on Cooling Degree Days (CDD) and Heating Degree Days (HDD). These include climate zone 3 (i.e.,  $4,500 < CDD_{50} \leq 6,300$  and  $HDD_{65} \leq 5,400$ ) for the Dallas-Ft. Worth and El Paso areas, and climate zone 2 (i.e.,  $6,300 < CDD_{50} \leq 9,000$ ) 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 Local Climatological Data (LCD) (NOAA 2018), and the Typical Meteorological Year (TMY3) (NREL 2019) stations, which are used for simulation purposes.



<sup>5</sup> The "2000 IECC" notation is used to signify the 2000 International Residential Code (IRC), which includes the International Energy Conservation Code (IECC). The 2000 IECC, as modified by the 2001 Supplement (IECC 2001), published by the ICC in March of 2001, as was referenced by Senate Bill 5. The latest version adoption of IECC in Texas is IECC 2015.

Figure 3: TCEQ Nonattainment and Affected Counties



**Available Weather Files & Weather Stations**

List of Available TMY3 Weather Files	
<b>Texas TMY3 Weather Files</b>	
1	Lufkin Angelina Co (LFK)
2	San Antonio Intl AP (SAT)
3	Brownsville S Padre Isl Intl (BRO)
4	Dallas-Fort Worth Intl AP (DFW)
5	El Paso International AP [UT] (ELP)
6	Houston Bush Intercontinental (IAH)
7	Port Arthur Jefferson County (BPT)
8	Lubbock International AP (LBB)
9	Waco Regional AP (ACT)
10	Midland International AP (MAF)
11	Corpus Christi Intl Arprt [UT] (CRP)
12	Amarillo International AP [Canyon - UT] (AMA)
13	Abilene Regional AP [UT] (ABI)
14	San Angelo Mathis Field (SJT)
15	Austin Mueller Municipal AP [UT] (ATT)
16	Victoria Regional AP (VCT)
17	Wichita Falls Municipal Arprt (SPS)
18	Rockport/Aransas Co (RKP)
19	Fort Hood (ILE)
20	College Station Easterwood FI (CLL)
21	Childress Municipal AP (CDS)
22	Galveston/Scholes (GLS)
23	Longview Gregg County AP [Overton - UT] (GGG)
24	Dalhart Municipal AP (DHK)
25	McAllen Miller Intl AP [Edinburg - UT] (EBG)
26	Greenville/Majors (GVT)
27	Alice Intl AP (ALI)
28	Kingsville (IKG)
29	Cotulla Faa AP (COT)
30	Cox Fld (PRX)
31	Palacios Municipal AP (PSX)
32	Hondo Municipal AP (HDO)
33	Nacogdoches (AWOS) (OCH)
34	Mineral Wells Municipal AP (MWL)
35	Marfa AP (MRF)
36	Tyler/Pounds Fld (TYR)
37	Del Rio Laughlin AFB (DRT)
38	Laredo Intl AP [UT] (LRD)
39	Georgetown (AWOS) (GTU)
40	Wink Winkler County AP (INK)

Figure 4: Available weather data, and TMY3 weather files compared to IECC weather zones for Texas

## 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.

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.

These responsibilities were not updated in 2013.

These responsibilities 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.

These responsibilities were not updated in 2017.

These responsibilities were not updated in 2018.

These responsibilities were not updated in 2019.

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 2005-2018) 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.
- 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. (HB1365, 2003)
- 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. (HB1365, 2003)

#### 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

This section has been merged into Section 2.2.3.

### 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 79<sup>th</sup> 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 80<sup>th</sup> 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 81<sup>st</sup> 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 82<sup>nd</sup> Legislature (2011) through HB-1, the Laboratory's responsibilities under TERP increased:

The 82<sup>nd</sup> 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 82<sup>nd</sup> 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 82<sup>nd</sup> 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 82<sup>nd</sup> 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 83<sup>rd</sup> 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.

The 85<sup>th</sup> Legislature (2017) did not change any of the Laboratory's previously established responsibilities under TERP.

The 86<sup>th</sup> Legislature (2019) did not change any of the Laboratory's previously established responsibilities under TERP.

### 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
- A Volume I Summary Report, and
- Supporting data files (Volume II Technical Appendix), including weather data, and wind energy 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 the improved method and 2019 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 2019 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 2019 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 May 1 to September 30, and Non-Ozone Season Period (Non-OSP);
- predicting 2008 wind power generation as a baseline, using developed coefficients from 2018 daily OSP and Non-OSP models for all the wind farms; and
- the analysis of 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 nineteen new wind farms which started operation in 2018 and 2019 were added, including BLSUMMIT\_UNIT2\_17, BLSUMMIT\_UNIT2\_25, CABEZON\_WIND1, CABEZON\_WIND2, CFLATS\_U1, CN\_BRKS\_UNIT\_1, LOCKETT\_UNIT1, MIDWIND\_UNIT1, OVEJA\_G1, OVEJA\_G2, SHAFFER\_UNIT1, STELLA\_UNIT1, S\_HILLS\_UNIT1, TAHOKA\_UNIT\_1, TAHOKA\_UNIT\_2, TORR\_UNIT1\_25, TORR\_UNIT2\_23, TORR\_UNIT2\_25, WL\_RANCH\_UNIT1. Figure 5 shows the measured annual wind power generation in 2019 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 2019 is 74,903,938 MWh/yr, which is 2.4% lower 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 2019 is 198,978 MWh/day, which is 2.4% lower than the 2008 OSP baseline wind production. For the analysis of this year, the measured 2019 wind power generation is slightly lower 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.

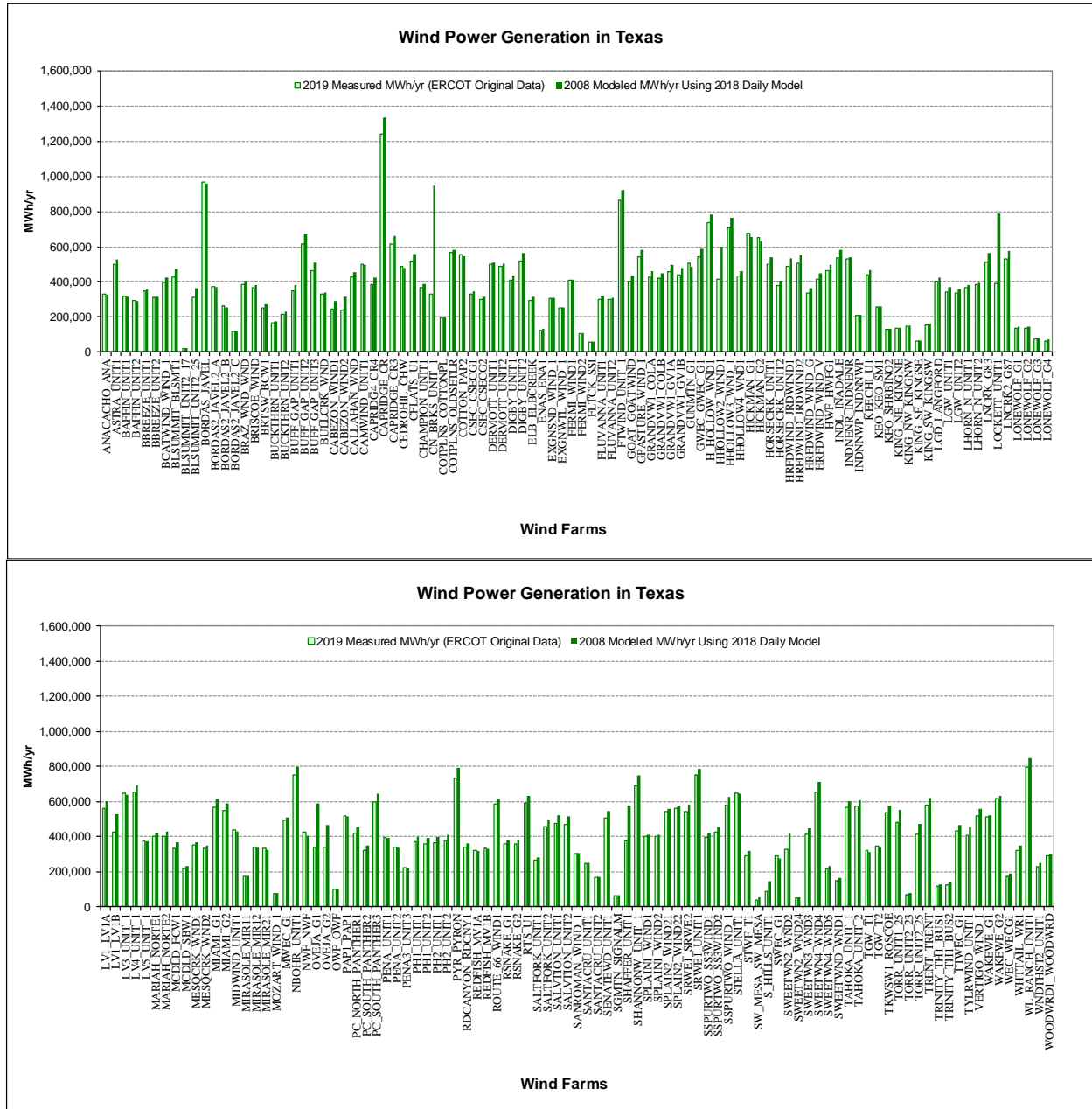


Figure 5: Comparison of 2019 Measured and 2008 Estimated Wind Power Production for Each Wind Farm

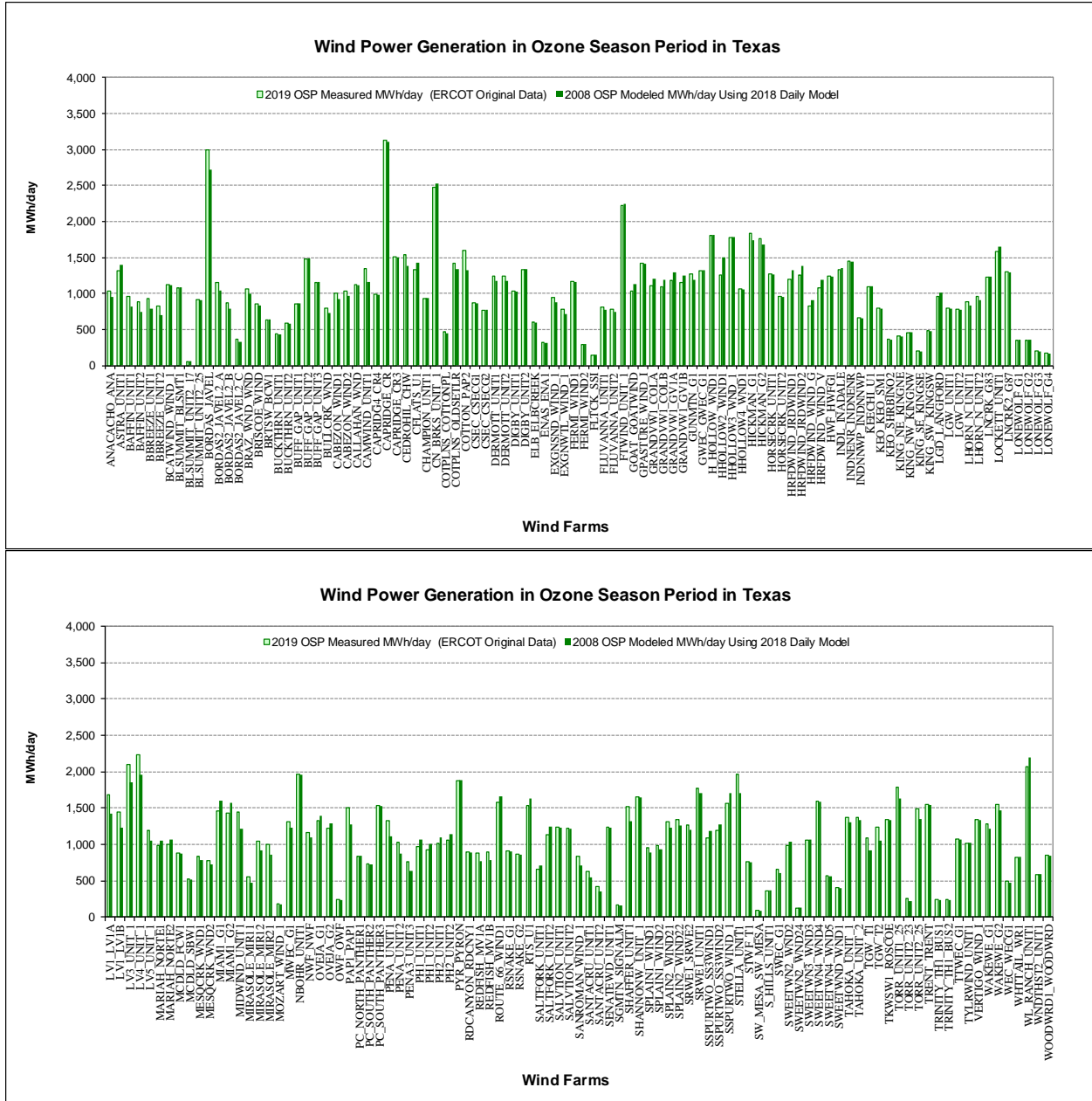


Figure 6: Comparison of 2019 OSP Measured and 2028 OSP Estimated Wind Power Production for Each Wind Farm

### 3.2 Analysis of emissions reductions from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NO<sub>x</sub> reductions from electricity savings from wind projects implemented in the Competitive Load (CL) zones in ERCOT was presented. The calculation of the NO<sub>x</sub> emission reductions is based on the 2016 eGRID as modified according to ESL-TR-08-12-04 report (US EPA and ESL, 2008). As shown in Table 4 based on the 2019 measured ERCOT data, the total MWh savings for all the wind farms within the ERCOT region are 74,903,938 MWh/yr and 203,888 MWh/day for an average day in the OSP. The total NO<sub>x</sub> emissions reductions in 2019 across all the counties amount are 37,812 tons/yr and 108.4 tons/day for the OSP.

Table 4: Electricity Generation and NO<sub>x</sub> Emission Reductions for All the Wind Farms in ERCOT Region in 2019

	<b>Annual</b>	<b>OSP</b>
<b>Actual Measured Electricity Generation in 2019</b>	74,903,938 [MWh/yr]	203,888 [MWh/day]
<b>NO<sub>x</sub> Emission Reduction in 2019</b>	37,812 [tons/yr]	108.4 [tons/day]

### 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.

In this analysis, a sliding statistical index was established for each site that used the 10th, 25th, 50th, 75th, 90th, and 99th 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 5*, of the one hundred and forty-one sites analyzed, eighty-eight sites showed an increase when one compares the 90th percentile of the whole period to the 90th percentile of the first 12-month period, ranging from 0.3% to 62.1%. The remaining fifty-three sites showed a decrease from -0.1% to -26.9%. The weighted average of this increase across all wind farms studied is 4.2% (positive), which indicates that no degradation was observed from the aggregated energy production from these wind farms over the studied operation period. Based on the observations, special attention needs to be paid to sites Papalote Creek Wind Farm (-11.3%), Penascal Wind 3 (-13.0%), Southwest Mesa Wind Farm (-15.2%), Big Spring Wind Farm (-21.3%), Harbor Wind (-21.9%), and Sherbino 2 Wind (-26.9%). Those wind farms have comparison percentages larger than 10%, which may be caused by wind farm operation issues, meter problems or other similar issues.

Table 5: Summary of 90th Percentile Hourly Wind Power Analysis for 141 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%	83.0	-0.5%	89.2	6.9%	74	100
Baffin Wind 1	Jan-16	82.7	81.9	-1.0%	63.6	-23.1%	86.1	4.1%	48	100
Baffin Wind 2	Jan-16	80.3	77.9	-3.0%	57.3	-28.6%	82.8	3.2%	48	102
Barton Chapel Wind 1	Dec-09	74.9	75.5	0.8%	61.2	-18.2%	89.1	19.0%	121	120
Big Spring Wind Farm	Dec-02	27.2	21.4	-21.3%	11.1	-59.2%	27.2	0.0%	205	41
Blue Summit Wind	Oct-13	121.9	119.8	-1.7%	114.6	-6.0%	128.5	5.4%	75	135
Bobcat Bluff Wind	Nov-13	115.0	108.2	-5.9%	92.8	-19.4%	127.9	11.2%	74	150
Brazos Wind Ranch	Dec-04	127.5	123.3	-3.3%	93.5	-26.7%	139.4	9.3%	181	160
Briscoe Wind	Jun-16	123.4	117.4	-4.9%	102.4	-17.0%	128.3	4.0%	43	149.8
Buffalo Gap 1	Nov-06	100.9	97.7	-3.2%	75.4	-25.2%	105.7	4.8%	158	120
Buffalo Gap2	Apr-08	183.4	178.8	-2.5%	104.9	-42.8%	207.6	13.2%	141	233
Buffalo Gap3	Apr-10	122.4	140.1	14.5%	122.4	0.0%	152.1	24.2%	117	170
Bull Creek Wind Plant	Dec-09	93.9	95.5	1.7%	41.5	-55.8%	130.4	38.9%	121	180
Callahan Divide Wind	Feb-06	93.3	94.3	1.1%	83.9	-10.0%	101.5	8.8%	167	114
Cameron County Wind [Camwind_Unit	Oct-16	142.4	129.7	-8.9%	119.8	-15.9%	142.5	0.1%	39	165
Camp Springs Wind 2	Jan-09	94.0	97.3	3.5%	79.4	-15.5%	107.9	14.8%	132	120
Camp Springs Wind Energy Center	Apr-08	111.3	106.2	-4.6%	87.7	-21.2%	120.9	8.6%	141	130
Capricorn Ridge Wind 1&2	Aug-08	258.0	256.9	-0.4%	174.5	-32.4%	309.3	19.9%	137	364
Capricorn Ridge Wind 3	Jan-09	120.3	137.7	14.5%	97.9	-18.6%	157.2	30.7%	132	186
Capricorn Ridge Wind 4	May-09	83.5	86.8	4.0%	67.6	-19.0%	100.2	20.0%	128	112.5
Cedro Hill Wind	Dec-11	136.3	123.4	-9.5%	101.9	-25.2%	136.9	0.4%	97	150
Champion Wind Farm	Jan-09	89.4	102.2	14.2%	87.7	-1.9%	113.2	26.6%	132	126.5
Desert Sky Wind Farm	Dec-02	89.0	116.3	30.7%	83.1	-6.7%	134.4	50.9%	205	160.5
Doug Colbeck's Corner (Conway) B	Jan-17	90.1	91.7	1.8%	85.7	-4.8%	94.7	5.2%	36	100.2
Doug Colbeck's Corner (Conway) A	Jan-17	92.6	92.9	0.3%	91.2	-1.5%	95.2	2.8%	36	100.2
Elbow Creek Wind	Dec-09	94.5	93.3	-1.3%	70.2	-25.7%	104.5	10.6%	121	121.9
Forest Creek Wind	Dec-07	105.2	104.4	-0.8%	92.4	-12.1%	111.2	5.7%	145	124.2
Goat Wind	Apr-09	67.0	103.8	54.9%	61.8	-7.8%	122.6	83.0%	129	150
Goldthwaite Wind 1	Dec-14	122.8	127.6	3.9%	115.8	-5.7%	134.4	9.4%	61	149
Grandview Wind 1 (Conway) GV1A	Nov-15	99.3	99.1	-0.1%	97.2	-2.1%	101.4	2.2%	50	107
Grandview Wind 1 (Conway) GV1B	Nov-15	94.0	94.5	0.5%	90.8	-3.5%	98.0	4.2%	50	104
Green Pastures Wind 1	Feb-16	125.2	134.5	7.5%	125.2	0.0%	139.2	11.2%	47	150
Gulf Wind 1	Jun-10	108.6	104.7	-3.6%	85.2	-21.6%	119.4	9.9%	115	141.6
Gulf Wind 2	Jun-10	116.5	114.4	-1.8%	89.7	-23.0%	126.3	8.4%	115	141.6
Gunsight Mountain Wind	Jan-17	109.5	113.7	3.8%	109.5	0.0%	115.2	5.2%	36	119.9
Hackberry Wind	Dec-09	138.0	127.0	-8.0%	105.8	-23.3%	140.6	1.9%	121	165.5
Harbor Wind	Jan-13	6.1	4.8	-21.9%	0.7	-88.0%	7.1	15.9%	84	9
Hereford Wind G	Dec-15	80.9	83.5	3.3%	79.9	-1.2%	86.9	7.5%	49	99.9
Hereford Wind V	Dec-15	90.4	94.1	4.1%	90.4	0.0%	95.7	5.8%	49	100
Hidalgo & Starr Wind 11	Jul-17	45.1	46.6	3.3%	45.1	0.0%	47.3	5.1%	30	52
Hidalgo & Starr Wind 12	Jul-17	85.8	89.1	3.8%	85.8	0.0%	91.2	6.3%	30	98
Hidalgo & Starr Wind 21	Jul-17	85.0	87.7	3.2%	85.0	0.0%	89.2	4.9%	30	100
Horse Hollow Phase 1	Jun-06	157.0	166.4	6.0%	141.3	-10.0%	185.1	17.9%	163	213
Horse Hollow Phase 2	Aug-07	145.7	139.6	-4.2%	99.0	-32.1%	160.6	10.2%	149	184
Horse Hollow Phase 3	May-07	169.2	167.6	-1.0%	123.9	-26.8%	187.7	11.0%	152	223.5
Horse Hollow Phase 4	Jun-07	88.6	90.0	1.6%	80.9	-8.7%	103.1	16.3%	151	115
Inadale Wind	Sep-10	117.9	139.5	18.4%	99.0	-16.0%	166.3	41.1%	112	197
Indian Mesa Wind Farm	Dec-02	48.0	54.7	13.9%	36.0	-24.9%	72.2	50.5%	205	82.5
Javelina Wind 18	Sep-16	211.0	221.7	5.1%	211.0	0.0%	229.3	8.7%	40	249.7
Jumbo Road Wind 1	Mar-16	117.3	124.0	5.8%	117.3	0.0%	129.1	10.1%	46	146.2
Jumbo Road Wind 2	Mar-16	119.7	127.8	6.8%	119.7	0.0%	133.0	11.1%	46	153.6
Keechi Wind 138 Kv Joplin	Dec-15	99.7	102.5	2.9%	99.5	-0.2%	103.8	4.1%	49	110
King Mountain-NE Wind Farm	Dec-02	41.8	43.5	4.0%	20.8	-50.3%	56.4	34.8%	205	79.3
King Mountain-NW Wind Farm	Dec-02	44.7	51.8	15.9%	27.7	-37.9%	65.3	46.1%	205	79.3
King Mountain-SE Wind Farm	Dec-02	21.6	21.9	1.4%	11.8	-45.7%	28.1	29.8%	205	40.3
King Mountain-SW Wind Farm	Dec-02	41.6	44.1	6.1%	22.9	-44.9%	53.7	29.1%	205	79.3
Langford Wind	Dec-10	115.7	125.9	8.8%	107.8	-6.9%	134.3	16.0%	109	150
Logans Gap Wind 1 U1	Apr-16	88.5	85.7	-3.2%	80.6	-9.0%	90.6	2.3%	45	103.8
Logans Gap Wind 1 U2	Apr-16	83.8	83.4	-0.5%	77.5	-7.6%	86.6	3.3%	45	106.3
Lone Star-Mesquite Wind	Sep-08	140.4	147.6	5.1%	128.9	-8.2%	168.1	19.7%	136	200
Lone Star-Post Oak Wind	Mar-09	149.1	152.7	2.4%	134.7	-9.6%	170.5	14.4%	130	200
Longhorn Wind North U1	Mar-16	91.0	93.0	2.2%	91.0	0.0%	94.0	3.3%	46	100
Longhorn Wind North U2	Dec-15	88.9	93.2	4.9%	88.9	0.0%	95.0	6.9%	49	100
Loraine Windpark I	Dec-10	30.4	36.0	18.5%	25.9	-14.8%	42.3	39.2%	109	126
Loraine Windpark II	Dec-10	27.8	36.6	31.8%	25.7	-7.6%	43.3	55.7%	109	124.5
Loraine Windpark III	Jan-12	16.2	20.5	26.3%	16.2	0.0%	22.6	39.4%	96	26
Loraine Windpark IV	Dec-12	17.4	17.3	-0.7%	5.0	-71.5%	20.8	19.1%	85	24
Los Vientos Wind I	Oct-13	148.5	165.5	11.4%	148.5	0.0%	175.1	17.9%	75	200.1
Los Vientos Wind II	Nov-13	153.3	152.2	-0.8%	134.4	-12.3%	164.3	7.2%	74	201.6
Los Vientos III Wind	Feb-16	154.0	168.6	9.5%	154.0	0.0%	175.9	14.3%	47	200
Los Vientos IV Wind	Apr-17	167.7	175.3	4.5%	167.7	0.0%	180.0	7.3%	33	200
Los Vientos V Wind	Nov-16	91.9	93.8	2.1%	91.7	-0.2%	96.8	5.4%	38	110



Table 5: Summary of 90th Percentile Hourly Wind Power Analysis for 141 Sites in Texas (Continued)

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		
Magic Valley Wind (Redfish) 1A	Apr-13	88.6	86.0	-2.9%	79.3	-10.5%	90.7	2.4%	81	99.8
Magic Valley Wind (Redfish) 1B	Jul-13	94.2	89.7	-4.8%	83.8	-11.1%	94.6	0.4%	78	103.5
McAdoo Wind	Dec-09	111.7	136.5	22.2%	111.7	0.0%	143.6	28.5%	121	150
Mesquite Creek Wind 1	Dec-15	93.3	93.2	-0.1%	87.4	-6.3%	97.7	4.7%	49	105.6
Mesquite Creek Wind 2	Dec-15	90.5	91.4	1.0%	84.8	-6.3%	96.2	6.2%	49	105.6
Miami Wind G1	Aug-15	125.8	130.0	3.3%	125.8	0.0%	132.6	5.4%	53	144
Miami Wind G2	Aug-15	126.0	130.5	3.6%	126.0	0.0%	133.4	5.9%	53	144
Notrees Windpower	Feb-10	103.7	112.9	9.0%	103.7	0.0%	122.9	18.6%	119	153
Ocotillo Windpower	Dec-09	39.1	39.9	2.0%	27.3	-30.2%	47.2	20.7%	121	58.8
Panhandle Wind 1 U1	May-15	94.5	97.8	3.6%	93.5	-1.1%	101.3	7.2%	56	109
Panhandle Wind 1 U2	May-15	90.6	93.7	3.4%	87.1	-3.8%	98.0	8.2%	56	109
Panhandle Wind 2 U1	Oct-15	88.2	87.9	-0.4%	84.8	-3.8%	90.0	2.0%	51	94
Panhandle Wind 2 U2	Sep-15	90.2	90.7	0.7%	88.1	-2.3%	93.4	3.6%	52	97
Panther Creek 2	Dec-09	91.8	96.4	5.0%	83.5	-9.0%	104.2	13.5%	121	115.5
Panther Creek 3	Aug-10	128.5	155.1	20.7%	120.0	-6.6%	177.1	37.8%	113	199.5
Panther Creek	Dec-09	114.4	121.4	6.1%	107.8	-5.8%	128.9	12.7%	121	142.5
Papalote Creek Phase II	Dec-11	174.2	164.5	-5.6%	154.2	-11.5%	176.3	1.2%	97	200.1
Papalote Creek Wind Farm	Dec-10	150.1	133.2	-11.3%	39.6	-73.6%	157.9	5.2%	109	180
Penascal Wind 1	Feb-11	133.2	124.5	-6.5%	99.7	-25.2%	141.5	6.2%	107	161
Penascal Wind 2	Dec-09	83.3	108.3	30.0%	80.7	-3.1%	125.4	50.5%	121	142
Penascal 3	May-11	87.1	75.8	-13.0%	65.7	-24.6%	88.8	2.0%	104	101
Pyron	Dec-09	157.2	192.4	22.5%	151.4	-3.7%	220.1	40.0%	121	249
Rattlesnake Den Wind Phase 1 G1	Mar-16	97.0	95.6	-1.5%	81.6	-15.8%	99.7	2.8%	46	104.3
Rattlesnake Den Wind Phase 1 G2	Mar-16	93.5	92.3	-1.2%	81.0	-13.4%	97.3	4.0%	46	103
Red Canyon1	Aug-07	76.4	75.5	-1.1%	71.0	-7.0%	79.1	3.6%	149	84
Roscoe Wind Farm	Dec-08	169.4	153.3	-9.5%	108.1	-36.2%	179.8	6.2%	133	209
Route 66 Wind	Mar-16	139.0	140.1	0.8%	132.9	-4.4%	142.6	2.5%	46	150
Saltfork_Unit1	Aug-17	58.1	60.6	4.3%	58.1	0.0%	61.7	6.2%	29	64
Saltfork_Unit2	Aug-17	100.9	104.2	3.3%	100.9	0.0%	105.4	4.4%	29	110
Sand Bluff Wind	Nov-08	69.4	64.4	-7.2%	48.5	-30.2%	75.4	8.6%	134	90
Senate Wind	Sep-13	127.1	125.7	-1.1%	119.0	-6.4%	132.2	4.0%	76	150
Sendero Wind Energy	Aug-16	67.2	70.4	4.8%	67.2	0.0%	72.4	7.7%	41	76
Shannon Wind	Oct-16	175.3	179.5	2.4%	175.3	0.0%	183.9	4.9%	39	204.1
Sherbino 1 Wind	Dec-09	104.7	107.1	2.4%	77.5	-26.0%	128.1	22.4%	121	150
Sherbino 2 Wind	Dec-12	125.7	91.9	-26.9%	36.8	-70.7%	125.7	0.0%	85	150
Silver Star Wind	Apr-09	40.6	42.7	5.3%	16.5	-59.4%	50.5	24.4%	129	60
Snyder Wind Project	Dec-08	46.5	44.2	-5.0%	34.2	-26.3%	50.9	9.6%	133	63
South Plains Wind 2	Jul-16	89.2	90.7	1.7%	88.1	-1.2%	92.5	3.7%	42	98
South Plains Wind II A	Dec-16	120.2	135.5	12.7%	120.2	0.0%	141.3	17.5%	37	148.5
South Plains Wind II B	Dec-16	137.7	141.5	2.8%	128.1	-6.9%	145.1	5.4%	37	151.8
South Plains Wind I	Jul-16	94.8	93.8	-1.0%	90.7	-4.4%	95.5	0.8%	42	102
South Trent Wind Farm	Dec-09	67.7	83.1	22.8%	65.4	-3.5%	91.0	34.4%	121	101.2
Southwest Mesa Wind Farm	Dec-02	51.1	43.3	-15.2%	11.9	-76.6%	56.5	10.6%	205	74.6
Spinning Spur 3 (Wind 1)	Apr-16	87.5	90.5	3.4%	87.5	0.0%	91.6	4.7%	45	96
Spinning Spur 3 (Wind 2)	Apr-16	88.4	92.8	4.9%	88.4	0.0%	93.9	6.2%	45	98
Spinning Spur Wind Two	May-15	140.9	145.9	3.6%	140.9	0.0%	149.4	6.1%	56	161
Stanton Wind Energy	Dec-08	79.4	96.4	21.4%	79.4	0.0%	107.1	34.8%	133	120
Stephens Ranch Wind 2	Mar-16	144.3	148.9	3.3%	144.3	0.0%	151.9	5.3%	46	164.7
Stephens Ranch Wind 1	Nov-15	182.9	189.0	3.3%	182.9	0.0%	193.1	5.6%	50	211
Sweetwater Wind 1	Dec-04	34.1	32.9	-3.4%	28.8	-15.4%	35.8	5.0%	181	37.5
Sweetwater Wind 2	Jan-06	71.4	82.1	15.1%	71.4	0.0%	89.5	25.4%	168	97.5
Sweetwater Wind Farm 3	Dec-06	99.6	101.2	1.6%	67.1	-32.7%	111.2	11.6%	157	135
Sweetwater Wind 4	Mar-08	161.0	171.3	6.4%	153.2	-4.9%	182.2	13.2%	142	240.8
Sweetwater Wind 5	Dec-08	66.5	62.4	-6.1%	56.3	-15.3%	69.3	4.3%	133	80.5
Sweetwater Wind24	Mar-08	13.1	13.7	4.7%	12.0	-8.7%	14.8	13.3%	142	16
Trent Mesa Wind Farm	Dec-02	108.8	113.2	4.0%	34.2	-68.5%	132.8	22.0%	205	150
Trinity Hills Wind Farm 1	Dec-12	77.8	77.8	-1.3%	35.7	-54.7%	89.3	13.3%	85	118
Trinity Hills Wind Farm 2	Dec-12	74.8	75.9	1.5%	35.9	-52.0%	88.0	17.7%	85	108
Turkey Track Wind Energy Center	Dec-09	77.4	125.4	62.1%	76.5	-1.1%	143.1	85.0%	121	169.5
Tyler Bluff Wind	Aug-17	104.0	107.8	3.7%	104.0	0.0%	110.7	6.5%	29	125.6
Vertigo Wind (Formerly Green Pastures)	Nov-16	123.5	129.8	5.1%	121.3	-1.8%	133.4	8.0%	38	150
Wake Wind 1	Apr-17	109.3	109.1	-0.2%	107.4	-1.8%	110.2	0.8%	33	114.9
Wake Wind 2	Apr-17	136.0	135.5	-0.4%	133.3	-2.0%	137.0	0.7%	33	142.3
Whirlwind	Dec-08	54.0	51.8	-4.1%	39.8	-26.3%	56.9	5.4%	133	60
Whitetail Wind	Oct-13	72.9	68.4	-6.1%	64.2	-11.9%	73.1	0.3%	75	92
Windthorst 2 Wind	Oct-15	50.3	56.7	12.6%	50.3	0.0%	59.4	18.1%	51	68
WKN Mozart Wind	Oct-13	22.4	22.2	-1.1%	20.4	-9.0%	25.8	15.0%	75	30
Wolf Ridge Wind	Dec-09	105.9	101.3	-4.4%	87.5	-17.4%	108.8	2.7%	121	112.5
Woodward Wind Farm	Dec-02	85.3	94.4	10.7%	65.2	-23.5%	112.4	31.8%	205	159.7
<b>Weighted Average:</b>				<b>4.2%</b>		<b>-14.1%</b>		<b>14.5%</b>	<b>Total:</b>	<b>18114.2</b>

### 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 6 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/OSP energy savings and annual NOx emission reductions for solar photovoltaic, including solar power, solar thermal, biomass, and hydroelectric projects. The annual/OSP energy savings calculation for solar photovoltaic and solar thermal was conducted based on the project data from various web sources. 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/OSP energy generation. Then, the annual NOx emission reductions calculation was conducted with the special version of Texas 2016 eGrid.

In 2019, the total annual/OSP energy savings from each renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 418,001 MWh/yr and 1,283 MWh/day; in addition, solar power projects (utility-scale): 4,412,015 MWh/yr and 14,696 MWh/day,
- solar thermal projects: 250 MWh/yr and 0.7 MWh/day,
- biomass projects: 420,635 MWh/yr and 1,324 MWh/day, and
- hydroelectric projects: 955,864 MWh/yr and 3,096 MWh/day.

In 2019, the annual NOx emission reductions from renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 153.3 tons/yr; in addition, solar power projects (utility-scale): 2277.2 tons/yr,
- solar thermal projects: 0.1 tons/yr and,
- hydroelectric projects: 341.5 tons/yr.

Table 6: Number of Identified Projects for Other Renewable Sources

Renewable Energy Projects	Number of 2019 New Projects	Total Number of Projects	Annual Measured/ Estimated Electricity Generation in 2019 [MWh/yr]	OSP Measured/ Estimated Electricity Generation in 2019 [MWh/day]	NOx Emission Reductions in 2019 [tons/yr]
Solar photovoltaic <sup>6, 7</sup>	N/A	29,406	418,001	1,283	153.3
Solar Power <sup>3</sup>	21	79	4,412,015	14,696	2277.2
Solar Thermal <sup>3</sup>	2	40	250	0.7	0.1
Biomass <sup>8</sup>	0	14	420,635	1,324	-
Hydroelectric	0	30	955,864	3,096	341.5
Geothermal	8	294	-	-	-
Landfill Gas-Fired <sup>9</sup>	0	34	-	-	-

<sup>6</sup> Based on previous report data, the “Tracking the Sun” project dataset of Lawrence Berkeley National Laboratory (LBNL) (<https://emp.lbl.gov/tracking-the-sun/>) is newly integrated from the 2020 report due to the service termination of the NREL “OpenPV” database. Thus, the total number of PV projects until 2019, including PV projects from various websites, is now 29,406. Previously, it was 4,794.

<sup>7</sup> The utility scale solar power used measured data of annual generations while non-utility scale solar photovoltaic and non-utility solar thermal used the estimations of electricity generations using the ESL calculators.

<sup>8</sup> Seven biomass projects had no generation. Therefore, they are excluded from the list for this year. Also, NOx emission reductions for biomass is not reported since biomass itself has high NOx emissions.

<sup>9</sup> 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.

### 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](http://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 2019 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 7 contains the data reported by ERCOT from 2001 to 2019. 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 7: Annual Electricity Generation by Renewable Resources (MWh, ERCOT: 2001 - 2019)<sup>10</sup>

Year	Biomass (MWh)	Hydro (MWh)	Landfill gas (MWh)	Solar <sup>6</sup> (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	848,410	57,796,161	59,804,357
2017	216,431	444,453	446,119	2,289,394	66,076,742	69,473,139
2018	287,014	334,460	395,428	3,183,238	73,960,577	78,160,716
2019	153,531	248,783	335,361	4,465,696	81,472,592	86,675,964

NOTE: The REC Program tracks renewable generation in Texas, including non-ERCOT regions of Texas.<sup>11</sup>

<sup>10</sup> Solar includes the utility scale solar power only

<sup>11</sup> <https://www.texasrenewables.com/reports.asp>

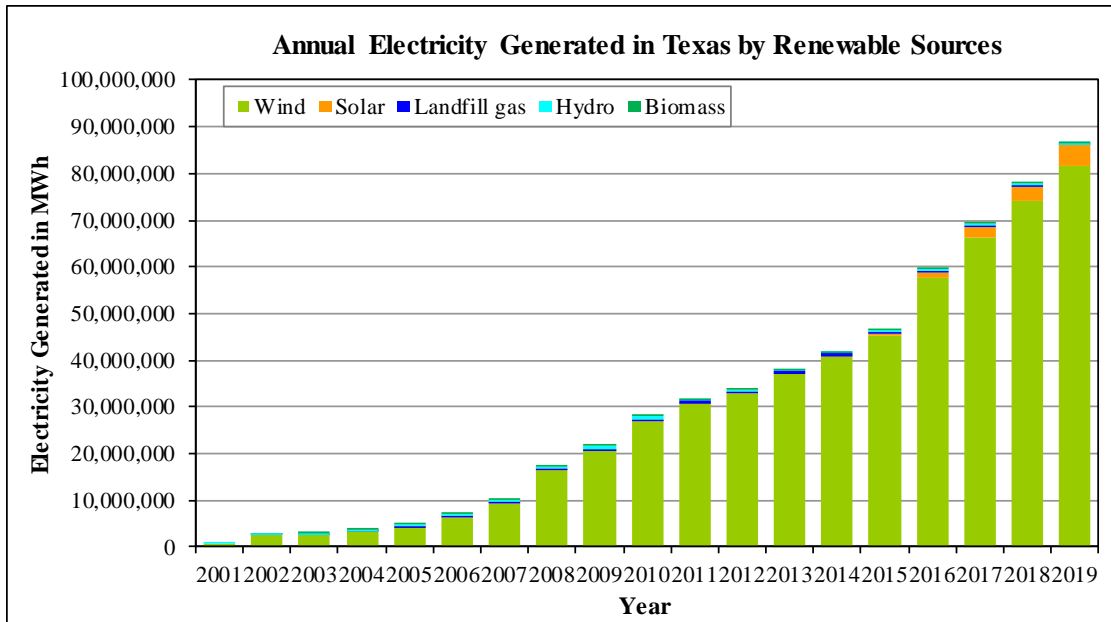


Figure 7: Electricity Generation by Renewable Resources (ERCOT: 2001–2019 Annual)

#### 4 Calculated NO<sub>x</sub> Reductions Potential from Energy Savings of New Construction in 2019

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<sup>12</sup>) and commercial buildings.

##### 4.1 2019 Results for New Single-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NO<sub>x</sub> emissions reductions in 2019 using the 2008 base year which implemented the 2015 IECC for new single-family residences in Texas, including the 42 non-attainment and affected counties as well as other counties in the ERCOT region.<sup>13</sup> To calculate the NO<sub>x</sub> emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2019 building permits per county was obtained from the real estate center at Texas A&M University (REC 2020). 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 2018 Home Innovation Research Labs (HIRL) data<sup>14</sup> were used to determine the appropriate construction data corresponding to housing types. Then the NO<sub>x</sub> reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2016 eGRID database (USEPA 2016).<sup>15</sup>

In Table 8, the 2019 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 8, 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 Table 8 represent the only changes that were made to the simulation to obtain the savings calculations. In cases where the 2019 values were more efficient than the 2015 IECC requirements, the 2018 values were used in the 2019 new single-family simulations. Otherwise, the 2015 IECC values were used in both simulations.<sup>16</sup> For example, in Collin County, according to the HIRL's survey data, the roof insulation is R-29.72, which is less than the code-required insulation of R-38. Therefore, R-38 was used in the 2019 simulation.

<sup>12</sup> The potential energy savings and NO<sub>x</sub> reductions analysis from energy savings of new single- and multi-family constructions in 2016 through 2019 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.

<sup>13</sup> The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.

<sup>14</sup> 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>

<sup>15</sup> 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.

<sup>16</sup> 2018 HIRL data and 2015 IECC are used for the 2019 new code-compliant simulations and 2008 NAHB data and 2006 IECC are used for the base-year simulations

In Table 9 the code-traceable simulation results for single-family residences are shown for each county. In a similar fashion to Table 8, Table 9 is first divided into the US EPA's non-attainment and affected classifications, followed by an alphabetical list of other ERCOT counties and other counties in Texas. In the third column, the 2015 IECC climate zone is listed followed by the number of new projected housing units<sup>17</sup> 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 2019 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 10, the Competitive Load (CL) Zones<sup>18</sup> assignments for each county are shown. In Table 11, the annual electricity savings are assigned to CL Zones provider(s) according to Table 10.<sup>19</sup> The total electricity savings for each CL Zone, as shown in Table 11, then entered into the bottom row of Table 12, which is the 2016 US EPA's eGRID database<sup>20</sup> for Texas. Next, the county's NOx reductions (lbs) are calculated using the assigned 2016 eGRID proportions (lbs-NOx/MWh) to each electric power market and each CL zone in the county. The calculated NOx reductions are presented in the columns adjacent to the corresponding each electric power market and CL 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.

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<sup>17</sup> The number of the new housing units in 2019 were obtained from the Real Estate Center at Texas A&M University.

<sup>18</sup> ERCOT region has employed the Competitive Load (CL) zones, and it is currently divided into four zones: Houston (H), North (N), South (S), and West (W).

<sup>19</sup> 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.

<sup>20</sup> This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 7%. Counties were assigned to CL Zones as indicated.

Table 8: 2019 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences

	County	Climate Zone	Division East or West	2019 Average				2015 IECC				
				Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	CHAMBERS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	COLLIN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	DALLAS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	DENTON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	EL PASO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	ELLIS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	FORT BEND	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	GALVESTON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	HARRIS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	JOHNSON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	KAUFMAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	LIBERTY	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	MONTGOMERY	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	PARKER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	ROCKWALL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	TARRANT	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	WALLER	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	WISE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	Affected	BASTROP	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
BEXAR		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
CALDWELL		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
COMAL		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
GREGG		3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20	
GUADALUPE		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
HARRISON		3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20	
HAYS		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
NUECES		2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
RUSK		3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20	
SAN PATRICIO		2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
SMITH		3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20	
TRAVIS		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
UPSHUR		3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
VICTORIA		2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
WILLIAMSON		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
WILSON		2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
ANDERSON		2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
ERCOT		ANDREWS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
		ANGELINA	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	ARANSAS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	ARCHER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	ATASCOSA	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	AUSTIN	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	BANDERA	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	BASTROP	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	BAYLOR	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	BEE	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	BELL	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	BEXAR	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	BLANCO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	BORDEN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	BOSQUE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	BRAZORIA	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	BRAZOS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	BREWSTER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	BRISCOE	4	West Texas	0.39	0.53	29.1	17.2	0.35	0.4	49	20	
	BROOKS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	BROWN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	BURLESON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	BURNET	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	CALDWELL	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	CALHOUN	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	CALLAHAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	CAMERON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	CHAMBERS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	CHEROKEE	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	CHILDRESS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	CLAY	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	COKE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	COLEMAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	COLLIN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	COLORADO	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
	COMAL	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
	COMANCHE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	CONCHO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	COOKE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
	CORYELL	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
COTTLE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20		

Table 8: 2019 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences (Continued)

	County	Climate Zone	Division East or West	2019 Average				2015 IECC			
				Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)
ERCOT	CRANE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	CROCKETT	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	CROSBY	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	CULBERSON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	DAWSON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	DE WITT	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	DELTA	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	DICKENS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	DIMMIT	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	DUVAL	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	EASTLAND	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	ECTOR	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	EDWARDS	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	ELLIS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	ERATH	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	FALLS	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	FANNIN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	FAYETTE	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	FISHER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	FOARD	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	FRANKLIN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	FREESTONE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	FRIO	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	GILLESPIE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	GLASSCOCK	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	GOLIAD	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	GONZALES	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	GRAYSON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	GRIMES	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	GUADALUPE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	HALL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HAMILTON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HARDEMAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HARRIS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	HASKELL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	HENDERSON	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20
	HIDALGO	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	HILL	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	HOOD	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HOPKINS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HOUSTON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	HOWARD	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HUDSPETH	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	HUNT	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	IRION	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
JACK	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
JACKSON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
JEFF DAVIS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
JIM HOGG	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
JIM WELLS	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
JOHNSON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
JONES	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KARNES	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
KAUFMAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KENDALL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KENEDY	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
KENT	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KERR	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KIMBLE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KING	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
KINNEY	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
KLEBERG	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
KNOX	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
LA SALLE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
LAMAR	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20	
LAMPASAS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20	
LAVACA	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	
LEE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13	
LEON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13	



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	County	Climate Zone	Division East or West	2019 Average				2015 IECC			
				Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)
ERCOT	LIMESTONE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	LIVE OAK	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	LLANO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	LOVING	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MADISON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	MARTIN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MASON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MATAGORDA	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	MAVERICK	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	MCCULLOCH	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MCLENNAN	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	MCMULLEN	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	MEDINA	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	MENARD	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MIDLAND	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MILAM	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	MILLS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MITCHELL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MONTAGUE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	MONTGOMERY	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	MOTLEY	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	NACOGDOCHES	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20
	NAVARRO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	NOLAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	NUECES	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	PALO PINTO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	PECOS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	PRESIDIO	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	RAINS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	REAGAN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	REAL	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	RED RIVER	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20
	REEVES	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	REFUGIO	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	ROBERTSON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	RUNNELS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	SAN SABA	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	SCHLEICHER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	SCURRY	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	SHACKELFORD	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	SMITH	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20
	SOMERVELL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	STARR	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	STEPHENS	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	STERLING	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	STONEWALL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	SUTTON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	TAYLOR	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	TERRILL	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	THROCKMORTON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	TITUS	3	East Texas	0.39	0.53	29.7	14.1	0.35	0.25	38	20
	TOM GREEN	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	UPTON	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	UVALDE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	VAL VERDE	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	VAN ZANDT	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	WALLER	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	WARD	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	WASHINGTON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	WEBB	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	WHARTON	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	WICHITA	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	WILBARGER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	WILLACY	2	East Texas	0.39	0.53	29.7	14.1	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	WINKLER	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	YOUNG	3	West Texas	0.39	0.53	29.1	17.2	0.35	0.25	38	20
	ZAPATA	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13
	ZAVALA	2	West Texas	0.39	0.53	29.1	17.2	0.4	0.25	38	13

Table 9: 2019 Annual Electricity Savings from New Single-family Residences

2019 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)	
Nonattainment County	BRAZORIA	3	3,207	55,799	50,326	5,856	509,871	485,856	24,015	
	CHAMBERS	3	792	13,558	12,237	1,414	137,724	130,018	7,706	
	COLLIN	3	9,259	180,060	155,879	25,873	3,482,346	3,177,377	304,969	
	DALLAS	3	5,547	107,977	93,041	15,982	1,798,131	1,661,088	137,043	
	DENTON	3	6,477	126,368	108,711	18,893	2,086,215	1,929,444	156,771	
	EL PASO	2	2,433	44,257	37,976	6,721	681,305	650,535	30,770	
	ELLS	3	1,913	37,238	32,087	5,512	620,123	572,861	47,262	
	FORT BEND	3	8,452	145,653	131,042	15,633	1,459,627	1,364,401	95,225	
	GALVESTON	3	2,197	38,226	34,477	4,012	349,294	332,842	16,452	
	HARDIN	2	208	3,563	3,214	372	36,085	34,058	2,027	
	HARRIS	2	17,903	308,521	277,573	33,114	3,091,776	2,890,071	201,706	
	JEFFERSON	2	623	10,672	9,629	1,117	108,072	101,980	6,092	
	JOHNSON	2	712	13,860	11,943	2,051	230,804	213,213	17,591	
	KAUFMAN	2	542	10,540	9,125	1,515	203,848	185,996	17,852	
	LIBERTY	2	823	14,191	12,763	1,528	141,740	132,733	9,007	
	MONTGOMERY	3	6,082	104,811	94,297	11,250	1,050,337	981,814	68,523	
	ORANGE	2	269	4,609	4,158	483	46,664	44,033	2,630	
	PARKER	2	390	7,387	6,394	1,062	127,115	117,428	9,687	
	ROCKWALL	2	1,283	24,950	21,600	3,585	482,541	440,282	42,259	
	TARRANT	2	8,432	164,137	141,432	24,294	2,733,341	2,525,021	208,320	
	WALLER	2	24	414	372	44	4,145	3,874	270	
	WFE	3	94	1,828	1,583	263	35,354	32,258	3,096	
	Affected County	BASTROP	2	166	3,065	2,683	409	32,304	27,711	4,593
		BEXAR	2	5,083	95,331	82,882	13,320	1,154,833	991,544	163,289
CALDWELL		3	292	5,300	4,641	706	62,904	53,914	8,990	
COMAL		3	2,747	51,520	44,792	7,199	624,105	535,859	88,246	
GREGG		3	192	3,338	2,974	389	43,353	42,271	1,082	
GUADALUPE		2	816	15,304	13,306	2,138	185,391	159,178	26,214	
HARRISON		2	56	974	868	113	12,645	12,329	316	
HAYS		2	3,211	58,309	51,043	7,774	691,675	592,733	98,942	
NUECES		3	1,262	22,298	19,992	2,468	184,907	173,153	11,755	
RUSK		2	0	0	0	0	0	0	0	
SAN PATRICIO		2	339	5,990	5,370	663	49,670	46,512	3,158	
SMITH		2	592	10,280	9,212	1,143	140,530	137,753	2,777	
TRAVIS		3	9,524	172,948	151,398	23,059	2,051,546	1,758,078	293,469	
UPSHUR		3	6	113	98	16	1,594	1,478	116	
VICTORIA		2	141	2,456	2,207	267	23,675	22,210	1,465	
WILLIAMSON		3	5,233	99,515	86,769	13,638	1,528,282	1,305,503	222,779	
ERCOT		WILSON	2	20	375	326	52	4,544	3,901	642
	ANDERSON	2	20	338	306	35	3,715	3,479	236	
	ANDREWS	3	28	520	450	75	9,645	8,980	664	
	ANGLINA	2	95	1,606	1,452	165	17,648	16,526	1,122	
	ARANSAS	2	241	4,258	3,818	471	35,311	33,066	2,245	
	ARCHER	3	31	615	531	90	12,410	11,478	932	
	ATASCOSA	2	45	844	734	118	10,239	8,792	1,447	
	AUSTIN	2	27	465	419	50	4,663	4,359	304	
	BANDERA	2	1	19	16	3	227	195	32	
	BAYLOR	3	0	0	0	0	0	0	0	
	BEE	2	11	192	172	21	1,847	1,733	114	
	BELL	2	2,111	41,602	36,060	5,930	658,245	567,403	90,841	
	BLANCO	3	11	206	176	33	2,491	2,286	205	
	BORDEN	3	19	391	337	58	7,084	6,550	533	
	BOSQUE	2	7	138	120	20	2,183	1,881	301	
	BRAZOS	2	1,009	17,388	15,644	1,866	174,250	162,882	11,368	
	BREWSTER	3	19	361	311	54	6,497	6,015	482	
	BRISCOE	4	7	139	122	18	3,516	2,899	617	
	BROOKS	2	1	32	29	4	230	209	21	
	BROWN	3	154	3,035	2,631	433	48,020	41,393	6,627	
	BURLESON	2	6	103	93	11	1,036	969	68	
	BURNET	3	603	11,304	9,631	1,790	136,545	125,317	11,228	
	CALHOUN	2	92	1,603	1,440	174	15,448	14,492	956	
	CALLAHAN	3	11	219	189	33	4,547	4,199	348	
	CAMERON	2	1,390	25,447	22,551	3,099	178,605	162,925	15,680	
	CHEROKEE	2	17	287	260	29	3,158	2,957	201	
	CHILDRESS	3	0	0	0	0	0	0	0	
	CLAY	3	3	59	51	9	1,201	1,111	90	
	COKE	3	1	19	16	3	342	316	26	
	COLEMAN	3	0	0	0	0	0	0	0	
	COLORADO	2	13	224	202	24	2,245	2,099	146	
	COMANCHE	3	0	0	0	0	0	0	0	
	CONCHO	3	1	19	16	3	342	317	25	
COOKE	3	68	1,322	1,145	189	25,647	23,372	2,275		
CORYELL	2	174	3,429	2,972	489	54,256	46,768	7,488		
COTTLE	3	0	0	0	0	0	0	0		
CRANE	3	0	0	0	0	0	0	0		
CROCKETT	3	19	361	311	54	6,497	6,015	482		
CROSBY	3	1	21	18	3	373	345	28		
CULBERSON	3	8	145	125	22	2,240	2,139	101		
DAWSON	3	0	0	0	0	0	0	0		
DE WITT	2	7	122	110	13	1,175	1,103	73		
DELTA	3	7	136	118	20	2,633	2,402	231		
DICKENS	3	0	0	0	0	0	0	0		
DDMMIT	2	0	0	0	0	0	0	0		
DUVAL	2	0	0	0	0	0	0	0		
EASTLAND	3	5	100	86	15	2,067	1,909	158		

Table 9: 2019 Annual Electricity Savings from New Single-family Residences (Continued)

2019 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	ECTOR	3	743	13,802	11,942	1,990	255,927	238,296	17,632
	EDWARDS	2	0	0	0	0	0	0	0
	ERATH	3	35	697	600	104	14,466	13,360	1,107
	FALLS	2	13	256	222	37	4,054	3,494	559
	FANNIN	3	30	583	505	84	11,315	10,311	1,003
	FAYETTE	2	13	224	202	24	2,245	2,099	146
	FISHER	3	0	0	0	0	0	0	0
	FOARD	3	0	0	0	0	0	0	0
	FRANKLIN	3	2	39	34	6	752	686	66
	FREESTONE	2	5	99	85	14	1,550	1,344	215
	FRIIO	2	6	113	98	16	1,365	1,172	193
	GILLESPIE	3	64	1,200	1,022	190	14,492	13,301	1,192
	GLASS COCK	3	0	0	0	0	0	0	0
	GOLIAD	2	0	0	0	0	0	0	0
	GONZALES	2	13	244	212	34	2,954	2,536	418
	GRAYSON	3	634	12,322	10,673	1,765	239,118	217,911	21,207
	GRIMES	2	102	1,758	1,581	189	17,615	16,466	1,149
	HALL	3	0	0	0	0	0	0	0
	HAMILTON	3	3	59	51	8	935	806	129
	HARDEMAN	3	0	0	0	0	0	0	0
	HASKELL	3	3	60	51	9	1,240	1,145	95
	HENDERSON	2	66	1,146	1,027	127	15,667	15,358	310
	HIDALGO	2	3,526	64,551	57,205	7,860	453,065	413,289	39,776
	HILL	2	40	788	683	112	12,473	10,751	1,721
	HOPKINS	3	26	806	438	73	9,779	8,922	856
	HOUSTON	2	1	17	15	2	186	174	12
	HOWARD	3	42	780	675	112	14,467	13,470	997
	HOOD	2	202	3,817	3,310	543	66,159	61,077	5,081
	HUDSPETH	3	0	0	0	0	0	0	0
	HUNT	2	290	5,636	4,882	807	109,376	99,676	9,700
	IRION	3	0	0	0	0	0	0	0
	JACK	3	0	0	0	0	0	0	0
	JACKSON	2	8	139	125	15	1,343	1,260	83
	JEFF DAVIS	3	0	0	0	0	0	0	0
	JIMHOGG	2	0	0	0	0	0	0	0
	JIMWELLS	2	16	283	253	31	2,344	2,195	149
	JONES	3	0	0	0	0	0	0	0
	KARNES	2	60	1,126	979	158	13,651	11,705	1,946
	KENDALL	3	365	6,843	5,830	1,084	82,651	75,855	6,796
	KENEDY	2	0	0	0	0	0	0	0
	KENT	3	0	0	0	0	0	0	0
	KERR	3	88	1,650	1,406	261	19,927	18,288	1,639
	KIMBLE	3	1	19	16	3	342	317	25
	KING	3	0	0	0	0	0	0	0
	KINNEY	2	0	0	0	0	0	0	0
	KLEBERG	2	37	654	583	77	5,083	4,666	417
	KNOX	3	0	0	0	0	0	0	0
	LA SALLE	2	0	0	0	0	0	0	0
	LAMAR	3	31	539	480	63	6,985	6,808	177
	LAMPASAS	3	32	631	547	90	9,978	8,601	1,377
	LAVACA	2	18	338	299	41	3,815	3,633	182
	LEE	2	20	363	318	48	4,308	3,693	616
	LEON	2	0	0	0	0	0	0	0
	LIMESTONE	2	14	276	239	39	4,365	3,763	602
	LIVE OAK	2	5	88	79	10	733	686	47
	LLANO	3	107	2,006	1,709	318	24,229	22,237	1,992
	LOVING	3	0	0	0	0	0	0	0
	MADISON	2	7	121	109	13	1,209	1,130	79
	MARTIN	3	16	297	257	43	5,511	5,132	380
	MASON	3	4	75	64	12	906	831	74
	MATAGORDA	2	156	2,718	2,442	295	26,194	24,573	1,621
	MAVERICK	2	88	1,786	1,534	269	17,829	15,218	2,611
	MCCULLOCH	3	0	0	0	0	0	0	0
	MCLENNAN	2	863	17,007	14,742	2,424	269,098	231,961	37,137
	MCMLLEN	2	0	0	0	0	0	0	0
	MEDINA	2	26	488	424	68	5,907	5,072	835
	MENARD	3	0	0	0	0	0	0	0
	MIDLAND	3	1,290	23,962	20,733	3,455	444,342	413,730	30,612
	MILAM	2	8	158	137	23	2,495	2,150	344
	MILLS	3	0	0	0	0	0	0	0
	MITCHELL	3	5	100	86	15	2,067	1,909	158
	MONTAGUE	3	9	175	152	25	3,394	3,093	301
	MOTLEY	3	0	0	0	0	0	0	0
	NACOGDOCHES	3	21	365	325	42	4,752	4,630	121
	NAVARRO	3	312	6,149	5,330	877	97,287	83,861	13,426
	NOLAN	3	5	100	86	15	2,067	1,909	158
	PALO PINTO	3	10	199	171	30	4,133	3,817	316
	PECOS	3	6	114	98	17	2,052	1,899	152
	POTTER	4	446	7,760	6,999	814	70,908	67,568	3,340
	PRESIDIO	3	21	399	343	59	7,180	6,648	533
	RAINS	3	18	350	303	50	6,770	6,177	593
	REAGAN	3	0	0	0	0	0	0	0
	REAL	2	0	0	0	0	0	0	0
	RED RIVER	3	6	104	93	12	1,352	1,318	34
	REEVES	3	67	1,245	1,077	179	23,078	21,488	1,590

Table 9: 2019 Annual Electricity Savings from New Single-family Residences (Continued)

2019 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	REFUGIO	2	49	854	767	93	8,227	7,718	509	
	ROBERTSON	2	76	1,310	1,178	141	13,125	12,269	856	
	RUNNELS	3	5	95	82	14	1,710	1,583	127	
	SAN SABA	3	3	56	48	9	679	623	56	
	SCHLEICHER	3	0	0	0	0	0	0	0	
	SCURRY	3	3	62	53	9	1,118	1,034	84	
	SHACKELFORD	3	0	0	0	0	0	0	0	
	SOMERVILL	3	19	370	319	55	6,159	5,690	469	
	STARR	2	3	55	49	7	385	352	34	
	STEPHENS	3	4	80	69	12	1,653	1,527	126	
	STERLING	3	0	0	0	0	0	0	0	
	STONEWALL	3	0	0	0	0	0	0	0	
	SUTTON	3	0	0	0	0	0	0	0	
	TAYLOR	3	343	6,833	5,879	1,020	141,771	130,925	10,846	
	TERRILL	3	0	0	0	0	0	0	0	
	THROCKMORTON	3	0	0	0	0	0	0	0	
	TITUS	3	34	592	527	69	7,661	7,466	195	
	TOM GREEN	3	283	5,374	4,626	801	96,764	89,585	7,179	
	UPTON	3	4	74	64	11	1,380	1,285	95	
	UVALDE	2	28	525	457	73	6,361	5,462	899	
	VAL VERDE	2	123	2,307	2,006	322	27,945	23,994	3,951	
	VAN ZANDT	3	32	622	539	89	12,035	10,981	1,054	
	WARD	3	0	0	0	0	0	0	0	
	WASHINGTON	2	55	948	853	102	9,498	8,879	620	
	WEBB	2	1,302	26,426	22,703	3,984	263,791	225,164	38,627	
	WHARTON	2	125	2,178	1,957	237	20,989	19,690	1,299	
	WICHITA	3	99	1,963	1,695	287	39,632	36,657	2,975	
	WILBARGER	3	2	40	34	6	801	741	60	
	WILLACY	2	46	842	746	103	5,911	5,392	519	
	WINKLER	3	3	56	48	8	1,033	962	71	
	WOOD	3	17	319	277	45	4,517	4,187	329	
	YOUNG	3	2	40	34	6	827	763	63	
	ZAPATA	2	0	0	0	0	0	0	0	
	ZAVALA	2	0	0	0	0	0	0	0	
	OTHER TEXAS COUNTIES	ARMSTRONG	4	8	159	140	21	4,019	3,313	705
		BAILEY	4	0	0	0	0	0	0	0
		BOWIE	3	50	870	775	102	11,266	10,980	286
		CAMP	3	7	122	108	14	1,577	1,537	40
		CARSON	4	3	60	52	8	1,507	1,242	264
		CASS	3	16	278	248	33	3,605	3,514	92
CASTRO		4	0	0	0	0	0	0	0	
COCHRAN		4	0	0	0	0	0	0	0	
COLLINGSWORTH		3	0	0	0	0	0	0	0	
DALLAM		4	5	99	87	13	2,512	2,071	441	
DEAF SMITH		4	2	40	35	5	1,005	828	176	
DONLEY		4	0	0	0	0	0	0	0	
FLOYD		4	0	0	0	0	0	0	0	
Gaines		3	2	37	32	5	689	641	47	
GARZA		3	2	40	34	6	826	763	63	
GRAY		4	1	20	17	3	502	414	88	
HALE		4	9	179	157	23	4,521	3,727	793	
HANSFORD		4	2	40	35	5	1,005	828	176	
HARTLEY		4	0	0	0	0	0	0	0	
HEMPHILL		3	0	0	0	0	0	0	0	
HOCKLEY		4	9	179	157	23	4,521	3,727	793	
HUTCHINSON		4	0	0	0	0	0	0	0	
JASPER		2	32	548	495	57	5,551	5,238	313	
LAMB		4	5	99	87	13	2,512	2,071	441	
LIPSCOMB		4	0	0	0	0	0	0	0	
LUBBOCK		3	1,507	29,998	25,820	4,471	622,128	574,740	47,388	
LYNN		3	1	20	17	3	413	381	31	
MARION		3	4	70	62	8	903	881	23	
MOORE		4	16	318	279	41	8,037	6,626	1,411	
MORRIS		3	1	17	15	2	225	220	6	
NEWTON		2	0	0	0	0	0	0	0	
OCHILTREE		4	1	20	17	3	502	414	88	
OLDHAM		4	0	0	0	0	0	0	0	
PANOLA		3	8	139	124	16	1,810	1,764	46	
PARNIER		4	1	20	17	3	502	414	88	
POLK		2	268	4,590	4,142	480	46,494	43,883	2,611	
RANDALL		4	97	1,925	1,692	250	48,725	40,173	8,552	
ROBERTS		4	0	0	0	0	0	0	0	
SABINE		3	1	17	15	2	226	220	6	
San Augustine		3	0	0	0	0	0	0	0	
SAN JACINTO		2	394	6,794	6,110	731	67,856	63,544	4,312	
SHELBY		3	1	17	15	2	226	220	6	
SHERMAN		4	11	218	192	28	5,525	4,556	970	
SWISHER		4	0	0	0	0	0	0	0	
TERRY		3	0	0	0	0	0	0	0	
TRINITY		2	3	51	46	5	557	522	35	
TYLER		2	6	103	93	11	1,041	982	58	
WALKER	2	353	6,083	5,473	653	60,962	56,985	3,977		
WHEELER	3	0	0	0	0	0	0	0		
YOAKUM	4	4	79	70	10	2,009	1,657	353		
<b>TOTAL</b>			<b>129,140</b>			<b>308,980</b>			<b>2,862,132</b>	

Table 10: Allocation of CL Zones for Each of Applicable ERCOT Counties

County	Plant	CL Zones Percentage			
		H	N	W	S
Anderson	Apex Bethel Energy Center	13.35	81.87	3.95	0.84
Angelina	Aspen Biomass Power Plant	13.35	81.87	3.95	0.84
	Pinecrest Energy Center				
Atascosa	San Miguel	11.04	0.74	0.04	88.18
Bastrop	Bastrop Clean Energy Center	11.04	0.74	0.04	88.18
	Lost Pines 1				
	Sim Gideon				
Bell	Panda Temple Power Station	13.35	81.87	3.95	0.84
Bexar	Covel Gardens Gas Recovery	11.04	0.74	0.04	88.18
	J K Spruce				
	J T Deely				
	Leon Creek				
	Nelson Gardens Landfill Gas to Energy				
	O W Sommers				
	Tessman Road				
	V H Braunig				
	Mission Road				
	University of Texas at San Antonio				
UTSA TERP II					
W B Tuttle					
Bosque	Bosque County Power Plant	13.35	81.87	3.95	0.84
Brazoria	Ascend Performance Materials Texas Inc.	99.06	0.01	0.00	0.93
	BASF Freeport Works				
	Freeport Energy				
	Freeport Energy Center				
	Oyster Creek Unit VIII				
	Power Island				
	Sweeny Cogeneration Facility				
Freeport LP Pretreatment Facility					
Brazos	Bryan (TX)	13.35	81.87	3.95	0.84
	Central Utility Plant - Texas A&M				
	Roland C. Dansby Power Plant				
Calhoun	CFB Power Plant	11.04	0.74	0.04	88.18
	Formosa Utility Venture Ltd				
	Point Comfort Operations				
	Seadrift Coke LP				
	Union Carbide Seadrift Cogen				
	Port Comfort Power LLC				
Cameron	Silas Ray	11.04	0.74	0.04	88.18
	La Palma				
	La Paloma Energy Center				
Chambers	Baytown	99.06	0.01	0.00	0.93
	Baytown Energy Center				
	Cedar Bayou				
	Cedar Bayou 4				
	Enterprise Products Operating				
Mont Belvieu Cogeneration Unit					
Cherokee	Stryker Creek	13.35	81.87	3.95	0.84
	Neches Station, LLC				
Coke	Jameson Gas Processing Plant	0.10	0.58	99.31	0.01
	McKinney LFG				
Collin	Ray Olinger	13.35	81.87	3.95	0.84
	University of Texas at Dallas				
Colorado	Sky Global Power One	11.04	0.74	0.04	88.18
	Rockwood Energy Center LLC				
Comal	Mesquite Creek LFGTE Project	11.04	0.74	0.04	88.18
Dallas	Ameresco Dallas LLC	13.35	81.87	3.95	0.84
	Lake Hubbard				
	Mountain Creek Generating Station				
	Skyline Gas Recovery				
	State Farm Insur Support Center Central				
	C E Newman				
	North Lake				
Parkdale					
Denton	Denton Power LLC	13.35	81.87	3.95	0.84
	DFW Gas Recovery				
	Farmers Branch Renewable Energy Facility				
	Spencer				
Ector	Ector County Energy Center	0.10	0.58	99.31	0.01
	Odessa Ector Generating Station				
	Quail Run Energy Center				
	Texas Clean Energy Project				
Ellis	Ennis Power Company, LLC	13.35	81.87	3.95	0.84
	Midlothian Energy				
Fayette	Sam Seymour	11.04	0.74	0.04	88.18
	Winchester Power Park				
Fort Bend	Brazos Valley Energy, LP	99.06	0.01	0.00	0.93
	Carbon Capture Plant				
	W A Parish				
Freestone	Big Brown	13.35	81.87	3.95	0.84
	Freestone Power Generation				
Frio	Pearsall	11.04	0.74	0.04	88.18
Galveston	Coastal Plains	99.06	0.01	0.00	0.93
	Power Station 4				
	South Houston Green Power Site				
	Texas City Cogeneration				
	Bacliff Generating Station				
P H Robinson					
Power Station 3					
Goliad	Coletto Creek	11.04	0.74	0.04	88.18
Grayson	Panda Sherman Power Station	13.35	81.87	3.95	0.84
	Van Alstyne Energy Center				
Grimes	Gibbons Creek Steam Electric Station	13.35	81.87	3.95	0.84
	Tenaska Frontier Generating Station				
Guadalupe	Guadalupe Generating Station	11.04	0.74	0.04	88.18
	Rio Nogales Power Project, LP				
	Clear Springs Energy Center				

Table 10: Allocation of CL Zones for Each of Applicable ERCOT Counties (Continued)

County	Plant	CL Zones Percentage			
		H	N	W	S
Harris	Air Liquide Bayport Complex	99.06	0.01	0.00	0.93
	Atascosita				
	Bluebonnet				
	Channel Energy Center				
	Channelview Cogeneration Facility				
	Clear Lake Cogeneration				
	Deer Park Energy Center				
	Exelon Laporte Generating Station				
	ExxonMobil Baytown Refinery				
	ExxonMobil Baytown Turbine				
	Greens Bayou				
	Helios Plaza CHP Plant				
	Houston Chemical Complex Battleground				
	Optim Energy Altura Cogen, LLC				
	Pasadena Power Plant				
	PRSI FCC Generator				
	Rice University				
	San Jacinto Steam Electric Station				
	Shell Deer Park				
	T H Wharton				
	TECO CHP-1				
	Texas Petrochemicals				
	The Methodist Hospital, Gas Turbine				
	Westhollow Technology Center				
	Chamon Power LLC				
	Deer Park Plant				
	Friendswood Energy				
NET Power La Porte Station					
Pasadena					
Sam Bertron					
Webster					
Hays	Hays Energy Facility	11.04	0.74	0.04	88.18
Henderson	Trinidad	13.35	81.87	3.95	0.84
	Halyard Henderson Energy Center				
Hidalgo	Calpine Hidalgo Energy Center	11.04	0.74	0.04	88.18
	Frontera Generation Facility				
	Magic Valley Generating Station				
	Red Gate Power Plant				
	Rio Grande Valley Sugar Growers				
J L Bates					
Hill	Hill County Generation Facility	13.35	81.87	3.95	0.84
Hood	Decorдова	13.35	81.87	3.95	0.84
	Wolf Hollow Generating Station				
	Wolf Hollow II				
Howard	C. R. Wing Cogeneration Plant	0.10	0.58	99.31	0.01
Hunt	Power Lane Steam Plant	13.35	81.87	3.95	0.84
Johnson	Johnson County Generation Facility	13.35	81.87	3.95	0.84
Kaufman	Forney Power Plant	13.35	81.87	3.95	0.84
Lamar	Lamar Power Plant	13.35	81.87	3.95	0.84
	Paris Energy Center				
Limestone	Limestone	13.35	81.87	3.95	0.84
Llano	T C Ferguson Power Plant	11.04	0.74	0.04	88.18
McLennan	Sandy Creek Energy Station	13.35	81.87	3.95	0.84
	Lake Creek				
	Tradinghouse				
Milam	Sandow	11.04	0.74	0.04	88.18
	Sandow Station				
Mitchell	Morgan Creek	0.10	0.58	99.31	0.01
	FGE Texas I				
	FGE Texas II				
Nacogdoches	Nacogdoches Power LLC	13.35	81.87	3.95	0.84
Nolan	Pecan Creek Energy Center	0.10	0.58	99.31	0.01
	TXU Sweetwater Generating Plant				
Nueces	Barney M. Davis	11.04	0.74	0.04	88.18
	Corpus Christi				
	Corpus Christi Energy Center				
	Corpus Refinery				
	Nueces Bay				
	Ticona Polymers Inc				
	Valero Refinery Corpus Christi West				
	Lon C Hill				
Valero Refinery Corpus Christi East					
Palo Pinto	R W Miller	13.35	81.87	3.95	0.84
Parker	Westside Landfill Gas Recovery	13.35	81.87	3.95	0.84
	North Texas				
	Weatherford				
Pecos	Yates Gas Plant	0.10	0.58	99.31	0.01
Reagan	Midkiff Plant	0.10	0.58	99.31	0.01
Red River	River Crest	13.35	81.87	3.95	0.84
Robertson	Oak Grove	13.35	81.87	3.95	0.84
	Twin Oaks				
Rusk	Martin Lake	13.35	81.87	3.95	0.84
	Tenaska Gateway Generating Station				
San Patricio	Gregory Power Facility	11.04	0.74	0.04	88.18
	Ingliside Cogeneration				
Scurry	EG17B Facility	0.10	0.58	99.31	0.01
Tarrant	Handley Generating Station	13.35	81.87	3.95	0.84
	Village Creek Water Reclamation Facility				
	Eagle Mountain				
	North Main				
Titus	Monticello	13.35	81.87	3.95	0.84

Table 10: Allocation of CL Zones for Each of Applicable ERCOT Counties (Continued)

County	Plant	CL Zones Percentage			
		H	N	W	S
Travis	Austin Gas Recovery				
	Central Utility Plant				
	Decker Creek				
	GRS Sunset Farms				
	Hal C.Weaver Power Plant	11.04	0.74	0.04	88.18
	Robert Mueller Energy Center				
	Sand Hill Energy Center				
	Domain Integrated Energy System				
	Holly Street				
Upton	Benedum Plant	0.10	0.58	99.31	0.01
Victoria	Sam Rayburn Plant				
	Victoria Power Station				
	Victoria Texas Plant	11.04	0.74	0.04	88.18
	Victoria City Power LLC				
Ward	Victoria Port Power LLC				
	Permian Basin	0.10	0.58	99.31	0.01
Webb	Laredo	11.04	0.74	0.04	88.18
Wharton	Colorado Bend Energy Center				
	New Gulf Power Facility				
	Colorado Bend II	11.04	0.74	0.04	88.18
	Halyard Wharton Energy Center				
Wichita	PPG Industries Works 4	0.10	0.58	99.31	0.01
	Signal Hill Generating LLC				
Wilbarger	Oklahoma Power Station	0.10	0.58	99.31	0.01
Wilson	Union Valley Energy Center	11.04	0.74	0.04	88.18
Wise	Bridgeport Gas Processing Plant				
	Jack County Generation Facility	13.35	81.87	3.95	0.84
	Wise County Power Company, LLC				
Wood	ExxonMobil Hawkins Gas Plant	13.35	81.87	3.95	0.84
Young	Graham	0.10	0.58	99.31	0.01

Table 11: 2019 Totalized Annual Electricity Savings by Electric Power Markets and CL Zones from New Single-family Residences

Electric Power Market	CL Zone	Total Electricity Savings by CL Zone (MWh) [2019-TRY 2008]
ERCOT	Houston (H)	60,073
	North (N)	117,945
	West (W)	8,543
	South (S)	93,260
SPP	-	6,405
SERC	-	16,033
WECC	-	6,721
<b>Total</b>		<b>308,980</b>

Table 12: 2019 Annual NOx Reductions from New Single-family Residences Using 2016 eGRID

Area	County	ERCOT-H	NOx Reductions (lbs)	ERCOT-N	NOx Reductions (lbs)	ERCOT-W	NOx Reductions (lbs/year)	ERCOT-S	NOx Reductions (lbs)	SPP	NOx Reductions (lbs)	SERC	NOx Reductions (lbs)	WECC	NOx Reductions (lbs)	Total NOx Reductions (lbs)	Total NOx Reductions (Tons)
Houston-Galveston Area	Brazoria	0.061577	3698.91	0.000078	0.92	0.000004	0.00	0.005769	53.80	0.000000	0.00	0.000000	0.00	0.000000	0.00	3753.63	1.38
	Chambers	0.0196236	1178.79	0.000025	0.29	0.000001	0.00	0.0001838	17.14	0.000000	0.00	0.000000	0.00	0.000000	0.00	1196.23	0.20
	Fort Bend	0.0751386	4813.79	0.0000095	1.12	0.0000005	0.00	0.0007039	65.65	0.000000	0.00	0.000000	0.00	0.000000	0.00	4880.57	2.60
	Galveston	0.0135834	815.99	0.000017	0.20	0.000001	0.00	0.0001273	11.87	0.000000	0.00	0.000000	0.00	0.000000	0.00	828.06	0.41
	Harris	0.1212648	7305.76	0.000154	1.83	0.000007	0.01	0.011394	106.26	0.000000	0.00	0.000000	0.00	0.000000	0.00	7413.84	3.71
	Liberty	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Montgomery	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.0448843	719.65	0.000000	0.00	719.65	0.36
	Waller	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Hardin	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.0097374	11.82	0.000000	0.00	11.82	0.01
	Jefferson	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.1790227	2876.43	0.000000	0.00	2876.43	1.44
Beaumont/Port Arthur Area	Change	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.3289413	3894.42	0.000000	0.00	3894.42	1.92
	Colin	0.0001044	6.27	0.0006407	75.57	0.0000399	0.26	0.0000695	0.61	0.000000	0.00	0.000000	0.00	0.000000	0.00	82.72	0.04
	Dallas	0.0020857	125.30	0.0127949	1509.09	0.0006180	5.28	0.0001305	12.12	0.000000	0.00	0.000000	0.00	0.000000	0.00	1651.84	0.83
	Denton	0.0015278	91.78	0.0093721	1108.41	0.0044527	3.87	0.0000956	0.92	0.000000	0.00	0.000000	0.00	0.000000	0.00	1209.97	0.60
	Henderson	0.0002013	12.09	0.0012348	145.64	0.0000996	0.51	0.0001728	1.12	0.000000	0.00	0.000000	0.00	0.000000	0.00	159.42	0.08
	Hood	0.0011288	67.81	0.0062345	316.70	0.0003345	2.86	0.0001706	6.59	0.000000	0.00	0.000000	0.00	0.000000	0.00	393.96	0.43
	Hunt	0.0000342	2.04	0.0002100	24.77	0.0000101	0.09	0.000021	0.20	0.000000	0.00	0.000000	0.00	0.000000	0.00	27.11	0.01
	Tarrant	0.0007507	45.69	0.0046649	543.13	0.0002234	1.90	0.000470	4.38	0.000000	0.00	0.000000	0.00	0.000000	0.00	594.51	0.30
	Bris	0.0009845	59.14	0.0002917	712.33	0.0002917	2.49	0.000616	5.75	0.000000	0.00	0.000000	0.00	0.000000	0.00	779.71	0.39
	Johnson	0.0001392	8.36	0.0008539	100.71	0.0004412	0.35	0.000087	0.81	0.000000	0.00	0.000000	0.00	0.000000	0.00	110.34	0.06
Dallas/Fort Worth Area	Kaufman	0.0002987	167.35	0.0170891	2015.87	0.0008254	7.05	0.0011743	16.28	0.000000	0.00	0.000000	0.00	0.000000	0.00	2296.23	1.13
	Parker	0.0006351	38.15	0.0038588	459.49	0.0001882	1.61	0.000497	3.71	0.000000	0.00	0.000000	0.00	0.000000	0.00	502.96	0.25
	Rockwall	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Wise	0.0028208	169.45	0.0173039	2040.91	0.0008358	7.14	0.0001765	16.46	0.000000	0.00	0.000000	0.00	0.000000	0.00	2233.96	1.12
	B Pasa Area	B Pasa	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	1.272368	8215.49	4.14
	Bear	0.0015685	94.65	0.0009049	124.55	0.0000115	0.44	0.126544	1169.23	0.000000	0.00	0.000000	0.00	0.000000	0.00	1278.27	6.36
	Comal	0.0004238	25.46	0.0000286	3.37	0.0000014	0.01	0.0033848	315.67	0.000000	0.00	0.000000	0.00	0.000000	0.00	344.51	0.17
	Guadalupe	0.0025537	153.41	0.0001722	20.31	0.0000083	0.07	0.0020945	1992.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	2075.79	1.04
	Wilson	0.0001742	10.46	0.0001117	1.39	0.0000006	0.00	0.0013911	129.73	0.000000	0.00	0.000000	0.00	0.000000	0.00	141.59	0.07
	Blanco	0.0003029	121.40	0.0001363	16.08	0.0000066	0.06	0.0161398	1505.21	0.000000	0.00	0.000000	0.00	0.000000	0.00	1642.74	0.82
Austin Area	Castroville	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Hays	0.0004570	27.45	0.0000308	3.63	0.0000015	0.01	0.0036495	340.35	0.000000	0.00	0.000000	0.00	0.000000	0.00	371.45	0.19
	Travis	0.0037244	223.73	0.0002512	29.63	0.0000121	0.10	0.0297443	2773.96	0.000000	0.00	0.000000	0.00	0.000000	0.00	3027.43	1.51
	Williamson	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Gregg	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.0066563	42.63	0.000000	0.00	0.000000	0.00	42.63	0.02
	Harrison	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.2677145	1702.17	0.000000	0.00	0.000000	0.00	1702.17	0.85
	Rusk	0.0239642	1387.62	0.1417007	16712.85	0.0088443	25.47	0.0144527	134.83	0.000000	0.00	0.000000	0.00	0.000000	0.00	18293.77	9.13
	Smith	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Utshur	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.00	0.00
	Nueces	0.0003946	236.97	0.0002660	31.38	0.0000128	0.11	0.0130333	2958.01	0.000000	0.00	0.000000	0.00	0.000000	0.00	3206.46	1.60
Corpus Christi Area	San Patricio	0.0009901	595.88	0.0004444	52.42	0.0000213	0.18	0.0236306	498.36	0.000000	0.00	0.000000	0.00	0.000000	0.00	5356.84	2.68
	Victoria	0.0003569	31.49	0.0000015	0.19	0.0000004	0.00	0.0198338	192.04	0.000000	0.00	0.000000	0.00	0.000000	0.00	1102.68	0.56
	Anderson	0.0000993	5.94	0.0000691	71.84	0.0000294	0.25	0.0000062	0.58	0.000000	0.00	0.000000	0.00	0.000000	0.00	78.63	0.04
	Angelina	0.0023609	141.83	0.0144832	1708.32	0.0006996	5.98	0.0001478	13.78	0.000000	0.00	0.000000	0.00	0.000000	0.00	1869.80	0.93
	Atascosa	0.0056178	337.48	0.0003789	44.69	0.0000183	0.16	0.048662	4184.24	0.000000	0.00	0.000000	0.00	0.000000	0.00	4566.57	2.28
	Bell	0.0003169	19.03	0.0019438	229.26	0.0000939	0.80	0.0001998	1.85	0.000000	0.00	0.000000	0.00	0.000000	0.00	250.95	0.13
	Bosque	0.0005586	32.54	0.0024349	404.17	0.0001655	1.41	0.0000390	2.28	0.000000	0.00	0.000000	0.00	0.000000	0.00	442.44	0.23
	Brazos	0.0006309	37.90	0.0008702	456.47	0.0001869	1.60	0.0000395	3.68	0.000000	0.00	0.000000	0.00	0.000000	0.00	499.65	0.25
	Calhoun	0.0008052	534.96	0.0006006	70.84	0.0000290	0.25	0.071201	6632.69	0.000000	0.00	0.000000	0.00	0.000000	0.00	7238.73	3.62
	Cameron	0.0003829	23.00	0.0000258	3.05	0.0000012	0.01	0.0030576	285.15	0.000000	0.00	0.000000	0.00	0.000000	0.00	311.21	0.16
North East Texas Area	Cherokee	0.0003163	19.00	0.00019403	228.84	0.0000297	0.80	0.0000198	1.85	0.000000	0.00	0.000000	0.00	0.000000	0.00	250.49	0.13
	Coke	0.0000186	1.12	0.0000114	13.44	0.0019354	165.35	0.0000012	0.11	0.000000	0.00	0.000000	0.00	0.000000	0.00	180.02	0.09
	Colorado	0.0014238	85.53	0.0000960	11.33	0.0000046	0.04	0.011796	1060.43	0.000000	0.00	0.000000	0.00	0.000000	0.00	1157.32	0.58
	Ector	0.0000875	5.26	0.0005370	63.34	0.0911920	779.05	0.0000055	0.51	0.000000	0.00	0.000000	0.00	0.000000	0.00	848.16	0.42
	Fayette	0.0145746	875.54	0.0009825	115.93	0.0000475	0.41	0.1163983	1085.38	0.000000	0.00	0.000000	0.00	0.000000	0.00	1184.27	5.92
	Freestone	0.0119627	720.44	0.0735691	8677.08	0.0033555	30.36	0.0097506	70.09	0.000000	0.00	0.000000	0.00	0.000000	0.00	9097.83	4.25
	Frio	0.0070463	423.47	0.0047354	56.07	0.0000230	0.20	0.052384	520.44	0.0000							



## 4.2 2019 Results for New Multi-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NO<sub>x</sub> emissions reductions in 2019 using the 2008 base year which implemented the 2015 IECC for new multi-family residences in the 42 non-attainment and affected counties as well as other counties in the ERCOT region.<sup>21</sup> To calculate the NO<sub>x</sub> emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2019 building permits per county was obtained from the real estate center at Texas A&M University (REC 2020). 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 2018 HIRL's survey data<sup>22</sup> were used to determine the appropriate construction data corresponding to housing types. Then, the NO<sub>x</sub> reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2016 eGRID database.<sup>23</sup>

In Table 13, the 2019 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 13, 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 13 represent the changes for building envelope that were made to the simulations to obtain the savings calculations. In cases where the 2019 new multi-family values were more efficient than the 2015 IECC requirements, the 2019 new multi-family values were used in 2019 new multi-family simulations. Otherwise, the 2015 IECC values were used in both simulations. For the 2019 new multi-family simulations, the more efficient values from 2018 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 14, the code-traceable simulation results for multi-family residences are shown for each county. In a similar fashion to Table 13, Table 14 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<sup>24</sup> 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 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 14 are assigned to CL Zones<sup>25</sup> provider(s) in a similar fashion to the single-family residential assignments. The total electricity savings for each CL Zone, as shown in Table 15, are then entered into the bottom row of Table 16, the 2016 US EPA's eGRID database for Texas. Next, the county's NO<sub>x</sub> reductions (lbs) are calculated using the assigned 2016 eGRID proportions (lbs-NO<sub>x</sub>/MWh) to each electric power

<sup>21</sup> The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.

<sup>22</sup> The NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: <http://www.homeinnovation.com>

<sup>23</sup> This analysis assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated.

<sup>24</sup> The number of the new housing units in 2019 were obtained from the Real Estate Center at Texas A&M University.

<sup>25</sup> ERCOT region has employed the Competitive Load (CL), and it is currently divided into four zones: Houston (H), North (N), South (S), and West (W).

market and each CL zone in the county. The calculated NOx reductions are presented in the columns adjacent to the corresponding CL 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 13: 2019 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences

	County	Climate Zone	Division East or West	2019 Average			2015 IECC					
				Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	CHAMBERS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	COLLIN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	DALLAS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	DENTON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	EL PASO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	ELLIS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	FORT BEND	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	GALVESTON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	HARRIS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	JOHNSON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	KAUFMAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	LIBERTY	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	MONTGOMERY	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	PARKER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	ROCKWALL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	TARRANT	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	WALLER	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	WISE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	Affected	BASTROP	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
BEXAR		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
CALDWELL		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
COMAL		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
GREGG		3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
GUADALUPE		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
HARRISON		3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
HAYS		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
NUECES		2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
RUSK		3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
SAN PATRICIO		2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
SMITH		3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TRAVIS		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
UPSHUR		3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
VICTORIA		2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WILLIAMSON		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WILSON		2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
ERCOT		ANDERSON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
		ANDREWS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
		ANGELINA	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	ARANSAS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	ARCHER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	ATASCOSA	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	AUSTIN	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BANDERA	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BASTROP	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BAYLOR	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	BEE	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BELL	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BEXAR	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BLANCO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	BORDEN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	BOSQUE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BRAZORIA	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BRAZOS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
	BREWSTER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
	BRISCOE	4	West Texas	0.39	0.53	40.4	20.6	0.35	0.4	49	20	
BROOKS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
BROWN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
BURLESON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
BURNET	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
CALDWELL	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
CALHOUN	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
CALLAHAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
CAMERON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
CHAMBERS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
CHEROKEE	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
CHILDRESS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
CLAY	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
COKE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
COLEMAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
COLLIN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
COLORADO	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
COMAL	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
COMANCHE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
CONCHO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
COOKE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		
CORYELL	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13		
COTTLE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20		

Table 14: 2019 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences (Continued)

	County	Climate Zone	Division	2019 Average				2015 IECC			
				East or West	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)
ERCOT	CRANE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	CROCKETT	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	CROSBY	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	CULBERSON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	DAWSON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	DE WITT	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	DELTA	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	DICKENS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	DIMMIT	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	DUVAL	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	EASTLAND	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	ECTOR	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	EDWARDS	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	ELLIS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	ERATH	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	FALLS	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	FANNIN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	FAYETTE	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	FISHER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	FOARD	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	FRANKLIN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	FREESTONE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	FRIO	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	GILLESPIE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	GLASSCOCK	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	GOLIAD	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	GONZALES	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	GRAYSON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	GRIMES	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	GUADALUPE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	HALL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HAMILTON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HARDEMAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HARRIS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	HASKELL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	HENDERSON	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HIDALGO	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	HILL	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	HOOD	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HOPKINS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HOUSTON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	HOWARD	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	HUDSPETH	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
HUNT	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
IRION	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
JACK	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
JACKSON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
JEFF DAVIS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
JIM HOGG	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
JIM WELLS	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
JOHNSON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
JONES	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KARNES	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
KAUFMAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KENDALL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KENEDY	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
KENT	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KERR	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KIMBLE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KING	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
KINNEY	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
KLEBERG	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
KNOX	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
LA SALLE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
LAMAR	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
LAMPASAS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
LAVACA	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
LEE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
LEON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	

Table 14: 2019 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences (Continued)

	County	Climate Zone	Division East or West	2019 Average				2015 IECC			
				Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)
ERCOT	LIMESTONE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	LIVE OAK	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	LLANO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	LOVING	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MADISON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MARTIN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MASON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MATAGORDA	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MAVERICK	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MCCULLOCH	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MCLENNAN	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MCMULLEN	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MEDINA	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MENARD	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MIDLAND	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MILAM	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MILLS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MITCHELL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MONTAGUE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	MONTGOMERY	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	MOTLEY	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	NACOGDOCHES	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	NAVARRO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	NOLAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	NUECES	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	PALO PINTO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	PECOS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	PRESIDIO	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	RAINS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	REAGAN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	REAL	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	RED RIVER	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	REEVES	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	REFUGIO	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	ROBERTSON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	RUNNELS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	SAN SABA	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	SCHLEICHER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	SCURRY	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	SHACKELFORD	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	SMITH	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	SOMERVELL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
	STARR	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13
	STEPHENS	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20
STERLING	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
STONEWALL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
SUTTON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TARRANT	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TAYLOR	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TERRELL	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
THROCKMORTON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TITUS	3	East Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TOM GREEN	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
TRAVIS	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
UPTON	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
UVALDE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
VAL VERDE	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
VAN ZANDT	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
VICTORIA	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WALLER	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WARD	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
WASHINGTON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WEBB	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WHARTON	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WICHITA	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
WILBARGER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
WILLACY	2	East Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WILLIAMSON	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WILSON	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
WINKLER	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
WISE	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
YOUNG	3	West Texas	0.39	0.53	40.4	20.6	0.35	0.25	38	20	
ZAPATA	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	
ZAVALA	2	West Texas	0.39	0.53	40.4	20.6	0.4	0.25	38	13	

Table 14: 2019 Annual Electricity Savings from New Multi-family Residences

2019 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)	
Nonattainment County	BRAZORIA	2	3	472	442	31.40	1,631	1,596	34.97	
	CHAMBERS	2	0	0	0	0.00	0	0	0.00	
	COLLIN	2	4,552	752,781	692,386	64,622.51	3,991,791	3,567,393	424,398.16	
	DALLAS	2	11,503	1,890,460	1,734,409	166,975.45	9,049,795	8,140,094	909,701.38	
	DENTON	2	1,654	272,159	249,509	24,235.03	1,297,721	1,168,305	129,415.59	
	EL PASO	3	633	100,611	91,812	9,415.32	451,286	406,009	45,277.06	
	ELLIS	3	145	23,830	21,863	2,104.79	114,076	102,609	11,467.16	
	FORT BEND	2	2,306	360,850	338,239	24,193.80	1,300,144	1,264,636	35,508.37	
	GALVESTON	2	334	52,511	49,244	3,495.67	181,557	177,663	3,893.10	
	HARDIN	2	52	8,145	7,640	539.52	29,701	28,951	750.53	
	HARRIS	2	19,852	3,106,502	2,911,847	208,280.75	11,192,742	10,887,056	305,686.12	
	JEFFERSON	2	203	31,799	29,829	2,108.30	115,948	112,903	3,045.47	
	JOHNSON	3	352	57,849	53,074	5,109.57	276,930	249,093	27,837.51	
	KAUFMAN	2	153	25,302	23,272	2,172.07	134,170	119,906	14,264.70	
	LIBERTY	3	0	0	0	0.00	0	0	0.00	
	MONTGOMERY	3	1,592	249,121	233,511	16,702.75	897,584	873,070	24,514.02	
	ORANGE	2	8	1,253	1,176	83.17	4,569	4,452	117.63	
	PARKER	2	418	67,824	62,306	5,905.02	326,964	292,914	34,049.36	
	ROCKWALL	2	288	47,628	43,807	4,088.99	252,556	225,705	26,851.20	
	TARRANT	3	8,551	1,405,314	1,289,309	124,124.76	6,727,358	6,051,112	676,245.89	
	WALLER	2	78	12,206	11,441	818.35	43,977	42,776	1,201.06	
	WISE	3	153	25,302	23,272	2,172.07	134,170	119,906	14,264.70	
	Affected County	BASTROP	3	10	1,571	1,464	115.16	6,028	5,412	616.32
		BEXAR	3	6,076	970,698	898,318	77,447.20	3,807,936	3,384,571	423,365.06
CALDWELL		3	10	1,571	1,464	115.16	0	0	0.00	
COMAL		3	198	31,632	29,274	2,523.79	124,090	110,294	13,796.29	
GREGG		2	22	3,451	3,221	245.86	14,229	14,302	-73.01	
GUADALUPE		3	518	82,755	76,585	6,602.64	324,640	288,546	36,093.33	
HARRISON		3	0	0	0	0.00	0	0	0.00	
HAYS		3	263	41,340	38,504	3,033.89	158,385	142,318	16,066.81	
NUECES		2	22	3,501	3,278	238.64	11,573	11,328	244.52	
RISK		2	0	0	0	0.00	0	0	0.00	
SAN PATRICIO		3	192	30,551	28,604	2,082.70	100,998	98,864	2,133.99	
SMITH		3	65	10,198	9,547	696.09	43,365	43,782	-416.58	
TRAVIS		3	11,893	1,869,401	1,741,183	137,194.15	7,162,264	6,435,714	726,549.49	
UPSHUR		3	0	0	0	0.00	0	0	0.00	
VICTORIA		2	60	9,481	8,880	642.13	33,835	32,996	838.92	
WILLIAMSON		2	1,435	232,179	214,388	19,036.23	1,051,597	909,958	141,639.09	
WILSON		2	0	0	0	0.00	0	0	0.00	
ANDERSON		2	136	0	0	0.00	0	0	0.00	
ANDREWS		3	140	23,198	20,923	2,435.26	119,454	103,979	15,475.74	
ERCOT		ANGELINA	2	76	0	0	0.00	0	0	0.00
	ARANSAS	2	0	0	0	0.00	0	0	0.00	
	ARCHER	3	0	0	0	0.00	0	0	0.00	
	ATASCOSA	2	0	0	0	0.00	0	0	0.00	
	AUSTIN	2	0	0	0	0.00	0	0	0.00	
	BANDERA	2	0	0	0	0.00	0	0	0.00	
	BAYLOR	3	0	0	0	0.00	0	0	0.00	
	BEE	2	6	948	888	64.21	3,384	3,300	83.89	
	BELL	2	244	41,207	37,343	4,134.05	195,003	165,107	29,896.43	
	BLANCO	3	0	0	0	0.00	0	0	0.00	
	BORDEN	3	0	0	0	0.00	0	0	0.00	
	BOSQUE	2	0	0	0	0.00	0	0	0.00	
	BRAZOS	2	317	49,605	46,497	3,325.86	178,728	173,846	4,881.25	
	BREWSTER	3	0	0	0	0.00	0	0	0.00	
	BRISCOE	4	0	0	0	0.00	0	0	0.00	
	BROOKS	2	0	0	0	0.00	0	0	0.00	
	BROWN	3	9	1,520	1,377	152.49	7,193	6,090	1,102.74	
	BURLESON	2	72	11,267	10,561	755.40	40,594	39,486	1,108.67	
	BURNET	3	2	326	296	32.47	1,274	1,155	119.59	
	CALHOUN	2	4	632	592	42.81	2,256	2,200	55.93	
	CALLAHAN	3	0	0	0	0.00	0	0	0.00	
	CAMERON	2	427	70,375	64,777	5,989.76	210,366	204,941	5,424.59	
	CHEROKEE	2	0	0	0	0.00	0	0	0.00	
	CHILDRESS	3	0	0	0	0.00	0	0	0.00	
	CLAY	3	0	0	0	0.00	0	0	0.00	
	COKE	3	0	0	0	0.00	0	0	0.00	
	COLEMAN	3	0	0	0	0.00	0	0	0.00	
	COLORADO	2	6	939	880	62.95	3,383	3,290	92.39	
	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	16	2,702	2,449	271.09	12,787	10,827	1,960.42	
	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	
	CTLBERSON	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	10	1,721	1,552	180.40	9,890	8,647	1,243.13		

Table 15: 2019 Annual Electricity Savings from New Multi-family Residences (Continued)

2019 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	ECTOR	3	1,039	172,166	155,275	18,073.09	886,522	771,670	114,852.11
	EDWARDS	2	0	0	0	0.00	0	0	0.00
	ERATH	3	306	52,655	47,496	5,520.23	302,648	264,608	38,039.83
	FALLS	2	0	0	0	0.00	0	0	0.00
	FANNIN	3	2	331	304	28.29	1,756	1,568	187.62
	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
	GILLISPIE	3	4	652	592	64.95	2,549	2,310	239.18
	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	364	60,173	55,361	5,149.04	319,534	285,387	34,146.75
	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	7	1,098	1,028	74.96	4,670	4,715	-44.86
	HIDALGO	2	1,844	303,913	279,738	25,866.78	908,465	885,039	23,426.08
	HILL	2	0	0	0	0.00	0	0	0.00
	HOOD	3	26	4,214	3,874	363.93	20,379	18,252	2,127.10
	HOPKINS	3	16	2,646	2,434	227.14	14,031	12,539	1,491.73
	HOUSTON	2	0	0	0	0.00	0	0	0.00
	HOWARD	3	4	663	598	69.58	3,413	2,971	442.16
	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	0	0	0	0.00	0	0	0.00
	JONES	3	0	0	0	0.00	0	0	0.00
	KARNES	2	0	0	0	0.00	0	0	0.00
	KENDALL	3	0	0	0	0.00	0	0	0.00
	KENEDY	2	0	0	0	0.00	0	0	0.00
	KENT	3	0	0	0	0.00	0	0	0.00
	KERR	3	4	652	592	64.95	2,549	2,310	239.18
	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	64	10,584	9,735	908.58	56,124	50,157	5,966.93
	LAMPASAS	3	2	338	306	33.89	1,598	1,353	245.05
	LAVACA	2	0	0	0	0.00	0	0	0.00
	LEE	2	2	314	293	23.03	1,206	1,082	123.26
	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	2	326	296	32.47	1,274	1,155	119.59
	LOVING	3	0	0	0	0.00	0	0	0.00
	MADISON	2	0	0	0	0.00	0	0	0.00
	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	4	636	596	43.39	2,104	2,060	44.46
	MCCULLOCH	3	0	0	0	0.00	0	0	0.00
	MCLENNAN	2	346	58,433	52,954	5,862.22	276,521	234,126	42,394.12
	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	0	0	0	0.00	0	0	0.00
	MILAM	2	0	0	0	0.00	0	0	0.00
	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	627	585	44.40	2,587	2,602	-14.25
	NAVARRO	3	16	2,702	2,449	271.09	12,787	10,827	1,960.42
	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	38	6,360	5,747	656.56	32,459	28,557	3,902.28
	POTTER	4	26	4,088	3,833	272.12	14,133	13,830	303.06
	PRESIDIO	3	0	0	0	0.00	0	0	0.00
	RAINS	3	0	0	0	0.00	0	0	0.00
	REAGAN	3	6	995	897	104.50	5,119	4,457	662.87
	REAL	2	0	0	0	0.00	0	0	0.00
	RED RIVER	3	0	0	0	0.00	0	0	0.00
	REEVES	3	0	0	0	0.00	0	0	0.00

Table 15: 2019 Annual Electricity Savings from New Multi-family Residences (Continued)

2019 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	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	
	SOMERVILLE	3	0	0	0	0.00	0	0	0.00	
	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	16	2,753	2,483	288.64	15,825	13,836	1,989.01	
	TERRELL	3	0	0	0	0.00	0	0	0.00	
	THROCKMORTON	3	0	0	0	0.00	0	0	0.00	
	TIHUS	3	0	0	0	0.00	0	0	0.00	
	TOMGREEN	3	0	0	0	0.00	0	0	0.00	
	UPTON	3	0	0	0	0.00	0	0	0.00	
	UVALDE	2	0	0	0	0.00	0	0	0.00	
	VAL VERDE	2	8	1,278	1,183	101.97	5,014	4,456	557.43	
	VAN ZANDT	3	4	661	608	56.79	3,308	3,135	372.93	
	WARD	3	0	0	0	0.00	0	0	0.00	
	WASHINGTON	2	0	0	0	0.00	0	0	0.00	
	WEBB	2	300	47,735	44,694	3,254.22	157,810	154,476	3,334.36	
	WHARTON	2	0	0	0	0.00	0	0	0.00	
	WICHITA	3	56	9,607	8,673	999.52	53,519	46,780	6,738.77	
	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	
	WOOD	3	66	10,489	9,665	881.03	47,566	42,830	4,736.13	
	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	
	OTHER TEXAS COUNTIES	ARMSTRONG	4	0	0	0	0.00	0	0	0.00
		BAILEY	4	0	0	0	0.00	0	0	0.00
BOWIE		3	0	0	0	0.00	0	0	0.00	
CAMP		3	2	0	0	0.00	0	0	0.00	
CARSON		4	0	0	0	0.00	0	0	0.00	
CASS		3	8	0	0	0.00	0	0	0.00	
CASTRO		4	0	0	0	0.00	0	0	0.00	
COCHRAN		4	0	0	0	0.00	0	0	0.00	
COLLINGSWORTH		3	0	0	0	0.00	0	0	0.00	
DALLAM		4	0	0	0	0.00	0	0	0.00	
DEAF SMITH		4	0	0	0	0.00	0	0	0.00	
DONLEY		4	0	0	0	0.00	0	0	0.00	
FLOYD		4	0	0	0	0.00	0	0	0.00	
Gaines		3	0	0	0	0.00	0	0	0.00	
GARZA		3	0	0	0	0.00	0	0	0.00	
GRAY		4	0	0	0	0.00	0	0	0.00	
HALE		4	0	0	0	0.00	0	0	0.00	
HANSFORD		4	0	0	0	0.00	0	0	0.00	
HARTLEY		4	0	0	0	0.00	0	0	0.00	
HEMPHILL		3	0	0	0	0.00	0	0	0.00	
HOCKLEY		4	0	0	0	0.00	0	0	0.00	
HUTCHINSON		4	0	0	0	0.00	0	0	0.00	
JASPER		2	72	11,280	10,580	748.57	41,125	40,066	1,058.68	
LAMB		4	0	0	0	0.00	0	0	0.00	
LIPS COMB		4	0	0	0	0.00	0	0	0.00	
LUBBOCK		3	745	128,126	115,592	13,411.34	736,591	643,383	93,207.52	
LYNN		3	0	0	0	0.00	0	0	0.00	
MARION		3	0	0	0	0.00	0	0	0.00	
MOORE		4	0	0	0	0.00	0	0	0.00	
MORRIS		3	0	0	0	0.00	0	0	0.00	
NEWTON		2	0	0	0	0.00	0	0	0.00	
OCHILTREE		4	0	0	0	0.00	0	0	0.00	
OLDHAM		4	0	0	0	0.00	0	0	0.00	
PANOLA		3	0	0	0	0.00	0	0	0.00	
PARMER		4	0	0	0	0.00	0	0	0.00	
POLK		2	98	15,349	14,399	1,016.79	55,975	54,561	1,414.46	
RANDALL		4	4	679	623	60.54	4,478	3,778	700.46	
ROBERTS		4	0	0	0	0.00	0	0	0.00	
SABINE		3	0	0	0	0.00	0	0	0.00	
San Augustine		3	0	0	0	0.00	0	0	0.00	
SAN JACINTO		2	0	0	0	0.00	0	0	0.00	
SHELBY		3	0	0	0	0.00	0	0	0.00	
SHERMAN		4	2	340	311	30.27	2,239	1,889	350.23	
SWISHER	4	0	0	0	0.00	0	0	0.00		
TERRY	3	0	0	0	0.00	0	0	0.00		
TRINITY	2	0	0	0	0.00	0	0	0.00		
TYLER	2	0	0	0	0.00	0	0	0.00		
WALKER	2	235	36,774	34,469	2,465.54	132,495	128,877	3,618.59		
WHEELER	3	0	0	0	0.00	0	0	0.00		
YOAKUM	4	0	0	0	0.00	0	0	0.00		
<b>TOTAL</b>			<b>80,801</b>			<b>1,021,670</b>			<b>4,499,756</b>	

Table 15: 2019 Totalized Annual Electricity Savings by CL Zone from New Multi-family Residences

<b>Electric Power Market</b>	<b>CL Zone</b>	<b>Total Electricity Savings by CL Zone (MWh) [2019-TRY 2008]</b>
<b>ERCOT</b>	<b>Houston (H)</b>	236,820
	<b>North (N)</b>	431,977
	<b>West (W)</b>	22,808
	<b>South (S)</b>	285,431
<b>SPP</b>	-	14,020
<b>SERC</b>	-	21,199
<b>WECC</b>	-	9,415
<b>Total</b>		1,021,670



Table 16: 2019 Annual NOx Reductions from New Multi-family Residences Using 2016 eGRID

Area	County	ERCOT-H	NOx Reductions (lbs)	ERCOT-N	NOx Reductions (lbs)	ERCOT-W	NOx Reductions (lbs/year)	ERCOT-S	NOx Reductions (lbs)	SPP	NOx Reductions (lbs)	SERC	NOx Reductions (lbs)	WECC	NOx Reductions (lbs)	Total NOx Reductions (lbs)	Total NOx Reductions (Tons)
Houston-Galveston Area	Brazoria	0.0615732	14581.89	0.0000078	3.37	0.0000000	0.00	0.0005769	164.65	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	14749.93	7.37
	Chambers	0.0196236	4647.03	0.0000025	1.08	0.0000000	0.00	0.0001838	52.47	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4700.58	2.35
	Fort Bend	0.0751386	17794.32	0.0000095	4.12	0.0000005	0.00	0.0007039	204.93	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	17999.38	9.00
	Galveston	0.0153834	3216.82	0.0000017	0.74	0.0000000	0.00	0.0001273	36.32	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3253.88	1.63
	Harris	0.1216150	28800.86	0.0001154	6.67	0.0000007	0.02	0.0011354	325.21	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	29132.75	14.57
	Liberty	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Montgomery	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0448843	951.51	0.0000000	0.00	951.51	0.48
	Waller	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Hardin	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0007374	15.63	0.0000000	0.00	15.63	0.01
	Jefferson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.1794027	2803.17	0.0000000	0.00	2803.17	1.36
Beaumont/Port Arthur Area	Orange	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2429913	51.49	0.0000000	0.00	51.49	2.57
	Calhoun	0.0001044	24.74	0.0006407	276.79	0.0000309	0.71	0.0000065	1.87	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	304.09	0.15
	Dallas	0.0020857	493.94	0.0127949	5827.10	0.0006180	14.10	0.0001305	37.26	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6072.40	3.04
	Denton	0.0015278	361.81	0.0092723	4048.59	0.0004527	10.32	0.0000956	27.29	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4448.02	2.22
	Henderson	0.0002013	47.67	0.0012348	533.43	0.0000956	1.36	0.0000126	3.60	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	586.05	0.29
	Hood	0.0011288	287.32	0.0069245	2991.20	0.0003345	7.63	0.0000706	20.16	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3286.31	1.64
	Hunt	0.0000342	8.11	0.0002100	90.71	0.0000101	0.23	0.0000021	0.61	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	99.66	0.05
	Tarrant	0.0007507	177.77	0.0046409	1989.23	0.0002224	5.07	0.0000470	13.41	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2185.49	1.09
	Ellis	0.0009845	233.15	0.0060295	2608.93	0.0002917	6.65	0.0000614	17.59	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2866.33	1.43
	Johnson	0.0001392	32.96	0.0008539	368.87	0.0000412	0.94	0.0000087	2.49	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	405.26	0.20
Dallas/Fort Worth Area	Kaufman	0.0027857	699.72	0.0178991	7382.10	0.0008252	18.83	0.0001743	49.76	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	8110.41	4.08
	Parker	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Rockwall	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Wise	0.0028208	668.01	0.0170309	7474.89	0.0008358	19.06	0.0001765	50.39	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	8212.36	4.11
	El Paso	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1.2223686	11508.99	11508.99	5.75
	Bexar	0.0156585	3708.24	0.0101560	4561.99	0.0009510	1.16	0.1285444	3694.42	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	9860.00	49.23
	Comal	0.0004238	100.37	0.0002204	12.33	0.0000014	0.03	0.0033848	96.61	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	107.87	0.54
	Guadalupe	0.0025537	604.76	0.0001722	74.40	0.0000083	0.19	0.0209485	583.23	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6590.57	3.23
	Wilson	0.0001742	41.25	0.0001117	5.07	0.0000006	0.01	0.0013911	397.06	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	443.39	0.22
	Bastrop	0.0020209	478.59	0.0001363	58.88	0.0000066	0.15	0.0161398	466.81	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	5144.43	2.57
Austin Area	Calderwell	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Hays	0.0004570	108.22	0.0001938	13.31	0.0000015	0.03	0.0054949	104.68	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1163.24	0.58
	Texas	0.0027244	820.21	0.0002512	108.59	0.0001801	4.28	0.0000997	11.34	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	9489.73	4.74
	Williamson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Gregg	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0066563	93.32	0.0000000	0.00	93.32	0.05
	Harrison	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2657716	3726.15	0.0000000	0.00	0.0000000	0.00	3726.15	1.86
	Rusk	0.0250990	5470.31	0.1470077	6121.38	0.0068444	156.10	0.0014457	412.64	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6720.44	33.63
	Smith	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Upton	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.00	0.00
	Comanche	0.0039446	934.17	0.0002660	114.92	0.0000128	0.29	0.0319033	892.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	10041.39	5.02
Corpus Christi Area	San Patricio	0.0065901	1560.66	0.0004444	191.99	0.0002125	4.49	0.0256306	1502.42	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	16775.56	8.39
	Victoria	0.0013565	321.25	0.0000915	39.52	0.0000044	0.10	0.0108338	3092.30	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3453.17	1.73
	Anderson	0.0000993	23.51	0.0006091	263.11	0.0000294	0.67	0.0000062	1.77	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	289.07	0.14
	Angelina	0.0025609	599.12	0.014832	6256.40	0.0006996	15.96	0.0001478	42.18	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6873.66	3.44
	Atascosa	0.0056768	1330.42	0.0007589	1632.67	0.0000185	0.42	0.0488662	12896.21	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	14500.72	7.15
	Bell	0.0005169	75.04	0.0001948	839.67	0.0000929	2.14	0.0000398	5.66	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	922.51	0.46
	Bosque	0.0005586	132.26	0.0003268	1480.39	0.0001655	3.78	0.0000350	9.98	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1626.35	0.81
	Brazos	0.0006709	149.41	0.0003710	1671.83	0.0001869	4.28	0.0000395	11.27	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1836.77	0.92
	Calhoun	0.0009052	2108.93	0.0006006	2594.44	0.0000220	0.46	0.0711201	2029.99	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	22668.91	11.33
	Cameron	0.0003829	90.67	0.0000258	11.15	0.0000012	0.03	0.0038756	872.73	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	974.58	0.49
Other ERCOT Counties	Cherokee	0.0003163	74.96	0.0001943	838.15	0.0000977	2.14	0.0000198	5.65	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	920.84	0.46
	Coke	0.0000186	4.40	0.0001140	49.23	0.0193554	441.45	0.0000012	0.33	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	495.42	0.25
	Colorado	0.0014238	337.17	0.0000960	41.48	0.0000046	0.11	0.0117906	3245.52	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3624.28	1.81
	Ector	0.0000875	20.73	0.0000570	231.99	0.0911920	2079.86	0.0000055	1.56	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2334.15	1.17
	Fayette	0.0145746	3451.56	0.0009829	424.61	0.0000475	1.08	0.1169883	3323.70	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	37100.95	18.55
	Freestone	0.0119927	2840.														

#### 4.3 2019 Results for New Residential Construction (Single-family and Multi-family)

Table 17 presents the individual and combined annual electricity savings and NO<sub>x</sub> emissions reductions resulted from the new single-family and multi-family Construction in 2019. In addition, Table 17 includes the combined natural gas savings from the new Construction for both single-family and multi-family and the corresponding NO<sub>x</sub> emissions reductions.<sup>26</sup>

The total NO<sub>x</sub> reductions from electricity and natural gas savings from total new single-family and multi-family Construction in 2019 are 482.06 tons NO<sub>x</sub>/year, including 105.85 tons NO<sub>x</sub>/year (21.96 %) from single-family residential electricity savings, 342.38 tons NO<sub>x</sub>/year (71.02 %) from multi-family residential electricity savings, and 33.83 tons NO<sub>x</sub>/year (7.02 %) from natural gas savings from both single-family and multi-family residences. Figure 8 through Figure 12 show the electricity savings and NO<sub>x</sub> reductions tabulated in Table 17. 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 NO<sub>x</sub> reductions by using a stacked bar chart. Figure 11 and Figure 12 show the spatial distribution of the NO<sub>x</sub> reductions from electricity only, and electricity and natural gas, by county across the state, respectively.

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<sup>26</sup> 0.092 lb-NO<sub>x</sub>/MMBtu of emission rate was used for the calculation.

Table 17: 2019 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	HARDIN	372.45	0.01	539.52	0.01	911.97	0.01	2,777.16	0.01	0.03
	HARRIS	33,114.28	3.71	208,280.75	14.57	241,395.03	18.27	507,391.63	2.33	20.61
	JEFFERSON	1,116.55	1.44	2,108.30	1.90	3,224.85	3.34	9,137.66	0.04	3.38
	ORANGE	482.67	1.95	83.17	2.57	565.85	4.52	2,748.13	0.01	4.53
	TARRANT	24,293.85	0.30	124,124.76	1.09	148,418.61	1.39	884,565.57	4.07	5.46
	COLLIN	25,873.13	0.04	64,622.51	0.15	90,495.65	0.19	729,367.26	3.36	3.55
	DALLAS	15,981.74	0.83	166,975.45	3.04	182,957.19	3.86	1,046,744.70	4.82	8.68
	HOOD	542.74	0.45	363.93	1.64	906.67	2.09	7,208.59	0.03	2.12
	HUNT	807.42	0.01	0.00	0.05	807.42	0.06	9,700.20	0.04	0.11
	HENDERSON	127.40	0.08	74.96	0.29	202.37	0.37	264.72	0.00	0.37
	BEXAR	13,320.22	6.36	77,447.20	19.93	90,767.42	26.29	586,654.25	2.70	28.99
	TRAVIS	23,059.02	1.51	137,194.15	4.74	160,253.17	6.25	1,020,018.07	4.69	10.95
	DENTON	18,893.02	0.60	24,235.03	2.22	43,128.05	2.83	286,187.04	1.32	4.15
	WILLIAMSON	13,638.05		19,036.23		32,674.27	0.00	364,418.41	1.68	1.68
	EL PASO	6,720.96	4.11	9,415.32	5.75	16,136.28	9.86	76,046.82	0.55	10.21
	MONTGOMERY	11,249.57	0.36	16,702.75	0.48	27,952.32	0.84	93,037.33	0.43	1.26
	GALVESTON	4,011.50	0.41	3,495.67	1.63	7,507.18	2.04	20,344.78	0.09	2.13
	BRAZORIA	5,855.66	1.88	31.40	7.37	5,887.06	9.25	24,049.78	0.11	9.36
	COMAL	7,198.63	0.17	2,523.79	0.54	9,722.42	0.71	102,042.49	0.47	1.18
	ROCKWALL	3,585.19		4,088.59		7,673.78	0.00	69,110.12	0.32	0.32
	HAYS	7,774.31	0.19	3,033.89	0.58	10,808.20	0.77	115,009.23	0.53	1.30
	NUECES	2,467.99	1.60	238.64	5.02	2,706.63	6.62	11,999.31	0.06	6.68
	FORT BEND	15,633.24	2.29	24,193.80	9.00	39,827.05	11.29	130,733.47	0.60	11.89
	ELLIS	5,511.64	0.39	2,104.79	1.43	7,616.43	1.82	58,729.44	0.27	2.09
	JOHNSON	2,051.38	0.06	5,109.57	0.20	7,160.95	0.26	45,428.07	0.21	0.47
	GUADALUPE	2,138.36	1.04	6,602.64	3.25	8,741.00	4.29	62,306.98	0.29	4.57
	KAUFMAN	1,514.55	1.10	2,172.07	4.06	3,686.62	5.16	32,116.87	0.15	5.31
	PARKER	1,062.16	0.25	5,905.02	0.92	6,967.18	1.18	43,736.58	0.20	1.38
	SMITH	1,142.78		696.09		1,838.87	0.00	2,360.29	0.01	0.01
	BASTROP	408.71	0.82	115.16	2.57	523.87	3.39	5,209.77	0.02	3.42
	CHAMBERS	1,413.76	0.60	0.00	2.35	1,413.76	2.95	7,706.32	0.04	2.98
	GREGG	388.89	0.02	245.86	0.05	634.75	0.07	1,008.84	0.00	0.07
	SAN PATRICIO	662.95	2.68	2,082.70	8.39	2,745.65	11.07	5,291.58	0.02	11.09
	LIBERTY	1,527.58		0.00		1,527.58	0.00	9,007.06	0.04	0.04
	VICTORIA	266.89	0.55	642.13	1.73	909.01	2.28	2,303.66	0.01	2.29
	CALDWELL	705.76		115.16		820.92	0.00	8,990.12	0.04	0.04
	WILSON	52.41	0.07	0.00	0.22	52.41	0.29	642.49	0.00	0.30
	WALLER	44.39		818.35		862.74	0.00	1,471.46	0.01	0.01
	UPSHUR	15.77		0.00		15.77	0.00	116.26	0.00	0.00
	RUSK	0.00	9.15	0.00	33.63	0.00	42.77	0.00	0.00	42.77
	HARRISON	113.42	0.85	0.00	1.86	113.42	2.71	315.54	0.00	2.72
	WISE	262.67	1.12	2,172.07	4.11	2,434.74	5.22	17,360.83	0.08	5.30
	HIDALGO	7,859.98	0.81	25,866.78	2.54	33,726.76	3.35	63,202.07	0.29	3.64
	CAMERON	3,098.52	0.16	5,989.76	0.49	9,088.28	0.64	21,104.85	0.10	0.74
	BELL	5,930.45	0.13	4,134.05	0.46	10,064.50	0.59	120,737.86	0.56	1.14
	WEBB	3,984.19	0.01	3,254.22	0.04	7,238.40	0.05	41,961.46	0.19	0.24
	BRAZOS	1,866.30	0.25	3,325.86	0.92	5,192.16	1.17	16,249.22	0.07	1.24
	KENDALL	1,083.76		0.00		1,083.76	0.00	6,796.18	0.03	0.03
BURNET	1,790.43		32.47		1,822.91	0.00	11,347.25	0.05	0.05	
GRAYSON	1,765.19	0.14	5,149.04	0.51	6,914.23	0.65	55,353.40	0.25	0.91	
CORYELL	488.82		271.09		759.90	0.00	9,448.06	0.04	0.04	
MIDLAND	3,455.07		0.00		3,455.07	0.00	30,612.23	0.14	0.14	
LLANO	317.71	0.07	32.47	0.23	350.18	0.31	2,111.89	0.01	0.32	
MAVERICK	269.28		43.39		312.67	0.00	2,655.20	0.01	0.01	
MCMULLEN	0.00		0.00		0.00	0.00	0.00	0.00	0.00	
ARANSAS	471.30		0.00		471.30	0.00	2,244.77	0.01	0.01	
WICHITA	287.30	0.01	999.52	0.02	1,286.82	0.03	9,713.64	0.04	0.08	
TAYLOR	1,020.00		288.64		1,308.63	0.00	12,834.77	0.06	0.06	
TOM GREEN	800.73		0.00		800.73	0.00	7,178.59	0.03	0.03	
MCLENNAN	2,424.43	1.19	5,862.22	4.38	8,286.65	5.58	79,531.09	0.37	5.94	
MCCULLOCH	0.00		0.00		0.00	0.00	0.00	0.00	0.00	
JIM HOOG	0.00		0.00		0.00	0.00	0.00	0.00	0.00	
VAL VERDE	322.33		101.97		424.30	0.00	4,508.75	0.02	0.02	
ECTOR	1,990.01	0.42	18,073.09	1.17	20,063.10	1.59	132,483.81	0.61	2.20	
WHARTON	236.60	0.36	0.00	1.12	236.60	1.48	1,298.53	0.01	1.49	
KERR	261.29		64.95		326.24	0.00	1,877.71	0.01	0.01	
PRESIDIO	59.42		0.00		59.42	0.00	532.69	0.00	0.00	
JIM WELLS	31.29		0.00		31.29	0.00	149.03	0.00	0.00	
CALHOUN	174.14	3.62	42.81	11.33	216.95	14.95	1,011.64	0.00	14.96	
GILLESPIE	190.03		64.95		254.98	0.00	1,430.84	0.01	0.01	
MATAGORDA	295.28		0.00		295.28	0.00	1,620.56	0.01	0.01	
NAVARRO	876.50		271.09		1,147.59	0.00	15,386.54	0.07	0.07	
ANGELINA	164.75	0.93	0.00	3.44	164.75	4.37	1,121.93	0.01	4.38	
NACOGDOCHES	42.33	0.06	44.40	0.21	86.73	0.27	106.94	0.00	0.27	
FANNIN	83.53		28.29		111.82	0.00	1,191.09	0.01	0.01	
ATASCOSA	117.74	2.28	0.00	7.15	117.74	9.43	1,446.75	0.01	9.44	
WASHINGTON	101.73		0.00		101.73	0.00	619.66	0.00	0.00	
LAMAR	63.20	0.84	908.58	3.10	971.78	3.95	6,144.33	0.03	3.98	
YAN ZANDT	89.42		56.79		146.21	0.00	1,426.94	0.01	0.01	
WILLACY	102.54		0.00		102.54	0.00	518.92	0.00	0.00	
BROWN	432.63		152.49		585.12	0.00	7,729.73	0.04	0.04	
ERATH	104.08		5,520.23		5,624.31	0.00	39,146.56	0.18	0.18	
AUSTIN	49.94		0.00		49.94	0.00	304.20	0.00	0.00	
COOKE	189.33		0.00		189.33	0.00	2,274.53	0.01	0.01	
MEDINA	68.13		0.00		68.13	0.00	835.24	0.00	0.00	

Table 17: 2019 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)
TITUS	69.32	6.37	0.00	22.05	69.32	28.42	194.56	0.00	28.42
UVALDE	73.38		0.00		73.38	0.00	899.49	0.00	0.00
FAYETTE	24.05	5.92	0.00	18.55	24.05	24.47	146.47	0.00	24.47
CALLAHAN	32.71		0.00		32.71	0.00	347.82	0.00	0.00
HOPKINS	72.65		227.14		299.80	0.00	2,348.11	0.01	0.01
LAMPASAS	89.90		33.89		123.78	0.00	1,622.09	0.01	0.01
BLANCO	32.66		0.00		32.66	0.00	204.82	0.00	0.00
FREESTONE	14.05	4.75	0.00	17.46	14.05	22.21	215.16	0.00	22.21
GRIMES	188.66	1.59	0.00	5.86	188.66	7.45	1,149.19	0.01	7.46
LEE	48.34		23.03		71.37	0.00	739.03	0.00	0.00
SOMERVELL	54.74		0.00		54.74	0.00	469.41	0.00	0.00
ANDREWS	74.99		2,435.26		2,510.25	0.00	16,140.19	0.07	0.07
BORDEN	57.50		0.00		57.50	0.00	533.17	0.00	0.00
CHEROKEE	29.48	0.13	0.00	0.46	29.48	0.59	200.77	0.00	0.59
DIMMIT	0.00		0.00		0.00	0.00	0.00	0.00	0.00
FALLS	36.52		0.00		36.52	0.00	559.42	0.00	0.00
COLORADO	24.05	0.58	62.95	1.81	87.00	2.39	238.86	0.00	2.39
FRIO	15.70	2.87	0.00	8.97	15.70	11.84	192.90	0.00	11.84
MILAM	22.53	2.87	0.00	9.00	22.53	11.88	344.26	0.00	11.88
JACKSON	15.14		0.00		15.14	0.00	83.11	0.00	0.00
ANDERSON	34.69	0.04	0.00	0.14	34.69	0.18	236.20	0.00	0.18
HILL	112.37	0.11	0.00	0.42	112.37	0.53	1,721.30	0.01	0.54
CULBERSON	22.01		0.00		22.01	0.00	101.17	0.00	0.00
MASON	11.88		0.00		11.88	0.00	74.48	0.00	0.00
POTTER	814.35	0.82	272.12	1.80	1,086.47	2.62	3,642.81	0.02	2.63
PECOS	16.98	0.01	656.56	0.04	673.53	0.05	4,054.47	0.02	0.07
RAINS	50.30		0.00		50.30	0.00	592.88	0.00	0.00
LAVACA	41.01		0.00		41.01	0.00	182.45	0.00	0.00
PALO PINTO	29.74	0.19	0.00	0.71	29.74	0.90	316.20	0.00	0.90
KIMBLE	2.83		0.00		2.83	0.00	25.37	0.00	0.00
MADISON	12.95		0.00		12.95	0.00	78.87	0.00	0.00
ARCHER	89.96		0.00		89.96	0.00	931.52	0.00	0.00
REFUGIO	92.75		0.00		92.75	0.00	509.02	0.00	0.00
LIMESTONE	39.33	8.08	0.00	29.72	39.33	37.80	602.45	0.00	37.80
CLAY	8.71		0.00		8.71	0.00	90.15	0.00	0.00
BEE	20.82		64.21		85.03	0.00	198.16	0.00	0.00
MARTIN	42.85		0.00		42.85	0.00	379.69	0.00	0.00
GONZALES	34.07		0.00		34.07	0.00	417.62	0.00	0.00
BURLESON	11.10		755.40		766.50	0.00	1,176.27	0.01	0.01
KARNES	157.74		0.00		157.74	0.00	1,946.14	0.01	0.01
KLEBERG	76.54		0.00		76.54	0.00	417.25	0.00	0.00
BREWSTER	53.76		0.00		53.76	0.00	481.95	0.00	0.00
WINKLER	8.04		0.00		8.04	0.00	71.19	0.00	0.00
WOOD	44.68	0.00	881.03	0.01	925.71	0.01	5,065.53	0.02	0.03
FRANKLIN	5.59		0.00		5.59	0.00	65.88	0.00	0.00
YOUNG	5.95	0.10	0.00	0.28	5.95	0.38	63.24	0.00	0.38
HOUSTON	1.73		0.00		1.73	0.00	11.81	0.00	0.00
SCURRY	9.08	0.66	0.00	1.82	9.08	2.49	84.19	0.00	2.49
BOSQUE	19.67	0.22	0.00	0.81	19.67	1.03	301.23	0.00	1.04
COMANCHE	0.00		0.00		0.00	0.00	0.00	0.00	0.00
BRISCOE	18.01		0.00		18.01	0.00	617.15	0.00	0.00
CONCHO	2.83		0.00		2.83	0.00	25.37	0.00	0.00
ZAVALA	0.00		0.00		0.00	0.00	0.00	0.00	0.00
NOLAN	14.87	0.06	0.00	0.16	14.87	0.21	158.10	0.00	0.21
BROOKS	4.00		0.00		4.00	0.00	20.69	0.00	0.00
ROBERTSON	140.57	5.23	0.00	19.23	140.57	24.46	856.26	0.00	24.46
LIVE OAK	9.78		0.00		9.78	0.00	46.57	0.00	0.00
HAMILTON	8.43		0.00		8.43	0.00	129.10	0.00	0.00
JONES	0.00		0.00		0.00	0.00	0.00	0.00	0.00
REAGAN	0.00	0.00	104.50	0.00	104.50	0.00	662.87	0.00	0.00
WARD	0.00	0.01	0.00	0.04	0.00	0.05	0.00	0.00	0.05
RED RIVER	12.23	0.01	0.00	0.05	12.23	0.07	34.33	0.00	0.07
HASKELL	8.92		0.00		8.92	0.00	94.86	0.00	0.00
HOWARD	112.49	0.07	69.58	0.19	182.07	0.26	1,438.84	0.01	0.27
SAN SABA	8.91		0.00		8.91	0.00	55.86	0.00	0.00
JACK	0.00		0.00		0.00	0.00	0.00	0.00	0.00
STEPHENS	11.89		0.00		11.89	0.00	126.48	0.00	0.00
RUNNELS	14.15		0.00		14.15	0.00	126.83	0.00	0.00
REEVES	179.45		0.00		179.45	0.00	1,589.94	0.01	0.01
DE WITT	13.25		0.00		13.25	0.00	72.72	0.00	0.00
CHILDRESS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
CROSBY	3.03		0.00		3.03	0.00	28.06	0.00	0.00
DAWSON	0.00		0.00		0.00	0.00	0.00	0.00	0.00
MITCHELL	14.87	0.13	0.00	0.36	14.87	0.49	158.10	0.00	0.49
WILBARGER	5.80	2.73	0.00	7.52	5.80	10.26	60.10	0.00	10.26
COLEMAN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
UPTON	10.72	0.00	0.00	0.00	10.72	0.00	94.88	0.00	0.00
COKE	2.83	0.09	0.00	0.25	2.83	0.34	25.53	0.00	0.34
CROCKETT	53.76		0.00		53.76	0.00	481.95	0.00	0.00
HARDEMAN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
BANDERA	2.62		0.00		2.62	0.00	32.12	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	0.00		0.00		0.00	0.00	0.00	0.00	0.00
DELTA	19.56		0.00		19.56	0.00	230.56	0.00	0.00

Other ERCOT Counties

Table 17: 2019 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	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	14.87		180.40		195.27	0.00	1,401.23	0.01	0.01
	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	0.00	1.98	0.00	6.20	0.00	8.18	0.00	0.00	8.18
	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	0.00		0.00		0.00	0.00	0.00	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	25.06		0.00		25.06	0.00	301.04	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	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SHACKELFORD	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SFARR	6.69		0.00		6.69	0.00	33.84	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	0.00		0.00		0.00	0.00	0.00	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
Other TEXAS Counties	ARMSTRONG	20.58		0.00		20.58	0.00	705.31	0.00	0.00
	BAILEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	BOWIE	101.94		0.00		101.94	0.00	286.12	0.00	0.00
	CAMP	14.27		0.00		14.27	0.00	40.06	0.00	0.00
	CARSON	7.72		0.00		7.72	0.00	264.49	0.00	0.00
	CASS	32.62	0.04	0.00	0.08	32.62	0.12	91.56	0.00	0.12
	CASTRO	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	COCHRAN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	COLLINGSWORTH	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	DALLAM	12.86		0.00		12.86	0.00	440.82	0.00	0.00
	DEAF SMITH	5.14		0.00		5.14	0.00	176.33	0.00	0.00
	DONLEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	FLOYD	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	Gaines	5.36	0.01	0.00	0.01	5.36	0.02	47.46	0.00	0.02
	GARZA	5.93		0.00		5.93	0.00	62.89	0.00	0.00
	GRAY	2.57	0.00	0.00	0.00	2.57	0.01	88.16	0.00	0.01
	HALE	23.15	0.04	0.00	0.10	23.15	0.14	793.47	0.00	0.14
	HANSFORD	5.14		0.00		5.14	0.00	176.33	0.00	0.00
	HARTLEY	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	HEMPHILL	0.00	0.07	0.00	0.16	0.00	0.23	0.00	0.00	0.23
	HOCKLEY	23.15		0.00		23.15	0.00	793.47	0.00	0.00
	HUTCHINSON	0.00	0.33	0.00	0.73	0.00	1.07	0.00	0.00	1.07
	JASPER	57.42	0.10	748.57	0.14	805.99	0.24	1,371.61	0.01	0.25
	LAMB	12.86	0.83	0.00	1.82	12.86	2.66	440.82	0.00	2.66
	LIPSCOMB	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	LUBBOCK	4,470.60	0.14	13,411.34	0.31	17,881.95	0.46	140,595.89	0.65	1.10
	LYNN	2.97		0.00		2.97	0.00	31.45	0.00	0.00
	MARION	8.10	0.08	0.00	0.18	8.10	0.26	22.54	0.00	0.26
	MOORE	41.16	0.00	0.00	0.00	41.16	0.00	1,410.62	0.01	0.01
	MORRIS	2.04	0.00	0.00	0.00	2.04	0.00	5.72	0.00	0.00
	NEWTON	0.00	0.12	0.00	0.16	0.00	0.28	0.00	0.00	0.28
	OCHLTREE	2.57		0.00		2.57	0.00	88.16	0.00	0.00
	OLDHAM	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	PANOLA	16.12		0.00		16.12	0.00	46.17	0.00	0.00
	FARMER	2.57		0.00		2.57	0.00	88.16	0.00	0.00
	POLK	479.89		1,016.79		1,496.67	0.00	4,025.70	0.02	0.02
	RANDALL	249.51		60.54		310.05	0.00	9,252.35	0.04	0.04
	ROBERTS	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SABINE	2.02		0.00		2.02	0.00	5.77	0.00	0.00
	Sun Augustine	0.00		0.00		0.00	0.00	0.00	0.00	0.00
	SAN JACINTO	731.31	0.02	0.00	0.03	731.31	0.05	4,312.01	0.02	0.07
	SHELBY	2.02		0.00		2.02	0.00	5.77	0.00	0.00
	SHERMAN	28.29		30.27		58.57	0.00	1,320.03	0.01	0.01
SWISHER	0.00		0.00		0.00	0.00	0.00	0.00	0.00	
TERRY	0.00		0.00		0.00	0.00	0.00	0.00	0.00	
TRINITY	5.20		0.00		5.20	0.00	35.43	0.00	0.00	
TYLER	10.74	0.01	0.00	0.01	10.74	0.01	58.46	0.00	0.01	
WALKER	652.93		2,465.54		3,118.47	0.00	7,595.69	0.03	0.03	
WHEELER	0.00		0.00		0.00	0.00	0.00	0.00	0.00	
YOAKUM	10.29	0.11	0.00	0.25	10.29	0.37	352.66	0.00	0.37	
<b>TOTAL</b>	<b>308,979.85</b>	<b>105.85</b>	<b>1,021,669.69</b>	<b>342.38</b>	<b>1,330,649.54</b>	<b>448.23</b>	<b>7,354,311.52</b>	<b>33.83</b>	<b>482.06</b>	

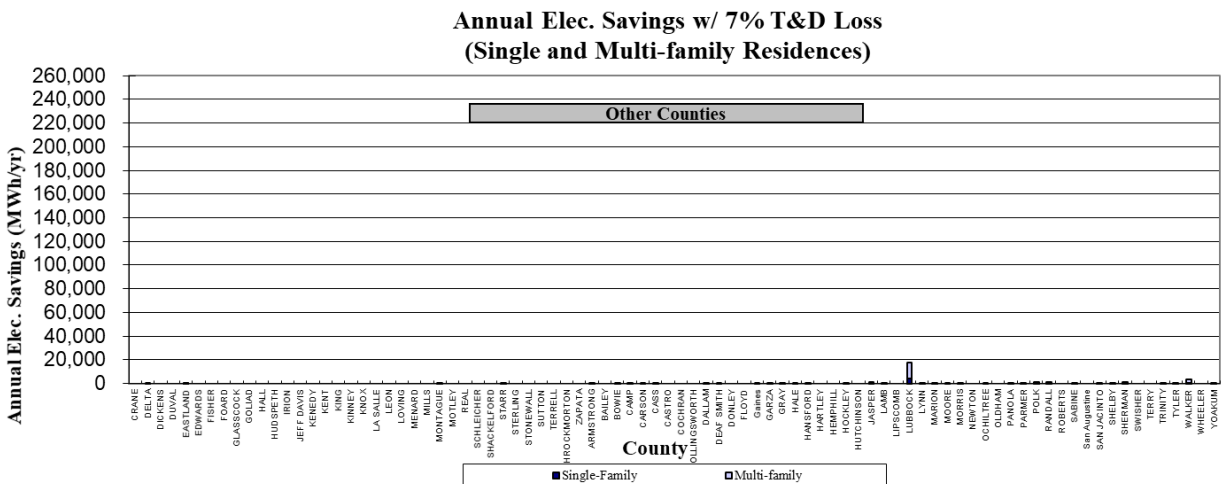
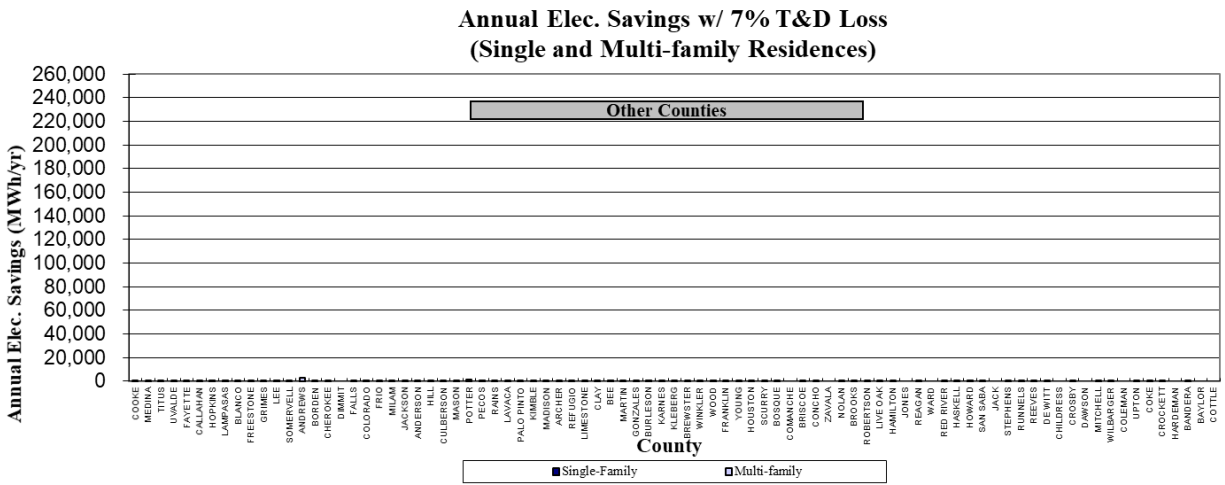
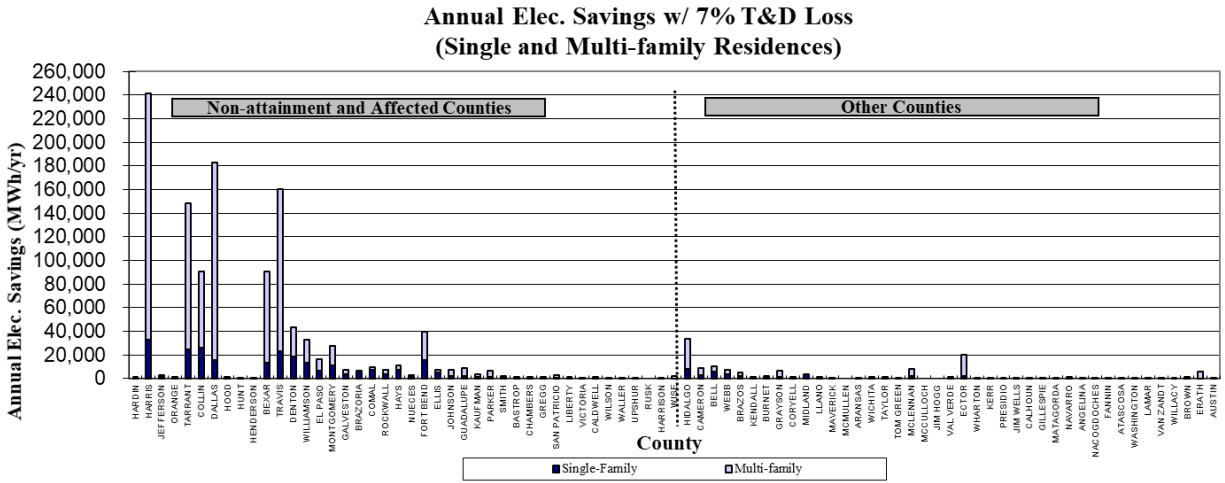


Figure 8: 2019 Annual Electricity Savings by County from New Single-family and Multi-family Residences

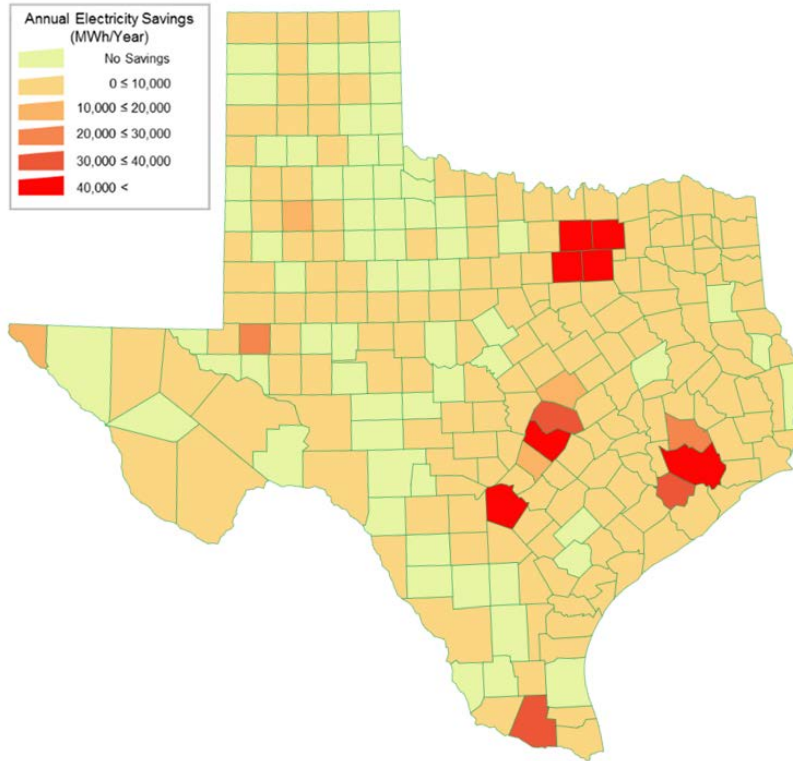


Figure 9: Map of 2019 Annual Electricity Savings by County from New Single-family and Multi-family Residences

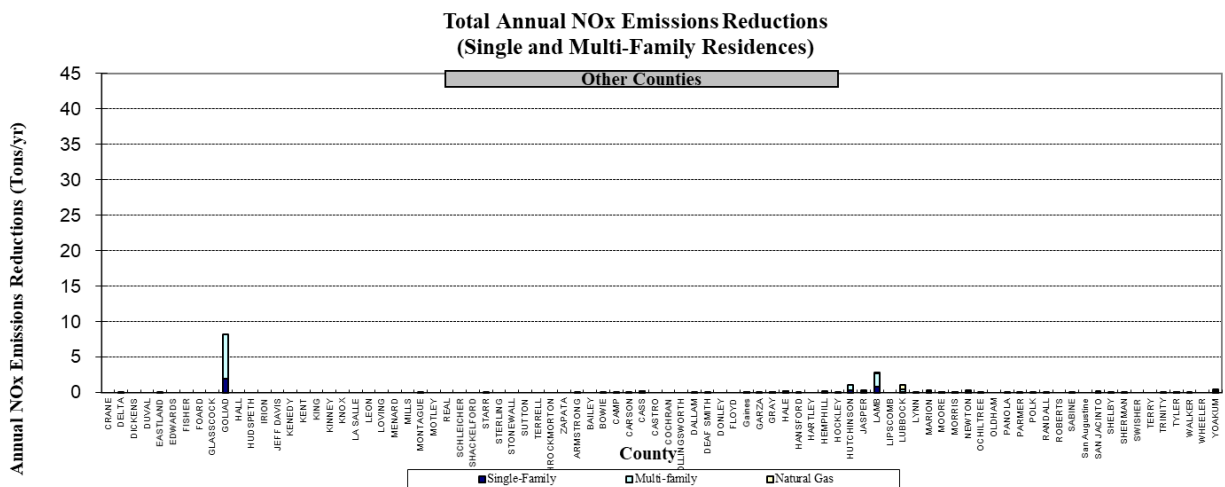
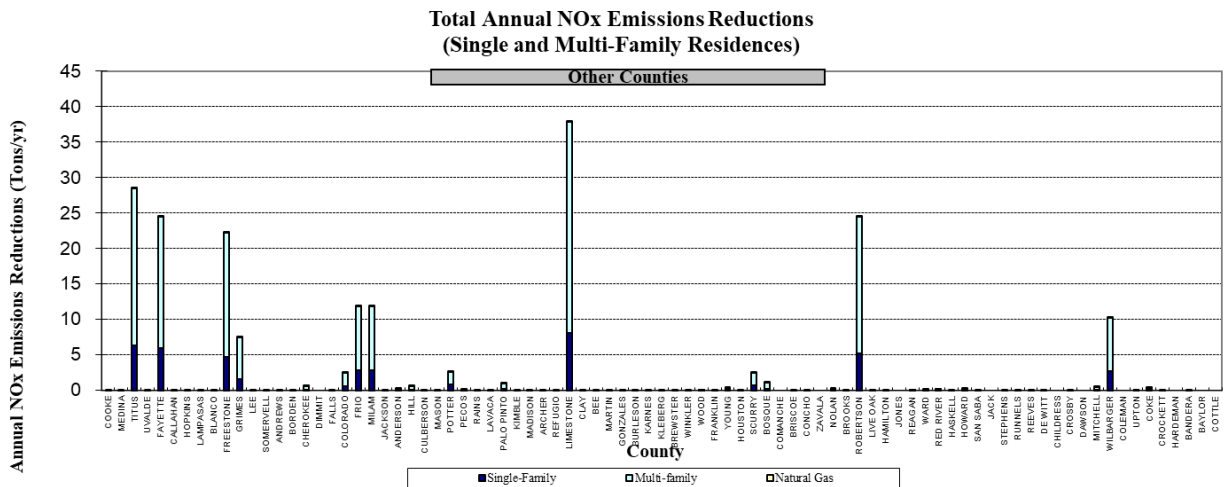
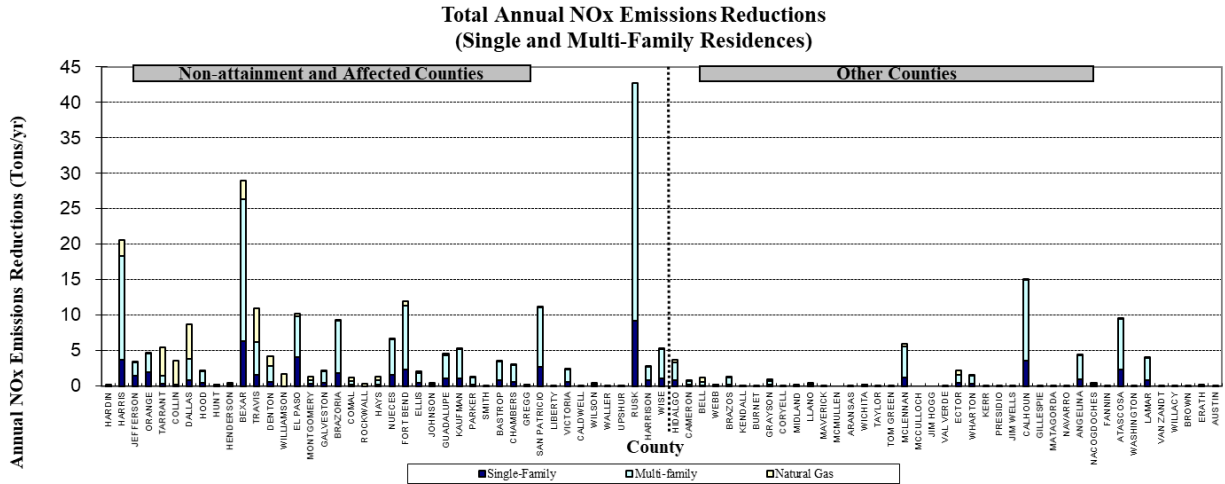


Figure 10: 2019 Annual NOx Reductions by County from New Single-family and Multi-family Residences



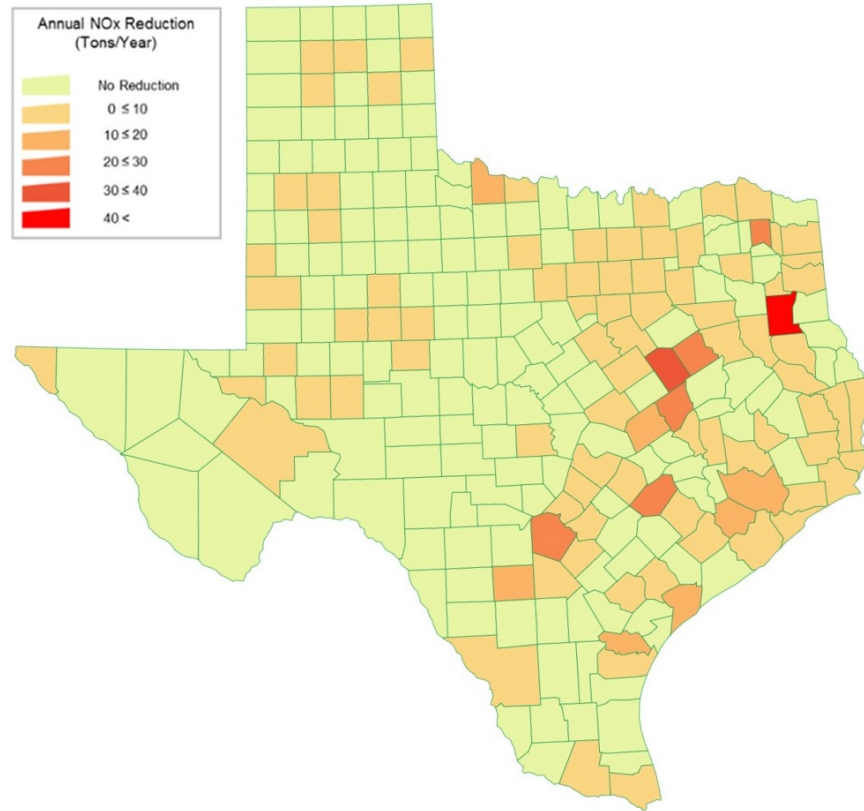


Figure 11: Map of 2019 Annual NOx Reductions from Electricity by County from New Single-family and Multi-family Residences

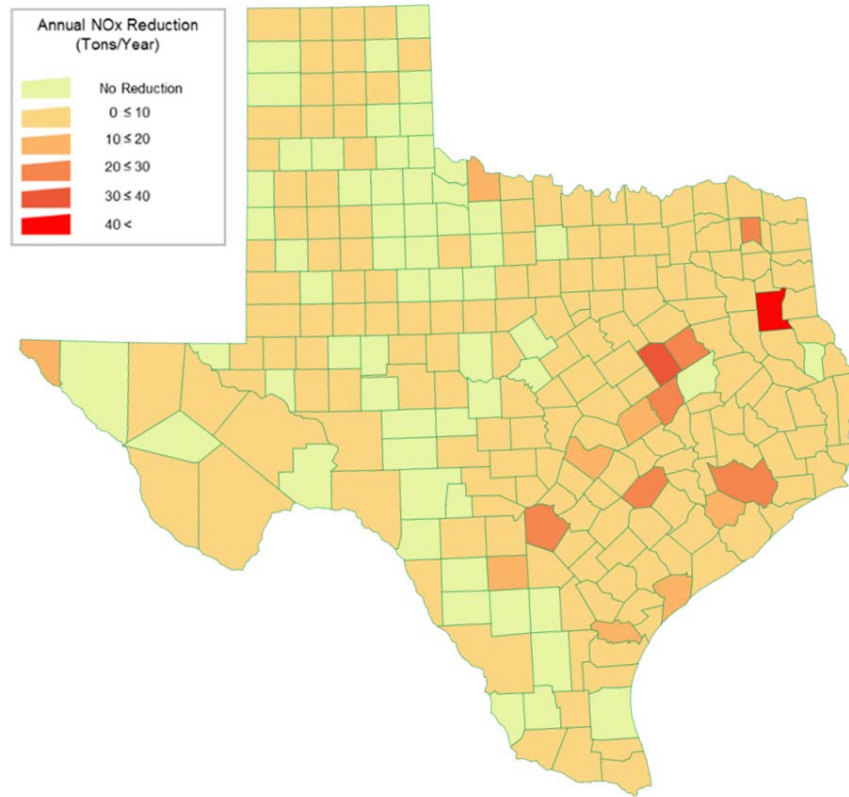


Figure 12: Map of 2019 Annual NO<sub>x</sub> Reductions from Electricity and Natural Gas by County from New Single-family and Multi-family Residences

#### 4.4 2019 Results for Commercial Construction

This section reports the calculated energy savings and emissions reductions from new commercial construction in 2019 that was built to meet ASHRAE Standard 90.1-2013.

To determine the energy savings and emissions reductions from new commercial construction in all counties in Texas, including the 42 non-attainment and affected counties, data from two sources (i.e., Dodge and USDOE) were merged into one analysis as shown in Figure 13. Beginning in the upper left of Figure 13, the Dodge database of the square footage of new commercial construction per county in Texas (Dodge 2020) 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 13 and Table 18 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 19 (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 14 for all building types and in Figure 15 for each building type.

In the next step, the annual energy savings were calculated. 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 20 to Table 22 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 23 shows the county-wide annual electricity and natural gas savings by building type.<sup>27</sup>

In the next calculation step, CL Zones were assigned to each county as shown in Table 24. In the case where more than one provider was shown in a county, a percentage of electricity use was allocated.

Table 26 shows the transformation of the annual county-wide electricity and natural gas savings, along with the associated 2019 NO<sub>x</sub> emissions reductions with 7% T&D losses.<sup>28</sup> Figure 16 shows the bar chart of the annual electricity savings for 2019. Figure 17 presents the NO<sub>x</sub> emissions reductions resulted from electricity and natural gas savings. The total NO<sub>x</sub> reductions from electricity and natural gas savings from new commercial Construction in 2019 are calculated to be 108.65 tons NO<sub>x</sub>/year which represents 62.19 tons NO<sub>x</sub>/year from electricity savings and 46.46 tons NO<sub>x</sub>/year from natural gas savings.

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<sup>27</sup> In this table (-) values are savings, (+) values are increased energy use.

<sup>28</sup> 0.092 lb-NO<sub>x</sub>/MMBtu of emission rate was used for the calculation.

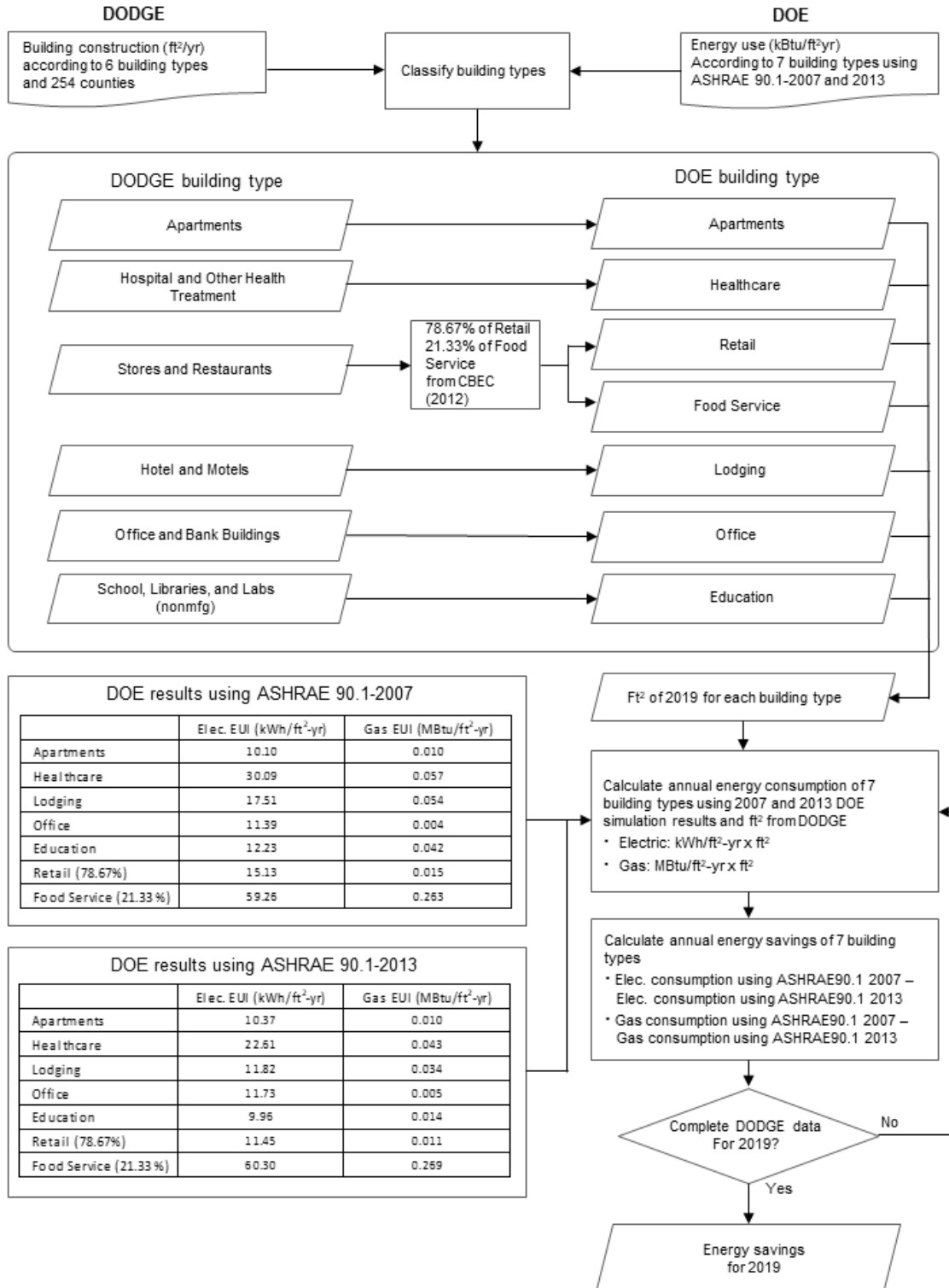


Figure 13: Calculation Method for 2019 Energy Savings from New Commercial Buildings

Table 18: 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 19: 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	

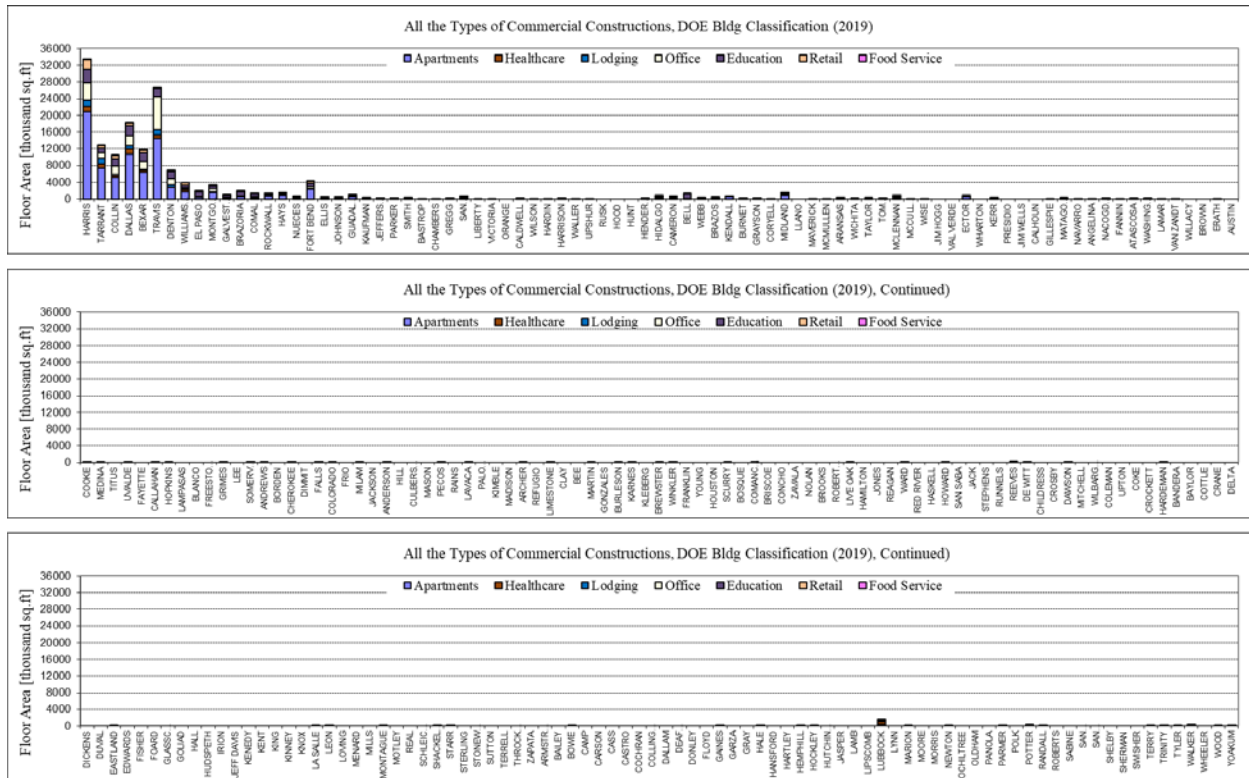


Figure 14: All the Types of 2019 New Commercial Building Construction (Dodge 2020)



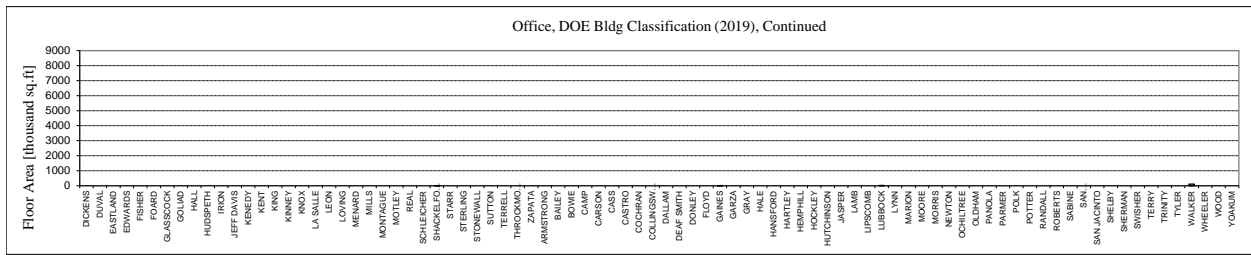
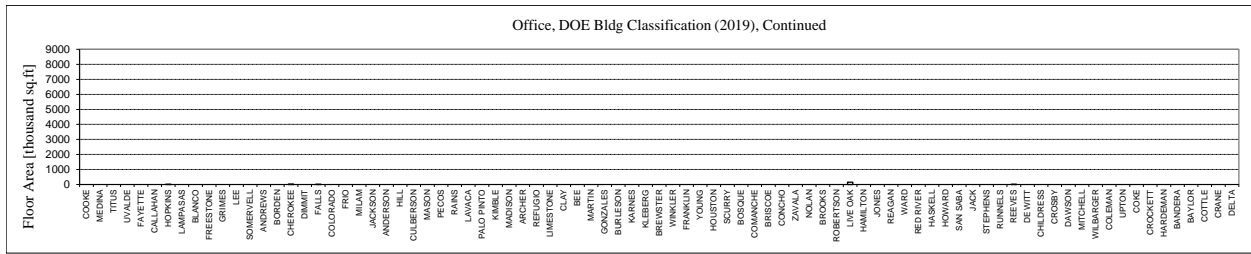
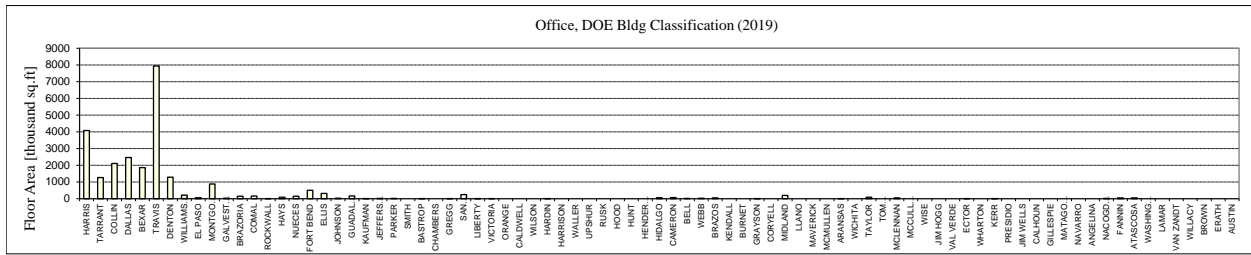
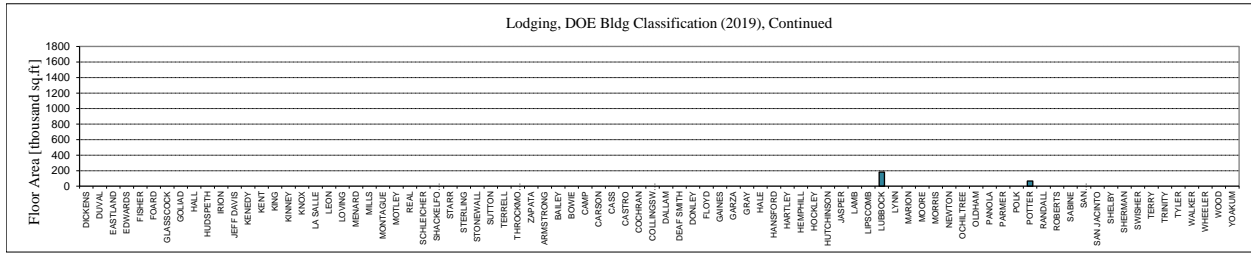
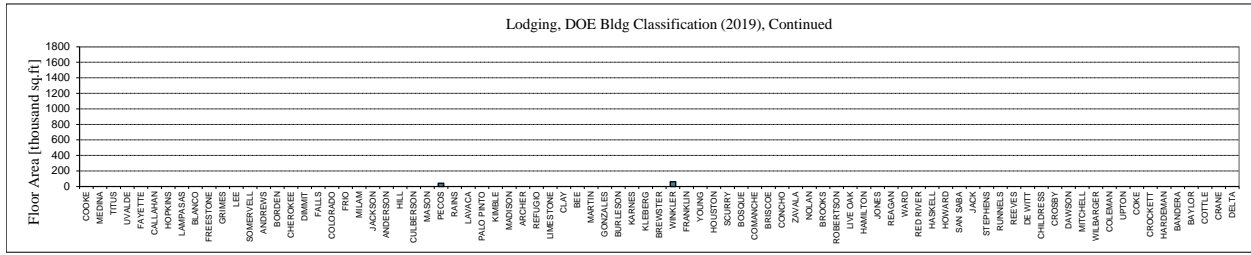
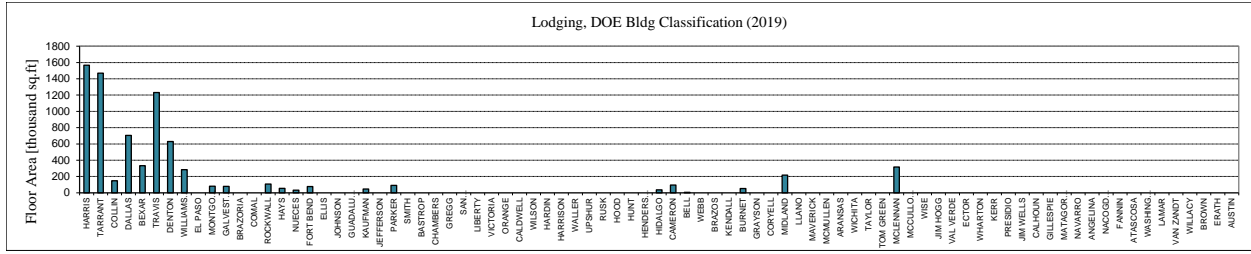


Figure 15: 2019 New Commercial Building Construction by Type (Dodge 2020) (Continued)

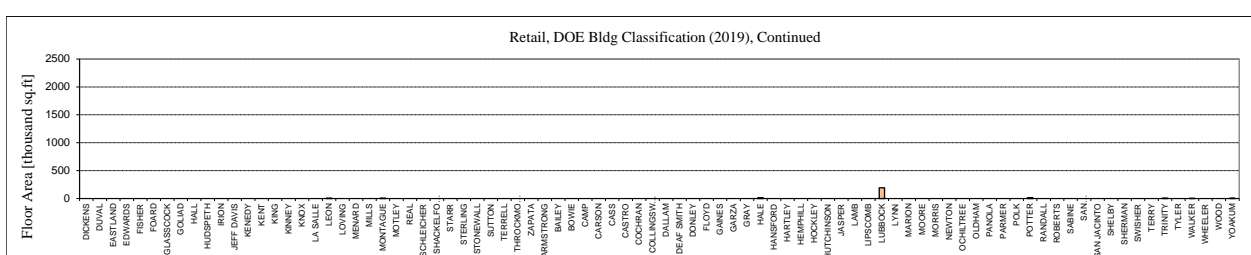
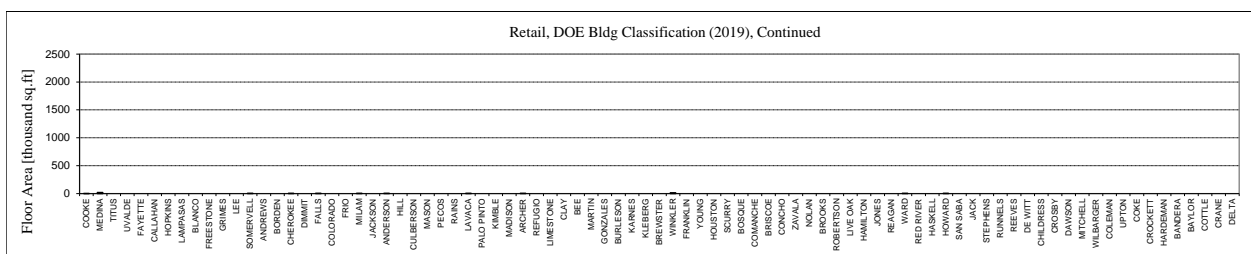
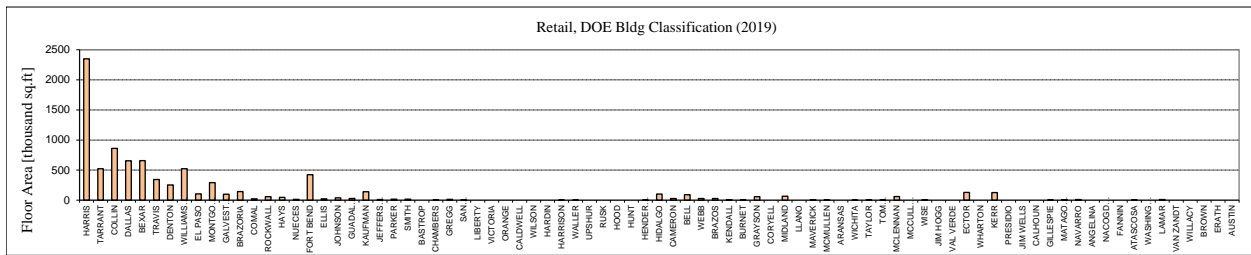
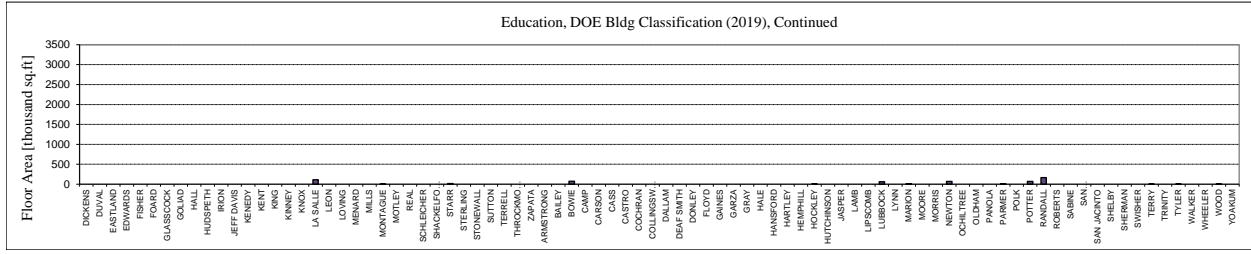
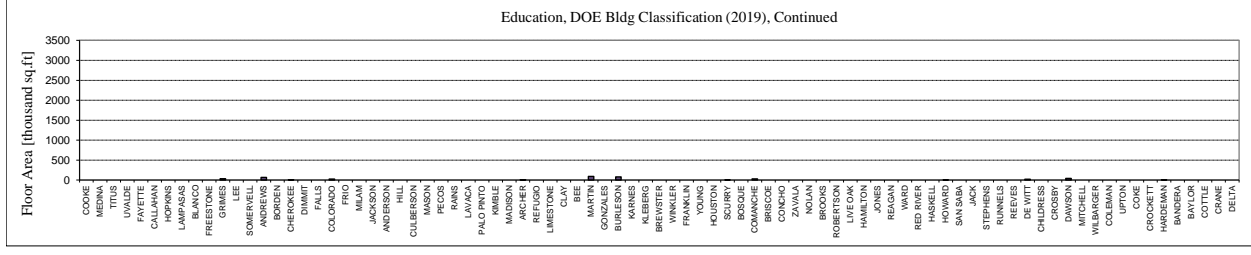
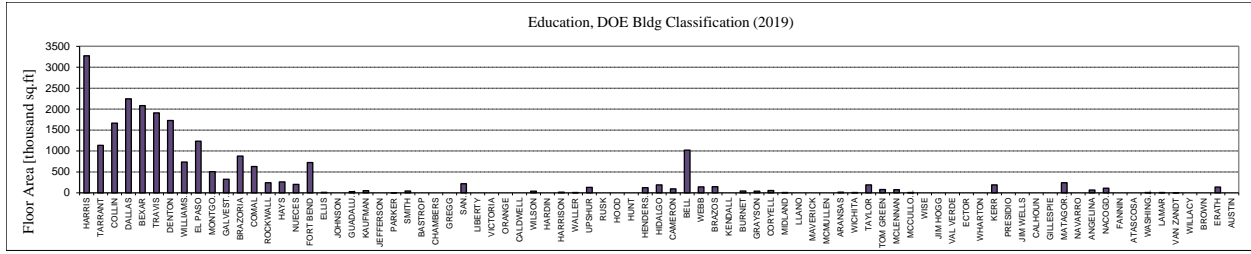


Figure 15: 2019 New Commercial Building Construction by Type (Dodge 2020) (Continued)



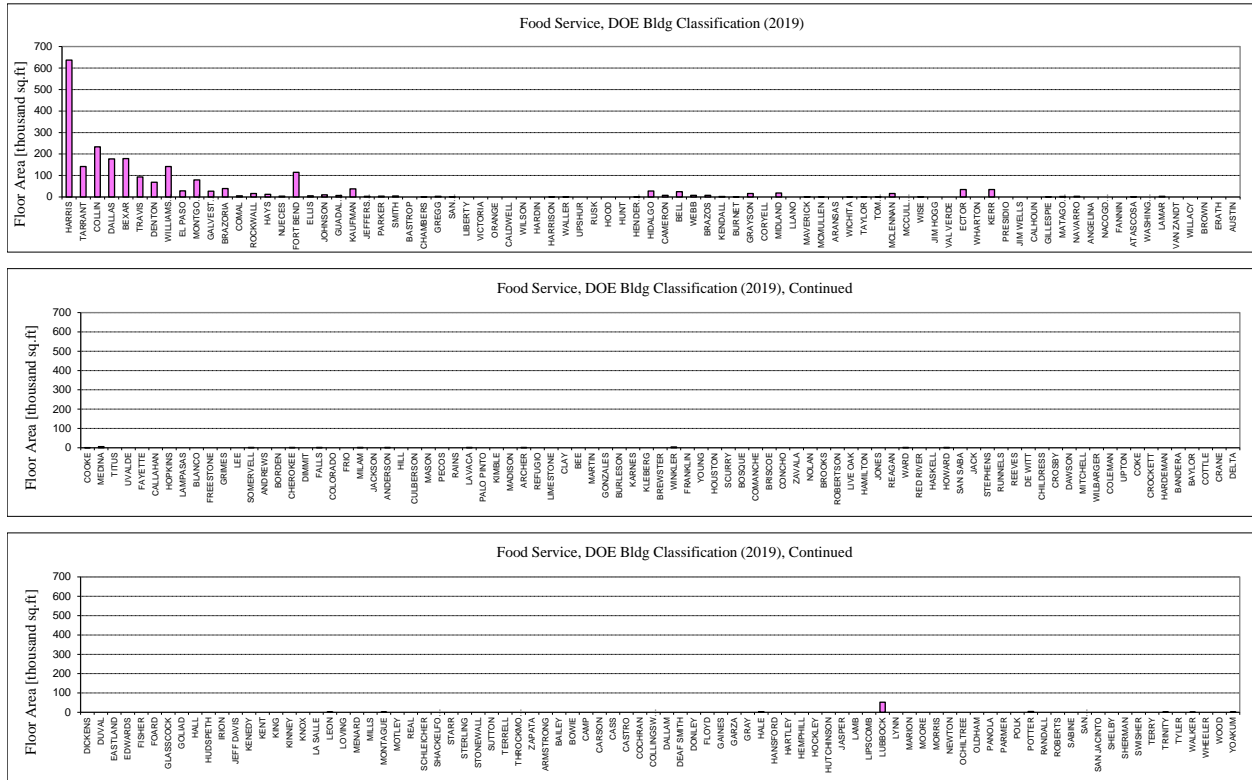


Figure 15: 2019 New Commercial Building Construction by Type (Dodge 2020) (Continued)

Table 20: 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	6017397	6180765	5811	5969	324989	244179	610	460	0	0	0	0
Chambers	0	0	0	0	0	0	0	0	0	0	0	0
Collin	51921249	53330876	50140	51502	14949471	11232241	28081	21166	2600134	1755699	8050	5073
Dallas	107950683	110881471	104248	107078	41071927	30859270	77149	58151	12344070	8335136	38215	24082
Denton	27620457	28370333	26673	27397	4008192	3011543	7529	5675	11029120	7447237	34144	21517
El Paso	4477710	4599277	4324	4442	649977	488358	1221	920	0	0	0	0
Ellis	585586	601484	566	581	662014	497402	1244	937	0	0	0	0
Fort Bend	23409289	24044835	22606	23220	3580892	2690492	6726	5070	1351719	912727	4185	2637
Galveston	3129854	3214827	3023	3105	2292974	1722820	4307	3246	1386738	936373	4293	2705
Hardin	0	0	0	0	0	0	0	0	0	0	0	0
Harris	210051569	215754326	202847	208354	40870314	30707789	76770	57865	27421344	18515824	84892	53496
Jefferson	336207	345335	325	333	2377231	1786125	4465	3366	0	0	0	0
Johnson	1384203	1421783	1337	1373	9126761	6857364	17144	12922	0	0	0	0
Kaufman	1085353	1114819	1048	1077	0	0	0	0	822938	555676	2548	1605
Liberty	0	0	0	0	0	0	0	0	0	0	0	0
Montgomery	15758310	16186137	15218	15631	743261	558447	1396	1052	1420006	958836	4396	2770
Orange	0	0	0	0	0	0	0	0	0	0	0	0
Parker	0	0	0	0	123375	92698	232	175	1586344	1071154	4911	3095
Rockwall	7525784	7730104	7268	7465	2747357	2064218	5161	3890	1873497	1265049	5800	3655
Tarrant	74888319	76921486	72320	74283	26859698	20180954	50453	38029	25740450	17380827	79688	50217
Waller	0	0	0	0	0	0	0	0	0	0	0	0
Wise	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	150458	113046	283	213	0	0	0	0
Bexar	63197810	64913588	61030	62687	15319597	11510334	28776	21690	5816596	3927563	18007	11348
Caldwell	475536	488446	459	472	0	0	0	0	0	0	0	0
Comal	2463498	2530380	2379	2444	3207757	2410139	6025	4542	0	0	0	0
Gregg	1060112	1088893	1024	1052	601831	452184	1130	852	0	0	0	0
Guadalupe	5340944	5485947	5158	5298	2347139	1763516	4409	3323	0	0	0	0
Harrison	0	0	0	0	1582814	1189243	2973	2241	0	0	0	0
Hays	9391581	9646556	9069	9316	0	0	0	0	963013	650259	2981	1879
Henderson	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
Hunt	0	0	0	0	0	0	0	0	0	0	0	0
Nueces	2354458	2418380	2274	2335	0	0	0	0	567302	383062	1756	1107
Rusk	0	0	0	0	0	0	0	0	0	0	0	0
San Patricio	0	0	0	0	1697162	1275158	3188	2403	0	0	0	0
Smith	767319	788151	741	761	1907803	1433422	3584	2701	0	0	0	0
Travis	146754815	150739109	141721	145569	22186484	16669749	41675	31412	21546968	14549245	66706	42036
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	17689733	18169997	17083	17547	10787813	8105391	20264	15274	4986654	3367158	15438	9728
Wilson	0	0	0	0	0	0	0	0	0	0	0	0

Table 21: 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	2877446	2955567	2779	2854	0	0	0	0	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	1009630	1037041	975	1001	0	0	0	0	105056	70937	325	205
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	2019261	2074082	1950	2003	0	0	0	0	0	0	0	0
BREWSTER	435151	446965	420	432	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	0	0	0	0	0	0	0	0
BURLESON	0	0	0	0	0	0	0	0	0	0	0	0
BURNET	0	0	0	0	105320	79132	198	149	906983	612426	2808	1769
CALHOUN	0	0	0	0	0	0	0	0	0	0	0	0
CALLAHAN	799627	821337	772	793	0	0	0	0	0	0	0	0
CAMERON	2910764	2989789	2811	2887	1817528	1365594	3414	2573	1663385	1123174	5150	3245
CHEROKEE	0	0	0	0	484474	364008	910	686	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	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	0	0	0	0	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	0	0	0	0	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	807704	829633	780	801	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	90275	67828	170	128	0	0	0	0
ECTOR	6189034	6357062	5977	6139	932837	700885	1752	1321	0	0	0	0
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
GLASCOCK	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	0	0	0	0	0	0	0	0
GRAYSON	0	0	0	0	2819576	2118480	5296	3992	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
HIDALGO	2245418	2306379	2168	2227	5025285	3775733	9439	7115	630335	425624	1951	1230
HILL	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
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 21: 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	258787	194439	486	366	0	0	0	0
KENDALL	5139018	5278539	4963	5097	601831	452184	1130	852	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	131252	134815	127	130	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	54165	40697	102	77	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	0	0	0	0
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	2675520	2748159	2584	2654	1296945	974456	2436	1836	5536447	3738397	17140	10801
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	9217925	9468185	8902	9143	219668	165047	413	311	3792518	2560837	11741	7399
MILAM	0	0	0	0	0	0	0	0	0	0	0	0
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	1035149	777756	1944	1466	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	0	0	0	0	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	0	0	0	0	731890	494197	2266	1428
POTTER	0	0	0	0	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	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	228176	234371	220	226	4212814	3165285	7913	5965	0	0	0	0
REFUGIO	0	0	0	0	0	0	0	0	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	129394	97219	243	183	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	589794	443140	1108	835	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	643135	660595	621	638	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	5473649	4112610	10282	7750	0	0	0	0
VAL VERDE	0	0	0	0	0	0	0	0	0	0	0	0
VAN ZANDT	0	0	0	0	505538	379834	950	716	0	0	0	0
WARD	0	0	0	0	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	809462	608187	1520	1146	0	0	0	0
WEBB	136300	140001	132	135	0	0	0	0	0	0	0	0
WHARTON	0	0	0	0	0	0	0	0	0	0	0	0
WICHITA	372554	382668	360	370	0	0	0	0	0	0	0	0
WILBARGER	0	0	0	0	0	0	0	0	0	0	0	0

Table 21: 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)	
WILLACY	0	0	0	0	0	0	0	0	0	0	0	0	
WINKLER	0	0	0	0	0	0	0	0	0	1064567	718832	3296	2077
WOOD	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
ZAPATA	0	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	0
ARMSTRONG	0	0	0	0	0	0	0	0	0	0	0	0	0
BAILEY	0	0	0	0	0	0	0	0	0	0	0	0	0
BOWIE	617894	634669	597	613	0	0	0	0	0	0	0	0	0
CAMP	0	0	0	0	0	0	0	0	0	0	0	0	0
CARSON	0	0	0	0	0	0	0	0	0	0	0	0	0
CASS	0	0	0	0	0	0	0	0	0	0	0	0	0
CASTRO	0	0	0	0	0	0	0	0	0	0	0	0	0
COCHRAN	0	0	0	0	0	0	0	0	0	0	0	0	0
COLLINGSWORTH	0	0	0	0	0	0	0	0	0	0	0	0	0
DALLAM	0	0	0	0	0	0	0	0	0	0	0	0	0
DEAF SMITH	0	0	0	0	0	0	0	0	0	0	0	0	0
DONLEY	0	0	0	0	0	0	0	0	0	0	0	0	0
FLOYD	0	0	0	0	0	0	0	0	0	0	0	0	0
GAINES	0	0	0	0	0	0	0	0	0	0	0	0	0
GARZA	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAY	0	0	0	0	0	0	0	0	0	0	0	0	0
HALE	0	0	0	0	0	0	0	0	0	0	0	0	0
HANSFORD	0	0	0	0	0	0	0	0	0	0	0	0	0
HARTLEY	0	0	0	0	0	0	0	0	0	0	0	0	0
HEMPHILL	0	0	0	0	833535	626274	1566	1180	0	0	0	0	0
HOCKLEY	0	0	0	0	0	0	0	0	0	0	0	0	0
HUTCHINSON	0	0	0	0	0	0	0	0	0	0	0	0	0
JASPER	0	0	0	0	0	0	0	0	0	0	0	0	0
LAMB	0	0	0	0	0	0	0	0	0	0	0	0	0
LIPSCOMB	0	0	0	0	0	0	0	0	0	0	0	0	0
LUBBOCK	4236409	4351424	4091	4202	17022778	12790013	31975	24101	3183194	2149401	9855	6210	0
LYNN	0	0	0	0	0	0	0	0	0	0	0	0	0
MARION	0	0	0	0	0	0	0	0	0	0	0	0	0
MOORE	0	0	0	0	0	0	0	0	0	0	0	0	0
MORRIS	0	0	0	0	0	0	0	0	0	0	0	0	0
NEWTON	0	0	0	0	0	0	0	0	0	0	0	0	0
OCHILTREE	0	0	0	0	0	0	0	0	0	0	0	0	0
OLDHAM	0	0	0	0	0	0	0	0	0	0	0	0	0
PANOLA	0	0	0	0	0	0	0	0	0	0	0	0	0
FARMER	0	0	0	0	0	0	0	0	0	0	0	0	0
POLK	0	0	0	0	0	0	0	0	0	0	0	0	0
RANDALL	0	0	0	0	3704267	2783190	6958	5245	1173124	792133	3632	2289	0
ROBERTS	0	0	0	0	0	0	0	0	0	0	0	0	0
SABINE	0	0	0	0	0	0	0	0	0	0	0	0	0
SAN AUGUSTINE	0	0	0	0	0	0	0	0	0	0	0	0	0
SAN JACINTO	0	0	0	0	0	0	0	0	0	0	0	0	0
SHELBY	0	0	0	0	0	0	0	0	0	0	0	0	0
SHERMAN	0	0	0	0	0	0	0	0	0	0	0	0	0
SWISHER	0	0	0	0	0	0	0	0	0	0	0	0	0
TERRY	0	0	0	0	0	0	0	0	0	0	0	0	0
TRINITY	0	0	0	0	297906	223831	560	422	0	0	0	0	0
TYLER	0	0	0	0	0	0	0	0	0	0	0	0	0
WALKER	0	0	0	0	0	0	0	0	0	0	0	0	0
WHEELER	155483	159704	150	154	2407322	1808734	4522	3408	0	0	0	0	0
YOAKUM	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>823475691</b>	<b>845832497</b>	<b>795230</b>	<b>816820</b>	<b>236639780</b>	<b>177798594</b>	<b>444501</b>	<b>335040</b>	<b>135888072</b>	<b>91756247</b>	<b>420685</b>	<b>265102</b>	<b>0</b>

Table 21: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 Code-Compliant Office and Education Building Types

<i>Non-attainment Counties</i>	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	1677661	1728491	639	696	10720828	8736826	36581	12236
Chambers	0	0	0	0	0	0	0	0
Collin	23990668	24717544	9137	9957	20342554	16577951	69412	23218
Dallas	28057829	28907932	10686	11645	27445759	22366634	93649	31325
Denton	14685515	15130460	5593	6095	21098110	17193683	71990	24080
El Paso	660586	680601	252	274	15081780	12290739	51461	17213
Ellis	3617279	3726876	1378	1501	162604	132512	555	186
Fort Bend	5783546	5958777	2203	2400	8830715	7196499	30132	10079
Galveston	312070	321525	119	130	3981952	3245050	13587	4545
Hardin	55808	57499	21	23	0	0	0	0
Harris	46466544	47874399	17697	19285	40001684	32598953	136491	45655
Jefferson	168563	173671	64	70	0	0	0	0
Johnson	307514	316831	117	128	0	0	0	0
Kaufman	75170	77448	29	31	613737	500158	2094	700
Liberty	60364	62193	23	25	0	0	0	0
Montgomery	10021548	10325184	3817	4159	6178933	5035457	21083	7052
Orange	0	0	0	0	0	0	0	0
Parker	242595	249945	92	101	48903	39853	167	56
Rockwall	154896	159589	59	64	2952537	2406139	10074	3370
Tarrant	14474810	14913372	5513	6007	13877536	11309353	47352	15839
Waller	0	0	0	0	110032	89670	375	126
Wise	0	0	0	0	0	0	0	0
<i>Affected Counties</i>	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	102505	105610	39	43	0	0	0	0
Bexar	21231013	21874275	8086	8811	25476179	20761545	86928	29077
Caldwell	0	0	0	0	0	0	0	0
Comal	1822307	1877519	694	756	7704716	6278878	26290	8794
Gregg	23918	24642	9	10	0	0	0	0
Guadalupe	1920256	1978436	731	797	325207	265024	1110	371
Harrison	0	0	0	0	184610	150446	630	211
Hays	1010241	1040850	385	419	3182383	2593450	10859	3632
Henderson	0	0	0	0	1516003	1235450	5173	1730
Hood	0	0	0	0	0	0	0	0
Hunt	0	0	0	0	0	0	0	0
Nueces	1676522	1727318	639	696	2487956	2027534	8489	2840
Rusk	0	0	0	0	0	0	0	0
San Patricio	2847354	2933624	1084	1182	2640779	2152075	9011	3014
Smith	0	0	0	0	537936	438386	1836	614
Travis	90462724	93203586	34453	37545	23363556	19039885	79720	26666
Upshur	0	0	0	0	1577132	1285267	5381	1800
Victoria	123006	126733	47	51	0	0	0	0
Williamson	2440752	2514703	930	1013	9012880	7344952	30753	10287
Wilson	0	0	0	0	496369	404510	1694	567

Table 22: 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	855808	697432	2920	977
ANGELINA	0	0	0	0	820353	668538	2799	936
ARANSAS	35307	36377	13	15	210284	171369	718	240
ARCHER	0	0	0	0	123481	100629	421	141
ATASCOSA	529608	545654	202	220	0	0	0	0
AUSTIN	0	0	0	0	0	0	0	0
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	179953	185405	69	75	12475234	10166561	42567	14238
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	561498	578511	214	233	1798419	1465603	6136	2053
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	996405	812010	3400	1137
BURNET	0	0	0	0	528156	430415	1802	603
CALHOUN	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0
CAMERON	843956	869526	321	350	1179792	961459	4026	1347
CHEROKEE	193620	199486	74	80	145487	118563	496	166
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	320317	261039	1093	366
COMANCHE	0	0	0	0	358217	291925	1222	409
CONCHO	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	0	0	0	0
CORYELL	0	0	0	0	684646	557945	2336	781
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	531823	433404	1815	607
DEWITT	0	0	0	0	276304	225171	943	315
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	148062	152548	56	61	0	0	0	0
EDWARDS	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	1677383	1366966	5723	1914
FALLS	46697	48111	18	19	0	0	0	0
FANNIN	509107	524532	194	211	0	0	0	0
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	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	0	0	0	0	0	0	0	0
GRAYSON	99088	102090	38	41	512262	417463	1748	585
GRIMES	0	0	0	0	440130	358679	1502	502
HALL	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	73355	59780	250	84
HASKELL	0	0	0	0	0	0	0	0
HIDALGO	703866	725192	268	292	2322907	1893029	7926	2651
HILL	0	0	0	0	0	0	0	0
HOPKINS	17084	17602	7	7	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	12226	9963	42	14
HUDSPETH	0	0	0	0	0	0	0	0
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 22: 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	0	0	0	0	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0
KERR	44419	45765	17	18	2320462	1891036	7918	2648
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	1359512	1107920	4639	1552
LAMAR	0	0	0	0	99029	80703	338	113
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	1708413	1760174	651	709	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	1149228	936551	3921	1312
MASON	0	0	0	0	0	0	0	0
MATAGORDA	0	0	0	0	2941534	2397172	10037	3357
MAVERICK	0	0	0	0	0	0	0	0
MCCULLOCH	0	0	0	0	80690	65758	275	92
MCLENNAN	506829	522185	193	210	938944	765182	3204	1072
MCMULLEN	0	0	0	0	0	0	0	0
MEDINA	0	0	0	0	0	0	0	0
MENARD	0	0	0	0	0	0	0	0
MIDLAND	2247132	2315216	856	933	100252	81699	342	114
MILAM	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	22006	17934	75	25
MOTLEY	0	0	0	0	0	0	0	0
NACOGDOCHES	239178	246424	91	99	1381518	1125854	4714	1577
NAVARRO	0	0	0	0	0	0	0	0
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
POTTER	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	0	0	0	0
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	11389	11734	4	5	0	0	0	0
REFUGIO	0	0	0	0	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0
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	55016	44835	188	63
SHACKELFORD	4556	4694	2	2	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0
STARR	0	0	0	0	183387	149450	626	209
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	1012519	1043197	386	420	2322907	1893029	7926	2651
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	0	0	0	0	975621	795072	3329	1114
UPTON	0	0	0	0	0	0	0	0
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	18339	14945	63	21
WARD	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	102697	83692	350	117
WEBB	287013	295709	109	119	1736067	1414790	5924	1981
WHARTON	0	0	0	0	0	0	0	0
WICHITA	0	0	0	0	111255	90666	380	127
WILBARGER	0	0	0	0	0	0	0	0



Table 22: 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)
WILLACY	0	0	0	0	0	0	0	0
WINKLER	0	0	0	0	0	0	0	0
WOOD	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
ARMSTRONG	0	0	0	0	0	0	0	0
BAILEY	0	0	0	0	0	0	0	0
BOWIE	0	0	0	0	903489	736289	3083	1031
CAMP	0	0	0	0	0	0	0	0
CARSON	0	0	0	0	0	0	0	0
CASS	0	0	0	0	0	0	0	0
CASTRO	0	0	0	0	0	0	0	0
COCHRAN	0	0	0	0	0	0	0	0
COLLINGSWORTH	0	0	0	0	0	0	0	0
DALLAM	0	0	0	0	0	0	0	0
DEAF SMITH	0	0	0	0	0	0	0	0
DONLEY	0	0	0	0	0	0	0	0
FLOYD	0	0	0	0	0	0	0	0
GAINES	33029	34030	13	14	0	0	0	0
GARZA	0	0	0	0	0	0	0	0
GRAY	0	0	0	0	0	0	0	0
HALE	0	0	0	0	0	0	0	0
HANSFORD	0	0	0	0	0	0	0	0
HARTLEY	0	0	0	0	0	0	0	0
HEMPHILL	0	0	0	0	0	0	0	0
HOCKLEY	0	0	0	0	74578	60776	254	85
HUTCHINSON	0	0	0	0	0	0	0	0
JASPER	0	0	0	0	0	0	0	0
LAMB	0	0	0	0	0	0	0	0
LIPSCOMB	0	0	0	0	0	0	0	0
LUBBOCK	289291	298056	110	120	777563	633666	2653	887
LYNN	0	0	0	0	0	0	0	0
MARION	0	0	0	0	122258	99633	417	140
MOORE	0	0	0	0	0	0	0	0
MORRIS	0	0	0	0	0	0	0	0
NEWTON	0	0	0	0	855808	697432	2920	977
OCHILTREE	0	0	0	0	0	0	0	0
OLDHAM	0	0	0	0	0	0	0	0
PANOLA	0	0	0	0	0	0	0	0
PARMER	0	0	0	0	141820	115574	484	162
POLK	0	0	0	0	0	0	0	0
RANDALL	0	0	0	0	839914	684479	2866	959
ROBERTS	0	0	0	0	2023374	1648928	6904	2309
SABINE	0	0	0	0	0	0	0	0
SAN AUGUSTINE	0	0	0	0	0	0	0	0
SAN JACINTO	0	0	0	0	0	0	0	0
SHELBY	0	0	0	0	0	0	0	0
SHERMAN	0	0	0	0	0	0	0	0
SWISHER	0	0	0	0	0	0	0	0
TERRY	0	0	0	0	0	0	0	0
TRINITY	0	0	0	0	50126	40850	171	57
TYLER	0	0	0	0	0	0	0	0
WALKER	0	0	0	0	18339	14945	63	21
WHEELER	1212973	1249724	462	503	0	0	0	0
YOAKUM	0	0	0	0	0	0	0	0
<b>Total</b>	<b>284402859</b>	<b>293019768</b>	<b>108316</b>	<b>118035</b>	<b>293710826</b>	<b>239356558</b>	<b>1002182</b>	<b>335223</b>

Table 22: Energy Use of ASHRAE Standard 90.1-2007 and 90.1-2013 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	2179540	1648681	2164	1649	2314405	2355121	10266	10494
Chambers	35711	27013	35	27	37920	38587	168	172
Collin	13037960	9862375	12943	9863	13844718	14088277	61408	62773
Dallas	9904945	7492451	9833	7493	10517840	10702872	46652	47689
Denton	3830563	2897573	3803	2898	4067589	4139147	18042	18443
El Paso	1583172	1197568	1572	1198	1681135	1710710	7457	7622
Ellis	316634	239514	314	240	336227	342142	1491	1524
Fort Bend	6420776	4856902	6374	4857	6818078	6938023	30242	30914
Galveston	1486754	1124633	1476	1125	1578750	1606524	7003	7158
Hardin	0	0	0	0	0	0	0	0
Harris	35567812	26904752	35309	26906	37768665	38433097	167523	171247
Jefferson	179744	135964	178	136	190866	194223	847	865
Johnson	563038	425902	559	426	597877	608395	2652	2711
Kaufman	2102167	1590154	2087	1590	2232244	2271514	9901	10121
Liberty	0	0	0	0	0	0	0	0
Montgomery	4431692	3352289	4399	3352	4705915	4788702	20873	21337
Orange	0	0	0	0	0	0	0	0
Parker	232119	175583	230	176	246482	250818	1093	1118
Rockwall	888005	671718	882	672	942953	959541	4182	4275
Tarrant	7898007	5974332	7841	5975	8386717	8534257	37199	38026
Waller	44043	33316	44	33	46768	47591	207	212
Wise	90467	68432	90	68	96065	97755	426	436
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	0	0	0	0	0	0	0	0
Bexar	9964463	7537473	9892	7538	10581041	10767184	46932	47976
Caldwell	0	0	0	0	0	0	0	0
Comal	317825	240414	316	240	337491	343428	1497	1530
Gregg	192838	145869	191	146	204770	208372	908	928
Guadalupe	401150	303444	398	303	425972	433466	1889	1931
Harrison	46424	35117	46	35	49296	50164	219	224
Hays	690406	522248	685	522	733127	746024	3252	3324
Henderson	46424	35117	46	35	49296	50164	219	224
Hood	0	0	0	0	0	0	0	0
Hunt	0	0	0	0	0	0	0	0
Nueces	195218	147670	194	148	207298	210945	919	940
Rusk	0	0	0	0	0	0	0	0
San Patricio	67850	51324	67	51	72049	73316	320	327
Smith	264259	199895	262	200	280611	285547	1245	1272
Travis	5185187	3922259	5147	3922	5506034	5602897	24422	24965
Upshur	0	0	0	0	0	0	0	0
Victoria	0	0	0	0	0	0	0	0
Williamson	7921814	5992340	7864	5993	8411997	8559982	37311	38141
Wilson	0	0	0	0	0	0	0	0

Table 23: 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	85706	64831	85	65	91009	92610	404	413
ANDREWS	0	0	0	0	0	0	0	0
ANGELINA	0	0	0	0	0	0	0	0
ARANSAS	0	0	0	0	0	0	0	0
ARCHER	104751	79238	104	79	111233	113190	493	504
ATASCOSA	83325	63030	83	63	88481	90037	392	401
AUSTIN	0	0	0	0	0	0	0	0
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	1360576	1029188	1351	1029	1444765	1470182	6408	6551
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	419005	316950	416	317	444932	452759	1973	2017
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	58327	44121	58	44	61937	63026	275	281
CALHOUN	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0
CAMERON	411863	311548	409	312	437348	445042	1940	1983
CHEROKEE	88086	66632	87	67	93537	95182	415	424
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	48805	36917	48	37	51824	52736	230	235
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	1943850	1470397	1930	1470	2064131	2100443	9155	9359
EDWARDS	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0
FALLS	83325	63030	83	63	88481	90037	392	401
FANNIN	0	0	0	0	0	0	0	0
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	0	0	0	0
GILLESPIE	55947	42320	56	42	59409	60454	264	269
GLASSCOCK	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0
GONZALES	0	0	0	0	0	0	0	0
GRAYSON	886815	670818	880	671	941689	958255	4177	4270
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
HIDALGO	1539129	1164252	1528	1164	1634367	1663119	7249	7410
HILL	0	0	0	0	0	0	0	0
HOPKINS	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0
HOWARD	64279	48623	64	49	68257	69457	303	309
HUDSPETH	0	0	0	0	0	0	0	0
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 23: 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	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	108322	81939	108	82	115025	117049	510	522
KENEDY	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0
KERR	1916472	1449687	1903	1450	2035059	2070860	9027	9227
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	159508	120657	158	121	169378	172357	751	768
LAMPASAS	0	0	0	0	0	0	0	0
LAVACA	83325	63030	83	63	88481	90037	392	401
LEE	0	0	0	0	0	0	0	0
LEON	85706	64831	85	65	91009	92610	404	413
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	111893	84640	111	85	118817	120907	527	539
MAVERICK	84515	63930	84	64	89745	91324	398	407
MCCULLOCH	0	0	0	0	0	0	0	0
MCLENNAN	895147	677121	889	677	950537	967259	4216	4310
MCMULLEN	39282	29714	39	30	41712	42446	185	189
MEDINA	326157	246717	324	247	346339	352432	1536	1570
MENARD	0	0	0	0	0	0	0	0
MIDLAND	1012992	766263	1006	766	1075674	1094597	4771	4877
MILAM	83325	63030	83	63	88481	90037	392	401
MILLS	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0
MONTAGUE	85706	64831	85	65	91009	92610	404	413
MOTLEY	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	0	0	0	0	0	0
NAVARRO	152365	115255	151	115	161793	164640	718	734
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
POTTER	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	0	0	0	0
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	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0
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	76183	57627	76	58	80897	82320	359	367
STARR	0	0	0	0	0	0	0	0
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	39282	29714	39	30	41712	42446	185	189
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	29759	22511	30	23	31600	32156	140	143
UPTON	0	0	0	0	0	0	0	0
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	0	0	0	0
WARD	84515	63930	84	64	89745	91324	398	407
WASHINGTON	0	0	0	0	0	0	0	0
WEBB	408292	308846	405	309	433556	441183	1923	1966
WHARTON	0	0	0	0	0	0	0	0
WICHITA	48805	36917	48	37	51824	52736	230	235
WILBARGER	0	0	0	0	0	0	0	0

Table 23: 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)
WILLACY	0	0	0	0	0	0	0	0
WINKLER	224977	170181	223	170	238898	243101	1060	1083
WOOD	90467	68432	90	68	96065	97755	426	436
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
ARMSTRONG	0	0	0	0	0	0	0	0
BAILEY	0	0	0	0	0	0	0	0
BOWIE	0	0	0	0	0	0	0	0
CAMP	0	0	0	0	0	0	0	0
CARSON	0	0	0	0	0	0	0	0
CASS	0	0	0	0	0	0	0	0
CASTRO	0	0	0	0	0	0	0	0
COCHRAN	0	0	0	0	0	0	0	0
COLLINGSWORTH	0	0	0	0	0	0	0	0
DALLAM	0	0	0	0	0	0	0	0
DEAF SMITH	0	0	0	0	0	0	0	0
DONLEY	0	0	0	0	0	0	0	0
FLOYD	0	0	0	0	0	0	0	0
GAINES	0	0	0	0	0	0	0	0
GARZA	0	0	0	0	0	0	0	0
GRAY	0	0	0	0	0	0	0	0
HALE	219025	165679	217	166	232578	236670	1032	1055
HANSFORD	0	0	0	0	0	0	0	0
HARTLEY	0	0	0	0	0	0	0	0
HEMPHILL	0	0	0	0	0	0	0	0
HOCKLEY	0	0	0	0	0	0	0	0
HUTCHINSON	0	0	0	0	0	0	0	0
JASPER	0	0	0	0	0	0	0	0
LAMB	0	0	0	0	0	0	0	0
LIPSCOMB	0	0	0	0	0	0	0	0
LUBBOCK	2918751	2207846	2898	2208	3099356	3153881	13747	14053
LYNN	0	0	0	0	0	0	0	0
MARION	0	0	0	0	0	0	0	0
MOORE	0	0	0	0	0	0	0	0
MORRIS	0	0	0	0	0	0	0	0
NEWTON	0	0	0	0	0	0	0	0
OCHILTREE	0	0	0	0	0	0	0	0
OLDHAM	0	0	0	0	0	0	0	0
PANOLA	0	0	0	0	0	0	0	0
PARMER	0	0	0	0	0	0	0	0
POLK	0	0	0	0	0	0	0	0
RANDALL	229739	173782	228	174	243954	248246	1082	1106
ROBERTS	0	0	0	0	0	0	0	0
SABINE	0	0	0	0	0	0	0	0
SAN AUGUSTINE	0	0	0	0	0	0	0	0
SAN JACINTO	0	0	0	0	0	0	0	0
SHELBY	0	0	0	0	0	0	0	0
SHERMAN	0	0	0	0	0	0	0	0
SWISHER	0	0	0	0	0	0	0	0
TERRY	0	0	0	0	0	0	0	0
TRINITY	0	0	0	0	0	0	0	0
TYLER	76183	57627	76	58	80897	82320	359	367
WALKER	0	0	0	0	0	0	0	0
WHEELER	48805	36917	48	37	51824	52736	230	235
YOAKUM	0	0	0	0	0	0	0	0
<b>Total</b>	<b>129514213</b>	<b>97969135</b>	<b>128572</b>	<b>97972</b>	<b>137528247</b>	<b>139947666</b>	<b>610008</b>	<b>623567</b>

Table 23: 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 eCrd	
	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
<b>Non-attainment Counties</b>																		
(Square feet in Thousands)																		
BRAZORIA	163368	158	-80809	-150	0	0	50830	57	-1984002	-24345	-530859	-515	40715	228	-2340756	-24567	2505	262866
CHAMBERS	0	0	0	0	0	0	0	0	0	0	-8698	-8	667	4	-8031	-5	9	50
COLLIN	1409627	1361	-3717231	-6915	-844435	-2977	736875	820	-3764603	-46194	-3175586	-3080	243558	1365	-9121794	-55620	9760	595137
DALLAS	2930788	2830	-10212657	-18998	-4008934	-14133	850103	959	-5079125	-62324	-2412494	-2340	185031	1037	-17747288	-92970	18990	994774
DENTON	749877	724	-996649	-1854	-3581883	-12628	444945	502	-3904426	-47910	-932990	-905	71558	401	-8149568	-61669	8720	659862
EL PASO	121567	117	-161619	-301	0	0	20015	23	-2791042	-34248	-385605	-374	29575	166	-3167109	-34617	3389	370399
ELLIS	15898	15	-164612	-306	0	0	109597	124	-30091	-569	-77121	-75	5915	33	-140414	-578	150	6186
FORT BEND	635546	614	-890399	-1656	-438993	-1548	175231	198	-1634216	-20053	-1563874	-1517	119945	672	-3596760	-23290	3849	249206
GALVESTON	84973	82	-570155	-1061	-450365	-1588	9455	11	-736902	-9042	-362121	-351	27774	156	-1997341	-11793	2137	126190
HARDIN	0	0	0	0	0	0	1691	2	0	0	0	0	0	0	1691	2	-2	20
HARRIS	5702758	5507	-10162525	-18905	-8905520	-31596	1407855	1588	-7402731	-90836	-8663060	-8404	664432	3724	-27358792	-138721	29274	1484319
JEFFERSON	9128	9	-591106	-1100	0	0	5107	6	0	0	-43779	-42	3358	19	-617292	-1109	661	11863
JOHNSON	37580	36	-2269396	-4222	0	0	9317	11	0	0	-137136	-133	10518	59	-2349117	-4249	2514	45464
KAUFMAN	29467	28	0	0	-267262	-942	2278	3	-113578	-1394	-512014	-497	39270	220	-821840	-2581	879	27622
LIBERTY	0	0	0	0	0	0	1829	2	0	0	0	0	0	0	1829	2	-2	22
MONTGOMERY	427827	413	-184814	-344	-461170	-1626	303635	342	-1143476	-14031	-1079403	-1047	82787	464	-2054613	-15828	2198	169362
ORANGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PARKER	0	0	-30678	-57	-515191	-1816	7350	8	-9050	-111	-56536	-55	4336	24	-599768	-2007	642	21471
ROCKWALL	204320	197	-683138	-1271	-608448	-2145	4693	5	-546393	-6705	-216287	-210	16589	93	-1828670	-10035	1957	107372
TARRANT	2033167	1963	-6678744	-12424	-8359623	-29471	438561	495	-2568184	-31513	-1923675	-1866	147540	827	-16910956	-71990	18095	770290
WALLER	0	0	0	0	0	0	0	0	-20363	-250	-10727	-10	823	5	-30267	-256	32	2736
WISE	0	0	0	0	0	0	0	0	0	-22035	-21	1690	9	-20345	-12	22	127	
<b>Affected Counties</b>																		
(Square feet in thousands)																		
BASTROP	0	0	-37412	-70	0	0	3106	4	0	0	0	0	0	0	-34306	-66	37	707
BEXAR	1715778	1657	-3809263	-7086	-1889033	-6660	643263	726	-4714634	-57851	-2426991	-2354	186143	1043	-10294737	-70526	11015	754627
CALDWELL	12910	12	0	0	0	0	0	0	0	0	0	0	0	0	12910	12	-14	-133
COMAL	66882	65	-797618	-1484	0	0	55213	62	-1425839	-17496	-77411	-75	5937	33	-2172836	-18895	2325	202173
GREGG	28781	28	-149647	-278	0	0	725	7	0	0	-46968	-46	3602	20	-163507	-275	175	2944
GRADALUPE	145003	140	-583623	-1086	0	0	38180	66	-40183	-738	-97706	-95	7494	42	-530835	-1671	588	17883
HARRISON	0	0	-395572	-732	0	0	0	0	-34164	-419	-11307	-11	867	5	-438176	-1157	469	12385
HAYS	254975	246	0	0	-312754	-1103	306099	35	-588933	-7227	-168158	-163	12897	72	-771365	-8139	825	87090
HENDERSON	0	0	0	0	0	0	0	0	-280552	-3443	-11307	-11	867	5	-290992	-3449	311	36901
HOOD	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	0	0	0	0	0	0	0	0	0	0
NUECES	63922	62	0	0	-184240	-650	50796	57	-460422	-5650	-47548	-46	3647	20	-573846	-6206	614	66403
RUSK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAN PATRICK	0	0	-422004	-785	0	0	86270	97	-488704	-5997	-16526	-16	1267	7	-839697	-6693	898	71619
SMITH	20832	20	-474381	-882	0	0	0	0	-99551	-1222	-64364	-62	4937	28	-612527	-2119	655	22670
TRAVIS	3984294	3848	-5516735	-10263	-6997722	-24670	2740862	3091	-4323671	-53054	-1262928	-1225	96863	543	-11279038	-81730	12069	874509
UPSHUR	0	0	0	0	0	0	0	0	-291865	-3581	0	0	0	0	-291865	-3581	312	38320
VICTORIA	0	0	0	0	0	0	3727	4	0	0	0	0	0	0	3727	4	-4	-45
WILLIAMSON	480264	464	-2682422	-4990	-1619496	-5709	73951	83	-1667928	-20466	-1929473	-1872	147985	829	-7197119	-31661	7701	338773
WILSON	0	0	0	0	0	0	0	0	-91858	-1127	0	0	0	0	-91858	-1127	98	12061

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







Table 24: 2019 Totalized Annual Electricity Savings by CL Zone from New Commercial Construction

<b>Electric Power Market</b>	<b>CL Zone</b>	<b>Total Electricity Savings by CL Zone (MWh) [2019-TRY 2008]</b>
<b>ERCOT</b>	<b>Houston (H)</b>	37,805
	<b>North (N)</b>	71,384
	<b>West (W)</b>	6,010
	<b>South (S)</b>	44,664
<b>SPP</b>	-	9,431
<b>SERC</b>	-	3,132
<b>WECC</b>	-	3,389
<b>Total</b>		175,816



Table 26: 2019 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 (Therms/County)	Annual NOx Reductions (Tons)	Annual NOx Reductions (Tons)
Non-attainment and Affected Counties	HARDIN	(1.81)	0.00	(20.41)	(0.00)	0.00
	HARRIS	29,273.91	2.32	1,484,318.97	6.83	9.15
	JEFFERSON	660.50	0.28	11,862.98	0.05	0.34
	ORANGE	0.00	0.38	0.00	0.00	0.38
	TARRANT	18,094.72	0.18	770,290.11	3.54	3.72
	COLLIN	9,760.32	0.03	595,137.12	2.74	2.76
	DALLAS	18,989.60	0.50	994,774.02	4.58	5.08
	HOOD	0.00	0.27	0.00	0.00	0.27
	HUNT	0.00	0.01	0.00	0.00	0.01
	HENDERSON	311.36	0.05	36,900.56	0.17	0.22
	BEXAR	11,015.37	3.13	754,626.80	3.47	6.60
	TRAVIS	12,068.57	0.74	874,509.20	4.02	4.77
	DENTON	8,720.04	0.37	659,861.95	3.04	3.40
	WILLIAMSON	7,700.92		338,772.69	1.56	1.56
	EL PASO	3,388.81	2.07	370,399.02	1.70	3.78
	MONTGOMERY	2,198.44	0.07	169,362.06	0.78	0.85
	GALVESTON	2,137.15	0.26	126,190.35	0.58	0.84
	BRAZORIA	2,504.61	1.18	262,865.64	1.21	2.39
	COMAL	2,324.93	0.08	202,172.54	0.93	1.01
	ROCKWALL	1,956.68		107,371.52	0.49	0.49
	HAYS	825.36	0.09	87,089.86	0.40	0.49
	NUECES	614.02	0.79	66,402.57	0.31	1.09
	FORT BEND	3,848.53	1.44	249,205.52	1.15	2.58
	ELLIS	150.24	0.24	6,186.28	0.03	0.26
	JOHNSON	2,513.56	0.03	45,463.95	0.21	0.24
	GUADALUPE	567.99	0.51	17,882.99	0.08	0.59
	KAUFMAN	879.37	0.67	27,621.51	0.13	0.80
	PARKER	641.75	0.15	21,471.00	0.10	0.25
	SMITH	655.40		22,669.82	0.10	0.10
	BASTROP	36.71	0.40	707.20	0.00	0.41
	CHAMBERS	8.59	0.38	50.27	0.00	0.38
	GREGG	174.95	0.03	2,944.04	0.01	0.04
	SAN PATRICIO	898.48	1.32	71,618.89	0.33	1.65
	LIBERTY	(1.96)		(22.07)	(0.00)	(0.00)
	VICTORIA	(3.99)	0.27	(44.98)	(0.00)	0.27
	CALDWELL	(13.81)		(133.40)	(0.00)	(0.00)
	WILSON	98.29	0.03	12,060.56	0.06	0.09
	WALLER	32.39		2,735.53	0.01	0.01
	UPSHUR	312.30		38,320.50	0.18	0.18
	RUSK	0.00	5.55	0.00	0.00	5.55
	HARRISON	468.85	1.25	12,384.93	0.06	1.31
WISE	21.77	0.68	127.36	0.00	0.68	
Other ERCOT Counties	HIDALGO	2,298.34	0.40	90,314.90	0.42	0.81
	CAMERON	1,282.40	0.08	57,494.34	0.26	0.34
	BELL	2,799.01	0.08	305,971.54	1.41	1.48
	WEBB	428.75	0.01	42,613.87	0.20	0.20
	BRAZOS	380.07	0.15	43,515.35	0.20	0.35
	KENDALL	36.90		1,689.53	0.01	0.01
	BURNET	461.82		24,547.60	0.11	0.11
	GRAYSON	1,061.79	0.08	27,614.21	0.13	0.21
	CORYELL	135.57		16,635.25	0.08	0.08
	MIDLAND	1,299.32		48,003.17	0.22	0.22
	LLANO	0.00	0.04	0.00	0.00	0.04
	MAVERICK	20.34		118.98	0.00	0.00
	MCMULLEN	9.45		55.30	0.00	0.00
	ARANSAS	(43.09)		4,289.27	0.02	0.02
	WICHITA	22.95	0.01	2,667.42	0.01	0.02
	TAYLOR	593.52		59,045.25	0.27	0.27
	TOM GREEN	181.67		23,566.71	0.11	0.11
	MCLENNAN	2,576.14	0.72	97,383.64	0.45	1.17
	MCCULLOCH	15.98		1,960.58	0.01	0.01
	JIM HOGG	0.00		0.00	0.00	0.00
	VAL VERDE	0.00		0.00	0.00	0.00
	ECTOR	531.34	0.29	5,563.20	0.03	0.32
	WHARTON	0.00	0.18	0.00	0.00	0.18
	KERR	915.39		59,026.61	0.27	0.27
	PRESIDIO	0.00		0.00	0.00	0.00
	JIM WELLS	0.00		0.00	0.00	0.00
	CALHOUN	0.00	1.78	0.00	0.00	1.78
	GILLESPIE	13.46		78.76	0.00	0.00
	MATAGORDA	609.39		71,629.71	0.33	0.33
	NAVARRO	36.66		214.50	0.00	0.00
	ANGELINA	162.44	0.57	19,932.60	0.09	0.66
	NACOGDOCHES	541.22	0.03	38,603.48	0.18	0.21
	FANNIN	(16.50)		(186.15)	(0.00)	(0.00)
	ATASCOSA	2.88	1.12	(76.34)	(0.00)	1.12
	WASHINGTON	235.70		6,501.65	0.03	0.03
	LAMAR	57.99	0.51	2,630.73	0.01	0.52
VAN ZANDT	138.13		2,947.70	0.01	0.01	
WILLACY	0.00		0.00	0.00	0.00	
BROWN	0.00		0.00	0.00	0.00	
ERATH	332.15		40,756.37	0.19	0.19	
AUSTIN	0.00		0.00	0.00	0.00	
COOKE	11.74		68.71	0.00	0.00	
MEDINA	78.48		459.17	0.00	0.00	
TITUS	0.00	4.65	0.00	0.00	4.65	

Table 27: 2019 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)
	UVALDE	1,456.31		27,091.32	0.12	0.12
	FAYETTE	0.00	2.91	0.00	0.00	2.91
	CALLAHAN	(23.23)		(224.32)	(0.00)	(0.00)
	HOPKINS	(0.55)		(6.25)	(0.00)	(0.00)
	LAMPASAS	0.00		0.00	0.00	0.00
	BLANCO	0.00		0.00	0.00	0.00
	FREESTONE	0.00	2.88	0.00	0.00	2.88
	CRIMES	87.15	0.97	10,694.09	0.05	1.02
	LEE	0.00		0.00	0.00	0.00
	SOMERVILL	18.33		107.25	0.00	0.00
	ANDREWS	169.46		20,794.07	0.10	0.10
	BORDEN	0.00		0.00	0.00	0.00
	CHEROKEE	172.63	0.08	5,986.06	0.03	0.10
	DIMMIT	0.00		0.00	0.00	0.00
	FALLS	18.54		100.23	0.00	0.00
	COLORADO	63.43	0.28	7,782.92	0.04	0.32
	FRIO	0.00	1.41	0.00	0.00	1.41
	MILAM	20.05	1.41	117.31	0.00	1.41
	JACKSON	0.00		0.00	0.00	0.00
	ANDERSON	20.62	0.02	120.66	0.00	0.02
	HILL	0.00	0.07	0.00	0.00	0.07
	CULBERSON	0.00		0.00	0.00	0.00
	MASON	0.00		0.00	0.00	0.00
	POTTER	0.00	1.21	0.00	0.00	1.21
	PECOS	254.33	0.01	8,966.27	0.04	0.05
	RAINS	0.00		0.00	0.00	0.00
	LAVACA	20.05		117.31	0.00	0.00
	PALO PINTO	0.00	0.12	0.00	0.00	0.12
	KIMBLE	0.00		0.00	0.00	0.00
	MADISON	0.00		0.00	0.00	0.00
	ARCHER	49.66		3,147.76	0.01	0.01
	REFUGIO	0.00		0.00	0.00	0.00
	LIMESTONE	14.41	4.90	268.08	0.00	4.90
	CLAY	0.00		0.00	0.00	0.00
	BEE	0.00		0.00	0.00	0.00
	MARTIN	227.56		27,923.46	0.13	0.13
	GONZALES	0.00		0.00	0.00	0.00
	BURLESON	197.30		24,210.24	0.11	0.11
	KARNES	68.85		1,280.84	0.01	0.01
	KLEBERG	0.00		0.00	0.00	0.00
	BREWSTER	(12.64)		(122.07)	(0.00)	(0.00)
	WINKLER	424.07		13,358.57	0.06	0.06
Other ERCOT Counties	WOOD	21.77	0.00	127.36	0.00	0.00
	FRANKLIN	0.00		0.00	0.00	0.00
	YOUNG	0.00	0.07	0.00	0.00	0.07
	HOUSTON	0.00		0.00	0.00	0.00
	SCURRY	10.89	0.46	1,336.76	0.01	0.47
	BOSQUE	0.00	0.13	0.00	0.00	0.13
	COMANCHE	70.93		8,703.80	0.04	0.04
	BRISCOE	0.00		0.00	0.00	0.00
	CONCHO	0.00		0.00	0.00	0.00
	ZAVALA	0.00		0.00	0.00	0.00
	NOLAN	0.00	0.04	0.00	0.00	0.04
	BROOKS	0.00		0.00	0.00	0.00
	ROBERTSON	0.00	3.17	0.00	0.00	3.17
	LIVE OAK	(55.39)		(624.68)	(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	0.00
	WARD	20.34	0.01	118.98	0.00	0.01
	RED RIVER	0.00	0.01	0.00	0.00	0.01
	HASKELL	0.00		0.00	0.00	0.00
	HOWARD	17.89	0.05	387.55	0.00	0.05
	SAN SABA	0.00		0.00	0.00	0.00
	JACK	0.00		0.00	0.00	0.00
	STEPHENS	0.00		0.00	0.00	0.00
	RUNNELS	0.00		0.00	0.00	0.00
	REEVES	1,113.86		20,782.76	0.10	0.10
	DE WITT	54.71		6,713.51	0.03	0.03
	CHILDRESS	0.00		0.00	0.00	0.00
	CROSBY	0.00		0.00	0.00	0.00
	DAWSON	81.85		12,695.44	0.06	0.06
	MITCHELL	0.00	0.09	0.00	0.00	0.09
	WILBARGER	0.00	1.90	0.00	0.00	1.90
	COLEMAN	0.00		0.00	0.00	0.00
	UPTON	0.00	0.00	0.00	0.00	0.00
	COKE	0.00	0.06	0.00	0.00	0.06
	CROCKETT	0.00		0.00	0.00	0.00
	HARDEMAN	14.53		1,782.35	0.01	0.01
	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

Table 27: 2019 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	EASTLAND	24.02		446.81	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	0.97	0.00	0.00	0.97
	HALL	0.00		0.00	0.00	0.00
	HUDSPETH	0.00		0.00	0.00	0.00
	IRION	0.00		0.00	0.00	0.00
	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	0.00		0.00	0.00	0.00
	LA SALLE	269.20		33,032.86	0.15	0.15
	LEON	20.62		120.66	0.00	0.00
	LOVING	0.00		0.00	0.00	0.00
	MENARD	0.00		0.00	0.00	0.00
	MILLS	0.00		0.00	0.00	0.00
	MONTAGUE	24.98		655.36	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	(0.15)		(1.67)	(0.00)	(0.00)
	STARR	70.74		5,096.29	0.02	0.02
	STERLING	0.00		0.00	0.00	0.00
	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
Other Counties	ARMSTRONG	0.00		0.00	0.00	0.00
	BAILEY	0.00		0.00	0.00	0.00
	BOWIE	160.95		21,779.26	0.10	0.10
	CAMP	0.00		0.00	0.00	0.00
	CARSON	0.00		0.00	0.00	0.00
	CASS	0.00	0.06	0.00	0.00	0.06
	CASTRO	0.00		0.00	0.00	0.00
	COCHRAN	0.00		0.00	0.00	0.00
	COLLINGSWORTH	0.00		0.00	0.00	0.00
	DALLAM	0.00		0.00	0.00	0.00
	DEAF SMITH	0.00		0.00	0.00	0.00
	DONLEY	0.00		0.00	0.00	0.00
	FLOYD	0.00		0.00	0.00	0.00
	Gaines	(1.07)	0.01	(12.08)	(0.00)	0.01
	GARZA	0.00		0.00	0.00	0.00
	GRAY	0.00	0.00	0.00	0.00	0.00
	HALE	52.70	0.06	308.35	0.00	0.07
	HANSFORD	0.00		0.00	0.00	0.00
	HARTLEY	0.00		0.00	0.00	0.00
	HEMPHILL	221.77	0.11	4,125.51	0.02	0.13
	HOCKLEY	14.77		1,812.05	0.01	0.01
	HUTCHINSON	0.00	0.49	0.00	0.00	0.49
	JASPER	0.00	0.02	0.00	0.00	0.02
	LAMB	0.00	1.23	0.00	0.00	1.23
	LIPSCOMB	0.00		0.00	0.00	0.00
	LUBBOCK	6,359.07	0.21	144,957.21	0.67	0.88
	LYNN	0.00		0.00	0.00	0.00
	MARION	24.21	0.12	2,970.58	0.01	0.13
	MOORE	0.00	0.00	0.00	0.00	0.00
	MORRIS	0.00	0.00	0.00	0.00	0.00
	NEWTON	169.46	0.02	20,794.07	0.10	0.12
	OCHILTREE	0.00		0.00	0.00	0.00
	OLDHAM	0.00		0.00	0.00	0.00
	PANOLA	0.00		0.00	0.00	0.00
	PARMER	28.08		3,445.87	0.02	0.02
	POLK	0.00		0.00	0.00	0.00
	RANDALL	1,614.81		53,437.02	0.25	0.25
	ROBERTS	400.66		49,163.12	0.23	0.23
	SABINE	0.00		0.00	0.00	0.00
	San Augustine	0.00		0.00	0.00	0.00
SAN JACINTO	0.00	0.00	0.00	0.00	0.00	
SHELBY	0.00		0.00	0.00	0.00	
SHERMAN	0.00		0.00	0.00	0.00	
SWISHER	0.00		0.00	0.00	0.00	
TERRY	0.00		0.00	0.00	0.00	
TRINITY	89.19		2,692.40	0.01	0.01	
TYLER	18.33	0.00	107.25	0.00	0.00	
WALKER	3.63		445.59	0.00	0.00	
WHEELER	608.39		11,496.39	0.05	0.05	
YOAKUM	0.00	0.17	0.00	0.00	0.17	
<b>TOTAL</b>	<b>175,816.36</b>	<b>62.19</b>	<b>10,100,385.60</b>	<b>46.46</b>	<b>108.65</b>	

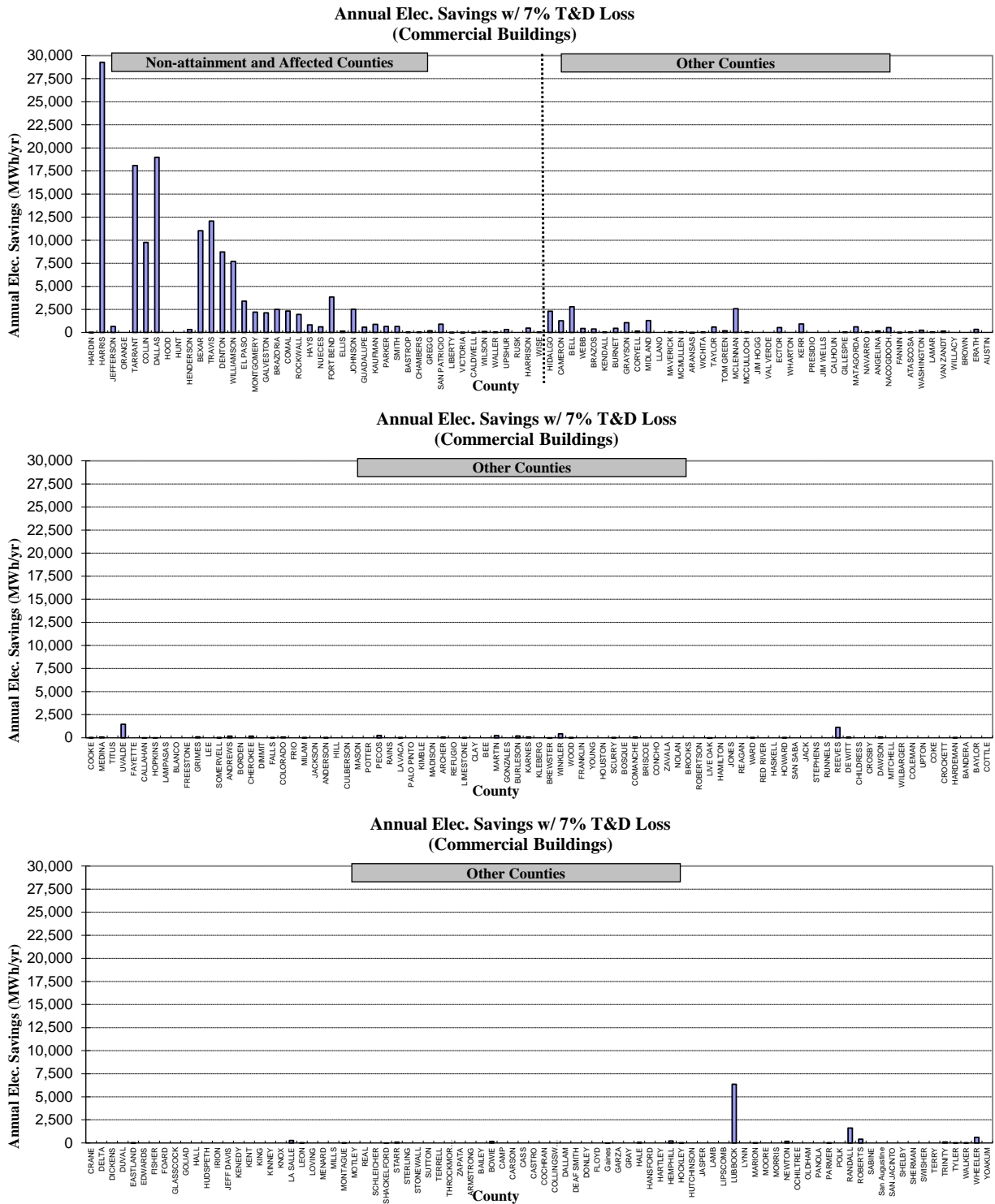


Figure 16: 2019 Annual Electricity Savings by County from New Commercial Construction

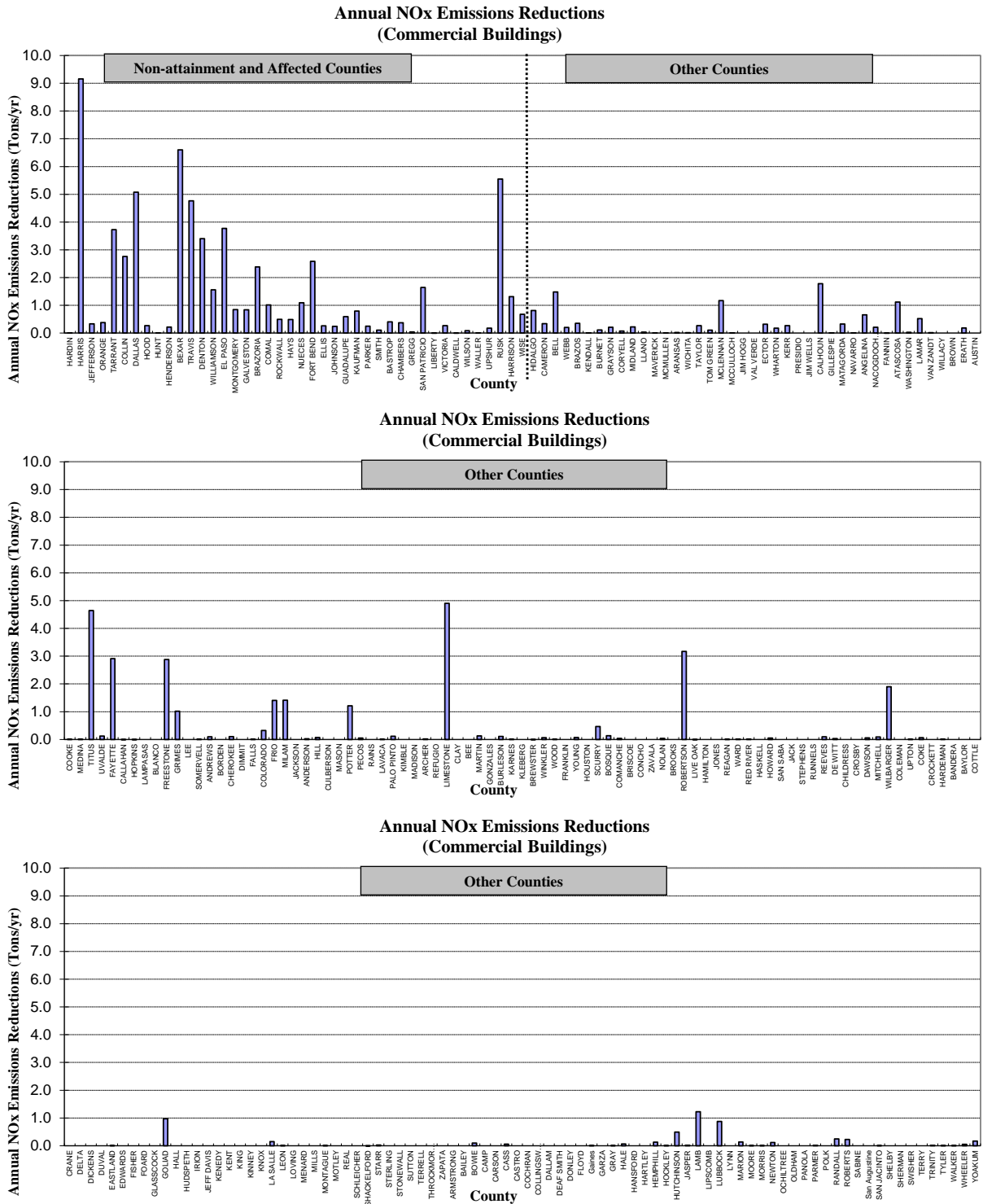


Figure 17: 2019 Annual NOx Reductions by County from New Commercial Construction

#### 4.5 2019 Results for New Residential (Single-family and Multi-family) and Commercial Construction

Figure 18 shows the bar chart and Figure 19 shows the spatial distribution of the 2019 annual electricity savings and Figure 20 shows the bar chart annual NO<sub>x</sub> reductions for new residential and commercial construction. Figure 21 and Figure 22 shows the spatial distribution of the 2019 annual NO<sub>x</sub> reductions from electricity only, and electricity and natural gas, for new residential and commercial construction, respectively. In general, the significant increase in the annual NO<sub>x</sub> emissions reduction shown in Figure 20, compared to the previous report is due to the higher energy savings. As shown in Table 27, the total annual electricity savings in 2019 resulted in 1,506,465.90 MWh/yr which includes 308,979.85 MWh/yr (i.e., 20.51 %) for single-family buildings, 1,021,669.69 MWh/yr (i.e., 67.82 %) for multi-family buildings, and 175,816.36 MWh/yr (i.e., 11.67 %) for new commercial buildings. In addition, the total annual natural gas savings from new residential and commercial Construction in 2019 resulted in 1,745,469.7 MMBtu<sup>29</sup> (17,454,697.12 therms).

The total NO<sub>x</sub> reductions<sup>30</sup> from electricity and natural gas savings from new residential (single-family and multi-family) and commercial Construction in 2019 resulted in 590.71 tons NO<sub>x</sub>/year which represents 510.42 tons NO<sub>x</sub>/year from electricity savings and 80.29 tons NO<sub>x</sub>/year from natural gas savings.

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<sup>29</sup> 1 Therm = 0.10 MMBtu, source from [www.eia.gov/tools/faqs/faq.cfm?id=45&t=8](http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8)

<sup>30</sup> 0.092 lb-NO<sub>x</sub>/MMBtu of emission rate was used for the calculation.











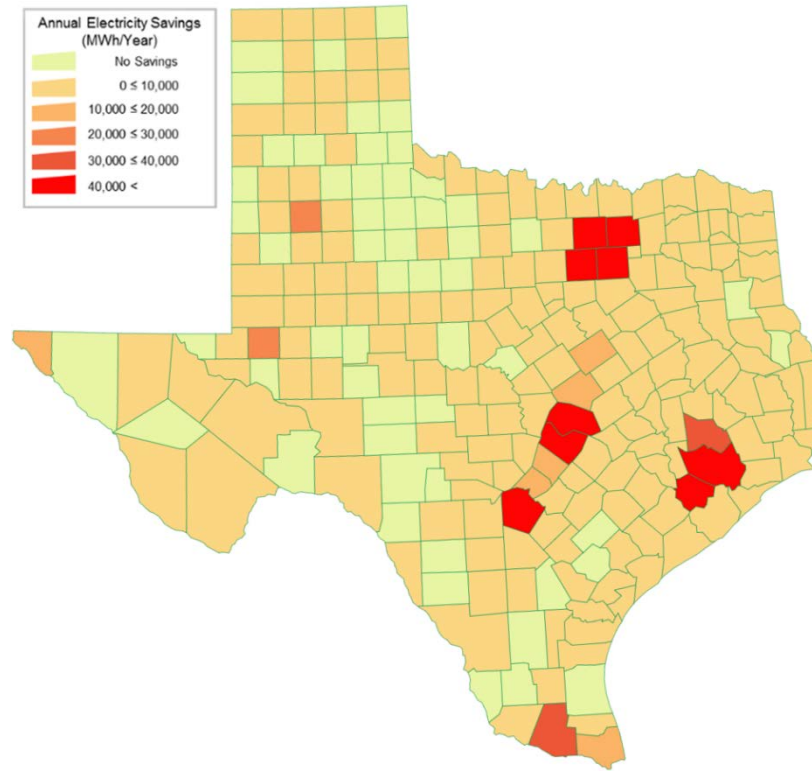


Figure 19: Map of 2019 Annual Electricity Savings by County from New Residential and Commercial Construction



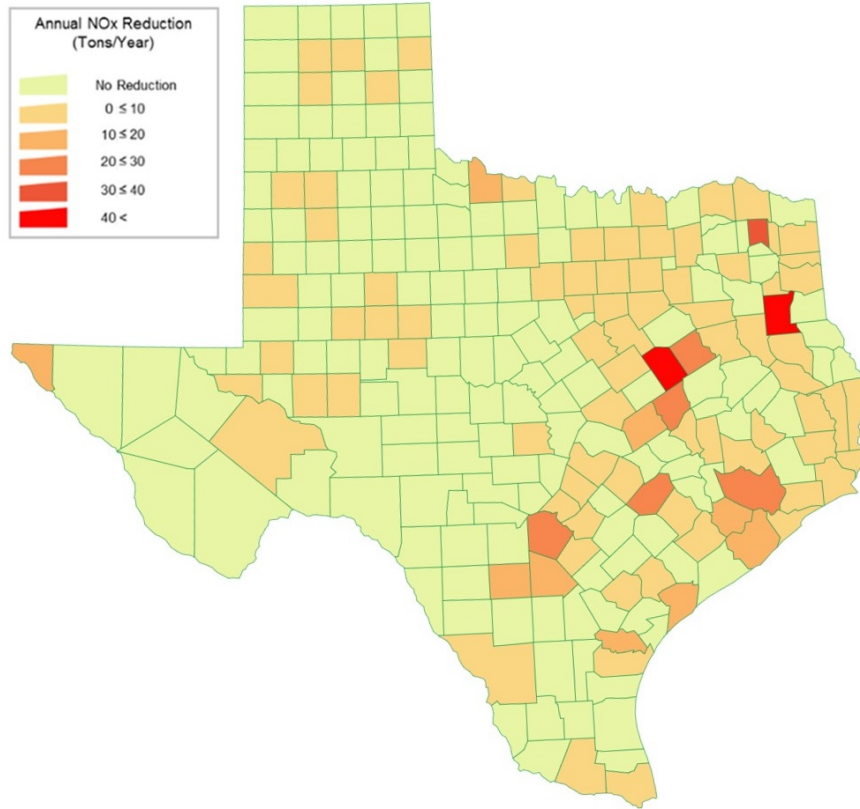


Figure 21: Map of 2019 Annual NOx Reductions from Electricity by County from New Residential and Commercial Construction

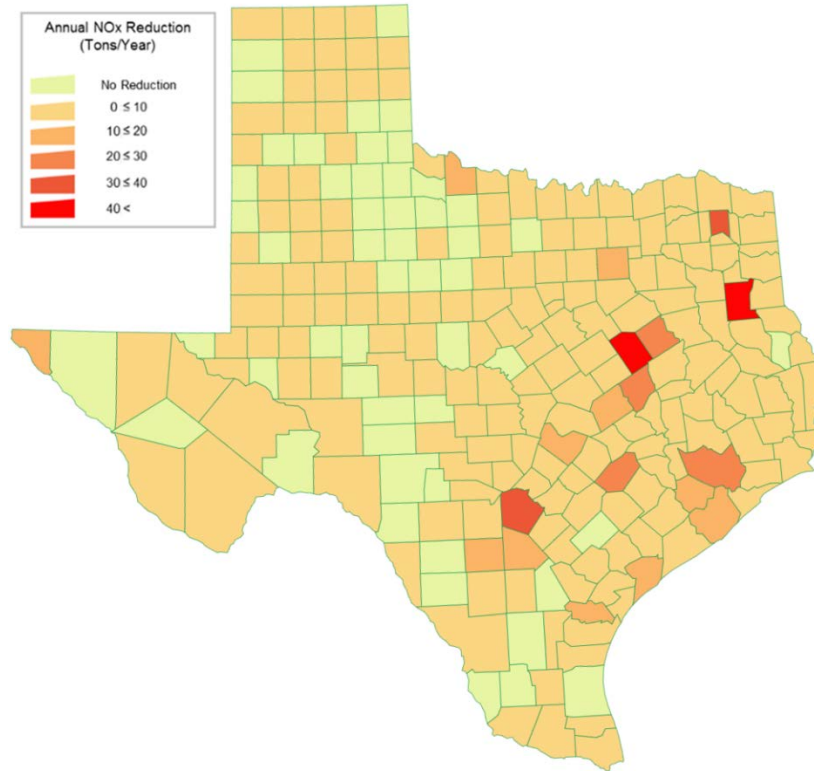


Figure 22: Map of 2019 Annual NOx Reductions from Electricity and Natural Gas by County from New Residential and Commercial Construction



## 5 Calculation of Integrated NO<sub>x</sub> 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 NO<sub>x</sub> 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 2024 for both the annual and Ozone Season Period (OSP) NO<sub>x</sub> reductions. The NO<sub>x</sub> emissions reductions from all these programs were calculated using estimated emissions factors for 2016 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose. The different programs included in this 2019 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 renewables in Texas (ERCOT)
- SEER 13/14 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 - 2019).

*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 2019).

*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 2019.

*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 2019 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* in Texas is reported. Actual measured electricity productions for 2001 through 2019 were included. For projections to 2024, the annual growth factor was estimated using the last six years installed power capacity.

Finally, NO<sub>x</sub> emissions reductions from *the installation of SEER 13 and SEER 14 air conditioners in existing residences* are also reported.

## 5.2 Description of the Analysis Method

Annual and Ozone Season Period (OSP) NO<sub>x</sub> emissions reductions were calculated for 2019 and integrated from 2009 to 2024 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 28 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 renewables, 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 renewables, the T&D losses were assumed to cancel out since renewable 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 used 60% before 2019, and since 2019, 30% is used. For the electricity from renewables, the discount factor was taken as 5%. In addition, the discount factor for SEER 13/14 single-family and SEER 13/14 multi-family program was 20%.

*Growth factor:* The growth factors shown in Table 24 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. The growth factor for renewable energy (8.5%) is a linear projection based on the installed renewable power generation capacity in 2019 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13/14 entries.

Figure 23 shows the overall information flow that was used to calculate the NO<sub>x</sub> emissions savings from the annual and OSP electricity savings (MWh) from all programs. For the Laboratory's single-family and multi-family code-implementation programs, the annual and OSP were calculated from DOE-2 hourly simulation models<sup>31</sup>. 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 2020). The OSP consumption is the average daily consumption for the period between May 1 and September 30.

The SECO electricity savings were submitted as annual savings by project<sup>32</sup>. A description of the measures completed for the project was also submitted for information purposes. The electricity production from renewables farms in Texas was from the actual on-site metered data measured at 15-minute intervals except non-utility scale solar photovoltaic (PV) projects.

Integration of the savings from the different programs into a uniform format allowed for creditable NO<sub>x</sub> emissions to be evaluated using different criteria as shown in Table 28. These include evaluation across programs, evaluation

<sup>31</sup> 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.

<sup>32</sup> 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 were estimated based on the baseline year of 2008. In addition, the emissions estimation throughout this report was updated to the 2016 eGRID database, which is applied to the four different Competitive Load (CL) zones: Houston, North, West, and South as well as other counties in Texas. For all the programs, except renewable projects, the corresponding OSP emissions reductions were calculated using an annual daily average. The OSP emissions reductions from the electricity generated by renewables except non-utility scale solar PV projects 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 2019 included the savings from code-compliant new housing in all 42 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 2019, based on year 2008, the annual electricity savings were calculated for new residential construction in all the counties in ERCOT region as well as other counties in Texas, which includes the 42 non-attainment and affected counties. These savings were then tabulated by county and program. Using the calculated values through 2019, savings were then projected to 2024 by incorporating the different adjustment factors mentioned above.

In these calculations, it was assumed that the same amount of electricity savings from the code-compliant construction would be achieved for each year after 2019 through 2024<sup>33</sup>. The projected energy savings through 2024, according to county, were then divided into the CL zones in the 2016 eGRID. To determine which CL zone was to be used, or in counties with multiple CL zone, the allocation to each CL zone by county was obtained from CL zone's listing published in the Laboratory's 2017 annual report<sup>34</sup>.

For the 2019 annual NO<sub>x</sub> emissions calculations, the US EPA's 2016 eGRID was used. An example of the eGRID spreadsheet is given in Table 29. The total electricity savings for each CL zone were used to calculate the NO<sub>x</sub> 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 2019 for commercial buildings were obtained from the annual reports for 2004 through 2019 submitted by the Laboratory to TCEQ. From 2009 to 2019, based on year 2008, the annual electricity savings were also calculated for new commercial construction by county. Using the calculated savings through 2019, savings were then projected to 2024 by incorporating the different adjustment factors mentioned above. In the projected annual electricity savings, it was assumed that the same 2019 amount of electricity savings would be achieved for each year through 2024. Similarly to the single-family calculations, the projected energy saving numbers through 2024, by county, were allocated into the appropriate CL zones.

*PUC-Senate Bill 7.* For the PUC Senate Bill 7 program savings, the annual electricity savings for 2001 through 2019 were obtained from the Public Utility Commission of Texas. Using these values savings were projected through 2024 by incorporating the different adjustment factors mentioned above. Similar savings were assumed for each year after 2019 until 2024. The 2016 annual eGRID was also used to calculate the NO<sub>x</sub> emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each CL zone were used to calculate the NO<sub>x</sub> emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet. The integrated NO<sub>x</sub> emissions reductions for each county were then calculated.

*SECO Savings.* The annual electricity consumption reported by political subdivisions for 19 counties (38 entities) through 2019 was obtained from the State Energy Conservation Office (SECO). Using the reported consumption,

<sup>33</sup> This would include the appropriate discount and degradation factors for each year.

<sup>34</sup> Haberl et al., 2019, Annual Report Volume I, pp. 45.

the annual and OSP 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 2024 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 2024. The 2016 annual eGRID was also used to calculate the NO<sub>x</sub> emissions savings for the SECO program.

*Electricity Generated by Renewables.* The measured and estimated electricity production from renewables in Texas for 2008 through 2019 was obtained from reports *Statewide Air Emissions Calculations from Wind and Other Renewables (2009-2019)*. Using the reported numbers for 2019, savings through 2024 were projected incorporating the different adjustment factors mentioned above. The 2010 eGRID was used for the period of 2008 through 2016 and 2016 eGRID was then used for the period of 2017 through 2024 to calculate the NO<sub>x</sub> emissions reductions for the electricity generated by renewables in Texas. The total electricity savings for each CL zone were used to calculate the NO<sub>x</sub> emissions reductions for each of the different counties.

*SEER 13 and 14 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. In addition to this, in January of 2015, Federal regulations enforced that the minimum efficiency for residential air conditioners be increased to SEER 14 from the previous SEER 14. Although the electricity savings from new construction reflected this change in values, the annual and OSP electricity savings from the replacement of the air conditioning units by air conditioners with an efficiency of SEER 13 and 14 in existing residences needed to be calculated. In this analysis, for SEER 10 to SEER 13 enforcement, 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. Also, the ESL introduced SEER 14 calculations for Single-Family and Multi-Family from 2019 calculations based on new constructions in 2002. The life span of A/C for the replacement was assumed 17 years.

In this report, the annual and OSP electricity savings for all the counties in ERCOT region as well as the 42 non-attainment and affected counties were calculated. Using the numbers for 2008, the savings after 2008 until 2024 were projected by incorporating the appropriate adjustment factors<sup>35</sup>. The total electricity savings for each CL zone were used to calculate the NO<sub>x</sub> emissions reductions for each of the different counties using the emissions factors contained in the 2016 eGRID. Integrated NO<sub>x</sub> emissions reductions for each county by ozone non-attainment and affected counties were also calculated.

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<sup>35</sup> 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 OSP electricity savings for all the different programs in the integrated format were calculated for 2009 through 2024 as shown in

Table 30, using the adjustment factors shown in Table 28. Annual and OSP NO<sub>x</sub> emissions reductions from the electricity savings (presented in

Table 30) for all the programs in the integrated format were shown in Table 31. Integrated OSP NO<sub>x</sub> emissions reduction projection and integrated OSP individual programs NO<sub>x</sub> emissions reduction projection were presented in Figure 24 and Figure 25.

In 2019, the total integrated annual savings from all programs are 75,802,813 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 6,279,626 MWh/year (8.3% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 4,628,168 MWh/year (6.1%),
- Savings from SECO's Senate Bill 5 program are 1,691,059 MWh/year (2.2%),
- Electricity savings from renewable power generation are 62,168,032 MWh/year (82.0%), and
- Savings from residential air conditioner retrofits<sup>36</sup> are 1,035,928 MWh/year (1.4%).

In 2019, the total integrated OSP savings from all programs are 228,698 MWh/day, which would be a 9,529 MW average hourly load reduction during the OSP. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 17,204 MWh/day (7.5%),
- Savings from the PUC's Senate Bill 7 programs are 12,680 MWh/day (5.5%),
- Savings from SECO's Senate Bill 5 program are 4,633 MWh/day (2.0%),
- Electricity savings from renewable power generation are 187,283 MWh/day (81.9%), and
- Savings from residential air conditioner retrofits are 6,898 MWh/day (3.0%).

By 2024, the total integrated annual savings from all programs will be 116,515,731 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 12,872,105 MWh/year (11.0% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 6,429,358 MWh/year (5.5%),
- Savings from SECO's Senate Bill 5 program will be 2,933,310 MWh/year (2.5%),
- Electricity savings from renewable power generation will be 93,479,378 MWh/year (80.2%), and
- Savings from residential air conditioner retrofits will be 801,581 MWh/year (0.7%).

By 2024, the total integrated OSP savings from all programs will be 347,864 MWh/day, which would be 14,494 MW average hourly load reduction during the OSP. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 35,266 MWh/day (10.1%),
- Savings from the PUC's Senate Bill 7 programs will be 17,615 MWh/day (5.1%),
- Savings from SECO's Senate Bill 5 program will be 8,036 MWh/day (2.3%),
- Electricity savings from renewable power generation will be 281,609 MWh/day (81.0%), and
- Savings from residential air conditioner retrofits will be 5,337 MWh/day (1.5%).

In 2019 (Table 31), the total integrated annual NO<sub>x</sub> emissions reductions from all programs are 32,291 tons-NO<sub>x</sub>/year. The integrated annual NO<sub>x</sub> emissions reductions from all the different programs are:

- NO<sub>x</sub> emissions reductions from code-compliant residential and commercial construction are 2,099 tons-NO<sub>x</sub>/year (6.5% of the total NO<sub>x</sub> savings),
- NO<sub>x</sub> emissions reductions from the PUC's Senate Bill 7 programs are 1,547 tons-NO<sub>x</sub>/year (4.8%),

<sup>36</sup> 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. SEER 14 calculations for existing homes were added from 2019-2024.

- NOx emissions reductions from SECO's Senate Bill 5 program are 546 tons-NOx/year (1.7%),
- NOx emissions reductions from renewable power generation are 27,757 tons-NOx/year (86.0%), and
- NOx emissions reductions from residential air conditioner retrofits are 342 tons-NOx/year (1.1%).

In 2019, the total integrated OSP NOx emissions reductions from all programs are 114.42 tons-NOx/day. The integrated OSP NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 6.13 tons-NOx/day (5.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 4.62 tons-NOx/day (4.0%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 1.58 tons-NOx/day (1.4%),
- NOx emissions reductions from renewable power generation are 99.65 tons-NOx/day (87.1%), and
- NOx emissions reductions from residential air conditioner retrofits are 2.43 tons-NOx/day (2.1%).

By 2024, the total integrated annual NOx emissions reductions from all programs will be 49,470 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 4,363 tons-NOx/year (8.8% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 2,136 tons-NOx/year (4.3%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 969 tons-NOx/year (2.0%),
- NOx emissions reductions from renewable power generation will be 41,738 tons-NOx/year (84.4%), and
- NOx emissions reductions from residential air conditioner retrofits will be 265 tons-NOx/year (0.5%).

By 2024, the total integrated OSP NOx emissions reductions from all programs will be 173.69 tons-NOx/day. The integrated OSP NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 12.77 tons-NOx/day (7.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 6.38 tons-NOx/day (3.7%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 2.81 tons-NOx/day (1.6%),
- NOx emissions reductions from renewable power generation will be 149.85 tons-NOx/day (86.3%), and
- NOx emissions reductions from residential air conditioner retrofits will be 1.88 tons-NOx/day (1.1%).

Table 28: Final Adjustment Factors used for the Calculation of the Annual and OSP NOx Savings for the Different Programs

	ESL-Single Family <sup>16</sup>	ESL <sup>16</sup> - Multifamily	ESL <sup>16</sup> - Commercial	PUC (SB7) <sup>15</sup>	SECO <sup>15</sup>	Renewables-ERCOT <sup>8</sup>	SEER13/14 Single Family	SEER/1314 Multi Family
Annual Degradation Factor <sup>11</sup>	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss <sup>9</sup>	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor <sup>12</sup>	20.0%	20.0%	20.0%	10.0%	60% / 30%	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 Renewables-ERCOT, the OSP energy consumption is the average daily consumption of the measured data from May 1 to September 30. In the SECO calculations, a 30% initial discount factor is used from 2019 and before 2019, a 60% initial discount factor was used for the estimations. SEER 14 calculations were added for 2019-2024 projections.

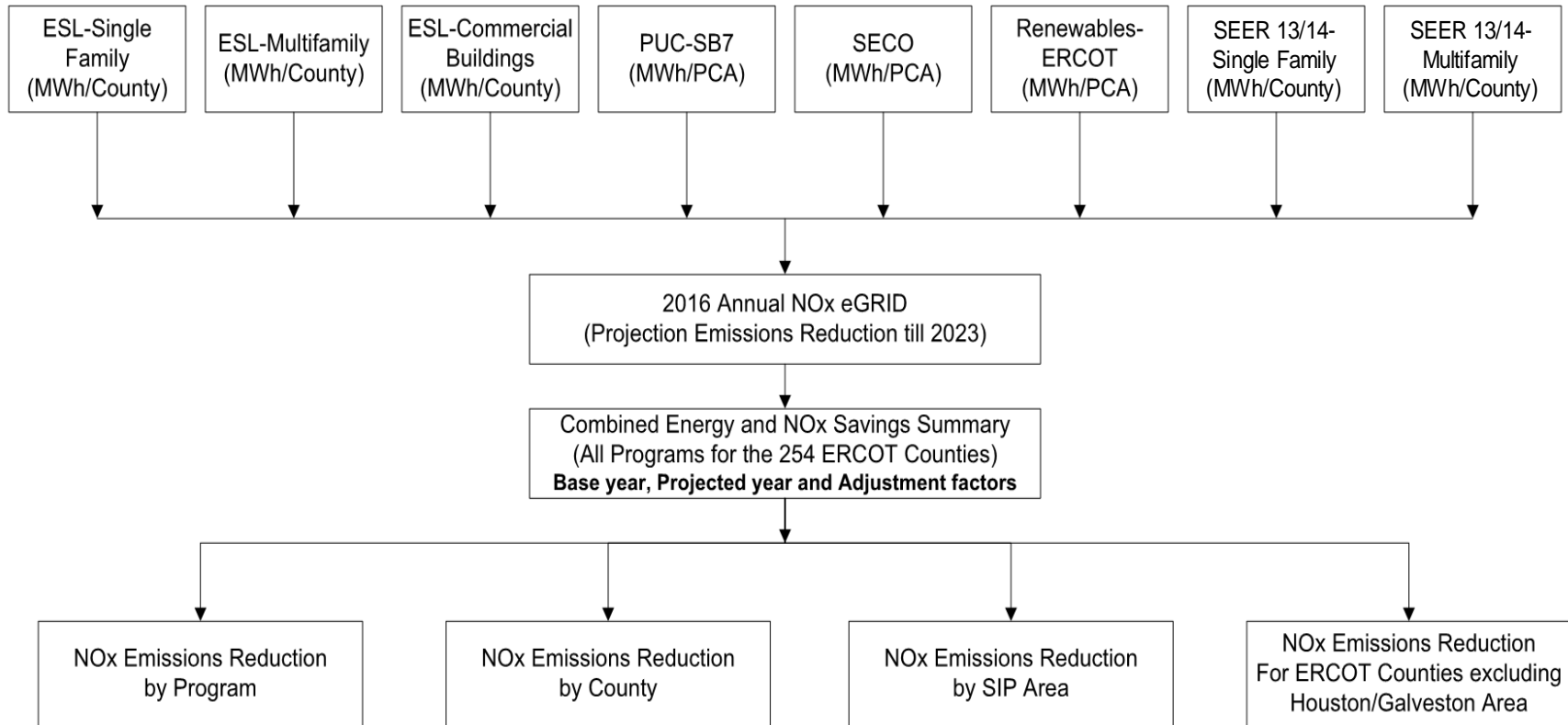


Figure 23: Process Flow Diagram of the NOx Emissions Reduction Calculations







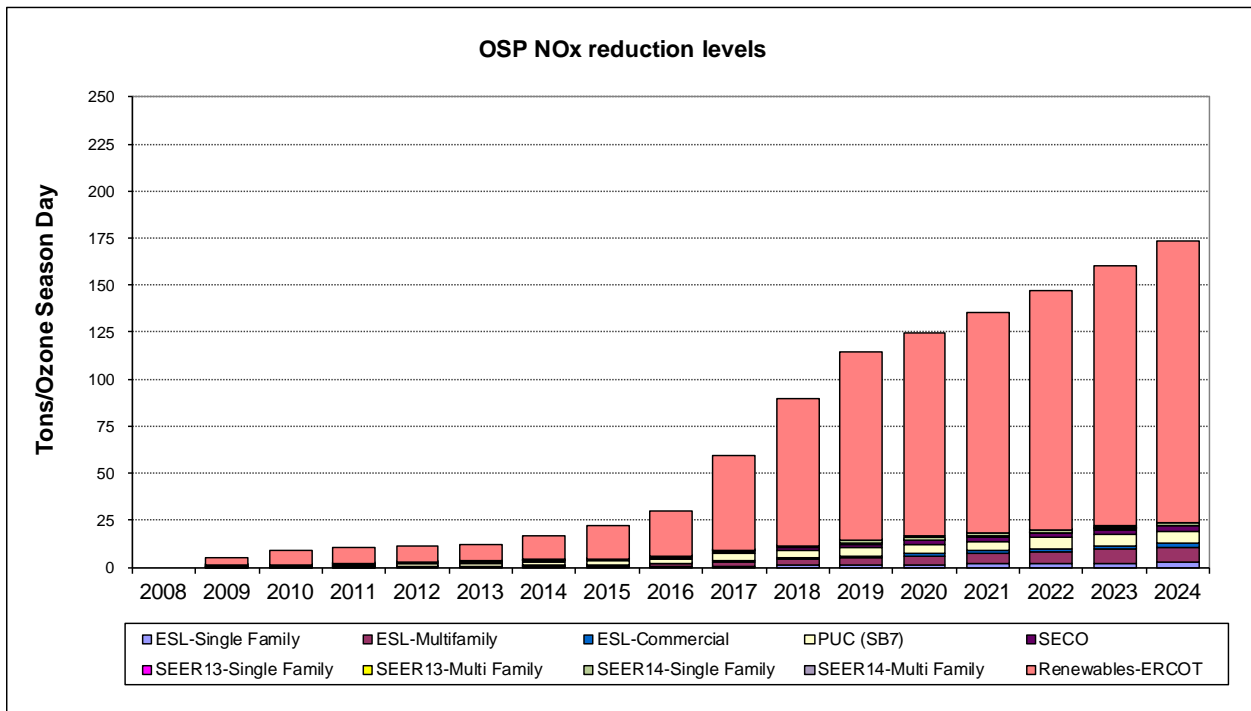


Figure 24: Integrated OSP NOx Emissions Reduction Projections through 2024 (Base Year 2008)

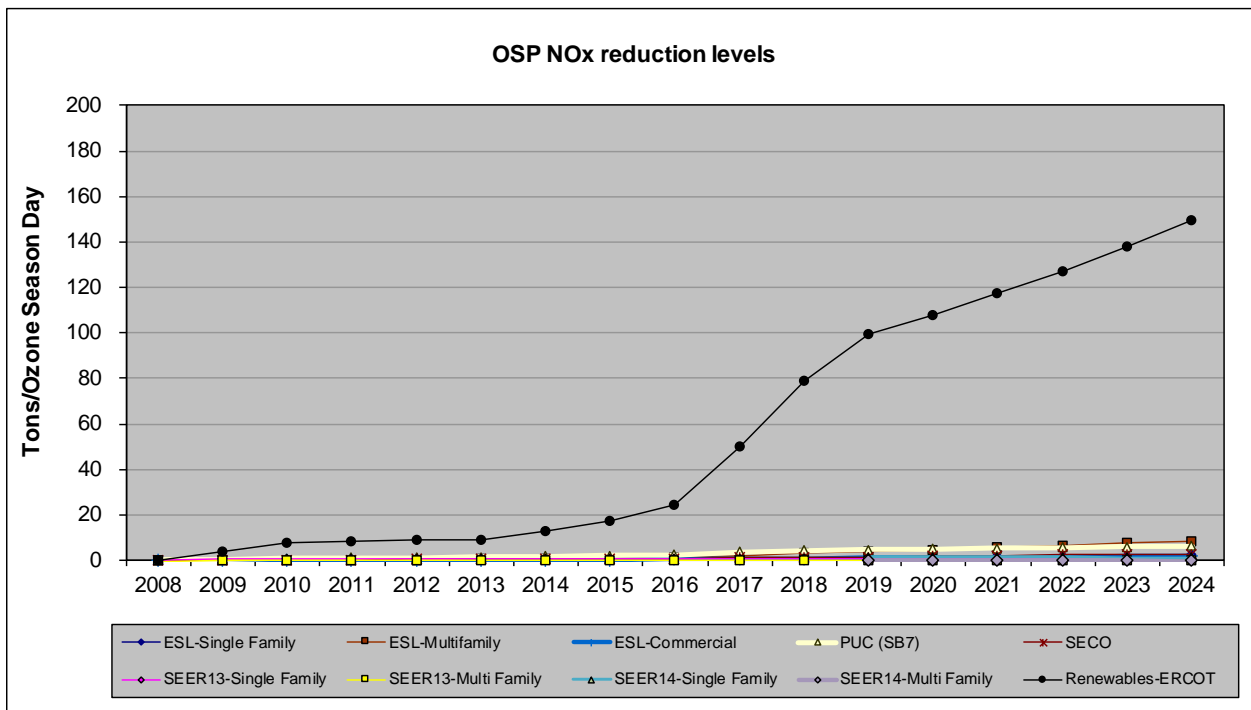


Figure 25: Integrated OSP Individual Programs NOx Emissions Reduction Projections through 2024 (Base Year 2008)

## 6 2019 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 81<sup>st</sup> 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*<sup>37</sup> and *TCV*.<sup>38</sup> 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 2019, the reports continued and numbers were gathered. Figure 26 shows the projects issued each month from January to December 2019. The projects are differentiated by the basic types, IECC performance path and ERI path. Figure 27 shows the cumulative users and projects through 2019. 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 28. Only counties with at least 10 new projects in 2019 are included in the chart. Figure 29 shows the certifications issued by city in 2019. Only those cities with at least 50 new projects are shown on the chart.

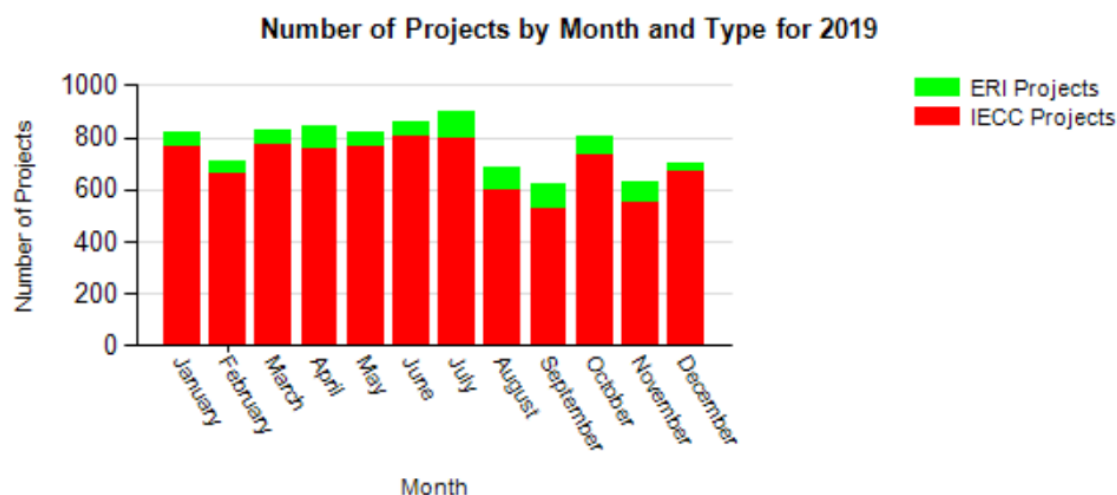


Figure 26: IC3 2019 Projects

<sup>37</sup> International Code Compliance Calculator, a web based, above code calculator for single family, detached, new construction in Texas.

<sup>38</sup> Texas Climate Vision, a web based, above code calculator for single family, detached, new construction in Austin Energy's service area.

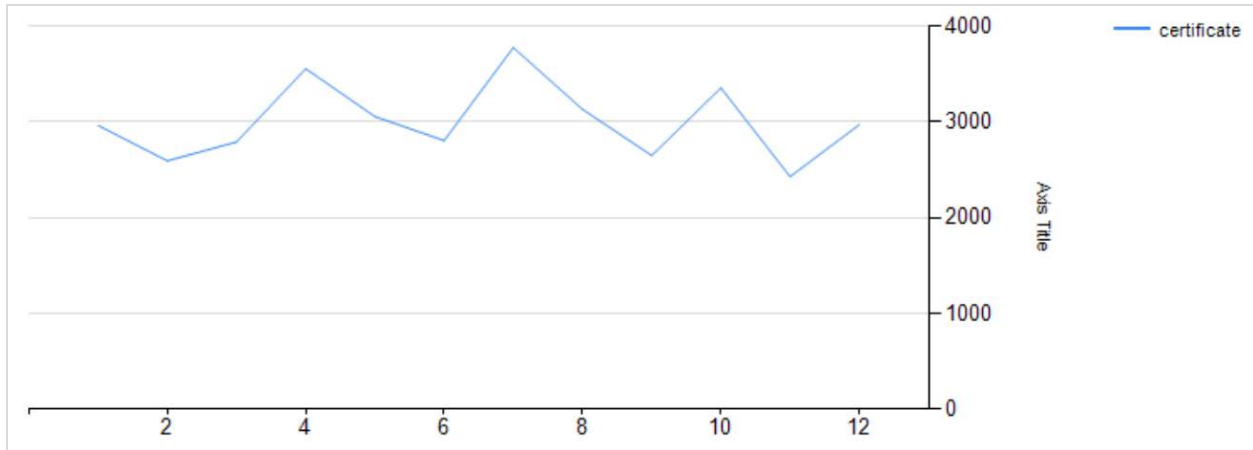


Figure 27: IC3 2019 New Certificates

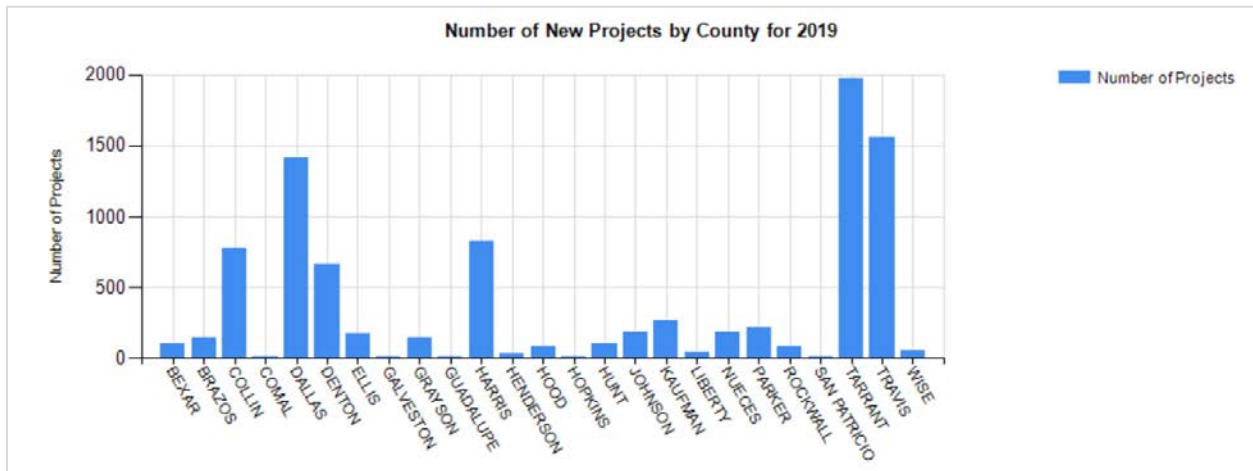


Figure 28: IC3 2019 Certificates – Counties with at least 10 Certificates

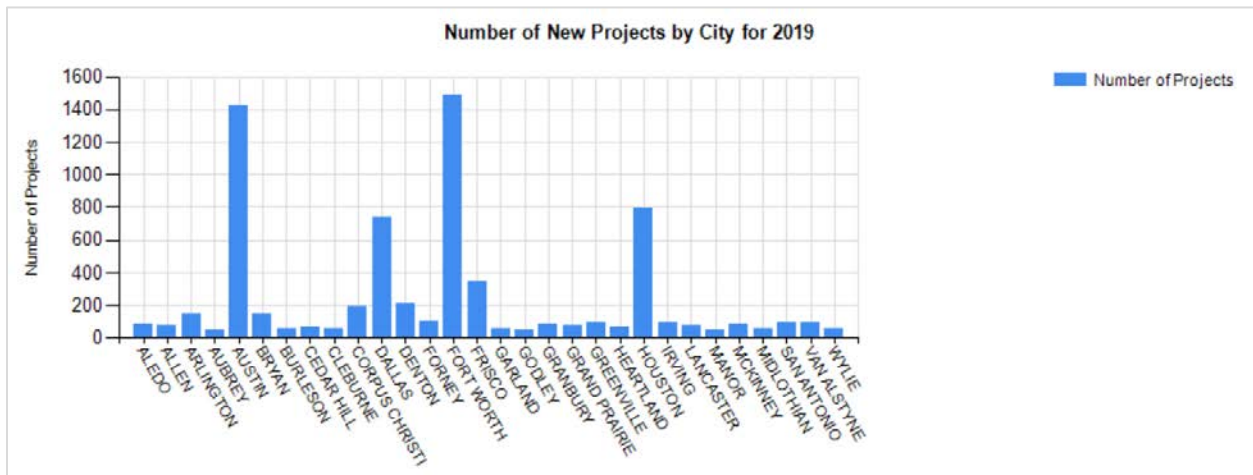


Figure 29: IC3 2019 Certificates – Cities with at least 50 Certificates

### 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 30 shows the “layout” of the *IC3* (v3.x and above) and *TCV*<sup>39</sup> (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.

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<sup>39</sup> 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.

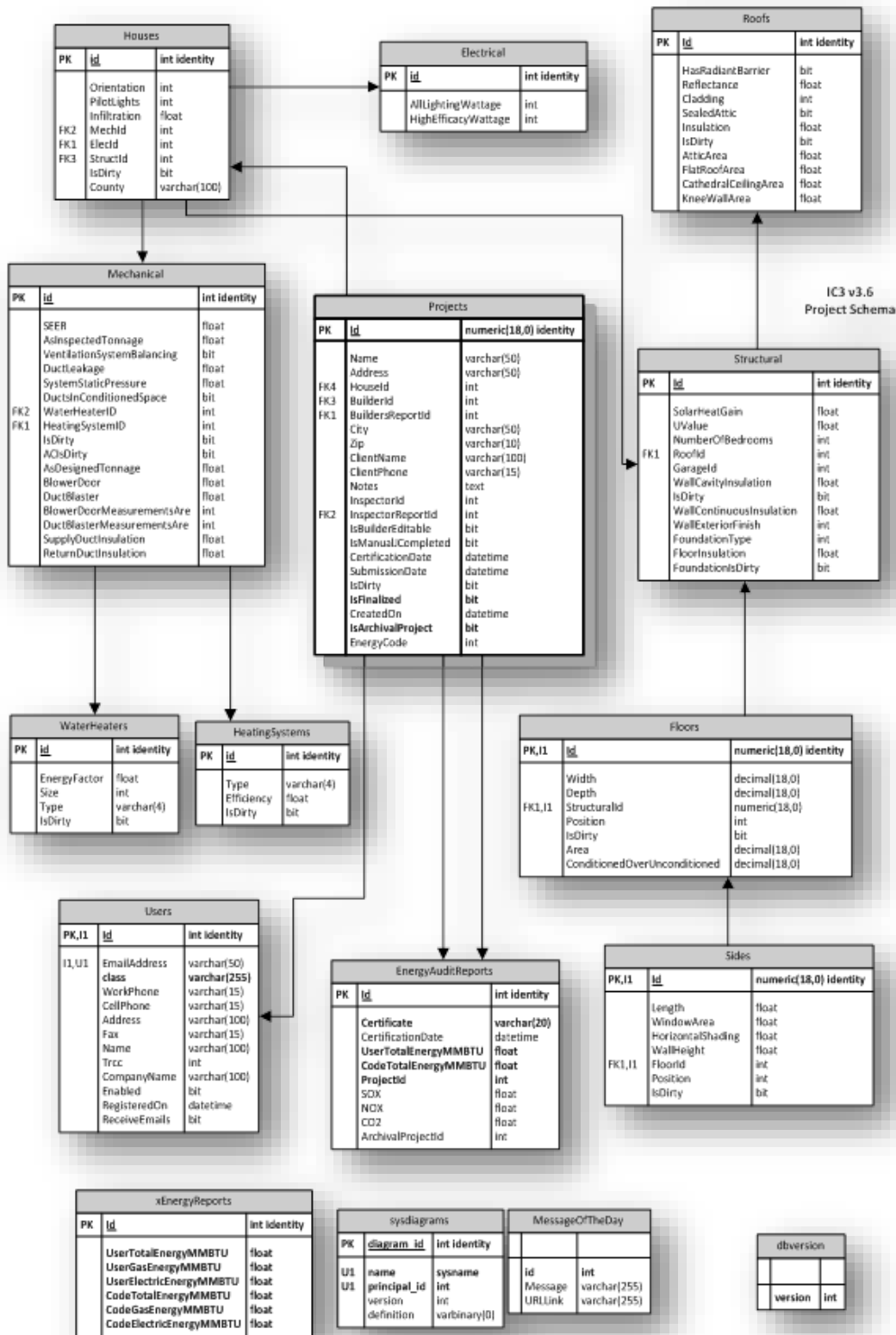


Figure 30: Database Schema

## 6.1.3 Usage Reports

Figure 27 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.

Table 32 shows where the usage was using Counties as the grouping entity. The North Central Texas Council of Governments (NCTCOG) led the way in usage during 2019.

Table 32 Counties Generating IC3 Certificates in 2019

County Name	January	February	March	April	May	June	July	August	September	October	November	December
ANDERSON				1								
AUSTIN							1					
BASTROP	1				1							
BEXAR	31	1	13	3		5	27	8	4	5		6
BLANCO									1			
BRAZORIA		1										
BRAZOS	7	18	13	22	7	15	12	8	9	17	16	5
BURNET	1		1						1			1
CALDWELL				1		1						
CAMERON						1						
COLEMAN						1						
COLLIN	40	50	64	56	80	71	81	68	67	41	73	83
COMAL												15
COOKE						1						1
DALLAS	110	103	169	152	93	95	149	122	104	134	98	89
DENTON	34	31	28	44	76	76	41	61	80	67	53	76
ELLIS	7	19	10	11	17	25	15	21	8	13	20	7
ERATH		2										
FORT BEND		2			2							
FREESTONE										1		
GALVESTON				3	2	2	2					1
GILLESPIE					1							
GRAYSON	18	12	22	3	18	8	11	10	12	15	6	10
GREGG								1				4
GUADALUPE				2	1	3	3	3		1		
HARRIS	99	56	113	60	82	51	81	44	49	66	58	72
HAYS			1			1	1		1	1	2	
HENDERSON			5	1	3	5		4	5	6	2	1
HIDALGO	2											
HOOD	1	2	7	5	9	8	4	10	16	9	10	8
HOPKINS	1	1								11		
HUNT	7	8	3	5	14	9	20	7	6	6	13	5
JEFFERSON						1		1	1	1		
JOHNSON	22	24	10	15	22	9	10	20	25	15	10	4
KAUFMAN	21	13	13	31	18	22	49	11	10	43	24	12
LIBERTY				14	2		14		6	4		
LLANO		1			1					1		
MASON	1			2					1		1	
MCLENNAN						4	1	2	1			
MEDINA			1							1		
MIDLAND	1									1		
MONTAGUE				2		1				1		
MONTGOMERY			1	1		1		1		1		
NAVARRO					1							
NEUCES	19	16	14	14	13	15	8	9	18	23	16	26
PALO PINTO									1	1	2	
PARKER	16	10	20	26	5	14	15	34	14	29	18	18
POTTER												1
RAINS								1				
ROCKWALL	1	6	2	16	12	16	8	6	3	10	2	5
SAN PATRICIO	2	2		1	1	2	2	1				
TARRANT	152	168	174	257	186	204	188	116	127	180	142	84
TAYLOR										1		
TRAVIS	225	161	139	93	144	186	145	110	48	91	54	165
VAN ZANDT	1				1		1					
WALKER							1					
WALLER					1			2				
WILLIAMSON			1									
WISE	2	4	3	3	4	8	10	3	7	5	4	5

### 6.1.4 Parameter Reports

A unique and valuable use of the Registry is to look at building trends across the State. Appendix C shows the yearly average parameter values by county.

This report shows the yearly average wall cavity insulation distribution in Texas for 2019. The colors in the figure show the relevant insulation values.

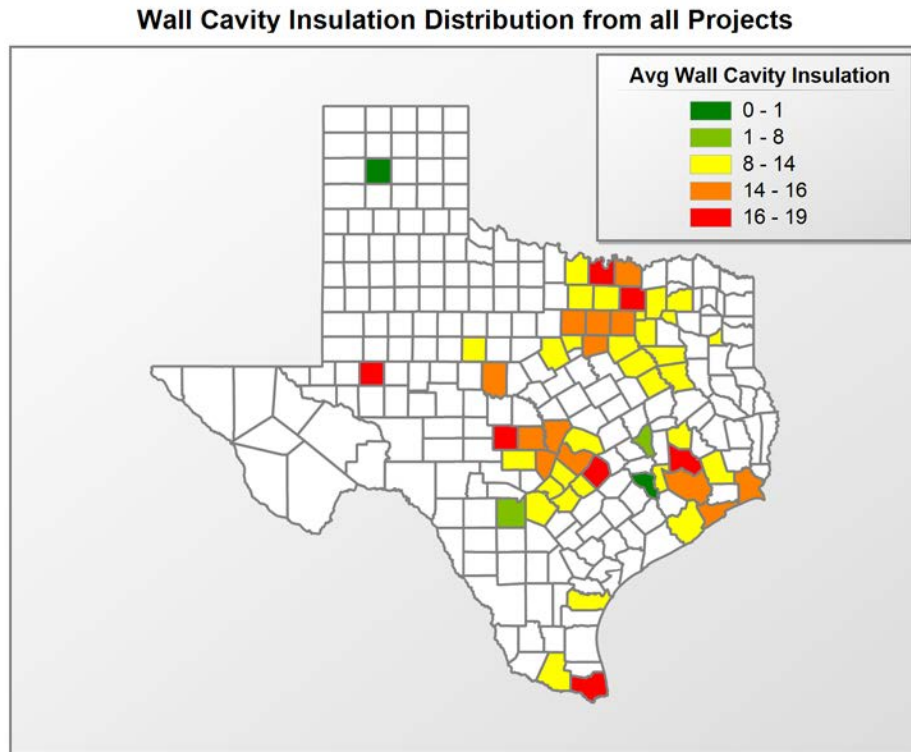


Figure 31: Yearly Average Wall Cavity Insulation Distribution by County in 2019 (All Projects)



### Wall Cavity Insulation Distribution from Submitted Projects

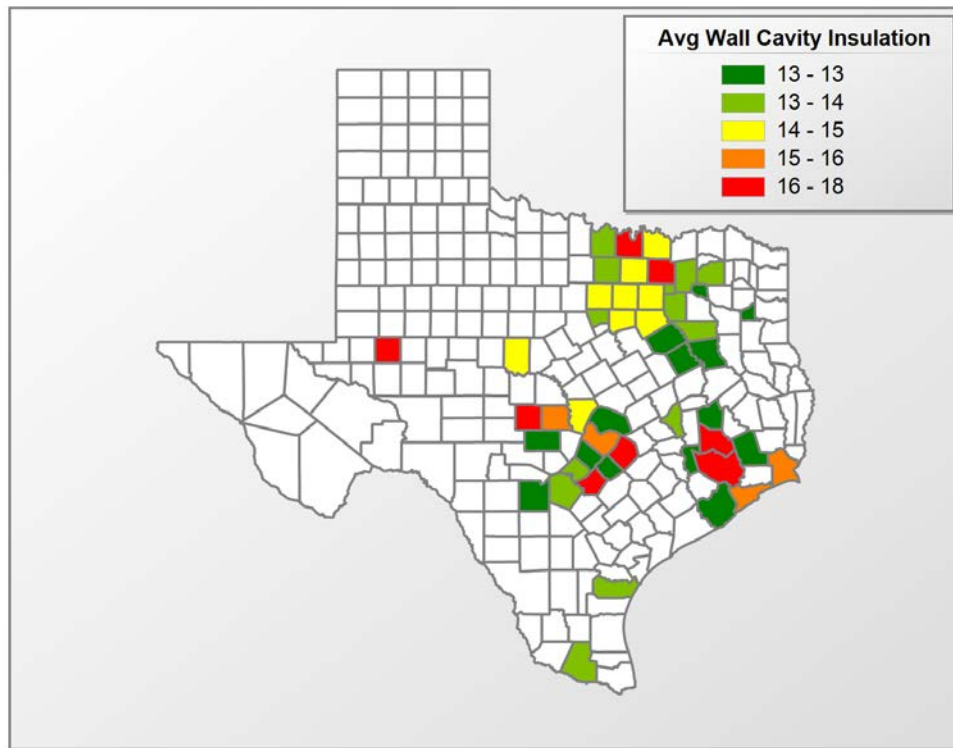


Figure 32: Yearly Average Wall Cavity Insulation Distribution by County in 2019 (Submitted Projects)

### Wall Cavity Insulation Distribution from Passed Projects

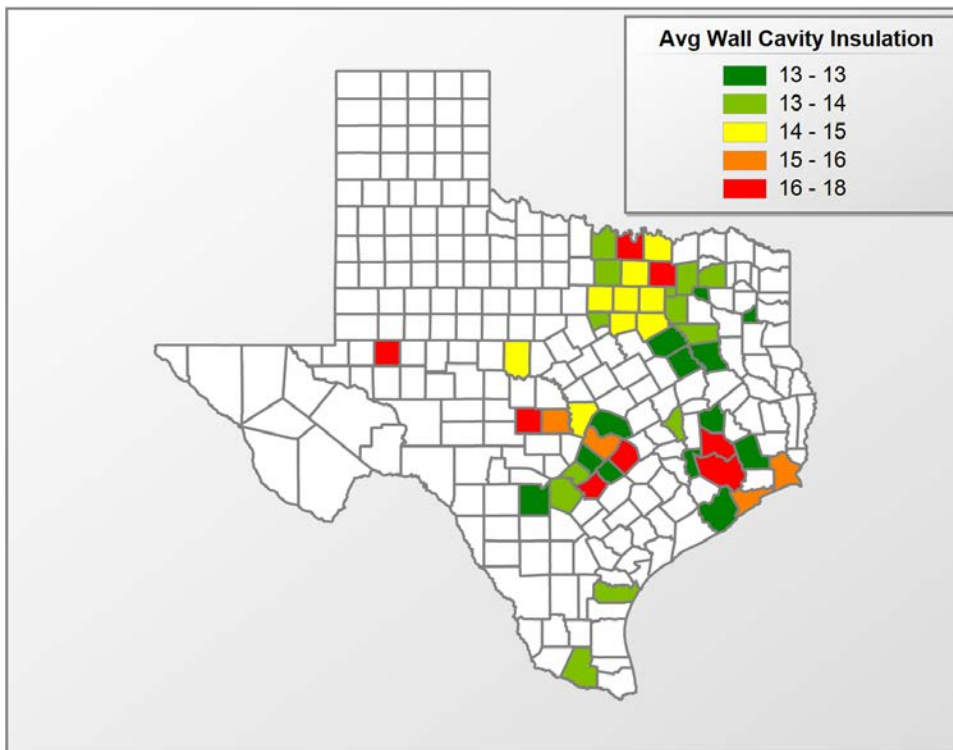


Figure 33: Yearly Average Wall Cavity Insulation Distribution by County in 2019 (Passed Projects)

This report shows water heater efficiencies across Texas in 2019

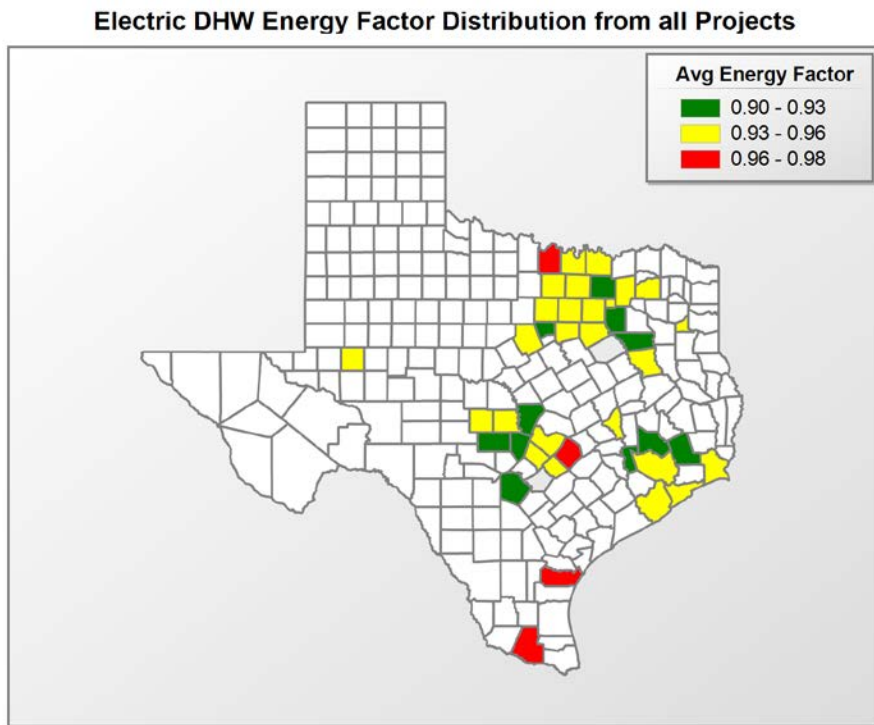


Figure 34: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2019 (All Projects)

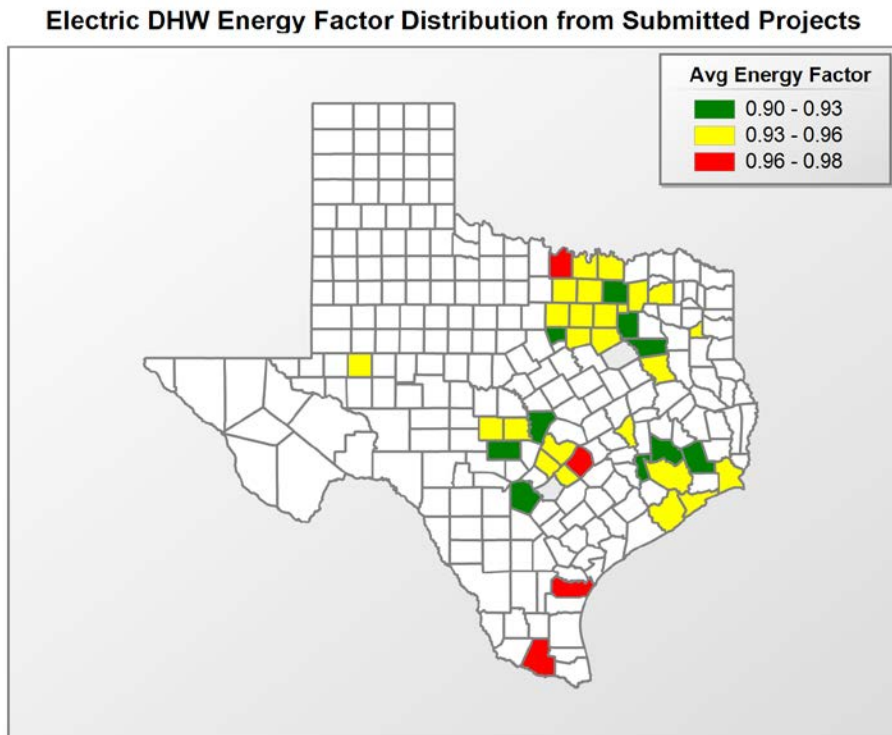


Figure 35: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2019 (Submitted Projects)

**Electric DHW Energy Factor Distribution from Passed Projects**

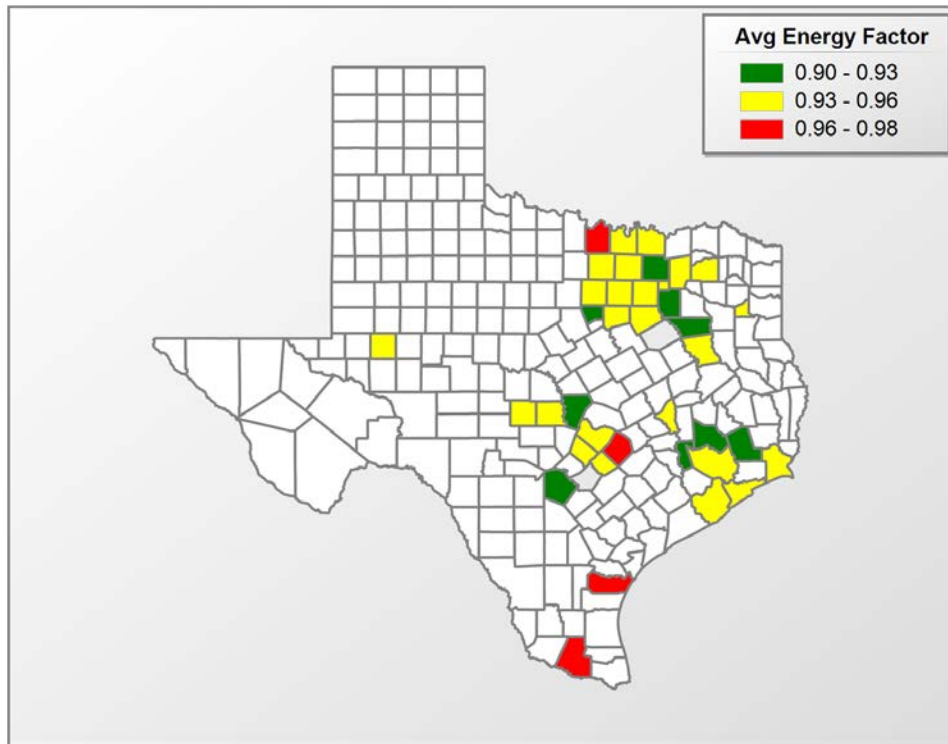


Figure 36: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2019 (Passed Projects)

**NGas DHW Energy Factor Distribution from all Projects**

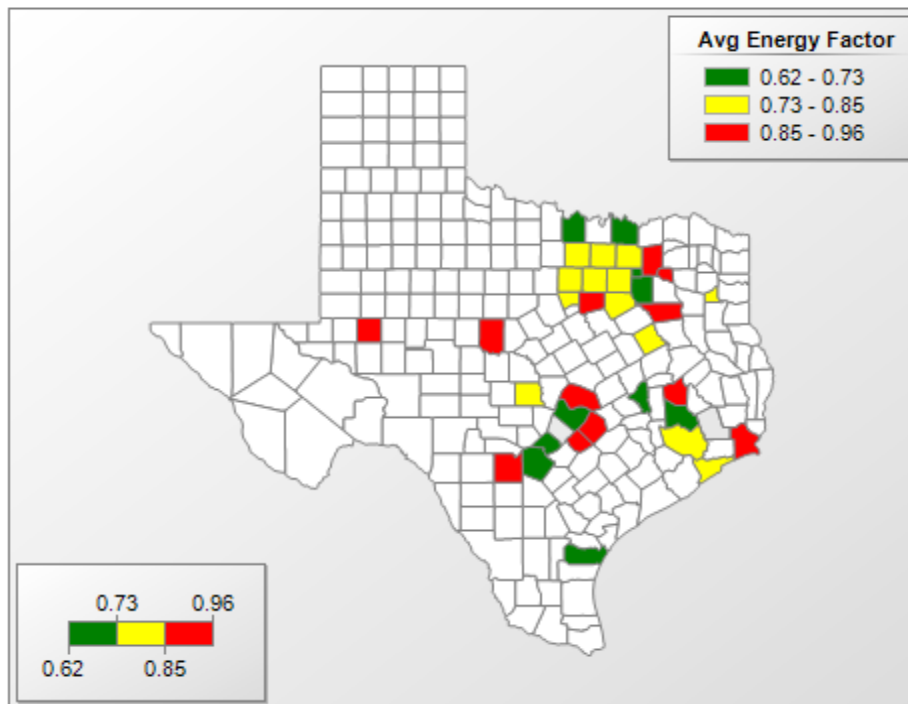


Figure 37: Yearly Average NGas Water Heater Energy Factor Distribution by County in 2019 (All Projects)

### NGas DHW Energy Factor Distribution from Submitted Projects

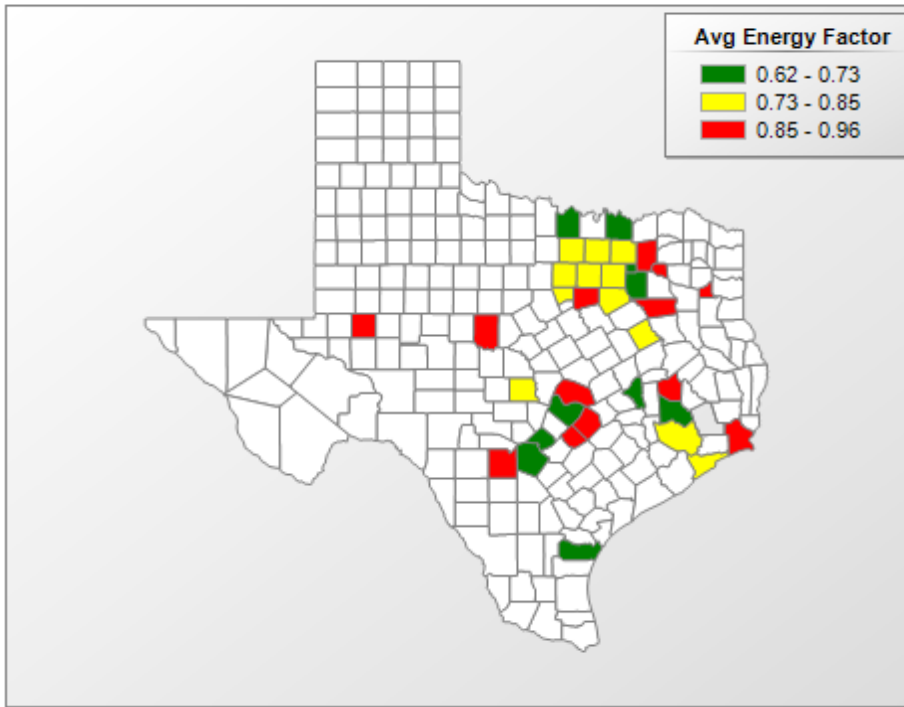


Figure 38: Yearly Average NGas Water Heater Energy Factor Distribution by County in 2019 (Submitted Projects)

### NGas DHW Energy Factor Distribution from Passed Projects

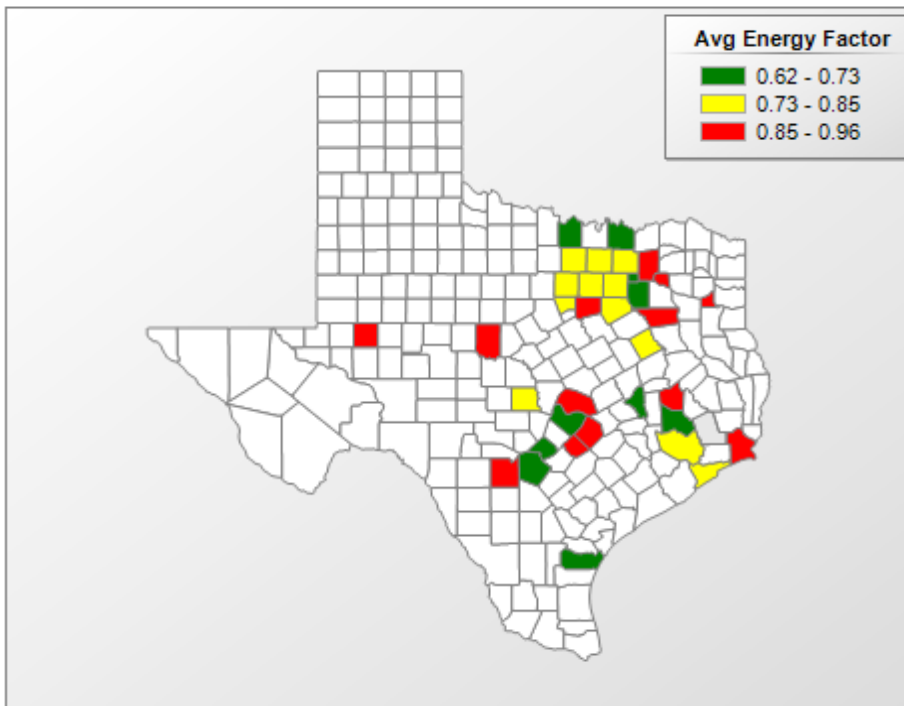


Figure 39: Yearly Average NGas Water Heater Energy Factor Distribution by County in 2019 (Passed Projects)

### Heat Pump DHW Energy Factor Distribution from all Projects

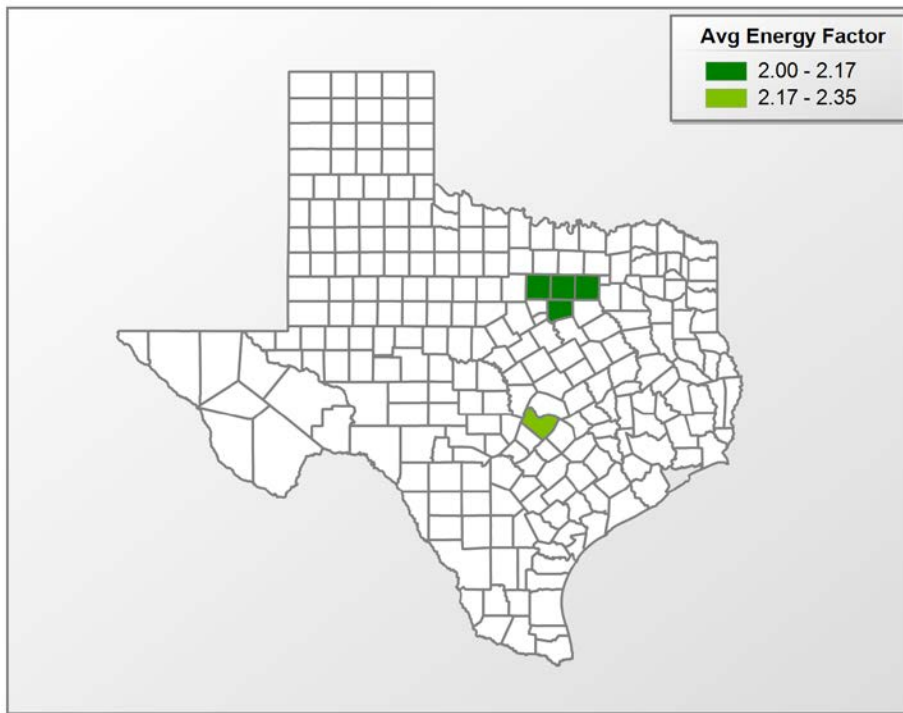


Figure 40: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2019 (All Projects)

### Heat Pump DHW Energy Factor Distribution from Submitted Projects

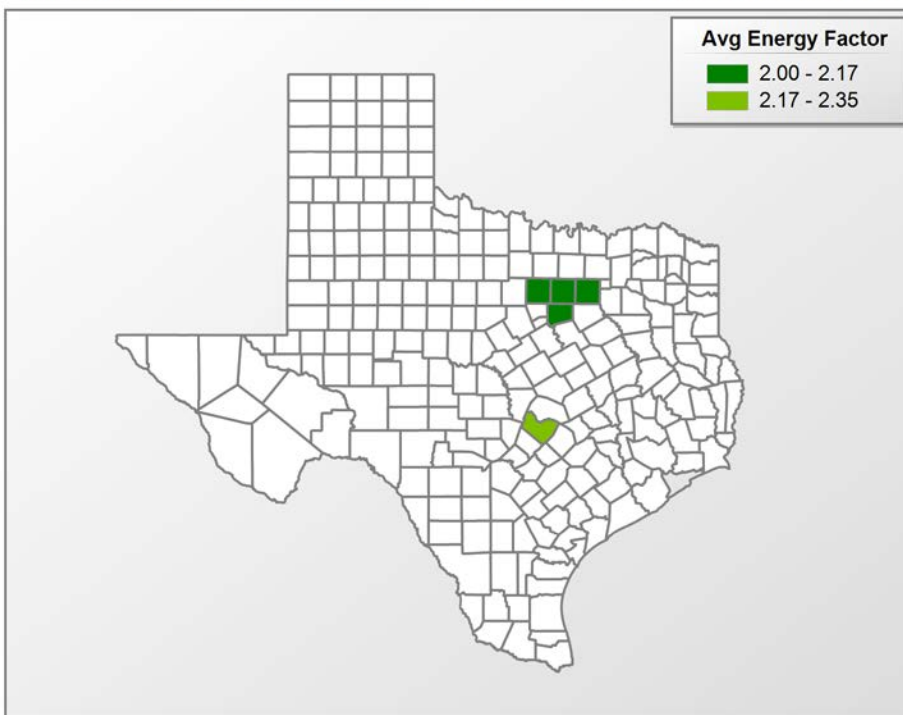


Figure 41: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2019 (Submitted Projects)

### Heat Pump DHW Energy Factor Distribution from Passed Projects

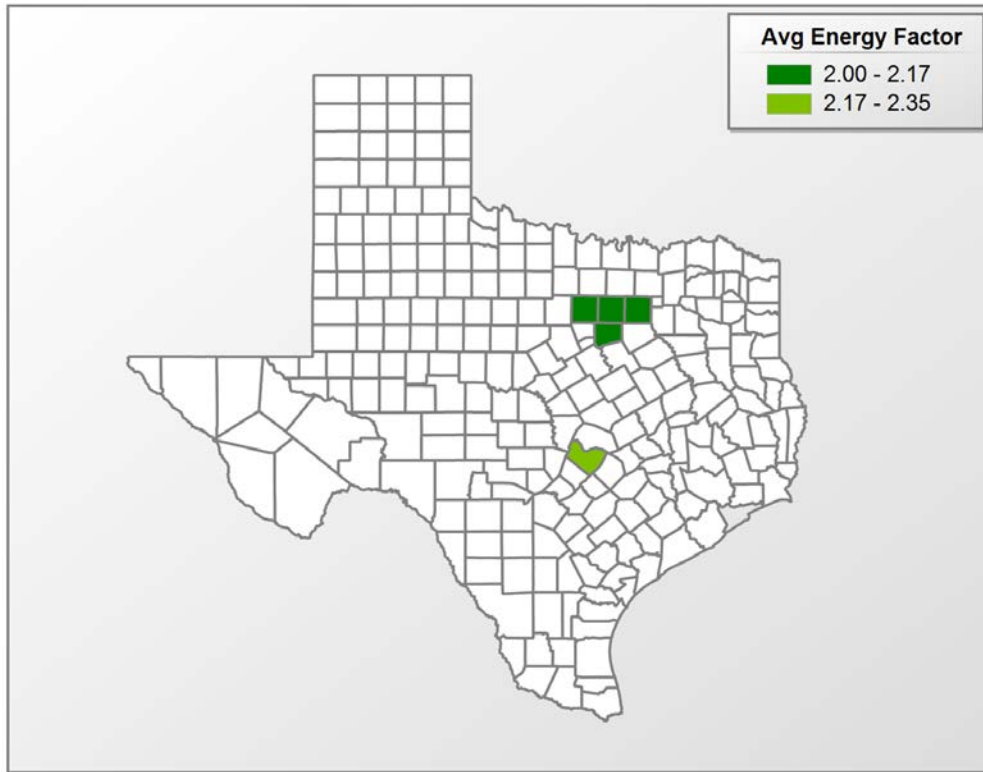


Figure 42: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2019 (Passed Projects)

This report shows the average A/C SEER across Texas in 2019. The efficiency (and sizing) of air conditioning is a vital component of energy efficiency in Texas.

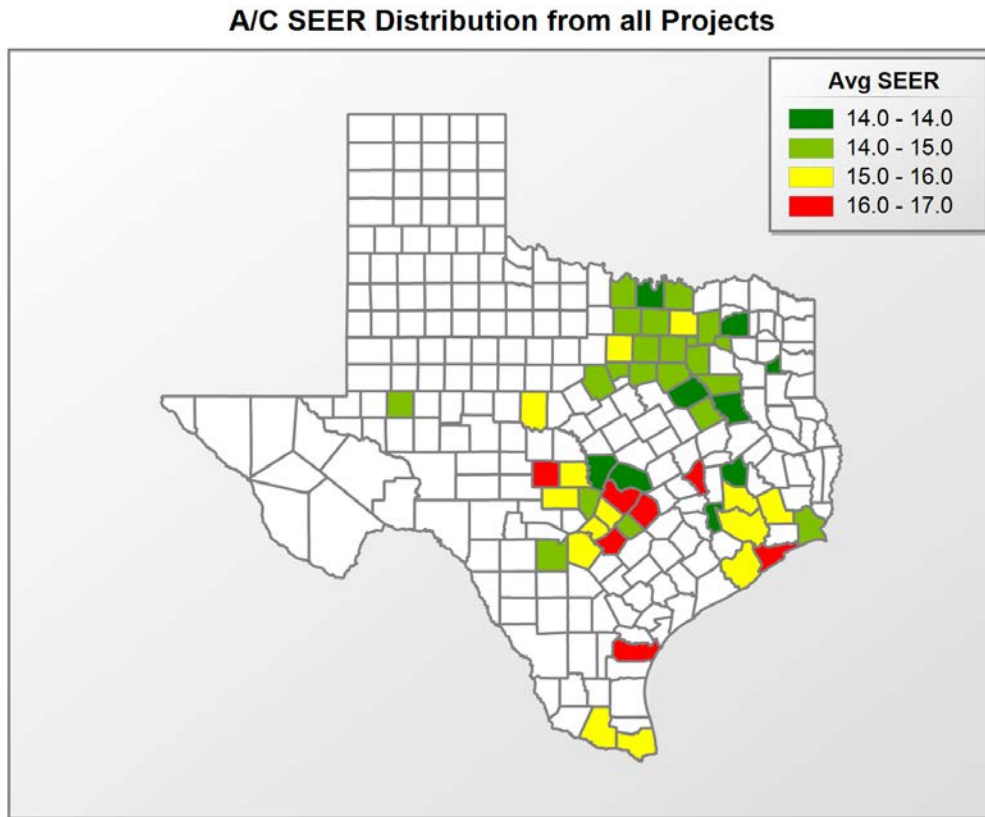


Figure 43: Average A/C SEER across Counties in 2019 (All Projects)

### A/C SEER Distribution from Submitted Projects

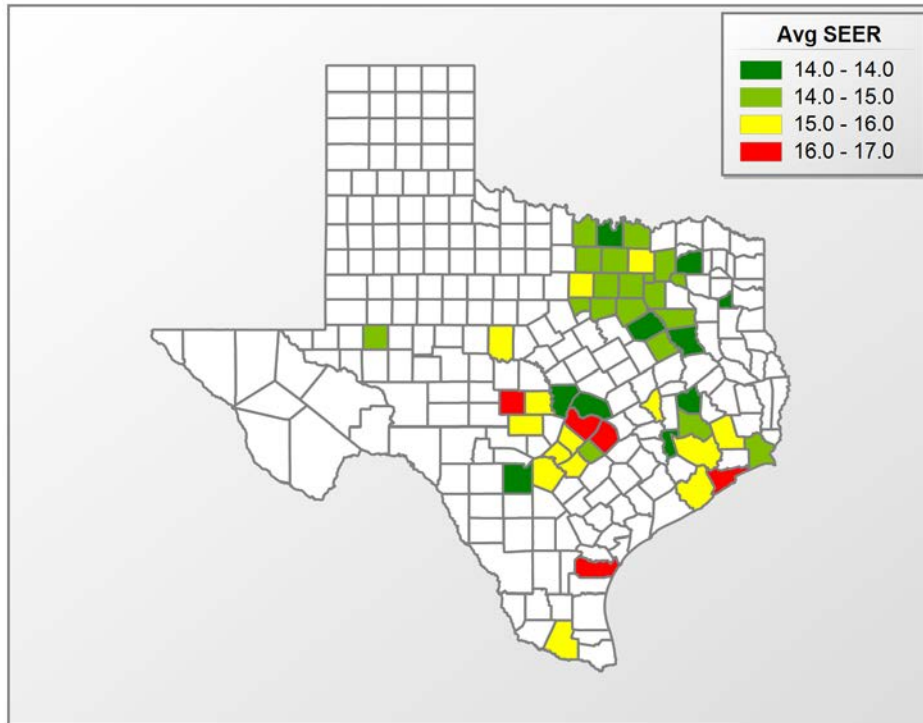


Figure 44: Average A/C SEER across Counties in 2019 (Submitted Projects)

### A/C SEER Distribution from Passed Projects

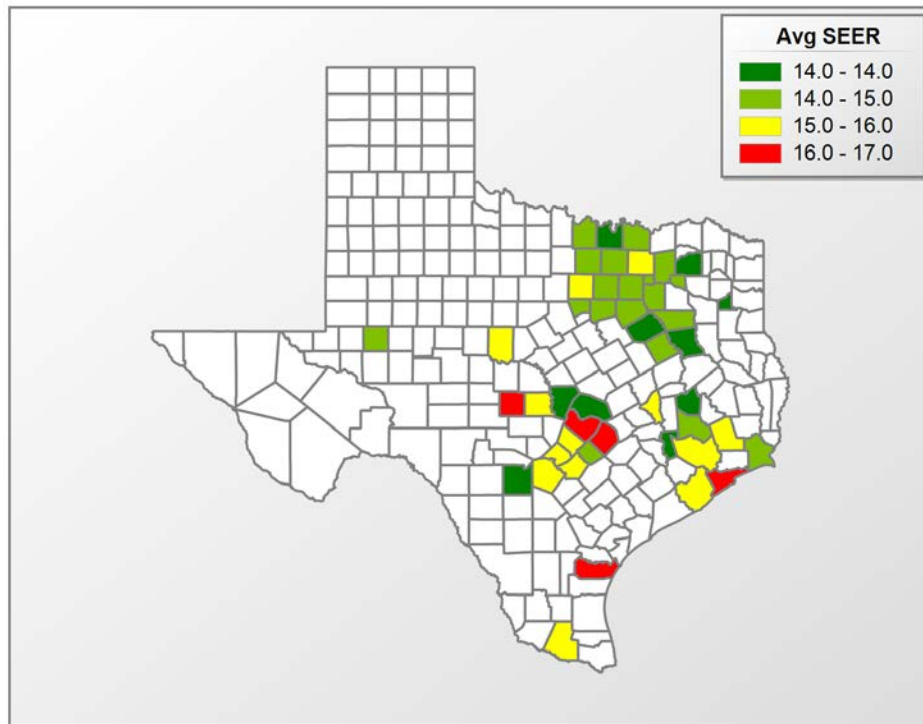


Figure 45: Average A/C SEER across Counties in 2019 (Passed Projects)



This report shows the average ceiling insulation across Texas in 2019.

### Ceiling Insulation Distribution from all Projects

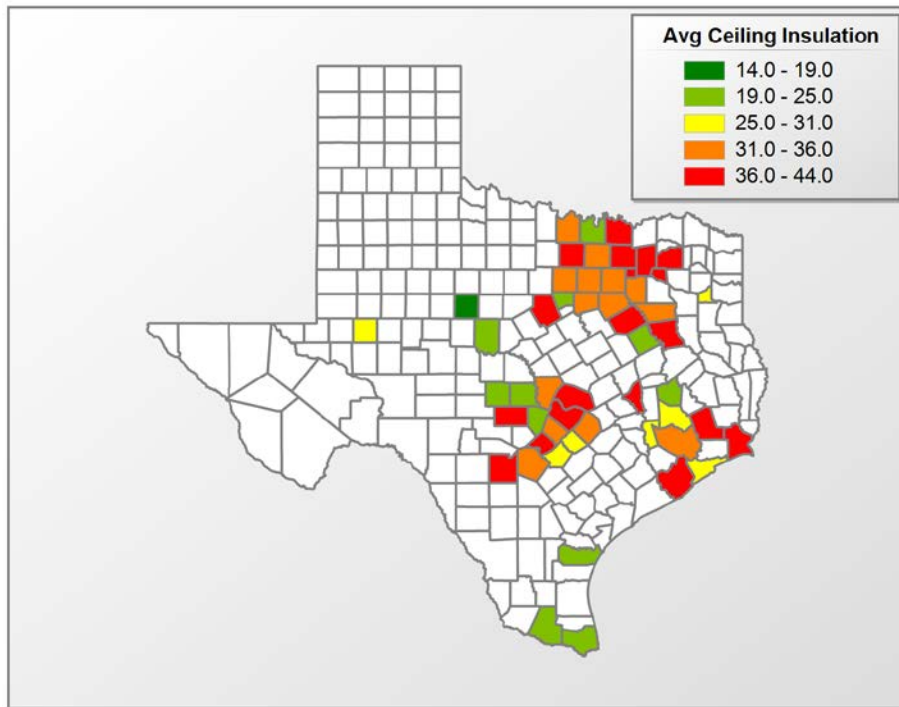


Figure 46: Average Ceiling Insulation across Counties in 2019 (All Projects)

### Ceiling Insulation Distribution from Submitted Projects

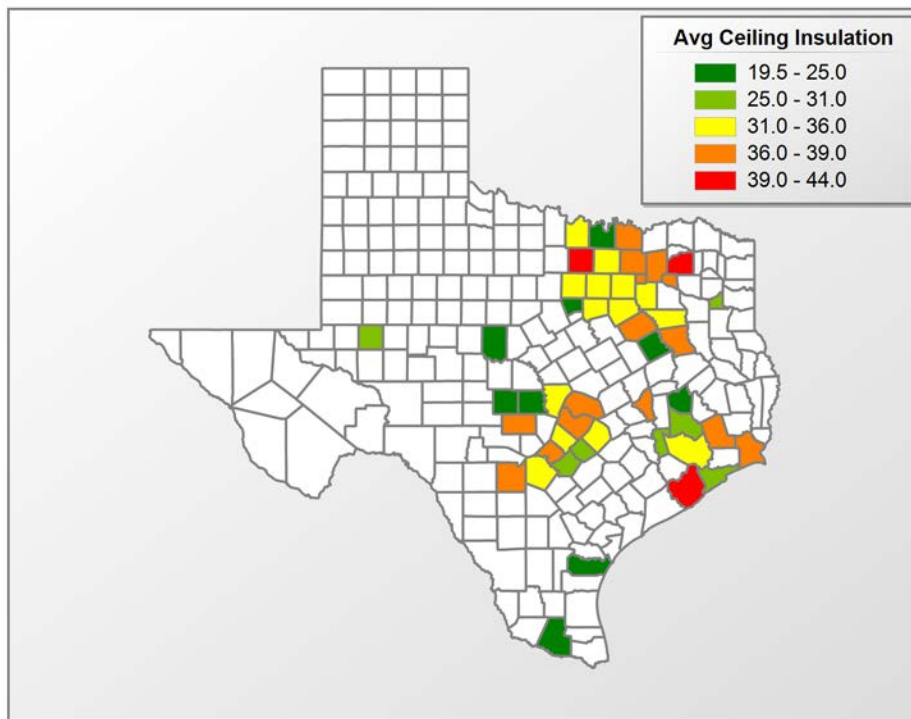


Figure 47: Average Ceiling Insulation across Counties in 2019 (Submitted Projects)

### Ceiling Insulation Distribution from Passed Projects

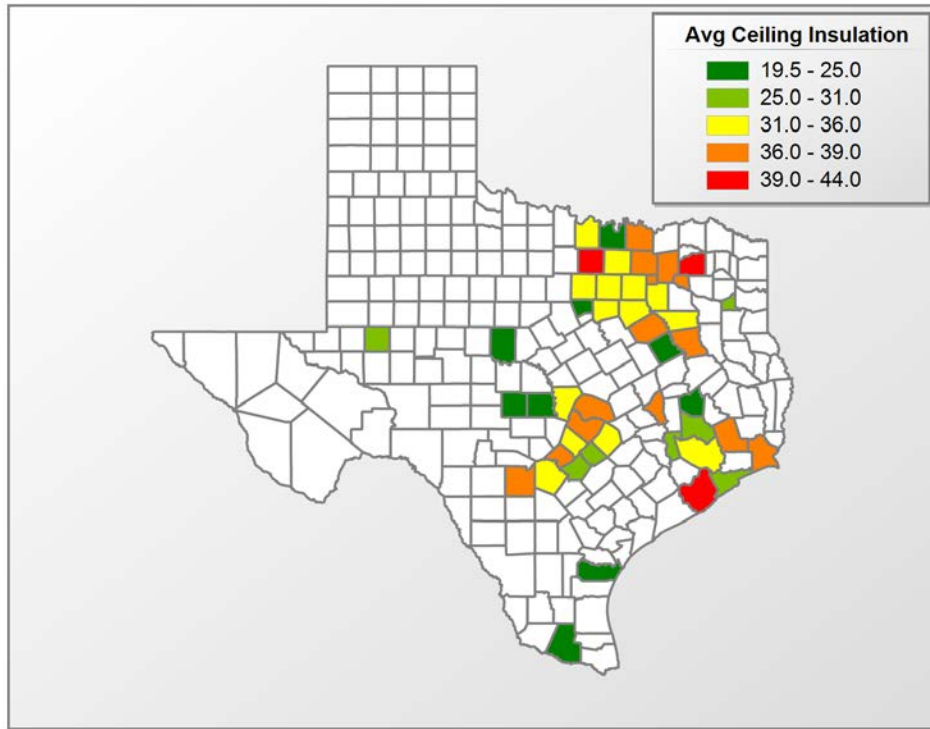


Figure 48: Average Ceiling Insulation across Counties in 2019 (Passed Projects)

This report shows the average heating efficiency across Texas in 2019.

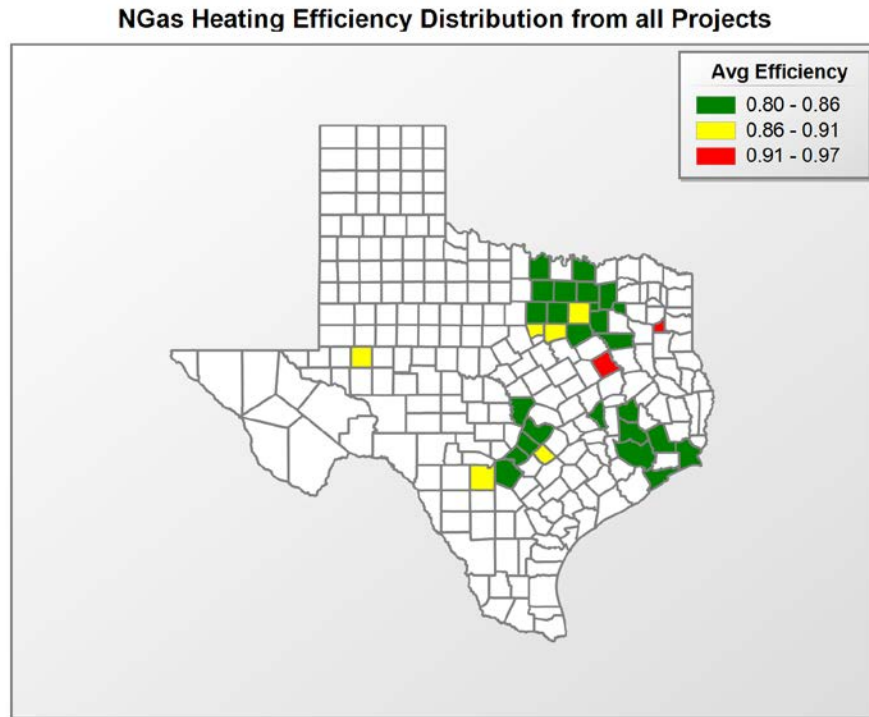


Figure 49: Average NGas Heating Efficiency across Counties in 2019 (All Projects)

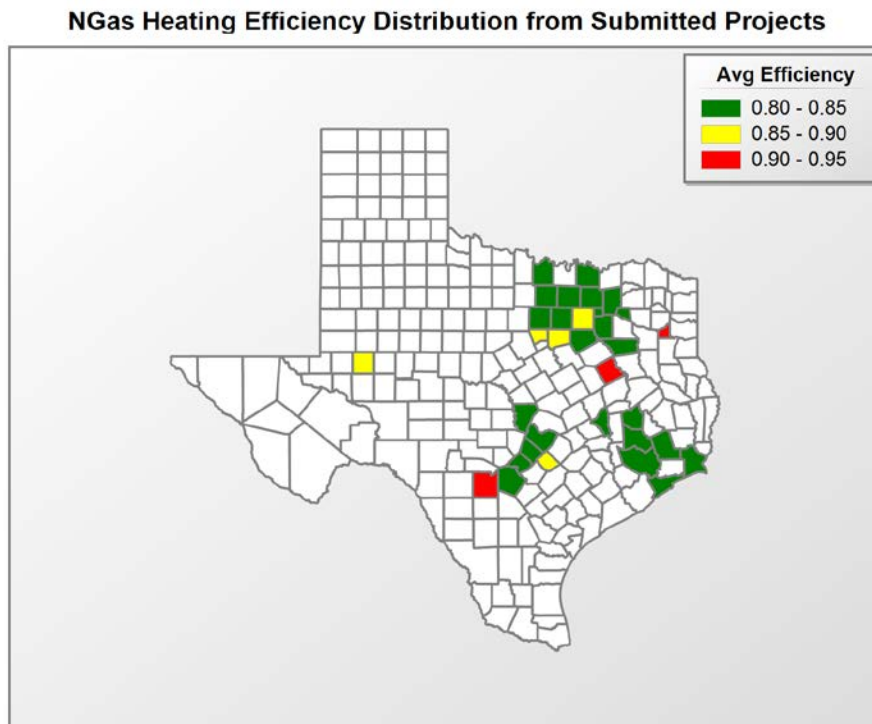


Figure 50: Average NGas Heating Efficiency across Counties in 2019 (Submitted Projects)

### NGas Heating Efficiency Distribution from Passed Projects

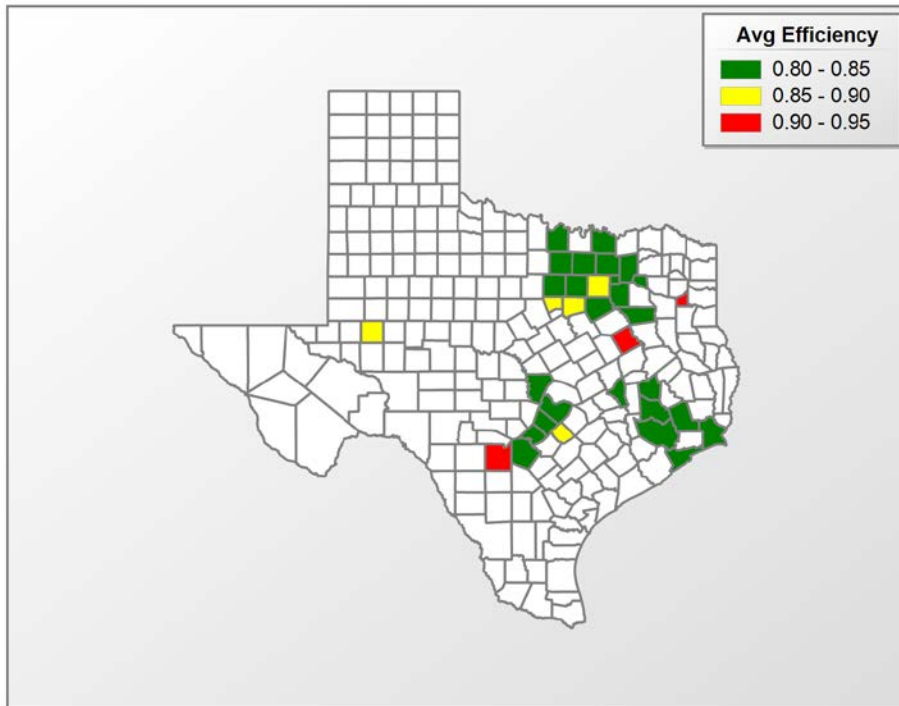


Figure 51: Average NGas Heating Efficiency across Counties in 2019 (Passed Projects)

### Heat Pump Heating Efficiency Distribution from all Projects

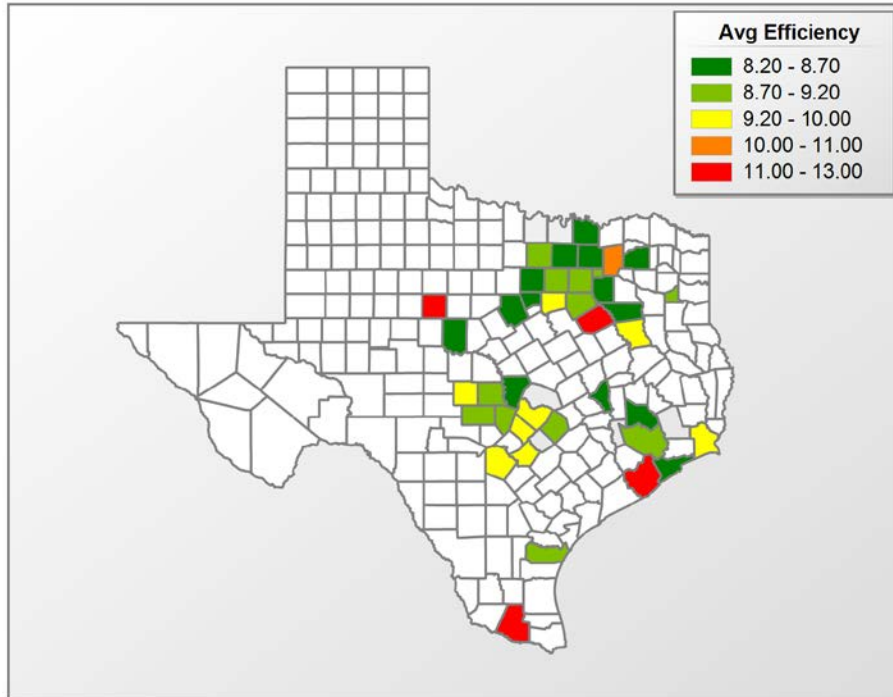


Figure 52: Average Heat Pump Heating Efficiency across Counties in 2019 (All Projects)

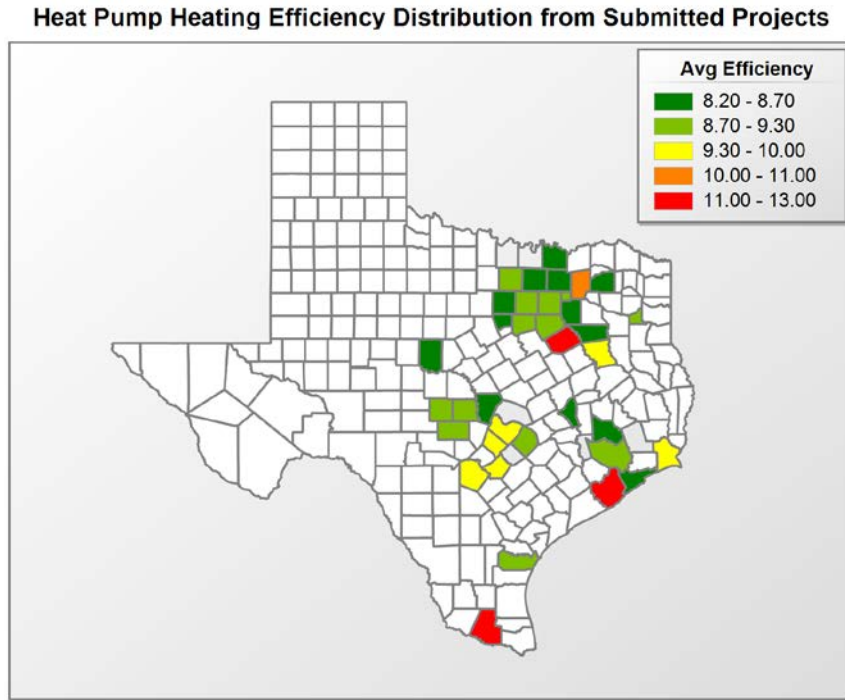


Figure 53: Average Heat Pump Heating Efficiency across Counties in 2019 (Submitted Projects)

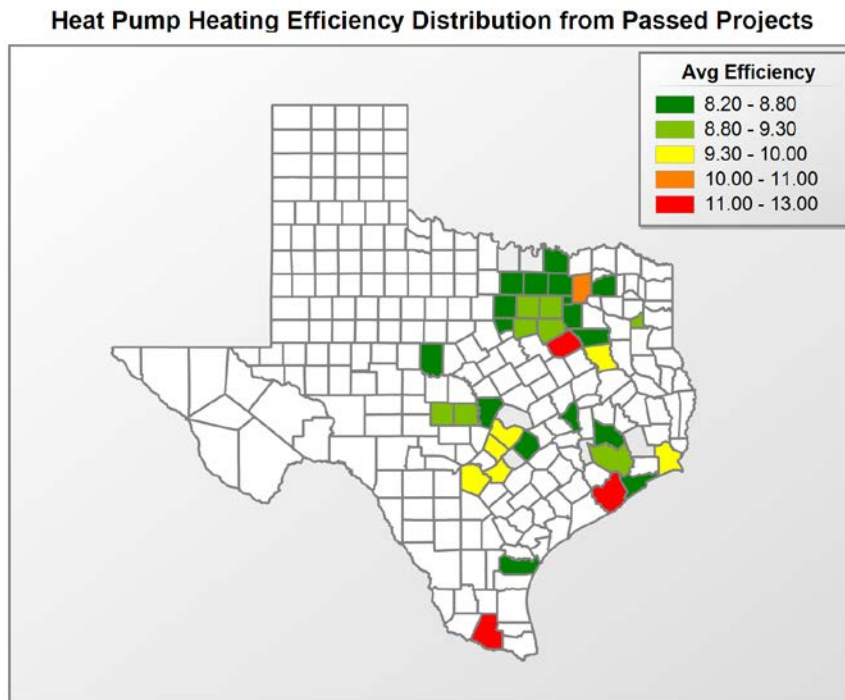


Figure 54: Average Heat Pump Heating Efficiency across Counties in 2019 (Passed Projects)

This report shows the average SHGC across Texas in 2019.

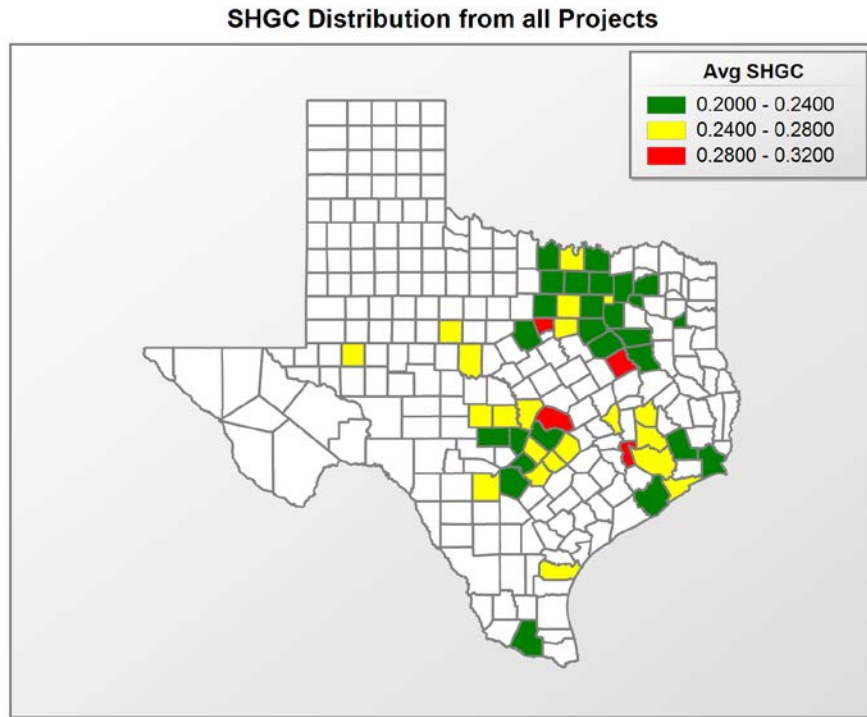


Figure 55: Average SHGC across Counties in 2019 (All Projects)

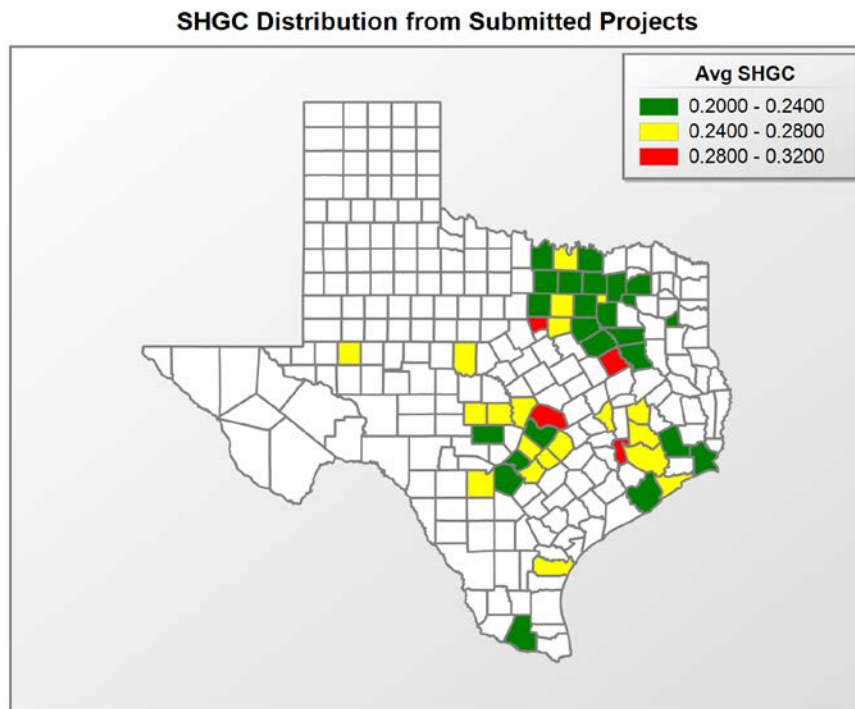


Figure 56: Average SHGC across Counties in 2019 (Submitted Projects)

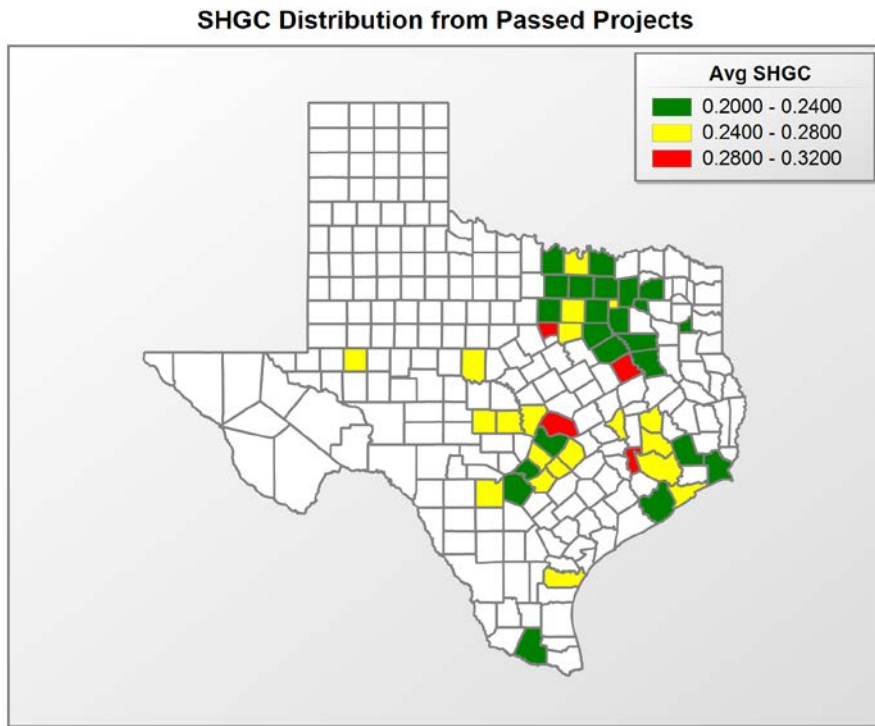


Figure 57: Average SHGC across Counties in 2019 (Passed Projects)

This report shows the average U Factor across Texas in 2019. The U Factor applies to the heat transfer of a window caused by temperature, no direct solar radiation.

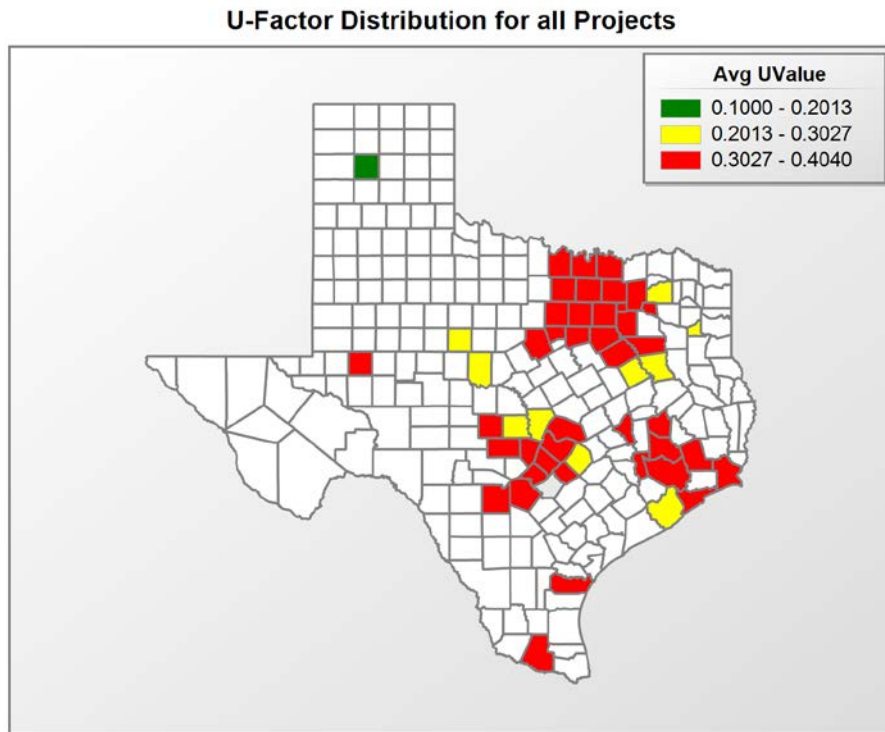


Figure 58: Average U Factor across Counties for Single-Family Homes in 2019 (All Projects)

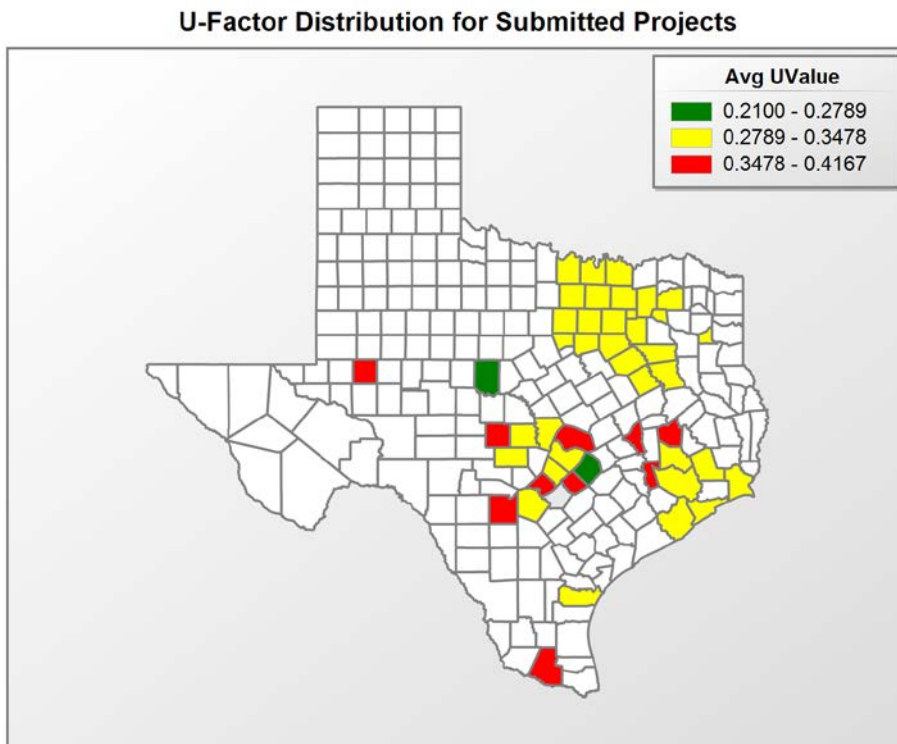


Figure 59: Average U Factor across Counties for Single-Family Homes in 2019 (Submitted Projects)



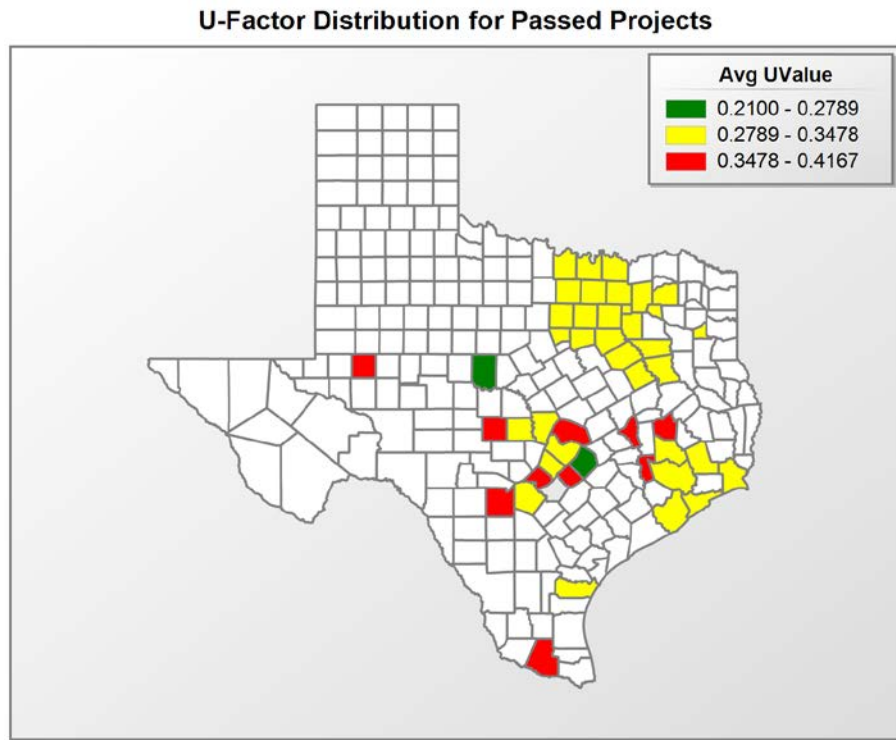


Figure 60: Average U Factor across Counties for Single-Family Homes in 2019 (Passed Projects)

## 6.2 IC3 Enhancements

IC3 is continuously being enhanced since 2009 released Version 3.5.2 to 2017 released Version 4.3.1. Numerous enhancements have been made and are detailed out in section 6.2.1 and section 6.2.2.

### 6.2.1 History of IC3 version 3 Enhancements

Most of the enhancements that are being added to IC3 in 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. Users will be prompted to enter their IC3 version 3.x credentials and 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
- The 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

In version 4.3 (March 2017)

- Added 2015 Austin Energy Amendments to list of codes
- Altered the duct model to improve accuracy

In version 4.3.1 (July 2017)

- Added NCTCOG 2015 ERI amendment to list of codes

In version 4.4 (July 2019)

- Updated weather files. This increases the temperature slightly and will increase energy usage in the summer months•
- Major update of ERI calculation to reflect the changes made to RESNET HERS rating algorithm. Importance: The amount of calculation needed for this calculation has more than doubled. An ERI calculation will now take up to 1 minute to complete

In version 4.4.1 (July 2019)

- Bug Fixes

In version 4.4.3 (July 2019)

- Bug Fixes

In version 4.5 (September 2019)

- Added IECC 2018 code support
- Added support for tankless NGas DHW

### 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 33 presents the summarized description of the changes in Single-Family Input file since the 2012 annual simulation.

Table 33: 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
4.01.12	Added option to include mixed ceilings for sealed attics.	10/28/2014
4.01.13	Natural ventilation module.	02/04/2015
4.01.14	Updated to match spec sheet version 4.01.14. Fixed bug in tcv schedules. incorporated provision for heat-pump dhw heater.	04/08/2015 06/16/2015
4.01.15	Corrected total room volume to include attic volume for different roof types.	10/22/2015
4.01.16	Modified setback schedule for thermostat schedule based on resnet 301-2014.	07/28/2016
4.01.17	Changed supply and return duct r-value= p-rsupply/p-return = [p-supplyductr[] + 0.5]/[p-returnductr[] + 0.5]. Change[p-atticfla[] eqs 0] to [p-atticfla[] eq 0].	04/09/2019 04/09/2019
4.02	Changed the bdl name from ver 4.01.17 to ver 4.02	05/13/2019

#### 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.<sup>40</sup> 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.

<sup>40</sup> It should be noted that loads from occupants were included in the loads for equipment.

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 include values for energy input 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.<sup>41</sup> In addition, the curves used for the 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).<sup>42</sup>

Corrected layers for cathedral ceiling

In BDL Version 4.01.10 specifications for the cathedral ceiling were added to the BDL. The modification included providing a separate entry in the BDL for cathedral ceiling insulation. 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.

No major changes to the input file were made in 2019.

<sup>41</sup> Email correspondence with Jeff Myron, EnergyGauge Technical Support (10/18/2013).

<sup>42</sup> 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 2019, the Laboratory redesigned its website to make navigation easier. On the navigation bar is a tab that links to the TERP homepage (Figure 61). The homepage contains the following items:

- Texas Emissions Reduction Program
- Texas Work
  - TERP Objectives
  - TERP Elements
  - ESL's TERP Responsibilities
  - Texas Energy Summit
- National Work
  - National Center of Excellence on Displaced Emission Reductions (CEDER)
  - Our Work
    - EPA Recognizes ESL and Dallas Partners

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

- History
- Code Compliance Calculator
  - IC3
    - City Amendments to the State Energy Code
      - City of Austin
      - City of Houston
      - North Central Texas COG
    - Resources
      - IC3 User Manual
      - IC3 Release Notes
      - RESNET Validation Report
      - FBI IC3 Unit
      - Aggregate Reports from IC3
    - FAQs
- Data
  - Texas Building Registry
    - IC3 Usage
    - IC3 House Construction
  - Weather
- Letters and Reports
  - Legislative Documents
  - EPA/CEDER Work
  - Builders Information
  - Reports – listed by year from 2002-2020
  - Presentations
- Workshops
  - International Code Compliance Calculator
  - ASHRAE
  - IECC Commercial Energy Code Training

- IECC Residential Energy Code Training
- Continuous Commissioning
- TERP Links
  - International Code Compliance Calculator (IC3)
  - 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

**TERP**

History

Code Compliance Calculator

IC3

Data

Texas Building Registry

IC3 Usage

IC3 House Construction

Weather

Letters & Reports

Legislative

EPA CEDER

Builder's Info

TERP Reports

2019 – 2020

2017 – 2018

2015 – 2016

2013 – 2014

2011 – 2012

## Texas Emissions Reduction Program

In 2001, the ESL was assigned an important role in the implementation of state energy standards and assistance with calculation of emissions reduction benefits from energy efficiency and renewable energy initiatives as part of the Texas Emissions Reduction Program (TERP). The TERP group is dedicated to building energy modeling, building energy efficiency, and emissions reductions. The majority of this work is funded via the State of Texas as described below. However, some work is conducted at a federal level.

### Texas Work

In 2001, the 77th Legislature passed Senate Bill 5 (SB5) defining the Texas Emissions Reduction Plan (TERP).

#### Objectives

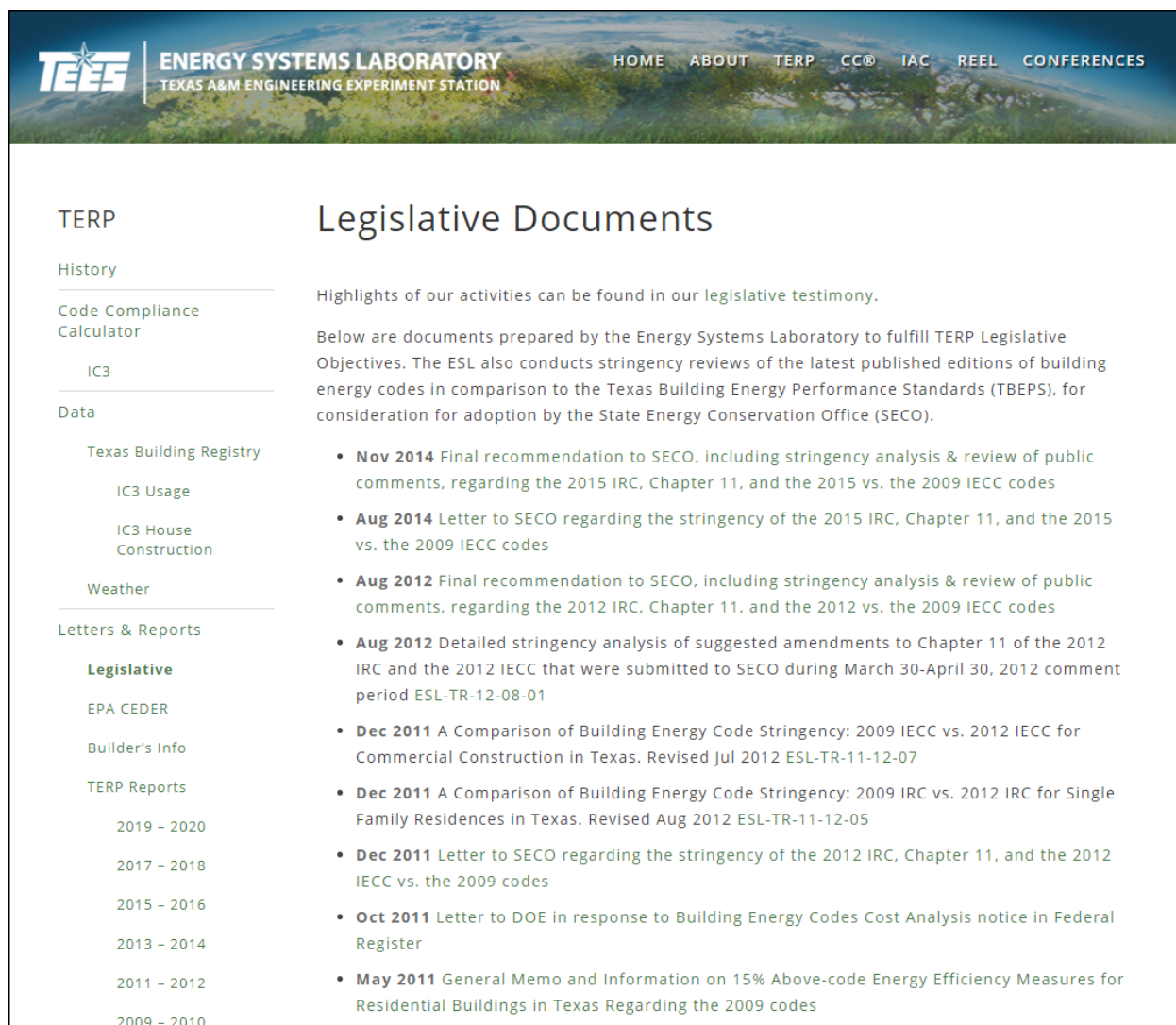
- Ensure that air in Texas meets the Federal Clean Air Act requirements as defined by the EPA
- Reduce Nitrous Oxides (aka *NOx*) emissions in non-attainment and near-non-attainment counties through mandatory and voluntary programs, including the implementation of energy efficiency and renewable energy programs (EE/RE)

#### Elements

- A diesel emissions reduction incentive program
- A motor vehicle purchase or lease incentive program
- A new technology research and development program
- An energy efficiency grant program
- A statewide Texas Building Energy Performance Standard (TBEPS) which defines the building energy code for all residential and commercial buildings

Figure 61. TERP Home Page





**TERP**

History

Code Compliance Calculator

IC3

Data

Texas Building Registry

IC3 Usage

IC3 House Construction

Weather

Letters & Reports

**Legislative**

EPA CEDER

Builder's Info

TERP Reports

2019 – 2020

2017 – 2018

2015 – 2016

2013 – 2014

2011 – 2012

2009 – 2010

## Legislative Documents

Highlights of our activities can be found in our legislative testimony.

Below are documents prepared by the Energy Systems Laboratory to fulfill TERP Legislative Objectives. The ESL also conducts stringency reviews of the latest published editions of building energy codes in comparison to the Texas Building Energy Performance Standards (TBEPS), for consideration for adoption by the State Energy Conservation Office (SECO).

- **Nov 2014** Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2015 IRC, Chapter 11, and the 2015 vs. the 2009 IECC codes
- **Aug 2014** Letter to SECO regarding the stringency of the 2015 IRC, Chapter 11, and the 2015 vs. the 2009 IECC codes
- **Aug 2012** Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2012 IRC, Chapter 11, and the 2012 vs. the 2009 IECC codes
- **Aug 2012** Detailed stringency analysis of suggested amendments to Chapter 11 of the 2012 IRC and the 2012 IECC that were submitted to SECO during March 30-April 30, 2012 comment period ESL-TR-12-08-01
- **Dec 2011** A Comparison of Building Energy Code Stringency: 2009 IECC vs. 2012 IECC for Commercial Construction in Texas. Revised Jul 2012 ESL-TR-11-12-07
- **Dec 2011** A Comparison of Building Energy Code Stringency: 2009 IRC vs. 2012 IRC for Single Family Residences in Texas. Revised Aug 2012 ESL-TR-11-12-05
- **Dec 2011** Letter to SECO regarding the stringency of the 2012 IRC, Chapter 11, and the 2012 IECC vs. the 2009 codes
- **Oct 2011** Letter to DOE in response to Building Energy Codes Cost Analysis notice in Federal Register
- **May 2011** General Memo and Information on 15% Above-code Energy Efficiency Measures for Residential Buildings in Texas Regarding the 2009 codes

Figure 62: TERP –Legislative Documents

The screenshot shows the Energy Systems Laboratory website. The header includes the TEEES logo and the text 'ENERGY SYSTEMS LABORATORY TEXAS A&M ENGINEERING EXPERIMENT STATION'. Navigation links include HOME, ABOUT, TERP, CC@, IAC, REEL, and CONFERENCES. The main content area is titled 'TERP Links' and features a sidebar with categories: History, Code Compliance Calculator, IC3, Data, Texas Building Registry, IC3 Usage, IC3 House Construction, Weather, Letters & Reports, Legislative, EPA CEDER, Builder's Info, and TERP Reports. The main content area contains a paragraph about the laboratory's partnerships and a list of these partners.

TERP	TERP Links
History	The Energy Systems Laboratory is honored to work with the following agencies, organizations and offices at the local, state, and national level.
Code Compliance Calculator	
IC3	International Code Compliance Calculator
Data	Public Utility Commission of Texas
Texas Building Registry	U.S. Department of Energy
IC3 Usage	Texas State Energy Conservation Office
IC3 House Construction	U.S. Environmental Protection Agency
Weather	International Code Council
Letters & Reports	American Society of Heating, Refrigeration and Air-Conditioning, Engineers
Legislative	North Central Texas Council of Governments
EPA CEDER	Alamo Area Council of Governments
Builder's Info	Circle of Ten
TERP Reports	
2019 - 2020	
2017 - 2018	
2015 - 2016	
2013 - 2014	
2011 - 2012	
2009 - 2010	

Figure 63: TERP Links

In addition, the Energy Systems Lab. (ESL) also hosted the Texas Energy Summit (previously Clear Air Through Energy Efficiency Conference (CATEE)). The Texas Energy Summit website and information are linked in the 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 file of these transactions is maintained at the Laboratory.

The Laboratory provides technical assistance to the TCEQ, 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 NO<sub>x</sub> 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, 2016, 2017, 2018, 2019 by the Laboratory, PUC, SECO, and Renewables-ERCOT.

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 2015 IECC, and developed 2018 code workshops.

6.4.3 ASHRAE Winter Conference Standards Committee Activities in Atlanta, Georgia, January 12-16, 2019

The following sections are the minutes and transactions of Standards Committee activities at the ASHRAE Winter Conference in Atlanta, Georgia, Jan 12 to Jan 16, 2019.

6.4.3.1 ASHRAE HC



**HISTORICAL COMMITTEE**

Sunday, January 13, 2019

8:30 a.m. – 12:00 p.m.

2019 Winter Conference, Atlanta

Omni Hotel, Hazelnut (3<sup>rd</sup> floor, North Tower)

**COMMITTEE MEMBERS**

**Voting Members:**

Bruce L Flaniken, Chair  
 Stanley M Westhoff, Vice Chair  
 Peggy J Fritz  
 Pamela Immekus  
 Lindsey King  
 Dr Ahmed Alaa Eldin Mohamed, PhD  
 Bernard A Nagengast  
 Eric Sturm  
 Branislav B Todorovic, PhD

**BOD Ex-Officio:**

Dr Ahmed Alaa Eldin Mohamed, PhD

**Coordinating Officer:**

Dr Julia A Keen, PE

**Region Historians:**

Stanley M Westhoff, Region I  
 Robert Thomas Pollard, Region II  
 Gary C Debes, Region III  
 Maurice Richard Harrison, Region IV  
 Lane D Snowberger, Region V  
 Sherman M Sweeney, Region VI  
 Benjamin (Drew) Godfrey, Region VII  
 Charles D Stoabs, Region VIII  
 Gary L Cooper, Region IX  
 Dean Borges, Region X  
 Douglas B LeCren, Region XI  
 John S Davant, Region XII  
 Siew M Leong, Region XIII  
 Andreas Triantafyllopoulos, Region XIV  
 Prof Atilla Biyikoglu, PhD, RAL

**A G E N D A**

1. Call to Order ..... Flaniken, Chair
2. Introduction of Members and Visitors ..... Flaniken  
 2.1 2018–2019 Historical Committee Roster ([Attachment A](#))
3. ASHRAE Code of Ethics Commitment ..... Flaniken  
 In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence,

[www.ashrae.org/historical](http://www.ashrae.org/historical)

integrity and respect for others, and we shall avoid all real or perceived conflicts of interests.  
 (See full Code of Ethics: <https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics>.)

3.	<u>Review of Agenda</u> .....	Flaniken
4.	<u>Approval of Houston Minutes</u> (Attachment B) .....	Flaniken
5.	<u>Review of Motions from Previous Meeting</u> (Attachment C) .....	Flaniken
6.	<u>Review of Action Items</u> .....	Flaniken
	<b>Action Item:</b> check re truncation on forms for Hall of Fame, Pioneers of the Industry .....	Sigman
7.	<u>New Business</u> .....	Flaniken
	7.1 BOD Ex-Officio Comments .....	Dr. Alaa
	7.2 Review progress on 125 <sup>th</sup> Anniversary Projects (Attachment D).....	Nagengast
	7.3 ASHRAE Historical Marker Pilot Project (Attachment E) .....	Flaniken
	7.4 Chapter Historian access to bios of members of the Region.....	Flaniken
	Members Council referral to Historical Committee (Attachment F)	
	7.5 Discuss PAOE recommendations for Historical (Attachment G) .....	Flaniken
	7.6 Review History Committee MBO .....	Flaniken
	7.7 Review Vice-Chair Report on History Committee All Regions PAOE Results to date ....	Flaniken
	Final report due at Annual meeting	
	7.8 Discuss how to provide better information/encourage growth.....	Flaniken
	Process to get better information and to encourage growth for Region and Chapter Historians using, i.e., Gold Ribbon Awards, Participation to Minimum and Par Values of PAOE	
	7.9 Adjustment of HC sub- committee Assignments .....	Flaniken
	7.10 Develop a Chapter Historian Training PowerPoint .....	Flaniken
	Create an Introductory PowerPoint with Screen shots of the Relevant HC ASHRAE website pages	
	7.11 Discuss possible changes to HC PAOE Points for Next year.....	Flaniken, Committee
8.	<u>Adjourn</u> .....	Flaniken

## 6.4.3.2 ASHRAE BIM MTG



1791 Tullie Circle, NE · Atlanta, Georgia 30329-2305 · Phone: 404.636.8400 · Fax: 404.321.5478 · www.ashrae.org

**Agenda for – BIM MTG**  
 Winter Meeting, Atlanta, Georgia  
 Monday January 14, 2019  
 MTG Building Information Modeling (BIM)  
 Monday, 10:15 am – 12:00 pm, Omni Hotel at CNN Center, M3, North Tower, Walnut

1. Call to Order
2. Roll Call
3. Approval of Houston Summer (June 2018) Meeting Minutes
4. Chair's Remarks
5. Roster Update
6. SPC-224 (*Standard for the Application of Building Information Modeling*)– Dennis Knight
7. gbXML - Roth
8. Research–
  - a. RP-1801 -Gotshall (*Standardizing and Utilizing ASHRAE Online BIM Data Exchange Protocols*) – cosponsoring with TC 1.5 as primary (7.1 as cosponsor as well)
  - b. WS 1815 (*Integrating Occupant Behavior Data into Building Information Models for Performance Simulation*)
  - c. New ideas?
9. Program Proposals – Discussion
  - a. KC relevant tracks: Fundamentals, Optimization in HVACR, Commissioning new and existing buildings, Modeling throughout the building life cycle
  - b. Building Performance Analysis Conference (Sept 25-27 Denver)
  - c. Orlando Feb 2020 relevant tracks: Fundamentals, Cutting Edge Approaches, Standards guidelines and codes
10. US TAG to ISO/TC 59/SC 13/WG13
  - a. TC 59 is the “Buildings and Civil Engineering Works” technical committee and currently consists of 9 subcommittees including SC 13 which is entitled “Organization of information about construction works”
  - b. SC13/WG13 – Update – Knight
  - c. WG11: 16757 Part 2 (*Data structures for electronic product catalogues for building services – Part 2: Geometry*) Update – Hywel Davies
11. Data.ashrae.org - Barnaby/Hitchcock
  - o Content
  - o Parameters
12. Other Liaison Reports – All Voting Members
13. New Business
14. Adjournment

6.4.3.3 ASHRAE SSPC 62.1

**DRAFT AGENDA**  
**SSPC 62.1 – Ventilation for Acceptable Indoor Air Quality**  
**January 2019, Atlanta, GA**

SSPC 62.1 and its subcommittees are scheduled to meet in the Omni at CNN Center as follows:

**FRIDAY, January 11, 2019**

**All times are EST**

SSPC 62.1 IAQ Guideline Subcommittee

Friday (1/11) 8:00 am - 12:00 pm, Room: 328, 3<sup>rd</sup> Floor

SSPC 62.1 Administration Subcommittee

Friday (1/11/2019) 1:00-5:00pm, Room: Walnut, Floor: M3 North

SSPC 62.1 Research and Education Subcommittee

Friday (1/11/2019) 1:00-5:00pm, Room: Hickory, Floor: M3 North

SSPC 62.1 Buildings, Systems and Equipment

Friday (1/11/2019) 1:00-5:00pm, Room: Chestnut, Floor: M3 North

SSPC 62.1 Ventilation Subcommittee

Friday (1/11/2019) 1:00-5:00pm, Room: Hazelnut, Floor: M3 North

(Room assignments are subject to change. Please see the published program schedule when available.)

**SATURDAY, January 12, 2019**

**SSPC 62.1 Ventilation for Acceptable Indoor Air Quality**

Saturday (1/12/2019) 8:00am-12:00pm, Room: Oak, Floor: Lobby South

8:00 Call to Order Bohanon  
*"Commitment to the ASHRAE Code of Ethics – In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, integrity and respect for others, and we shall avoid all real or perceived conflicts of interests. (See full Code of Ethics: <https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics>.)"*

**Introductions**

**Review of Agenda** Bohanon

**Staff Report:** Weber

**Chair's Report:** Bohanon

**Committee Organizational Structure:**

**Voting Roster (22 PCVMs):** Bohanon, Thomann, Isenbeck, Brown, Brueckner, Burley, Darwich, Dennison, Hafendorfer, Ho, Homer, Nelson, Pettway, Ray, Redmond, Smith, Stewart, Zaatari, Hussien, Gress, Howard, Kane

**Intervening Letter Ballots:**

The following is a list of the letter ballots that followed the Houston meeting in June 2018.

- 62.1i (DA-67) – Letter ballot to approve the 2<sup>nd</sup> PPR closed 7/31/2018. APPROVED.
- 62.1L (DA-71) – Letter ballot to approve the 2<sup>nd</sup> PPR closed 7/24/2018. APPROVED.
- 62.1t (DA-80) – Letter ballot to approve the 2<sup>nd</sup> PPR closed 7/25/2018. APPROVED.
- Approve sponsoring the RTAR submitted by Lisa Ng regarding the feasibility of predicting indoor formaldehyde, VOC, and CO<sub>2</sub> concentrations using simplified inputs to air quality models in new office buildings. Letter ballot closed 8/7/2018. APPROVED.
- Approve cosponsoring the RTAR submitted by SSPC 170 investigating the applicability of Standard 62.1's Ventilation Rate Procedure for Healthcare Rooms. Letter Ballot closed 7/30/2018. APPROVED.
- Approve cosponsoring the RTAR submitted by TC 2.3 regarding the evaluation of Indoor Air Contaminants with respect to Development of a Revised Indoor Air Quality Procedure (IAQP) Design Compound and Design Target Lists for Standard 62.1. Letter ballot closed 7/30/2018. APPROVED.
- Approve cosponsoring Work Statement WS-1838. Letter ballot closed 8/7/2018. APPROVED.

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- 62.1 (DA-90) – Letter ballot to approve PPR closed 9/13/2018. APPROVED.
- 62.1y (DA-88) – Letter ballot to approve the 2<sup>nd</sup> PRP closed 9/17/2018. APPROVED.
- 62.1 (DA-93) – Letter ballot to approve PPR closed 9/6/2018. APPROVED.
- 62.1n (DA-74) – Letter ballot to approve the responses to the comments on the 1<sup>st</sup> public review closed 9/6/2018. APPROVED.
- 62.1m (DA-73) – Letter ballot to approve the publication with unresolved objectors (negative PC votes and unresolved comment) closed 10/1/2018. APPROVED.
- 62.1x (DA-86) – Letter ballot to approve the 2<sup>nd</sup> PPR closed 10/4/2018. APPROVED.
- 62.1aa (DA-68) – Letter ballot to approve responses to comments on the 1<sup>st</sup> PPR closed 10/4/2018. APPROVED.
- 62.1aa (DA-86) – Letter ballot to approve the 2<sup>nd</sup> ISC PPR closed 10/4/2018. APPROVED.
- 62.1ab (DA-82) – Letter ballot to approve the responses to comments on the 1<sup>st</sup> PPR closed 9/27/2018. APPROVED.
- 62.1ab (DA-82) – Letter ballot to approve the 2<sup>nd</sup> ISC PPR closed 9/27/2018. APPROVED.
- 62.1ac (DA-91) – Letter ballot to approve the 2<sup>nd</sup> FULL PPR closed 10/4/2018. APPROVED.
- SSPC 62.1 Poll – 15 questions regarding 62.1 and acceptable IAQ closed 10/30/2018. Results presented during November 8, 2018 webinar. See webinar meeting minutes for Poll results.
- 62.1-2016 Buzz Wright (Auto Repair Room Exhaust). Approve the revised response to the request for official interpretation from Buzz Wright. Letter ballot closed 11/21/2018. APPROVED.
- 62.1s (DA-79) – Letter ballot to approve the 2<sup>nd</sup> PPR closed 11/30/2018. APPROVED.
- 62.1 (DA-96) – Letter ballot to approve the 1<sup>st</sup> PPR closed 1/4/2019. APPROVED.

**Addenda Status (62.1-2016):**

- 62.1a (DA61 – Drain Pans) – 1<sup>st</sup> PPR Closed October 2, 2016: 3 comments from 1 commenter. [Discontinued](#). (Assigned to Buildings, Systems and Equipment Subcommittee)
- 62.1b (DA42 – Simplified VRP Alternate Method) – [Approved for publication. Published on the ASHRAE website.](#)
- 62.1c (DA62 – Delete Informative Appendix C) – [Approved for publication. Published on the ASHRAE website.](#)
- 62.1d (DA63 – Delete Informative Appendix D) – [Approved for publication. Published on the ASHRAE website.](#)
- 62.1e (DA64 – Revise Informative Appendix F and delete Informative Appendix I) – [Approved for publication. Published on the ASHRAE website.](#)
- 62.1f (DA65 – System Ventilation Efficiency Equations to replace Table 6.2.5.2) – [Approved for publication. Published on the ASHRAE website.](#)
- 62.1g (CM 62.1-17-12-0002/002 Occupiable Space) – [Approved for publication. Published on the ASHRAE website.](#)
- 62.1h (DA66 - Appendix G Revision) - [Approved for publication. Published on the ASHRAE website.](#)

- 62.1i (DA67 - Scope Modification) – 2<sup>nd</sup> PPR closed November 11, 2018: 9 comments from 1 commenter. Committee needs to review comments. (Assigned to Administration Subcommittee)
- 62.1j (DA69 - Section 4 Update) - Approved for publication. Published on the ASHRAE website.
- 62.1k (DA70 - Section 6.2.1.3 Ozone) - Approved for publication. Published on the ASHRAE website.
- 62.1L (DA71 - NVP Rewrite) – 2<sup>nd</sup> PPR closed November 5, 2018: 6 comments from 1 commenter. Committee needs to review comments. (Assigned to Ventilation Subcommittee)
- 62.1m (DA73 - Section 6 and Appendix A Updates) - 1<sup>st</sup> PPR closed April 22, 2018: 8 comments from 6 commenters. Committee approved responses to comments in Houston on June 24, 2018 (Motion #5). Committee also approved editorial changes to the addendum in Houston on June 24, 2018 (Motion #4). Responses sent to commenter 7/25/2018 with a 8/8/2018 reply deadline. There is 1 unresolved comment. Letter ballot to approve publication of Addendum 62.1m with unresolved objectors closed 10/1/2018. Moving forward for publication approval by Standards Committee and the ASHRAE Board in Atlanta in January 2019. (Assigned to Buildings, Systems and Equipment Subcommittee)
- 62.1n (DA74 - Veterinary Spaces) - 1<sup>st</sup> PPR closed April 22, 2018: 3 comments from 1 commenters. Committee approved responses to comments by letter ballot on 9/6/2018. Responses sent to commenters on 9/7/2018 with a 9/23/2018 reply deadline. There are 2 unresolved comments from 1 commenter. Committee needs to review commenter replies and determine what action is needed. (Assigned to Ventilation Subcommittee)
- 62.1o (DA75 - Section 5.16.2.1 Improvements) - Approved for publication. Published on the ASHRAE website.
- 62.1p (DA76 - Review Exceptions 5.16.3.2.5 and 5.16.3.3.2) – Ballot closed January 15, 2018 (Ballot #3, Motion #2). There are 2 negative votes with reason. Responses to the negative votes required. Recirculation ballot needed. This addendum will need SPLS approval for public review. (Assigned to Buildings, Systems and Equipment Subcommittee)
- 62.1q (DA77 - Ventilation Air Distribution) - Approved for publication. Published on the ASHRAE website.
- 62.1r (DA78 - High Rise Residential Building Systems) - Approved for publication. Published on the ASHRAE website.
- 62.1s (DA79 - Alternate Compliance Paths for Labs) - 2<sup>nd</sup> PPR approved by SSPC 62.1 by letter ballot on November 30, 2018. Moving forward for public review approval by SPLS in Atlanta in January 2019. Expected to be posted for public review in early February 2019. (Assigned to Ventilation Subcommittee)
- 62.1t (DA80 - New Area Based Table for Simple Multi Zone Installations) – 2<sup>nd</sup> PPR closed November 5, 2018: No comments. Moving forward for publication approval by Standards Committee and the ASHRAE Board in Atlanta in January 2019. (Assigned to Ventilation Subcommittee)
- 62.1u (DA81 - Create Compliance Checklist) - Approved for publication. Published on the ASHRAE website.

- 62.1v (DA83 – Appendix B Update) - [Approved for publication. Published on the ASHRAE website.](#)
- 62.1w (DA84 – Laboratory Compliance) - [Approved for publication. Published on the ASHRAE website.](#)
- 62.1x (DA86 – Update Exhaust Section 6.5) – [2<sup>nd</sup> PPR closed December 16, 2018: 15 comments from 5 commenters. Committee needs to review comments. \(Assigned to Research and Education Subcommittee\)](#)
- 62.1y (DA88 – Inform Owners about Standard 188) - [2<sup>nd</sup> PPR closed December 16, 2018: 16 comments from 11 commenters. Committee needs to review comments. \(Assigned to Research and Education Subcommittee\)](#)
- 62.1z (DA89 – VRP Check Table) - [Approved for publication. Published on the ASHRAE website.](#)
- 62.1aa (DA68 - IAQP) – [1<sup>st</sup> PPR closed August 27, 2018: 133 comments from 62 commenters. Responses to commenters sent 10/4/2018. Reply deadline 10/18/2018. There are 41 unresolved comments from 12 commenters. 2<sup>nd</sup> ISC PPR closed December 16, 2018: 33 comments from 13 commenters. Committee needs to review comments. \(Assigned to Research and Education Subcommittee\)](#)
- 62.1ab (DA82 – Normative Appendix for CO2 Calculation) - [1<sup>st</sup> PPR closed August 27, 2018: 8 comments from 5 commenters. Responses to commenters sent 10/4/2018. Reply deadline 10/18/2018. There are 3 unresolved comments from 3 commenters. 2<sup>nd</sup> ISC PPR closed December 31, 2018: 6 comments from 3 commenters. Committee needs to review comments. \(Assigned to Research and Education Subcommittee\)](#)
- 62.1ac (DA91 – New Informative Appendix C for IAQP) - [2<sup>nd</sup> PPR closed December 31, 2018: 6 comments from 2 commenters. Committee needs to review comments. \(Assigned to Research and Education Subcommittee\)](#)
- 62.1ad (DA94 – Pressurization of Spaces Requiring Exhaust) - [1<sup>st</sup> PPR closed August 12, 2018: 3 comments from 2 commenters. Committee needs to review comments. \(Assigned to Ventilation Subcommittee\)](#)
- 62.1ae (DA90 – Humidity) – [1<sup>st</sup> PPR closed December 16, 2018: 15 comments from 8 commenters. Committee needs to review comments. \(Tom Rice, Lewis Harriman\)](#)
- 62.1af (DA93 – Ancillary Spaces) – [1<sup>st</sup> PPR closed December 16, 2018: 8 comments from 6 commenters. Committee needs to review comments. \(Abdel Darwich\)](#)
- [62.1ag \(DA96 - Calculate Exhaust/Intake Separation using 1635-RP\) – 1<sup>st</sup> PPR approved by letter ballot. Submittal package in process. Moving forward for public review approval by SPLS during their March 2019 conference call. Expected to be posted for public review in late March 2019. \(Brian Hafendorfer\)](#)

**Note:** All published addenda to Standard 62.1-2016 are available for free download from the ASHRAE website at <https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-62-1-2016>.

**Official Interpretation Requests:**

- 62.1-2016 Buzz Wright (Auto Repair Room Exhaust). Letter ballot to approve the revised response closed 11/21/2018. Response approved. Response sent to Mr. Wright 11/26/2018. (Assigned to Ventilation Subcommittee)

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Note: All published official interpretations are available for free download from the ASHRAE website at <https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-interpretations>

**Unofficial Interpretation Request:** Since the Chicago meeting in January 2018

- 62.1-2010 Lilian Nakayama (Exhaust for Natural Ventilation). Response sent 8/7/2018.
- 62.1-2010 Karl Recktenwald (Natural Ventilation). Response sent 9/24/2018.
- 62.1-2016 Mike Donovan (CO2 Exposure Limits). Response sent 11/7/2018.
- 62.1-2013 Duane Rothstein (Drain Pan Size). Response sent 11/29/2018.

**CM Proposals:**

- Travis English (CM 62.1-17-12-0001/001). Response approved by letter ballot 2/6/2018 (Ballot#1, Motion #1). Response needs to be sent to Travis English. (Assigned to Administration Subcommittee)
- Travis English (CM 62.1-17-12-0001/002). Response approved by letter ballot 2/6/2018 (Ballot#1, Motion #2). Response needs to be sent to Travis English. (Assigned to Administration Subcommittee)
- Steven Taylor (CM 62.1-17-12-0002/001). Response approved by letter ballot 1/15/2018 (Ballot#1, Motion #3). Response needs to be sent to Steve Taylor. (Assigned to Administration Subcommittee)
- Steven Taylor (CM 62.1-17-12-0002/002). Response approved by letter ballot 1/15/2018 (Ballot#1, Motion #4). Response needs to be sent to Steve Taylor. (Assigned to Administration Subcommittee)
- Peter Langowski (CM 62.1-18-12-0001/001). (Assigned to Administration Subcommittee.)
- Lew Harriman (CM 62.1-18-12-0002/001). (Assigned to Research and Education Subcommittee.)
- Jon McHugh (CM 62.1-18-12-0003/001). (Assigned to Ventilation Subcommittee.)
- Tom Rice (CM 62.1-18-12-0004/001). (Assigned to Buildings, Systems and Equipment Subcommittee.)
- Hwakong Cheng (CM 62.1-18-12-0005/001). (Assigned to Ventilation Subcommittee.)
- Steven Taylor (CM 62.1-18-12-0006/001). (Assigned to Administration Subcommittee.)
- Fabio Cavijo (0002-001, submitted online). (Assigned to Buildings, Systems, and Equipment Subcommittee.)
- Jon McHugh (no number assigned at this time). (Assigned to Ventilation Subcommittee.)

**Potential Addenda from Houston:**

- DA-72 (Air Movement in zones. E<sub>2</sub>)
- DA-87 (Air Distribution Update) – Brain Hafendorfer
- DA-92 (Update References)
- DA-93 (Ancillary spaces)

Note: New draft addenda may be reviewed in Subcommittee and brought forward to main committee

**Other Items:**

- [New online comment database now live. New site includes continuous maintenance and letter ballots. Letter ballot site is currently being tested.](#)

**8:30-9:30 Public Comment Period**

Anyone who wants to address the committee must sign up. Written comments will be accepted. Everyone who signs up will have 3-minutes to address the committee. If more than 20 people sign up, the chair will designate times for additional comments to be heard. Commenters are encouraged to bring new information and not repeat what previous commenters say. Anyone violating the ASHRAE code of ethics will be ruled out of order and forfeit their remaining time.

**9:30-9:45 Break**

**Subcommittee Reports**

**These reports will include any information items that impact full committee activities. Reports on Sunday should include only action items (items which need to be voted on by the committee including responses to commenters, revisions to addenda, responses to interpretation requests, responses to change proposals, and other official actions.). Anything to be voted on should be sent out to voting members by email on Saturday.**

9:45-10:00	IAQ Guideline Report and Plans	Isenbeck
10:00-10:30	Research and Education Subcommittee Report and Plans	Thomann

ASHRAE is changing its procedures slightly and it affects our approval of the User Manual Work Statement (WS). If you are intending to bid you cannot vote on the WS, or be involved in its preparation, or even see the final draft that the committee approves. Therefore, if you are intending to bid on the User Manual work you must let the Chair know so he can remove you from the ballot and make sure that you do not see the final version of the WS. Any committee member involved in the vote will not be allowed to bid on the UM.

10:30-11:00	Ventilation Subcommittee Report and Plans	Ho
11:00-11:30	Administration Subcommittee Report and Plans	Bruekner
11:30-11:45	Building, Systems, and Equipment Subcommittee Report and Plans	Hafendorfer
11:45-12:00	Closing Comments	Bohanon
12:00	Recess (until 1:00 p.m. Sunday)	

SSPC 62.1 Administration Subcommittee

Saturday (1/12/2019) 1:00-3:00pm, Room: Walnut, Floor: M3 North

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SSPC 62.1 Research and Education Subcommittee

Saturday (1/12/2019) 1:00-3:00pm, Room: Hickory, Floor: M3 North

SSPC 62.1 Buildings, Systems and Equipment Subcommittee

Saturday (1/12/2019) 1:00-3:00pm, Room: Chestnut, Floor: M3 North

SSPC 62.1 Ventilation Subcommittee

Saturday (1/12/2019) 1:00-3:00pm, Room: Hazelnut, Floor: M3 North

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Sunday, January 13, 2019  
1:00 pm – 7:00 pm Local Time

**SSPC 62.1 Ventilation for Acceptable Indoor Air Quality**  
Sunday (1/13/2019) 1:00-7:00pm, Room: Dogwood A, Floor: M1 North

- |      |   |  |
|------|---|--|
| 1:00 | Call to Order   | Bohanon  |
|      | “Commitment to the ASHRAE Code of Ethics – In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, integrity and respect for others, and we shall avoid all real or perceived conflicts of interests. (See full Code of Ethics: <a href="https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics">https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics</a> .)”  |  |
|      | <ul style="list-style-type: none"> <li>• Introductions</li> <li>• <b>Voting Roster (22 PCVMs):</b> Bohanon, Thomann, Isenbeck, Brown, Brueckner, Burley, Darwich, Dennison, Hafendorfer, Ho, Horner, Nelson, Pettway, Ray, Redmond, Smith, Stewart, Zaatari, Hussien, Gress, Howard, Kane</li> <li>• Bias/Conflict Notebook/Sign-in</li> <li>• Review of Agenda (Additions/Deletions)</li> </ul>  |  |
| 1:15 | Review of Saturday Actions  | Bohanon  |
| 1:20 | Liaison Reports   |  |
|      | <ul style="list-style-type: none"> <li>• SPLS</li> <li>• TC 2.1, <i>Physiology and Human Environment</i></li> <li>• TC2.3, <i>Gaseous Air Contaminants and Gas Contaminant Removal Equipment</i></li> <li>• TC2.4, <i>Particulate Air Contaminants and Particulate Contaminant Removal Equipment</i></li> <li>• TC 2.9, <i>Ultraviolet Air and Surface Treatment</i></li> <li>• TC5.5, <i>Air to Air Energy Recovery</i></li> <li>• TC7.6 <i>Federal Facilities WG</i></li> <li>• TC7.9, <i>Commissioning</i></li> <li>• TC9.10, <i>Laboratory Systems</i></li> <li>• SSPC 55, <i>Thermal Environmental Conditions for Human Occupancy</i></li> <li>• SSPC 62.2, <i>Ventilation and Acceptable Indoor Air Quality in Residential Buildings</i></li> <li>• SSPC 90.1, <i>Energy Standard for Buildings Except Low-Rise Residential Buildings</i></li> <li>• SSPC 154, <i>Ventilation for Commercial Cooking Operations</i></li> <li>• SSPC 170, <i>Ventilation of Health Care Facilities</i></li> <li>• SSPC 188, <i>Risk Management of Legionella in Building Water Systems</i></li> <li>• SSPC 189, <i>Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings</i></li> <li>• SPC 217, <i>Non-Emergency Ventilation in Enclosed Road, Rail and Mass Transit Facilities</i></li> <li>• MTG Air Change Rates</li> </ul> | <p>Peterman</p> <p>Olsen</p> <p>Muller</p> <p>Seyffer</p> <p>Hafendorfer</p> <p>Rice</p> <p>Zhivov</p> <p>Brueckner</p> <p>Ho</p> <p>Olsen</p> <p>Agopian, Gress,</p> <p>Howard</p> <p>Gress</p> <p>Darwich</p> <p>Stewart</p> <p>Gress</p> <p>Howard</p> <p>Agopian</p> |

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- MTG Impact of ASHRAE Standards and Technology on Energy Savings/Performance Muller
- MTG Indoor Swimming Pool Air Quality and Evaporation Gonzales
- MTG Health and Wellness Zaatari
- PC Chair's Meeting Bohanon/Isenbeck

- 1:50 Approval of Meeting Minutes:
- Approve the June 20-21, 2018 meeting minutes from Houston, TX.
  - Approve the August 7, 2018 webinar meeting minutes.
  - Approve the November 8, 2018 webinar meeting minutes.

**Reports on Sunday should include only action items (items which need to be voted on by the committee including responses to commenters, revisions to addenda, responses to interpretation requests, responses to change proposals, and other official actions.)**

- 2:00 Admin SC Report Brueckner
- 2:45 Break
- 3:00 Systems and Equipment Subcommittee Report Hafendorfer
- 3:40 Ventilation Subcommittee Report Ho
- 4:50 Break
- 5:10 Research and Education Subcommittee Report Thomann
- ASHRAE is changing its procedures slightly and it affects our approval of the User Manual Work Statement (WS). If you are intending to bid you cannot vote on the WS, or be involved in its preparation, or even see the final draft that the committee approves. Therefore, if you are intending to bid on the User Manual work you must let the Chair know so he can remove you from the ballot and make sure that you do not see the final version of the WS. Any committee member involved in the vote will not be allowed to bid on the UM.
- 6:55 Other Business Bohanon
- 7:00 Adjourn

## Tuesday January 15, 2019

SSPC 62.1 Natural Ventilation Working Group (if required)

Tuesday (1/15/2019) 8:00 am – 12:00 pm, Room: Hickory, Floor: M3 North

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## 6.4.3.4 ASHRAE SSPC 140

**AGENDA – SSPC 140**  
**Standard MOT for the Evaluation of Building Energy Analysis Computer Programs**  
**Monday Jan 14, 2019; Atlanta**

**Time: 2:15P – 6:15P**

**Location: Cypress (M2, North), Omni**

**Chair: Joel Neymark**

1. Introductions: Sign-in sheet, participant introductions, quorum (= 6 VMs).
2. Chair Announcements [5 min.]
  - See bottom of next page
3. Membership [5 min.]
4. Acceptance of Previous Minutes [5 min.]
5. Adjustments to Agenda? [5 min.]
6. 140-2017-A: Update Section 5.2 (IEA BESTEST thermal fabric, 1995) test spec/example results [Neymark 15 min.]
  - Round 5 (final) sim trial draft distributed Sep 2018; 8 results sets through Dec 2018
  - Meeting summary BESTEST Thermal Fabric Working Group, and Schedule
7. DOE Empirical Validation Activities [Judkoff 15 min]
  - Project update, brief discussion
8. 90.1 Referencing of 140-2017 [Glazer 20 min.]
  - Updated language and public review status
  - Summary of Sunday ECB/140 4p – 6p discussion: acceptance criteria, etc.
  - Discussion: role of SSPC 140, etc.
9. Prioritization of Possible Test Suites [Neymark/McDowell/Others, 2 hours; 3:15p start.]
  - One-pager slides and discussion, 5 minutes per slide [Judkoff, Kruis, McDowell, Muehleisen, Neymark, Witte, in order of hardcopy notes sheet, 1 hour]
  - Initial round voting [Kruis/Neymark, 30 min.]
  - Further discussion and second round voting, if needed [30 min.]
10. SSPC 140 Website (<http://sspc140.ashraepcs.org/index.html>) [Sturm, 5 min.]
  - Updates this cycle
11. Future Stakeholder Meeting [Muehleisen 20 min]
  - Topics: Roadmap/Prioritization, User's Manual, Other
  - Meeting format: As separate workshop in K.C. (e.g. Wed 2p – 6p), or webinar
12. Forthcoming Basecamp Site [Neymark/Kruis 5 min]

*[Following items if time permits]*

13. Incentive Programs *[Judkoff/Roth, 10 min]*

- New IRS Sec 179D rules (commercial building tax deductions under PATH Act) for projects placed in service on or after Jan 1, 2016 require testing against Standard 140-2014 and use of 90.1-2007 as the base case (instead of 90.1-2001) .
- RESNET Accreditation:
  - HERS Tools; Existing Homes Tax Credit Compliance
  - 45L Tax Credit Compliance is by DOE, references RESNET

8a. 90.1 Referencing of 140-2017 - Recap *[Glazer 10 min.]*

- Recap discussion for late-arriving members

14. New business

15. Adjourn

For Item 2. Chair Announcements

- 140-2017 CM revision is current; integrates airside HVAC cases with 140-2014 test suites.
- IRS rules re the deduction for energy efficient commercial buildings require software used for assessing tax credits be tested as follows for projects placed in service:
  - On/after Jan 1,2016: test to 140-2014 (except Secs. 5.2.4, 7, 8) **11 progs (26 vers.) qualified; up from 9/16 progs/vers last June**
  - On or before Dec 31, 2015: test to 140-2007, **13 programs qualified.**
 New submittals to [ron.judkoff@nrel.gov](mailto:ron.judkoff@nrel.gov).  
 Qualified programs listed at <http://energy.gov/eere/buildings/qualified-software-calculating-commercial-building-tax-deductions> (Last check 09Jan2019).
- RESNET or DOE list 3 (last check 09Jan2019) tools as either accredited for HERS ratings, “45L” tax credit compliance (DOE). Required tests are NREL’s HERS BESTEST (included in Std 140-2011,-2014), along with equipment modeling and other modeling tests developed by RESNET. “45L” submit to DOE ([45Lsoftware@ee.doe.gov](mailto:45Lsoftware@ee.doe.gov)) Other submittals to RESNET (<http://www.resnet.us/professional/programs/software>).
- ASHRAE 90.1 and 189.1 reference Standard 140;
  - 90.1-2016, published Fall 2016, references 140-2014 (except Sections 7, 8).
- 2018 IECC cites 140-2014; IGCC citation accords with IECC.
- ASHRAE 90.2-2018 is published, references Standard 140, Section 7

6.4.3.1 ASHRAE TC 1.5

## *Meeting Agenda*

ASHRAE 2019 Winter Meeting – Atlanta, GA

TC 1.5 Computer Applications Research Subcommittee

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**Sunday, January 13, 2019, 7:00-8:00pm, B208, GWCC, BLDG B**

Chair: Todd Gottshall [tgottshall@westernallied.com](mailto:tgottshall@westernallied.com) 925-381-3049

1. **Call to Order:**
2. **Welcome – Introductions:**
3. **Review of Agenda**
4. **New Business/Followup:**
  - A. **Work Statement Status**
    - i. **RP-1801 BIM-Data-Content-Development**
      1. Rob Hitchcock
      2. PMS Report (Meeting earlier on Sunday)
      3. PMS
        - a. Todd Gottshall, TC 1.5
        - b. Tim Dwyer, MTG-BIM
        - c. Krishnan Gowri, MTG-BIM
        - d. Michel Tardif, TC 7.1
        - e. Russell Taylor TC 7.1
    - ii. **RP-1810: gbXML Reference BIM Test Cases**
      1. Stephen Roth
      2. PES to review bids
    - iii. **WS-1811: Occupancy from Social Media Data Mining**
      1. Bing Dong
      2. Out for TC votes
  - B. **New RTAR Submission Deadlines**
    - i. MMAD
    - ii. March 15-ish, 2019
5. **NEW RTAR Ideas**
6. **RAC Report**
  - A. Shinsuke Kato ([kato@iis.u-tokyo.ac.jp](mailto:kato@iis.u-tokyo.ac.jp))
7. **Next Meeting Time**
  - A. June 23, 2019 – Kansas City, MO
8. **Adjourn**

## 6.4.3.2 ASHRAE TC 4.7



**TC4.7 Data-Driven Models Subcommittee Monday; January 14, 2019, 7:30 PM–9:00 PM**  
**Location: Atlanta, GA; B306 (3), GHWCC, Bldg B**

**Agenda:**

7:30 Call to order / Introductions / Changes to the agenda

7:40: Upcoming Due Dates (5 minutes)

- Annual Meeting 2019 (Kansas City, MO – June 22-26, 2019)
  - **February 8, 2019** – Revised Conference/Technical Papers for Review Due
  - **February 8, 2019** – Program (Seminar, Forum, Workshop, Debate and Panel) Proposals Due

7:45: Research: Work Statements / RTAR's (30 minutes)

- Current Work Statements
  - Update on WS 1763 – Development of an Improved Toolkit for Analyzing Building Energy Use from Time Series Data: Update to the Inverse Model Toolkit. (Balbach, Koran, Haberl)
- Current RTARs
- New Research Topics

Potential RTAR Topics		
RTAR Title	Champion(s)?	Status/Notes
Determining memory/forgetting factors for DDMs	A. Smith A. Reddy	
Understanding DDM calibration/forecasting residual -- Some useful information. Work for Joshua. Keon Kim in residential. Ching Wha University.	A. Smith A. Reddy B. Koran	
Establishing standard procedures for identifying outlier and bad data during the data cleaning	A Reddy C. Balbach L. Wang J. Balthazar	
Determining when a building's behavior have changed, Re-baselining	A. Fontanini Bass Balbach	
Data-driven clustering methods	C. Balbach K. Haddad A. Fontanini	

- Calibration Shootout/Kaggle Competition (Balbach)

- 8:15 Discussion of Program (15 minutes)
- Annual Meeting (Houston) Review
    - TC 4.7 Program Information
      - Seminar 14: Multiscale Building Energy Modeling, Part 10
        - Sunday, January 13<sup>th</sup> – 11:00 am – 12:30 pm, Room: GWCC Building A, A408
      - Seminar 57: Multiscale Building Energy Modeling, Part 9
        - Tuesday, January 15<sup>th</sup> – 11:00 am – 12:30 pm, Room: GWCC Building A, A408

<b>Annual Meeting 2018 (Houston)</b>	
Track 1:	Systems & Equipment in the Built Environment
Track 2:	Fundamentals and Applications
Track 3:	Optimization in HVAC&R
Track 4:	Commissioning New & Existing Buildings
Track 5:	Occupant Health & Safety
Track 6:	Modeling Throughout the Building Life Cycle
Track 7:	Professional Development
Track 8:	Research Summit
Track 9:	Radiant Heating & Cooling Mini-Track

<b>Potential Session Topics</b>				
<b>Meeting</b>	<b>Session Type</b>	<b>Session Title</b>	<b>Tentative Session Chair(s)</b>	<b>Speakers</b>
	Seminar	What do the differences between calibrated energy models and measured data tell you?	C. Balbach	
	Seminar	Are you normal?	L. Wang R. Muehleisen A. Fontanini	Ralph's Post-Doc
	Seminar	Identifying and removing outliers for DDMs	A. Reddy, C. Balbach, L. Wang, J. Balthazar	

- 8:30: Handbook: (15 minutes)  
 8:45: New Business (15 minutes)  
 9:00: Adjourn



**AGENDA**  
**ASHRAE TC 4.7 ENERGY CALCULATIONS – MAIN MEETING**  
**OMNI HOTEL,**  
**DOGWOOD A ROOM**  
**ATLANTA, GA**  
**TUESDAY, JUNE 26 2018, 6:00 PM – 8:30 PM**

"Commitment to the ASHRAE Code of Ethics: In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, integrity and respect for others, and we shall avoid all real or perceived conflicts of interest. (See full Code of Ethics: <https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics> )"

1. Roll call and introductions (5 minutes) Muehleisen
2. Accept agenda & approve minutes of previous meeting (10 minutes) Balbach
3. Announcements/Liaisons (5 minutes) Balbach
  - Program Submittals:
    - o Talk to the Track Chair before submitting
    - o Conform to one of the Tracks
    - o Physics vs new technology: interest of audience (declining programs). Show new technology used.
    - o Propose a Track to CEC, for Atlanta (Winter 2019) and Beyond.
  - 2019 ASHRAE Annual Conference in Kansas City:
    - o Conference Paper Abstracts, Technical Papers and Paper Session requests due August 21
  - 125th History in a couple of years (Historical Committee). TC's can organize or sponsor a program session for the 2019-2020 meetings.
  - Emergency Rosters can be submitted anytime during the year so that changes in subcommittees or other positions can be made official on the rosters (instead of waiting till after July 1).
  - Nominating ASHRAE Fellows: Haberl
4. Membership (5 minutes) Balbach
  - By the MOP, the maximum number of voting members on a committee is 18. However, the drawback of a high number of VM would be the quorum in meetings. (We currently have 13 Voting Members.)
  - Bass Abushakra will chair the Program Subcommittee for 1-year term (2018-2019).
  - Provisional Corresponding Members should go to: [Onebuilding.org](http://Onebuilding.org), to Subscribe to the TC4.7 Mailing List (TC47-L). Once subscribed, PCM, will stay up-to-date with the TC4.7 business.
5. Subcommittee reports
  - 5.1 Multiscale Building Energy Modeling (10 minutes) Judkoff
  - 5.2 Data-Driven Modeling (10 minutes) Muehleisen / Balbach
  - 5.3 Simulation and Component Models (10 minutes) Huang
  - 5.4 Research (15 minutes) Haberl
  - 5.5 Handbook (10 minutes) Pruett
  - 5.6 Program (15 minutes) Abushakra
  - 5.7 Historical (5 minutes) Haberl
    - Historical Committee - 125 Anniversary.
  - 5.8 Standards (15 minutes) Neymark
    - SSPC 140 SMOT for Evaluation of Building Energy Analysis Computer Programs Neymark
    - SPC 205 Standard Representation of Performance Simulation Data for HVAC and Other Facility Equipment Barnaby
    - SPC 209P Energy Simulation Aided Design Kolderup
  - 5.9 Web Site (5 minutes) (<https://tc0407.ashraetcs.org/>) New

6. Related activities reports (10 minutes)

- SPC 191 Standard for the Efficient Use of Water in Building and Mechanical Systems
- MTG O&MEE Operations and Maintenance Activities That Impact Energy Efficiency
- MTG OBB Occupant Behavior in Buildings
- MTG.BIM Building Information Modeling
- MTG ACR Air Change Rates (Contact Dennis Knight to join this MTG)
- TC 2.8 Building Environmental Impacts and Sustainability
- TC 4.1 Load Calculation Data and Procedures
- TC 4.2 Climatic Information
- TC 4.3 Infiltration & Ventilation Requirements
- TC 4.5 Fenestration
- TC 6.5 Radiant Heating and Cooling
- TC 7.5 Smart Building Systems
- TC 7.6 Building Energy Performance
- BuildingSMART (formerly IAI International Alliance for Interoperability)
- IBPSA: USA, Canada, World
- BPI-2400-S-2011 Standardization Qualification of Whole-house Energy Savings Est. Guideline 14
- IEA Annex 60 Modelica for Building Simulations
- IEA Annex 66 Occupant Patterns

7. Awards Nomination

Balbach

8. Old Business

Balbach

9. New business

Balbach

10. Adjourn

Balbach

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## 6.4.3.3 ASHRAE TC 7.5

**ASHRAE TC 7.5: Smart Building Systems Research Subcommittee Meeting**  
**Monday, January 14, 2019, 5:15 – 6:00 p.m, B301 (GWCC)**

**Agenda**

- |   |             |
|---|-------------|
| 1. Roll Call and Introduction   | 5:15 - 5:18 |
| 2. Announcements  | 5:18 – 5:20 |
| 3. Status of current Research Projects (Detailed current research plan is attached in next pages) | 5:20 – 5:40 |
| a. RP 1661  |             |
| b. RP 1756  |             |
| c. WS 1781  |             |
| d. WS 1783-submitted but changes to 1875  |             |
| e. WS 1809-ready for TC review and vote   |             |
| f. WS 1812  |             |
| g. New WS candidates  |             |
| h. RTARs/WS under development   |             |
| 4. TC 7.5 research new ideas and topics   | 5:40 – 5:55 |
| 5. New Business   | 5:55 – 6:00 |
| 6. Adjourn  | 6:00        |



## 6.4.3.4 ASHRAE TC 7.6



Shaping Tomorrow's  
Built Environment Today

### TC 7.6 Building Energy Performance

<https://tc0706.ashraetcs.org/>

Atlanta, GA

Tuesday, January 15, 2019, 1:00-3:30 pm

*TC 7.6 is concerned with the estimation, measurement, analysis, benchmarking, and management of whole building and building systems energy and water performance. This includes performance and resource management of new and existing buildings.*

1. Roll call and Introductions Landsberg
  - Welcome new members and visitors
  
2. ASHRAE Code of Ethics Commitment Landsberg

In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, integrity and respect for others, and we shall avoid all real or perceived conflicts of interests. (See full Code of Ethics: <https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics/>)
  
3. Accept agenda/approve minutes of Las Vegas meeting Landsberg
  - TC 76L listserv (170 names; Includes most TC 7.6 members + dozens more; is self-managed and not official). Mail to [tc76-l@lists.onebuilding.org](mailto:tc76-l@lists.onebuilding.org) – or go to [www.onebuilding.org](http://www.onebuilding.org) to sign up.
  - Roster access by TC members (log into My Membership on ASHRAE website)
  
4. Announcements and Chair Remarks
  - Chair Remarks Landsberg
    - ✓ Note that TC scope includes water, and new and existing buildings
    - ✓ Chair would like to emphasize focus in his term on:
      - Updates to Standard 105 and Guideline 14
      - Development of Best Practices Standard 211 and Users Manual Standard 100
      - EUIs: Current simple methods are not adequate to characterize energy use – keep focus on programs, research
  - Announcements and Atlanta Section 7 Updates Landsberg
  
5. Membership Kelsey
  - Currently 15 VMs.
  - J. Patrick Carpenter and Michael Deru rolling off 6/30/19
  - VC is Kelsey, Secretary is Smith
  
6. Standing Committee Liaison Reports (TAC/RAC/StdCom/Program/SpecPub/ALI/BuildingEQ)
  - BuildingEQ Boyd/Hunn
  - SSPC 90.1 Liaison (Drake Erbe is 90.1 Chair) Peterson/Chude
  - SSPC 90.2 Liaison (Theresa Weston is 90.2 Chair)
  - SSPC 100 Liaison (Wayne Stoppelmoor is 100 Chair) Landsberg
  
7. Multi-Disciplinary Task Group Reports
  - MTG-IASST (Impact of ASHRAE Standards and Technology on Energy Savings/Performance) Hinge

- MTG-ASEC (Avoided Source Energy Consumption Due to Waste Heat Recovery and Heat Pump Technologies) Xiufeng Pang/Eldridge

## 8. Subcommittee Reports

### A. Standing (Functional) Subcommittees

7.1 Research	Yang
7.2 Handbook	Boyd
7.3 Standards	Novosel
• Std 100 – Continuous Maintenance	
• Std. 105-2014 Revision (Continuous Maintenance?)	Carpenter
• Parallel Std. with TC 6.6 on water use accounting	
• Gdl. 14-2014 Revision	Landsberg
• Proposed standard on net-zero energy buildings (w/TC 2.8)	Deru/Stafford
7.4 Program	Smith
7.5 Web Site	Kim

### B. Topical Subcommittees

7.6 Monitoring & Energy Performance	Webb
7.7 Energy Management	Constantinide/Pearson
7.8 Commercial Building Audits	Boyd
• New Chair	
7.9 Federal Buildings	Zhivov

## 9. Other Topics

- AEDGs Reinders
- Energy Position Document (TC 7.6 is Cognizant) Hunn
- TC 7.3 (Operation and Maintenance Management) Interaction Constantinide

## 10. Old Business

- Status of Technical FAQs for review and revision Landsberg
- TC 7.6 name change to "Whole Building Performance"?
- Including IAQ Performance in TC work scope Kim

## 10. New business

- Webinar for daylighting controls commissioning Landsberg

## 11. Adjourn

### Subcommittee Meetings:

Federal Buildings	Sat. 9:00-3:00 and Sun. 9:00-noon
1702-RP PMS	Sun. 11:30-1:00
Research	Sun. 1:00-2:00
Energy Audits	Sun. 2:00-3:00
Handbook	Sun. 3:00-4:00
Monitoring and Energy Performance	Mon. 2:15-4:15
Energy Management	Mon. 4:15-5:15
Standards/Program	Mon. 5:15-6:15
Executive	Mon. 6:15-7:00

TC 7.6 Agenda

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6.4.4 ASHRAE Summer Conference Standards Committee Activities in Kansas City, Missouri, June 22-26, 2019

The following sections are the minutes and transactions of Standards Committee activities at the ASHRAE Summer Conference in Kansas City, Missouri, June 22-26, 2019.

6.4.4.1 ASHRAE HC



**HISTORICAL COMMITTEE**

Sunday, June 23, 2019

8:30 a.m. – 12:00 p.m.

2019 Annual Conference, Kansas City  
Marriott-West, 3rd Floor, Big Joe Turner B

**COMMITTEE MEMBERS**

**Voting Members:**

Bruce L Flaniken, Chair  
Stanley M Westhoff, Vice Chair  
Pamela Immekus  
Lindsey King  
Dr Ahmed Alaa Eldin Mohamed, PhD  
Bernard A Nagengast  
Eric Sturm  
Branislav B Todorovic, PhD

**BOD Ex-Officio:**

Dr Ahmed Alaa Eldin Mohamed, PhD

**Coordinating Officers:**

Dr Julia A Keen, PE (2018-19)  
Farooq Mehboob (2019-20)

**Region Historians:**

Stanley M Westhoff, Region I  
Robert Thomas Pollard, Region II  
Gary C Debes, Region III  
Maurice Richard Harrison, Region IV  
Lane D Snowberger, Region V  
Sherman M Sweeney, Region VI  
Benjamin (Drew) Godfrey, Region VII  
Charles D Stoabs, Region VIII  
Gary L Cooper, Region IX  
Dean Borges, Region X  
Douglas B LeCren, Region XI  
John S Davant, Region XII  
Siew M Leong, Region XIII  
Andreas Triantafyllopoulos, Region XIV  
Prof Atilla Biyikoglu, PhD, RAL

**A G E N D A**

1. Call to Order..... Flaniken, Chair
2. Introduction of Members and Visitors .....Flaniken  
2.1 2019–2020 Historical Committee Roster ([Attachment A](#))
3. ASHRAE Code of Ethics Commitment.....Flaniken  
In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence,

[www.ashrae.org/historical](http://www.ashrae.org/historical)

integrity and respect for others, and we shall avoid all real or perceived conflicts of interests.  
 (See full Code of Ethics: <https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics>.)

3.	<u>Review of Agenda</u> .....	Flaniken
4.	<u>Approval of Atlanta Minutes</u> (sent separately) .....	Flaniken
5.	<u>New Business</u> .....	Flaniken
	5.1 BOD Ex-Officio Comments .....	Dr. Alaa
	5.2 Discussion and vote on revised ROB and MOP..... (Attachment B) (Attachment C)	Flaniken
	5.3 Draft guideline to facilitate communication between Region Historians and RMCRs... Region and Chapter Historians Guide can be starting point (sent separately)	Flaniken
	5.3 ASHRAE Historical Marker Pilot Project and Form (Attachment D) .....	Flaniken
	5.4 Review progress on 125 <sup>th</sup> Anniversary Projects (sent separately) .....	Nagengast
	5.5 Discuss PAOE recommendations for Historical .....	Flaniken
	5.6 Review History Committee MBOs.....	Flaniken
	5.7 Introduce 2018-19 HC Chair, Stan Westhoff.....	Flaniken
	5.8 2019-20 Subcommittee Assignments .....	Westhoff
	5.9 2019-20 MBOs .....	Westhoff
6.	<u>Adjourn</u> .....	Flaniken

6.4.4.2 ASHRAE BIM MTG



1791 Tullie Circle, NE · Atlanta, Georgia 30329-2305 · Phone: 404.636.8400 · Fax: 404.321.5478 · www.ashrae.org

**Agenda for – BIM MTG**  
Annual Conference, Kansas City MO  
Monday June 24, 2019  
MTG Building Information Modeling (BIM)  
Monday, 10:15 am – 12:00 pm, KCCC, 2213

1. Call to Order
2. Roll Call
3. Approval of Atlanta Winter (January 2019) Meeting Minutes
4. Chair's Remarks
5. Roster Update
  - a. Chair-Vice Chair swap
  - b. Secretary
6. SPC-224 (*Standard for the Application of Building Information Modeling*)– Dennis Knight
7. gbXML - Roth
8. Research–
  - a. RP-1801 -Gotshall (*Standardizing and Utilizing ASHRAE Online BIM Data Exchange Protocols*) – cosponsoring with TC 1.5 as primary (7.1 as cosponsor as well)
  - b. RP-1810- Roth (*Development of Reference Building Information Model (BIM) Test Cases for Improving Usage of Software Interoperability Schemas*)
  - c. WS 1815 (*Integrating Occupant Behavior Data into Building Information Models for Performance Simulation*)
  - d. New ideas?
9. Program Proposals – Discussion
  - a. Orlando Feb 2020 relevant tracks: Fundamentals, Cutting Edge Approaches, Standards guidelines and codes
  - b. Future?
10. US TAG to ISO/TC 59/SC 13/WG13
  - a. TC 59
  - b. SC13/WG13 – Update – Knight
  - c. WG11: 16757 Part 2 (*Data structures for electronic product catalogues for building services –Part 2: Geometry*) Update – Hywel Davies
11. Data.ashrae.org - Barnaby/Hitchcock
  - o Content
  - o Parameters
12. Other Liaison Reports – All Voting Members
13. New Business
14. Adjournment

6.4.4.3 ASHRAE SSPC 90.1



**ASHRAE SSPC 90.1 MEETING AGENDA**  
 Summer Annual, Kansas City, MO  
 Marriott  
 June 22-24, 2019  
 Draft agenda June 10, 2019

**Full Committee meetings are at the Marriott-East, Trianon Level, Trianon AB – Kansas City, MO**

**Notes:**

- Full Committee meetings will start promptly at times noted.
- This meeting is open to observation by interested parties.
- Subcommittee meeting rooms are at end of agenda
- All sessions are open to the public.
- The agenda order shown may not be followed
- Material for Project Committee members is posted on the Committee Only FTP site

**Full Committee Saturday, June 22, 2019 .....8:00 AM-12:00 PM CDT**

**1) Introductions**

- a) Sign-in and Quorum Determination (Barbaree)
- b) Introductions of members and guests (Erbe)
- c) Antitrust Policy Reminder

American National Standards shall be developed in accordance with applicable antitrust and competition laws and meetings amongst competitors to develop American National Standards are to be conducted in accordance with these laws.

- d) ASHRAE Code of Ethics

**ASHRAE Code Of Ethics**

(Approved by ASHRAE Board of Directors January 30, 2013)

1.140.001.1 As members of ASHRAE or participants in ASHRAE committees, we pledge to act with honesty, fairness, courtesy, competence, integrity and respect for others in our conduct.

- A. Efforts of the Society, its members, and its bodies shall be directed at all times to enhancing the public health, safety and welfare.
- B. Members and organized bodies of the Society shall be good stewards of the world’s resources including energy, natural, human and financial resources.
- C. Our products and services shall be offered only in areas where our competence and expertise can satisfy the public need.
- D. We shall act with care and competence in all activities, using and developing up-to-date knowledge and skills.
- E. We shall avoid real or perceived conflicts of interest whenever possible, and disclose them to affected parties when they do exist.



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- F. The confidentiality of business affairs, proprietary information, intellectual property, procedures, and restricted Society discussions and materials shall be respected.
- G. Each member is expected and encouraged to be committed to the code of ethics of his or her own professional or trade association in their nation and area of work.
- H. Activities crossing national and cultural boundaries shall respect the ethical codes of the seat of the principal activity.
- 2) **Review Agenda-Insure intended actions/topics are on the correct day.**
  - 3) **Announcements (Erbe)**
    - a) Bias and Conflict Forms - Update with any changes - Send to ASHRAE HQ
    - b) Availability of Errata for Standard and Users Manual on public website <https://www.ashrae.org/standards-research-technology/standards-errata> (Barbaree)
      - 2010, 2013, 2016 – March 18, 2019
  - 4) **Results of Standards Committee Actions (Barbaree)**
    - a) Update on Public Review Addenda – Addenda from the April Interim Meeting closed on June 9, 2019 for 30 day reviews
    - b) Update on Publication Addenda – The following are currently pending approval by Standards Committee, Tech Council, and the BOD at the Kansas Meeting:
      - T, V, Y, AL, AN, AO, AT, AW, AY, AZ, BA, BB, BD, BF, BH, BI, BJ, BK, BL, BQ, BT, BX, BZ, CA, CC, CE, CG, CH, CI, CJ, CN, CO
  - 5) **Addenda Planning**  
 Scenario for last possible two public reviews for inclusion in 90.1-2019

June 2018 SSPC 90.1 Interim Meeting

- Approve 1<sup>st</sup> PPR
- SPLS (Special Call) week of July 23, 2018-Only if everything is done correctly
- Public review to begin as early as August 3, 2018
- August 3, 2018 to September 17, 2018 – 1<sup>st</sup> PPR Occurs

October 11-13, 2018 SSPC 90.1 Interim Meeting

- Approve 2<sup>nd</sup> PPR
- SPLS (Special Call) week of October 29, 2018 to approve addenda from fall meeting, schedule is tight, but doable – comments close before January 2019 Meeting
- November 23, 2018 to January 7, 2019 – 2<sup>nd</sup> PPR occurs



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January 11-14, 2019 SSPC 90.1 Winter Meeting

- Approve 3<sup>rd</sup> Public review
- SPLS (Special Call) First Week of February to approve addenda from winter meeting – comments close before April Interim Meeting
- Early February 2019 to April 2019 – 3<sup>rd</sup> PPR ISC occurs

April 2019 Interim 90.1 meeting – April 11-13, 2019

- Approve responses to comments on 3<sup>rd</sup> PPR
- Allow 30 days for commenters to indicate resolution status

June 2019 – SSPC 90.1 approval for publication with knowledge of unresolved objections.

NOTE: Given this timeline, if someone were to appeal after June 2019, the addendum may not be incorporated into 90.1-2019. If required: Web meetings for approval of energy saving addenda are necessary, the chair will schedule those based on the ExCom recommendations.

Goal: Publish October 2019

**6) Liaison Reports**

Liaison	Report
ASHRAE – Barbaree	
SPLS (Crawley)	
IES (Lien)	
<b>IES Modeling Effort (Salzberg/Myer)</b>	
CIS (VanGeem)	
INTERNATIONAL (Hogeling)	
TC 3.6 Water Treatment (Lindahl)	
TC 4.4 Building Materials and Building Envelope Performance (Humble)	
TC 4.5 Fenestration (Hogan)	
TC 5.2 Duct Design (Smith)	
TC 5.5 Air-to-air Energy Recovery (Fecteau)	
TC 6.1 Hydronic and Steam Equipment Systems (Myers)	
TC 6.5 Radiant Heat & Cool (Watson)	
TC 6.6 Service Water Heating Systems (Stanonik)	
TC 7.6 Energy Utilization (Chude)	
TC 8.6 Cooling Towers (Lindahl)	
TC 9.9 Mission Critical Facilities (Pavlak)	
TC 9.10 Laboratory Systems (Atkisson)	
SSPC 62.1 (Howard)	
SSPC 62.2	
SSPC 90.4	





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AEDG (Culp)	
IAS MTG (Hermans)	
Residential Building Committee (Mathis)	

- 7) **Approval of Minutes –**
- a) **Atlanta, GA – Spring Interim Meeting**
- 8) **Subcommittee and Working Group Reports and Actions – (unresolved objections = negative voters with reason or unresolved commenter)**
- a) **Format & Compliance**
- **Informative Reference Standards Update**
- b) **Envelope**
- **Harkins Official Interpretation**
  - **Addendum av – SSPC to respond to comments**
  - **Addendum cr – SSPC to respond to comments**
- c) **Lighting**
- **Addendum cw – SSPC to vote for publication with knowledge of unresolved objector**
  - **Addendum cv – SSPC to respond to comments**
  - **Lingren & Halverson ICs**
- d) **ECB**
- **Addendum bu – SSPC to vote for publication with knowledge of unresolved objectors**
  - **Addendum cl – SSPC to vote for publication with knowledge of unresolved objectors**
  - **Addendum ck – SSPC to respond to comments**
  - **Addendum cp – SSPC to respond to comments**
- e) **Mechanical**
- **Addendum bc – SSPC to vote for publication with knowledge of unresolved objectors**
  - **Addendum bs – SSPC to vote for publication with knowledge of unresolved objectors**
  - **Addendum bv – SSPC to vote for publication with knowledge of unresolved objectors**
  - **Addendum be – SSPC to respond to comment**
  - **Addendum bo – SSPC to respond to comment**
  - **Addendum bp – SSPC to respond to comments**
  - **Addendum br – SSPC to respond to comments**
  - **Addendum cd – SSPC to respond to comments**
  - **Addendum cq – SSPC to respond to comments**



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- 9) **TPS Working Group (Skalko)**
  - **Addendum cb – SSPC to respond to comments**
- 10) **Renewables Working Group (Culp)**
  - **Addendum by – SSPC to respond to comments**

**Meeting Reminder – Fall Interim Meeting (October 10-12, 2019 Atlanta, GA)**

**End of Full Committee Meeting.....12 p.m.**

**Full Committee Sunday, June 23, 2019 ..... 9 a.m. – 12 p.m. CDT**

- 1) **Introductions**
  - a) Sign-in and Quorum Determination (ASHRAE Staff)
  - b) Introductions of members and guests (Erbe)
- 2) **Announcements (Erbe)**
  - a) Bias and Conflict Forms
- 3) **DOE/ PNNL Update (Williams/Rosenberg)**
  - a) **Integrated Grid Efficiency Buildings and Energy Code – Presentation (Franconi 20 Minutes)**
- 4) **Subcommittee and Working Group (Continuation) – SC to provide updates on Work Plans**
  - a) Mechanical
    -
  - b) Format & Compliance
    -
  - c) Envelope
    -
  - d) ECB
    -
  - e) Lighting
- 5) **AES WG (Lord)**
  - a) **Status of the 2022 work plan-SC responsibilities and time line**
  - b) **Scalar WG Update**
- 6) **User’s Manual Update(Culp)**
  - a) **Starts July 1**



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- b) **User’s Manual Task Group - Update**
  - 7) **Continuous Maintenance Proposals Status – Reconcile with outstanding items from ASHRAE Staff– Conrad**
    - a) **Johnston (2) & Patel**
  - 8) **Interpretations – Status- Reconcile with outstanding items from ASHRAE Staff – Conrad**
  - 9) **Public time to address SSPC (30 minutes).**

Persons wishing to address the Project Committee should contact the Chair (Drake Erbe – [drakeerbe@airxchange.com](mailto:drakeerbe@airxchange.com) ) by NOON June 12, 2019.
- End of Full Committee Meeting..... 12 p.m.



**ASHRAE SSPC 90.1 MEETING AGENDA**  
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- 1) **Full Committee Monday, June 24, 2019 .....8:00 AM-12:00 PM CDT**
- 2) **Introductions**
  - a) Sign-in and Quorum Determination (Barbaree)
  - b) Introduction of members and guests (Erbe)
- 3) **Announcements (Erbe)**
  - a) Bias and Conflict Forms
- 4) **Membership (Erbe)**
- 5) **Future Meetings**
  - a) Fall Interim Meeting – AES October 9; October 10-12, 2019 in Atlanta @ ASHRAE HQ
  - b) Annual Winter Conference – January 31- February 3 in Orlando
- 6) **Subcommittee and Working Group Votes that didn't happen Saturday or Sunday**
  - a) Envelope
    -
  - b) Lighting
    -
  - c) ECB
    -
  - d) Format & Compliance
    -
  - e) Mechanical
    - 
    - Renewables WG Report (Culp)
    - Commissioning WG Report (Lord)
- 8) **Brief overview of subcommittee plans**
- 9) **Other Business**
- 10) **Adjournment ..... 12 PM**



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**Kansas City Meeting Schedule**

All meetings are in the Marriott-East on the Trianon Level

**SSPC 90.1 Energy Eff. Design of New Bldg.**

**Saturday 8:00 AM-12:00 PM** Marriott-East, Trianon Level, Trianon AB

**Sunday 9:00 AM-12:00 PM** Marriott-East, Trianon Level, Trianon AB

**Monday 8:00 AM-12:00 PM** Marriott-East, Trianon Level, Trianon AB

**SSPC 90.1 Envelope Subcommittee**

**Friday 9:00 AM-8:00PM** Marriott-East, Trianon Level, Trianon D

**Saturday 1:00 PM-8:00 PM** Marriott-East, Trianon Level, Trianon D

**Sunday 1:00 PM-8:00 PM** Marriott-East, Trianon Level, Trianon D

**SSPC 90.1 Envelope Subcommittee Working Group**

**Friday 5:00 PM-7:00 PM** Marriott-East, Trianon Level, Trianon A

**Saturday 4:00 PM-6:00 PM** Marriott-East, Trianon Level, Trianon E

**SSPC 90.1 Lighting Subcommittee**

**Friday 9:00 AM-10:00 PM** Marriott-East, Trianon Level, Trianon C

**Saturday 1:00 PM-7:00 PM** Marriott-East, Trianon Level, Trianon C

**Sunday 1:00 PM-8:00 PM** Marriott-East, Trianon Level, Trianon C



**ASHRAE SSPC 90.1 MEETING AGENDA**  
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**SSPC 90.1 Mechanical Subcommittee**

**Friday 9:00 AM-8:00 PM Marriott-East, Trianon Level, Trianon B**

**Saturday 1:00 PM-7:00 PM Marriott-East, Trianon Level, Trianon AB**

**Sunday 1:00 PM-8:00 PM Marriott-East, Trianon Level, Trianon AB**

**SSPC 90.1 ECB Subcommittee**

**Friday 4:00 PM-9:00 PM Marriott-East, Trianon Level, Lido**

**Saturday 1:00 PM-5:00 PM Marriott-East, Trianon Level, Lido**

**Sunday 1:00 PM-4:00 PM Marriott-East, Trianon Level, Lido**

**SSPC 90.1 Format & Compliance Subcommittee**

**Friday 5:00 PM-10:00 PM Marriott-East, Trianon Level, Burgundy**

**Saturday 1:00 PM-5:00 PM Marriott-East, Trianon Level, Burgundy**

**Sunday 4:00 PM-7:00 PM Marriott-East, Trianon Level, Trianon E**

**SSPC 90.1 Renewable Energy Working Group**

**Sunday 3:00 PM-5:00 PM Marriott-East, Trianon Level, Burgundy**

## 6.4.4.4 ASHRAE SSPC 140

**AGENDA – SSPC 140**  
**Standard MOT for the Evaluation of Building Energy Analysis Computer Programs**  
**Monday Jun 24, 2019; Kansas City**

**Time: 2:15P – 6:15P**

**Location: Marriott-West, 2nd Floor, Basie C1**

**Chair: Joel Neymark**

1. Introductions: Sign-in sheet, participant introductions, quorum (= 6 VMs).
2. Chair Announcements [5 min.]
  - See bottom of next page
3. Membership [5 min.]
4. Acceptance of Previous Minutes [5 min.]
5. Adjustments to Agenda? [5 min.]
6. Basecamp Site [Kruis 5 min]
7. 140-2017-A: Update Section 5.2 (IEA BESTEST thermal fabric, 1995) test spec/example results [Neymark 15 min].
  - Round 6 (final): 7 results sets thru May 2019 for final sim trial draft of Sep 2018
  - Meeting summary BESTEST Thermal Fabric Working Group, and Schedule
  - Items for Std 140 addendum, P/PR ballot planned next Feb
8. DOE Empirical Validation Activities [Judkoff 15 min]
  - Project update, brief discussion
9. 90.1 ECB/140 Acceptance Criteria WG Summary [Glazer 20 min.]
  - Summary of Sunday ECB/140 4p – 6p discussion: acceptance criteria, etc.
  - Discussion: role of SSPC 140, etc.
10. Test Suite Prioritization Roadmap [JN/TPM/MJW/Others, up to 2 hours; 3:30p start]
  - **Objective:** Approval of current “living” roadmap document
  - Update and Pre-Meeting Voting Results [Neymark/Kruis, 15 minutes]
  - Discussion
  - Possible additional brief presentations, if needed [Judkoff, Kruis, McDowell, Muehleisen, Neymark, Witte]
  - Supplementary prioritization voting if needed [Kruis/Neymark, 30 min.]
  - Approval of roadmap document [Neymark/Witte, 10 min]
11. SSPC 140 Website (<http://sspc140.ashraepcs.org/index.html>) [Sturm/McDowell, 5 min.]
  - Updates this cycle
  - Thanks to Eric
12. Future Stakeholder Meeting [Muehleisen 15 min]
  - Topics
  - Meeting format

*[Items we can come back to if time]*

7a. 140-2017-A: Update Section 5.2 *[if time, Neymark]*.

- Items for Std 140 addendum, P/PR ballot planned next Feb

9a. 90.1 ECB/140 Acceptance Criteria WG Summary *[if time, Glazer]*

- Discussion: role of SSPC 140, etc.

*[Following items if time permits]*

13. Incentive Programs *[Judkoff/Roth, 10 min]*

- New IRS Sec 179D rules (commercial building tax deductions under PATH Act) for projects placed in service on or after Jan 1, 2016 require testing against Standard 140-2014 and use of 90.1-2007 as the base case (instead of 90.1-2001) .
- RESNET Accreditation:
  - HERS Tools; Existing Homes Tax Credit Compliance
  - 45L Tax Credit Compliance is by DOE, references RESNET

14. SSPC 140 Work Plan *[Skip, JN's Reminder to update it.]*

15. New business

16. Adjourn

For Item 2. Chair Announcements

- **140-2017 is current; integrated airside HVAC cases with 140-2014 test suites.**
- **IRS rules re the deduction for energy efficient commercial buildings require software used for assessing tax credits be tested as follows for projects placed in service:**
  - On/after Jan 1, 2016: test to 140-2014 (except Secs. 5.2.4, 7, 8) **11 progs (26 vers.) qualified; same as last January**
  - On or before Dec 31, 2015: test to 140-2007, **13 programs qualified.**
- **New submittals to [ron.judkoff@nrel.gov](mailto:ron.judkoff@nrel.gov).**
- **Qualified programs listed at <http://energy.gov/eere/buildings/qualified-software-calculating-commercial-building-tax-deductions> (Last check 09Jun2019).**
- **RESNET or DOE list 3 (last check 19Jun2019) tools as either accredited for HERS ratings, "45L" tax credit compliance (DOE). Required tests are NREL's HERS BESTEST (included since Std 140-2011), along with equipment modeling and other modeling tests developed by RESNET. "45L" submit to DOE ([45Lsoftware@ee.doe.gov](mailto:45Lsoftware@ee.doe.gov)) Other submittals to RESNET (<http://www.resnet.us/professional/programs/software>).**
- **ASHRAE 90.1 and 189.1 reference Standard 140;**
  - 90.1-2016, published Fall 2016, references 140-2014 (except Sections 7, 8)
  - 90.1-2019, to be published Nov 2019, refs 140-2017 (except Sections 7, 8).
- **2018 IECC cites 140-2014; IGCC citation accords with IECC.**
- **ASHRAE 90.2-2018 is published, references Standard 140, Section 7**



## 6.4.4.5 ASHRAE SSPC 189.1

**ASHRAE/USGBC/IES/ICC SSPC 189.1,  
Standard for High-Performance Green Buildings Except Low-Rise Residential Buildings  
June 25-26, 2019 Meeting, Kansas City Annual Meeting, Kansas City Marriott Downtown  
AGENDA**

**Tuesday, 8:00 a.m. to 10:00 a.m. (Central Time) – Marriott East, Trianon AB, Trianon Level**

**Wednesday, 8:00 a.m. to noon (Central Time) – Marriott West, Basie A, 2<sup>nd</sup> Floor**

**1. Call to order**

**2. ASHRAE Code of Ethics Commitment**

In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, integrity and respect for others, and we shall avoid all real or perceived conflicts of interests. (See full Code of Ethics: <https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics>.)

**3. Logistics – Staff**

- o Bias/conflict announcement
- o Voting members (Balaras, Conrad, Cross, Cudahy, Edelson, Eley, Floyd, Francis, Gitlin, Gracie-Griffin, Hedrick, Hogarth, Horn, Jouaneh, Leslie, Mason, McHugh, McMillen, Paliaga, Pape, Rosenstock, Schoen, Sovocool, Stanke, Subasic, VanGeem, West, Wilen, Winters)
- o Guest Introductions

**4. Review Agenda**

**5. Chair’s Reminders and Remarks**

- o Membership duty to consider the issues, voice their opinions, and vote on all standards actions. In particular to read, consider and vote on continuation letter ballots that may be issued from meetings when the member was absent.
- o Do not communicate with committee members during letter ballots.
- o Include ASHRAE copyright on all working drafts.
- o Do not to distribute draft addenda, internal committee documents (e.g. input from designated reviewers) or member contact information outside of committee.
- o Revised copyright language – no SEHPCAC

**6. User’s Manual status**

- o ASHRAE Staff preparing RFP
- o Project Monitoring Subcommittee – Request Volunteers

**7. Approval of Meeting Minutes**

- o Minutes pending for 5/28. Vote to approve.

**8. 189.1-2020 publication schedule**

- o Target publication date – fall 2020.
- o Last regular public review period – early summer 2020, and only if no comments.
- o Last regular PPR period for addenda with comments – spring 2020, PC approval in December.

**9. Requests for Interpretation (RFI) status: None Pending**

**10. CMP status (submission date): Gitlin – Site and related definitions and usage**

**11. Addenda Status**

- Publication Approvals in Process:
  - 189.1bm (District Energy System Modeling)
- Public Review closed for:
  - 189.1a ISC (Cool Roofs in CZ4) – 3 comments from 3 commenters. Responses sent – no commenter reply
  - 189.1b ISC (Alternate Renewables Maximum Area) – 1 unresolved comment on PPR1.
  - 189.1k (Performance Renewables) – 3 comments from 3 commenters
  - 189.1m (Hot Water Distribution) – 0 comments, 3 negative PC votes
  - 189.1o (Section 5 Non-Core) – 9 comments, 6 negative PC votes
  - 189.1p (Section 7 Non-Core) – 7 comments, 0 negative PC votes
  - 189.1s (Section 6 Non-Core) – 2 comments, 3 negative PC votes
  - 189.1t (Section 9 Non-Core) – 3 comments – Response to comment 002/0002 sent
  - 189.1u (Delete Flashing) – 1 comment – Comment response sent
  - 189.1w (Air Tightness) – 1 comment
  - 189.1x (Elevators) – 0 comments, 3 negative PC votes
  - 189.1y (Mechanical Penetrations) – 1 comment
  - 189.1z (Source Energy) – 16 comments, 1 negative PC vote without reason
  - 189.1aa (Emissions Factors) – 17 comments, 0 negative PC votes
  - 189.1ac (Demand Response) – 2 comments, 0 negative PC votes
- PPR Approved – Began 5/17
  - 189.1ab (Views) – PPR closes 7/1
- Awaiting SPLS approval for PPR:
  - 189.1j (Prescriptive Renewables) ISC – Motion passed 20-1-1 – Comment responses sent
  - 189.1n (Composite Wood Products) 2<sup>nd</sup> Full PPR – Motion passed 22-0-0
  - 189.1q (Section 8 Non-Core) 2<sup>nd</sup> PPR ISC – Motion passed 21-0-1 – Comment responses sent
  - 189.1r (Section 8 Non-Core 2) 2<sup>nd</sup> PPR ISC – Motion passed 17-1-4 – Comment responses sent
  - 189.1ae (Construction and Demolition Waste) – Motion passed 21-1-0
  - 189.1af (Section 10 Non-Core) – Motion is currently passing 16-5-0, subject to a recirculation ballot
- Other:
  - 189.1ad (Chapter 7 Deletions) – Motion failed 13-1-5

## 12. Working Group Reports

- WG 6 – Pape
  - 189.1m (Hot Water Distribution) – Vote for 2<sup>nd</sup> PPR – Motion postponed from May 28
  - 189.1m – motion to amend to make 6.3.3 a [JO] postponed from May 28
  - 189.1s (Section 6 Non-Core) – Vote for 2<sup>nd</sup> PPR
- WG 7 – VanGeem
  - 189.1b (Alternate Renewables Maximum Area) – Vote for publication
  - WG07DA04 (Fan Efficiency) – Vote for 1<sup>st</sup> PPR
  - 189.1ad (Section 7 deletions) – Vote for 1<sup>st</sup> PPR
  - 189.1p (Section 7 Non-Core) – Vote for 2<sup>nd</sup> PPR ISC
  - 189.1p (Section 7 Non-Core) – Responses to comments – Vote to approve
  - 189.1y (Mechanical Penetrations) – Vote for 2<sup>nd</sup> PPR ISC
  - 189.1y (Mechanical Penetrations) – Responses to comments – Vote to approve
  - 189.1x (Elevators) – Vote for publication with knowledge of unresolved objectors
  - WG07DA01 (Dwelling Unit Lighting) – Vote for 1<sup>st</sup> PPR
  - WG07DA02 (Water Heating) – Vote for 1<sup>st</sup> PPR
  - WG07DA03 (Low Power Fans) – Vote for 1<sup>st</sup> PPR
- WG 7.5 – Eley
  - 189.1z (Source Energy) – Responses to comments – Vote to approve

- 189.1aa (Emissions Factors) – Responses to comments – Vote to approve
- 189.1k (Performance Renewables) – Vote for 2<sup>nd</sup> PPR
- WG075DA07 (On-Site Renewable Definition) – Vote for 1<sup>st</sup> PPR
- WG 8 – Subasic
- WG 9 – Horn
- WG 10 – Schoen
- WG 5 – Floyd
- 189.1a (Cool Roofs in CZ4) – Vote for publication – 3 negative PC votes
- 189.1o (Section 5 Non-Core) – Vote for 2nd PPR ISC
- 189.1o (Section 5 Non-Core) – Responses to comments – Vote to approve
- WG05DA05 (Greenfield Sites) – Vote for 1<sup>st</sup> PPR
- General - Hedrick
- ICC proposals – GG1-19, GG4-19 and GG5-19

### 13. New Business

### 14. Future Meetings

- Last Tuesday of the month is normal schedule, but August and October need rescheduling.
- August 20? – Poll to approve
- Monday, October 21? Tuesday, November 5? – Poll to select
- Web Meetings – July 30, August TBD, September 24, October TBD, November 26, December 17

### 15. Adjournment

### ACTION ITEMS

## 6.4.4.6 ASHRAE TC 1.5

## ASHRAE 2019 Summer Meeting – Kansas City

**TC 1.5 Computer Applications- Agenda**TC 1.5 Public Web site: <http://tc0105.ashraetcs.org/>

TC 1.5 ListServ (mailing list) : tc105\_all\_1st@listman.ashrae.org (Contact chair or vice chair to be added)

TC 1.5 Members-only Site: Basecamp (Contact chair ([sroth@carmelsoft.com](mailto:sroth@carmelsoft.com)) or vice chair to be added)

**Main Committee Meeting**                      **Monday June 24**                      **(25/25)**  
**6:30-9:00 PM CST**

Seminar Sponsoring and Cosponsoring:

**Seminar 16: Multiscale Building Energy Modeling, Part II.** June 23, 1:30 – 3:00 PM**Seminar 50: How the Blockchain Will Affect You and Your Work in HVAC&R and Buildings: Don't Get Left Behind, It's Happening Now!.** June 25, 11:00 AM – 12:30 PM**Seminar 62: Predictive Analytics for HVAC Engineers: What Is in the Box?.** June 26, 8:00 – 9:30 AM

1. **Welcome:** Introductions
2. **Roll Call:** Number of voting members present to reach quorum (6): Stephen Roth (Chair), Joshua New, Mike Galler, Steve Rosen, John Crosby, Bruce Billedeaux, Carol Lomonaco, Tim Dwyer, Ed Tsui, Cameron Labunski
3. **Review of Agenda**
4. **Approval of Minutes from 2019 Winter Conference in Atlanta (Basecamp)**
5. **Review Action Items from 2019 Winter Conference in Atlanta (open action items in table below)**

Responsible Member	Description	Due Date	Completion Date
Stephen Roth	Reserve Kansas City room locations	3.8.19	3.8.19
Mike Galler or someone else?	2 website action items: <ol style="list-style-type: none"> <li>1. Post section announcements on web site from subcommittee reports</li> <li>2. Find previous minutes to update new website</li> </ol>	Continuing	1 month after mtg.

**6. Subcommittee Reports:**

- a. Emerging Applications: Anthony Fontanini
- b. Programs: Mike Galler
- c. Research: Todd Gottshall
- d. Handbook: Krishnan Gowri
- e. Standards: Steven Rosen
- f. Cybersecurity: Mike Galler

**7. YEA update:** Dave Branson or Lindsey King

**8. Chair's Report:**

- a. Review goals for my 2-year term:
  - i. At least 4 sponsored or co-sponsored seminars/workshops per meeting
  - ii. At least 1 new RTAR and WS per meeting
  - iii. At least 3 new TC 1.5 members per meeting. In fact, since the last meeting we have 5 new members:

Hayden Reeve  
Amanda Smith  
Dan Macumber  
Shichao Liu  
Nader Moazami  
Sandeep Shinde

- iv. Sponsor or co-sponsor at least 1 new standard during the 2-year term
  - v. Rename our TC
- b. Ask members to update ASHRAE profile when info changes. There is a new online portal at:  
[https://web.ashrae.org/tech\\_committees2/index\\_v77.php?com\\_id=nave4rabakuw](https://web.ashrae.org/tech_committees2/index_v77.php?com_id=nave4rabakuw)
- c. Present new Roster for 2019-2020
- d. PEC report: Recommendations from TC 1.5
- e. Discuss possibly holding subcommittee meetings prior to actual ASHRAE Meeting
- f. You all will be receiving an email about employee thank you letters in early August with details on how to request a thank you letter.
- g. 2019 Remote Participation Meetings Request
- h. Present dinner plans

**9. Liaison Reports**

- a. BIM-MTG

b. TAC

10. Old Business

11. New Business

- a. ASHRAE Journal is making plans for the 125th anniversary with articles in the issues from July 2019 through June 2020. ASHRAE would like to publish some articles related to future trends in the HVAC&R industry. The publisher thought TC 1.5 would be a good place to start in the hunt for an author(s).
- b. Discuss update to TC 1.5 Title-Purpose-Scope (TPS). **It was rejected by TAC in May 2019.** During the 2019 Winter Meeting, we voted to rename TC 1.5 to “Emerging Technology Applications”. We also voted on the following updated scope:

“TC 1.5 is concerned with determination of emerging technology and digital applications to the design and optimization of refrigeration, heating, and air-conditioning systems, equipment and components thereof, and with programs for all such uses.”

We need to revisit this.

Regarding the title, RAC suggested this: Some suggestions came up using the word “Computer” back in the title somehow, or use “IT” applications, etc.

Regarding the scope: The scope is also becoming short and needs some revisions. The current scope says “computer applications” and you proposed “software applications” instead. Is that really correct? It seems using computer applications is more appropriate because it covers everything related to computer, including software, drone systems, etc.

12. Next Meeting Times: ASHRAE Winter Conference, February 3, 2020 – Orlando, FL

13. Adjournment

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## 6.4.4.7 ASHRAE TC 4.7



**TC4.7 Handbook Subcommittee**

**Agenda**

**5:00pm – 6:00 pm, June 25, 2019  
Kansas City, MO**

- 1) Sign-in / Introductions
- 2) Primary focus at this meeting: Review submitted revisions / questions, check status of pending revisions, and begin organizing reviewers. Section 7 is fouled up in master file from ASHRAE; have requested revision from ASHRAE.
- 3) Schedule / Upcoming Deadlines
  1. Feb. 1, 2020 Chapter revisions complete
  2. Jun. 1, 2020 Revised Chapter sent to TC4.7 for review and comments
  3. Jul. 1, 2020 TC4.7 approves Chapter 19 (Annual Conference, Austin, TX)
  4. Jul. 31, 2020 Chapter 19 sent to Handbook Committee Chair (Bass Abushakra)
- 4) Review/Revision of Existing Chapter 19 and Planned Additions [Green – Received / Red – Pending]
  1. **GENERAL CONSIDERATIONS** {Daniel Villa, Dan Macumber}
    - 1.1 Models and Approaches
      - Forward (Classical) Approach
      - Data-Driven (Inverse) Approach
    - 1.2 Overall Modeling Strategies
    - 1.3 Simulating Secondary and Primary Systems
    - 1.4 History of Simulation Method Development {Jeff Haberl}
    - 1.5 Using Energy Models {Erik Kolderup}
      - Typical Applications
      - Choosing Measures for Evaluation
      - When to Use Energy Models
      - Improving the Use of Energy Models [NEW] {Erik Kolderup, Sumayyah Theron}
      - Energy Modelers
      - Prototype Models [NEW] {Neal Kruis}
    - 1.6 Uncertainty in Modeling
    - 1.7 Choosing an Analysis Method
      - Selecting Energy Analysis Computer Programs

- 2. DEGREE-DAY AND BIN METHODS** {Daniel Villa}
  - 2.1 Degree-Day Method
    - Variable Base Degree-Day Method
    - Sources of Degree-Day Data
  - 2.2 Bin and Modified Bin Methods
- 3. THERMAL LOADS MODELING** {Joel Neymark}
  - 3.1 Space Sensible Load Calculation Methods
    - Heat Balance Method
    - Weighting-Factor Method
    - Comprehensive Room Transfer Function Method
    - Thermal-Network Models
  - 3.2 Envelope Component Modeling
    - Above-Grade Opaque Surfaces
    - Below-Grade Opaque Surfaces
    - Fenestration [add info on RP 1588] {Neal Kruis}
    - Infiltration
  - 3.3 Inputs to Loads Models
    - Choosing Climate Data
    - Internal Heat Gains
    - Occupant Behavior {Tianzhen Hong}
    - Thermal Zoning Strategies
- 4. HVAC COMPONENT MODELING** {Tim McDowell}
  - 4.1 Modeling Strategies
    - Empirical (or Regression-Based) Models
    - First-Principles Models
      - Standard 205 [NEW] {Neal Kruis, Tim McDowell}
      - Standard 209 [NEW] {Erik Kolderup}
  - 4.2 Terminal Components
    - Terminal Units and Controls
    - Underfloor Air Distribution
    - Thermal Displacement Ventilation
    - Radiant Heating and Cooling Systems
  - 4.3 Secondary System Components
    - Fans, Pumps, and Distribution Systems
    - Heat and Mass Transfer Components
    - Application to Cooling and Dehumidifying Controls
  - 4.4 Primary System Components
    - Boilers
    - Chillers
    - Cooling Tower Model
    - Variable-Speed Vapor-Compression Heat Pump Model
    - Ground-Coupled Systems
  - 4.5 Modeling of System Controls
  - 4.6 Integration of System Models



<b>5. LOW-ENERGY SYSTEM MODELING</b>	{Ron Judkoff}
5.1 Natural and Hybrid Ventilation	
Natural Ventilation	
Hybrid Ventilation	
5.2 Daylighting	
5.3 Passive Heating	
5.4 Passive Cooling [NEW]	{Ron Judkoff}
<b>MULTI-SCALE MODELING (NEW)</b>	{Tianzhen Hong}
<b>6. DATA-DRIVEN MODELING</b>	{Dan Macumber, Amanda Smith}
6.1 Categories of Data-Driven Methods	
Empirical or "Black-Box" Approach	
Gray-Box Approach	
6.2 Types of Data-Driven Models	
Steady-State Models	
Single-Variate Models	
Multivariate Models	
Hybrid Inverse Change Point Model	
Polynomial Models	
Physical Models	
Dynamic Models	
6.3 Model Accuracy and Goodness-of-Fit	
6.4 Examples Using Data-Driven Methods	
Modeling Utility Bill Data	
Neural Network Models	
6.5 Model Selection	
<b>7. MODEL CALIBRATION</b>	{Ralph Muehleisen}
7.1 Bayesian Analysis	
7.2 Pattern-Based Approach	
7.3 Multi-Objective Optimization	
<b>8. VALIDATION AND TESTING</b>	{Ron Judkoff, Joel Neymark}
8.1 Methodological Basis	
Empirical Validation	
Analytical Validation	
Mathematical Truth Standards	
Establishing Secondary Mathematical Truth Standards	
Other Considerations	
Combining Empirical, Analytical, and Comparative Techniques	
Testing Model Calibration Using Synthetic Data	
<b>REFERENCES</b>	{All Reviewers}

## 5) New topics being added in 2021 edition (Confirm placement location in Chapter):

1. Multi-Scale Modeling {Tianzhen Hong, Joshua New, Ralph Muehleisen}
  - Urban Scale
  - BEM to BIM (RP 1468)
2. Improve how to use energy modeling, when to use modeling {Erik Kolderup, Sumayyah Theron}
3. Passive Cooling {Ron Judkoff}
4. Use of Prototype Models - & Why to Use {Neal Kruis}
5. Standard 205 {Neal Kruis, Tim McDowell}
6. Standard 209 {Erik Kolderup}
7. Completed RP's
  - RP 1588 Fenestration {Neal Kruis}

## 6) New topics for future consideration (i.e. 2025 edition and beyond):

1. Combined Heat and Power Systems
2. Optimization Across Multiple Buildings
3. Grid Stuff – Demand Response, Grid Interaction / Grid Response
4. Elevation Variations – Air property issues
5. Dynamic System Modeling
6. Thermal Zoning – Improvement
7. Appropriate Simplification
8. Example of Model Simplification – any research?
9. Chilled Beams (RP?)
10. Renewables
11. HVAC Toolkit updates (if any)
12. Completed RP's
  - RP 1741 Fan Coils
  - Chiller plant Control Strategies
  - RP 1742 Plug Loads
  - Others?
13. Misc. Ideas
  - Based on the Introduction section of Joe Clarke's book -- "Energy Simulation in Building Design" (2001) 2nd Ed., Routledge – there are a few other topics that could be added in brief: Surface convection, interior and exterior IR exchange, internal gains, moisture. Proposed sections on 1. Boundary Conditions and 2. Moisture

- Section recommended on recent work by PG&E and LBNL to develop methods to test and validate the predictions of black box models, for example:
    - i. Granderson, et. al., "Accuracy of Automated Measurement and Verification (M&V) Techniques for Energy Savings in Commercial Buildings," *Applied Energy* 173 (2016) p. 296-308.
    - ii. Price, et. al., "Commercial Building Baseline Modeling Software: Performance Metrics and Method Testing with Open Source Models and Implications for Proprietary Software Testing," Final Report, ET no. ET12PGE5312, Sept. 9, 2013, [www.etcc-ca.com](http://www.etcc-ca.com).
    - iii. Jump, et. al., "Functional Test Protocols for Commercial Building Efficiency Baseline Modeling Software," ET no. ET12PGE5312, Sept. 9, 2013, [www.etcc-ca.com](http://www.etcc-ca.com).
  - Addressing the issue of temperature based control vs. load based control in simulation.
  - Also address coupling of models? Applications and general methods? Internal vs. external.
14. Building Energy Modeling for Net Zero (New Chapter section)
15. Atrium Modeling
- 7) Adjourn

## 6.4.4.8 ASHRAE TC 7.6



Shaping Tomorrow's  
Built Environment Today

**TC 7.6 Building Energy Performance**

<https://tc0706.ashraets.org/>

Kansas City, MO

Tuesday, June 25, 2019, 1:00-3:30 pm

**TC/TG/MTG/TRG MINUTES**

TC/TG/MTG/TRG No. TC 7.6 DATE 2019-06-25

TC/TG/MTG/TRG TITLE Building Energy Performance

DATE OF MEETING 2019-06-25 @ 1-3:30pm LOCATION Kansas City, MO in KCCC, 2209

*(Minutes of all Meetings are to be distributed to all persons listed below within 60 days following the meeting.)*

**Attendees**

Summary: Total = 43, VM = 15, YEA = 14, CM = 6, G = 21

Dennis Landsberg	Saba Zakeri	Chitra Nambiar
Annie Smith	Rupam Singla	Jeff Habel
Jim Kelsey	Caren Banister	Dick Pearson
Amir Nezamdoost	Yang-Seon Kim	Eric Yang
Amanda Webb	Christine Reinders	Ali Fallahi
Hyojin Kim	Nate Boyd	Cindy Bittel
Daric Adair	Yunyang Ye	Mohammad Heidaringejad
Ricson Chude	Yeonjin Bie	Soolyeon Cho
John Constantinide	Supriya Goel	Try Bush
Alexander Zhivov	Michael Rosenberg	Fredric Goldner
Sara Persily	Nicholas Long	David Eldridge
Paul Mathew	Michael Deru	Patrica Nattan
Mahabir Bhandari	Patrick Carpenter	Kimberly Pierson
Clark Donson	Chris Balbael	
Annabel Zhang	Bruce Hunn	

*TC 7.6 is concerned with the estimation, measurement, analysis, benchmarking, and management of whole building and building systems energy and water performance. This includes performance and resource management of new and existing buildings.*

**1. Roll call and Introductions**

Landsberg

- Quorum achieved
- Welcomed new members, visitors, and remote attendees

TC 7.6 Agenda

Page | 1

2. Reviewed the ASHRAE Code of Ethics Commitment Landsberg
3. Accepted agenda/approve minutes of Atlanta meeting Landsberg
4. Announcements and Chair Remarks Landsberg
- Note that TC scope includes water, and new and existing buildings
  - Discussion of updates to Standard 105 and Guideline 14, development of Best Practices Standard 211 and Users Manual Standard 100
  - Standard 228P – Net Zero
  - Announcements and St Louis Section 7 Updates: TCs will be able to reorganize themselves and are not going to force any mergers at this point.
  - Thank you notes are available to be sent to employers.
  - New ASHRAE Strategic Plan revealed on Saturday. Includes 4 goals including streamlining and increased chapter engagement.
5. Membership Kelsey
- Currently 15 VMs.
  - J. Patrick Carpenter and Michael Deru rolling off 6/30/19
  - New members will be Supriya Goel and Eric Yang
  - VC is Jim Kelsey, Secretary is Annie Smith
6. Standing Committee Liaison Reports (TAC/RAC/StdCom/Program/SpecPub/ALI/BuildingEQ)
- BuildingEQ Constantinide
    - 437 active projects, 73,000 sf average area
    - Portal being aligned with Std 211 for Level 1 reporting requirements
    - Outreach efforts include USGBC O+M rating to increase audit requirements for prerequisite compliance; Argentina Green Building Council for BuildingEQ Argentinian version
  - SSPC 90.1 Liaison (Drake Erbe is 90.1 Chair) Chude
    - Ongoing addendum updates
    - User manual being updated; first draft by December 2019
  - SSPC 90.2 Liaison (Theresa Weston is 90.2 Chair)
  - SSPC 100 Liaison (Wayne Stoppelmoor is 100 Chair) Landsberg
    - Adopted in Washington state
    - Minor modifications so it can be adopted in Canada and Saudi Arabia
    - Modifications to the tables to accommodate the latest CBECS data
7. Multi-Disciplinary Task Group Reports
- MTG-IAST (Impact of ASHRAE Standards and Technology on Energy Savings/Performance) Boyd
    - Discussed ways and means with contractor

- Focus is what has ASHRAE's impact been as a whole rather than counting every single Btu that ASHRAE can take credit for
- North America is scope currently; data hard to find regarding where ASHRAE standards have been adopted internationally
- MTG-ASEC (Avoided Source Energy Consumption Due to Waste Heat Recovery and Heat Pump Technologies) – This MTG was disbanded last year.
- Discussion of MTG-EBO (Effective Building Operations) **Boyd**
  - Focused on providing training, resources, best practices guides, and other technical resources to the senior management level of facilities managers.

**8. Subcommittee Reports**

**A. Standing (Functional) Subcommittees**

**8.1 Research**

**Yang**

- 1 accepted work statement, 13 work statements in progress
- Society is looking for nominations for Outstanding Service Award
- Discussion of PTAR process: 10% of Research Fund was given to special publications. Form is available online. Slides detailing this further is on Basecamp.
- Society's overall Research Strategic Plan is in the works. Looking for volunteers to work on this.
- These announcements, subcommittee meeting minutes, and further information also posted on Basecamp.
- RP-36 went to bid and had 7 responses. Subcommittee made a recommendation which voting members approved via email vote. PMS chair and PMS members have been identified.
  - Motion made by that a PMS be formed and the names that were read allowed to be on the roster.
    - 2 abstained, all other voted Yes
- Working group formed to explore whether we should explore revising the PMP for Commercial Buildings document (2010) or the 2012 PMP Best Practices Guide. Hyojin Kim to be the head of the working group. Let Hyojin know if you'd like to join.

**Hunn**

**8.2 Handbook**

**Constantinide**

- CBECs tables need to be provided via errata. Recommended errata will be provided to the TC for a vote via letter ballot. If approved, electronic version (Handbook Online) will be updated.
- Reviewing chapter 37 for updates regarding water scope with TC 2.8 Water-Energy Nexus subcommittee.
- Collaborating with Government Affairs committee regarding energy policies. Terry Sharp also working on researching Executive Orders.
- Chapter 42 will be reviewed by Nick Long.
- Eric Yang will provide content to be included in the Handbook chapters.

**8.3 Standards**

**Novosel**

- Std 100 – Continuous Maintenance
- Std. 105-2014 Revision (Continuous Maintenance?)

**Carpenter**

- Agreed unanimously on a set of edits. Will issue for public review in the next couple of months. Title, purpose, and scope was reviewed and approved recently.
  - Gdl. 14-2014 Revision Landsberg
    - Revised guideline should be out in the next 12-18 months
  - Proposed standard 2.28 on net-zero energy buildings (w/TC 2.8) Landsberg
    - First meeting held unofficially Saturday at 1pm. Adding voting members for the next meeting.
    - Discussed direction the new standard would be taken. General consensus that every building deserves a path to net zero but qualifiers will need to be put on when off-site generation is allowed.
  - Standard 211 Kelsey
    - Maintaining compatibility with BuildingSync
    - Keeping changes to a minimum to avoid substantive changes and avoid going for public review
  - New standard being developed Goel
    - Title: Evaluating Ruleset Implementation in Building Energy Modeling Software
    - Purpose would be to provide tests and acceptance criteria for implementation of rulesets and reporting in building performance modeling software.
    - Standard would include rulesets with specific requirements for determining with baseline meets code. Only software tools that comply with this standard could be used to comply with 90.1 Appendix G.
    - Cognizant TC is 4.7. Would like support from 7.6 because this TC is cognizant to 90.1.
    - Motion raised by Kelsey: To support the concept of the Standard titled "Evaluating Ruleset Implementation in Building Energy Modeling Software"
      - Passed unanimously.
- 8.4 Programs Smith
- Reviewed deadlines for Orlando conference
  - Transition to Christine Reinders (new Programs Chair)
- 8.5 Web Site Kim
- Discussed consolidating the five individual Basecamps for this TC into one main TC Basecamp (like TC 4.7 did)
  - Discussion of if there is capability to only send notifications to certain groups of people or if people can subscribe to notifications for certain folders
- B. Topical Subcommittees
- 8.6 Monitoring & Energy Performance Webb
- 28 attendees
  - Discussed governmental policy, benchmarking tools, etc.
  - New York City has usage targets that allows renewable energy credits to be used for compliance.
  - State of Washington adopted energy efficiency requirement based on ASHRAE Std 100
  - CBECS 2018 is 2 months into data collection.

- Subcommittee has agreed to house a potential working group to update the PMP document.
  - Minutes will be posted to the website.
- 8.7 Energy Management** **Chude**
- 24 attendees
  - Focused on education and training.
  - Revisited the Long Range Plan; key items discussed include resource management, GHG emissions, refrigerants, water, etc.
  - Dick Pearson and Eric Yang presented the 6-hour ALI course.
- 8.8 Commercial Building Audits** **Kelsey**
- Joe was unable to attend; Kelsey filled in for him.
  - Focus is to rewrite the PCBEA "Green Book," given the implications of publication of Std 211. Will remove definitions of the Levels 1-3 and shift focus to best practices.
  - Have some volunteer assignments; need to still do some reorganization.
  - Have calls every other week to work on it. Looking for volunteers.
- 8.9 Federal Buildings** **Zhivov**
- Presentations held during subcommittee meeting
  - Discussed threat analysis topics and resiliency metrics
  - Planning 2 workshops in upcoming months – 1 in January in Alaska to "freeze" a building to 40°F, another in Norway in April
  - Six technical papers need reviewers. Contact Alexander Zhivov for him to submit you as a suggested reviewer.
- 8.10 Building Data Exchange** **Long**
- 19 attendees
  - Researching programs/software/websites that have their own version of data exchange (well over 10)
  - Looking into providing training and webinar to spread the word.
  - RTAR regarding levels of fidelity in the works; targeting Orlando.
- 9. Other Topics**
- **AEDGs** **Reinders**
    - Zero Energy Guides in the works; Office Buildings published in June 2019. Being used for the new ASHRAE headquarters
    - Project committee formed for multi-family residential; scheduled for publication 2020.
    - Looking for a new liaison next summer July 2020. Contact Christine if you're interested.
  - **TC 7.3 (Operation and Maintenance Management) Interaction** **Constantinide**
    - David Handwork will be assisting as liaison/communication
- 10. Old Business**
- **Status of Technical FAQs for review and revision** **Landsberg**
    - No new action items
  - **Including IAQ Performance in TC work scope** **Kim**
- TC 7.6 Agenda Page | 5



- Discussed in Atlanta; Jim Kelsey reach out to talk to TC 2.8 Chair yesterday but was unable to get in touch with them.
- No proposed title change for TC 7.6; request that the scope include IEQ in the TC 7.6 scope.
- Questions Raised
  - Are any other TC's already including measurement of IEQ?
  - MTG regarding Health and Wellness in the Built Environment exists – are they working on this?
  - Concerns with ongoing TC merger if this is the right time.
  - Concerns with scope creep for the larger TC
- Hyojin to champion efforts with it tentatively living in Monitoring & Performance Subcommittee.

#### 11. Adjourn

- John C moved to adjourn; Kelsey seconded. Unanimously approved.

6.4.5 Other Meetings

6.4.5.1 Blue Bonnet Chapter Association

The following pages are meeting notes, agendas, and summaries from the Blue Bonnet Chapter Association meetings from 2019.



President	Bobby Horner
1st VP	Eric Moree
2nd VP	Joe Woods
Treasurer	Becky Skipper
Secretary	Tanika Claggett
Director	Steve Philen
Director	Patricia Loyola
Director	Brian Walden
Director	Barry Lightfoot
I.P.P.	Mike Beard



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**CHAPTER MEETING Minutes**

Wednesday – February 20, 2019

Time: 6:30 pm – 8:00 pm

**Abuellita’s Mexican Restaurant**

1623 N Valley Mills Dr.—Waco, Texas

**AGENDA**

- Call To Order - Bobby Horner
- Prayer / Pledge—Bobby Horner / Becky Skipper
- Recognition of New Members / Accomplishments— None To Date
- Guests: TSTC SkillsUSA Team and Instructors
- Program:** 2019 TSTC Team members for SkillsUSA + Instructors/Guests
  - Presentation of Hardhats to Team Members
- Review of Minutes from December 2018 Meeting—approved
- Review of Treasurer’s Report—Becky reported and approved
- Old Business:**
  - 1. Annual Meeting—review—successful meeting!
- New Business:**
  - 1. Golf Tournament Update + Annual Training Update—Bobby Horner
  - 2. Committees
  - 3. Proposed Calendar and Meeting Ideas—Bobby Horner
  - 4. Shirley Ellis—ICC Update
  - 5. Other topics?
  - 6. Raffle—John Russell—TSTC Winner of lotto drawing!
  - 7. Adjourn

*Handwritten initials*



President	Bobby Horner
1st VP	Eric Moree
2nd VP	Joe Woods
Treasurer	Becky Skipper
Secretary	Tanika Claggett
Director	Steve Philen
Director	Patricia Loyola
Director	Brian Walden
Director	Barry Lightfoot
I.P.P.	Mike Beard



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### CHAPTER MEETING NOTICE

Wednesday – March 20, 2019

Time: 6:30 pm – 8:00 pm

### The Junction Restaurant

1216 TX 36 - Gatesville, Texas 76528 (254-865-0351)

#### AGENDA

Call To Order

Prayer / Pledge

Recognition of New Members / Accomplishments—

Guests:

**Program: Andy Severy—Simpson Strong-Tie** (Bluebonnet Corporate Member)

Title: Post-Installed Anchor Applications for Residential Construction -Anchor Types -Post-Installed Anchors -Installation Procedures -Code Requirements for Anchors -Why use Post-installed Anchors

Review of Minutes from February 2018 Meeting

Review of Treasurer’s Report

#### Old Business:

1. Golf Tournament Update + Annual Training Update
2. Committees
3. Proposed Calendar and Meeting Ideas

#### New Business:

1. Shirley Ellis—ICC Update
2. Letter of Support for the Plumbing Code bills – SB 1106 and HB 3622
3. SkillsUSA Competition—Corpus
4. TIVA Summer Conference—Training and Practice Exam *Corpus Christi, 7/19*
5. Next Month’s meeting in Gatesville again *~The Feed Mill*
6. Other topics?
7. Raffle—Lotto Ticket Bouquet! (Bring some money for your chance! This was popular last month at our meeting!)
8. Adjourn

6.4.5.2 Texas Emergency Management

The following pages are meeting notes, agendas, and summaries from the Texas Emergency Management meetings from 2019.

**TEXAS**  
**EMERGENCY MANAGEMENT**

**Texas Recovery Housing Summit**  
**March 26-27, 2019**

Texas A&M Hotel and Conference Center  
177 Joe Rouff Blvd  
College Station, TX 77840

**Tuesday, March 26, 2019**

3:15 PM            **The Future of TSA in Texas**  
**Facilitated Discussion**

- *Mario Chapa, Mass Care State Coordinator, TDEM*
- *Kathy Clark, Associate Director, Emergency Disaster Services, The Salvation Army- TX*

**DRAA Impacts to IA**

- *Traci Brasher, Recovery Director, FEMA Region 6*

**Procurement/IDIQ Contracts**

- *Christa Lopez, Director, Texas General Land Office*

6:00 PM            **END OF DAY 1**

**Wednesday, March 27, 2019**

8:00 AM            Continental Breakfast Provided in Meeting Room

9:15 AM            **Developing and Exercising Local Pre-Disaster Recovery Plans**

- *Jonathan Wiggins, Regional Planner, City of Houston Mayor's Office of Public Safety and Homeland Security*

10:15 AM           **The Way Ahead**  
**Facilitated Discussion**

- *Hank Lawson, Director, TEEX/NERRTC*

12:00 PM           **End of Summit**

*SE*

6.4.5.3 Houston Chapter of the International Code Council

The following pages are meeting notes, agendas, and summaries from the Houston Chapter of the International Code Council meetings from 2019.

## Houston Chapter of the International Code Council

### Meeting Agenda

April 11, 2019

4:00- 5:00 PM

Conference Room B2

- I. Call to order
- II. Roll call
- III. Approval of minutes from last meeting
- IV. Open issues
  - a) Formal adoption of organization bylaws
- V. New Business
  - a) Speakers: Brooks Myers & Scott Harrington, Home Depot  
Building Safety Month- May 2019
  - b) Speaker: Shirley Ellis, ICC Board of Directors  
ICC High School Technical Training Program
  - c) Committee nominations
  - d) HCICC logo proposals
- VI. Membership forum
- VII. Adjournment



6.4.5.4 North Texas Chapter of the International Code Council

The following pages are meeting notes, agendas, and summaries from the North Texas Chapter of the International Code Council meetings from 2019.



**NOTICE OF MEETING**  
**North Texas Chapter**  
**International Code Council**



**Will Hold a Regular Meeting on:**

**Friday, April 12, 2019**  
11:30 a.m.

**Construction Education Foundation**  
1401 W Royal Lane (Use E 14<sup>th</sup> St w/GPS)  
Irving, Texas 75063

*Catered Lunch - \$15.00 per person (Meal is optional)*

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**PROGRAM**

1. Welcome – Call to Order – SA  
Introductions and welcome all members present
2. Approval of March 22, 2019 Meeting Minutes – CF
3. Treasurer’s Financial Report – DW
4. Speaker – Jacqueline Brown, PE, Hilti North America – SA  
Topic: IBC Code Update – Changes Related to Firestopping and Joint Systems
5. Chapter’s Upcoming Events & Members Updates/Announcements – CH
6. ICC Representative Updates/Announcements – SA/KS
7. Professional Members Updates/Announcements – EM
8. Employee of the Month - CH
9. Door Prizes – SA/CH
10. Adjournment

Suzanne Arnold, CBO  
President  
City of Coppell

Christine Hadley, CBO  
Vice President  
City of Irving

Carey Frazier  
Secretary  
City of Frisco

Dylan Whitehead, CBO  
Treasurer  
City of Burleson

Eddie McCormick  
Professional Officer  
DACA

[www.ntcicc.org](http://www.ntcicc.org)

A handwritten signature in black ink, appearing to be "EJ".

#### 6.4.5.5 Building Officials Association of Texas

The following pages are meeting notes, agendas, and summaries from the Building Officials Association of Texas meetings from 2019.



**BUSINESS MEETING  
NORTH TEXAS BPI  
May 21, 2019**

1. OPENING MEETING/ CHECK FOR QUORUM – Brett King
2. APPROVAL OF MINUTES
3. FINANCIAL REPORT – Jeffery Widmer
4. DISCUSSION & UPDATE ABOUT 2019 ANNUAL CONFERENCE – Mike Olson
5. BOARD MEMBER UPDATES
  - Legislative – Kurt Kasson
  - BPI – Selso Mata
  - Code Review – Brett King
  - Disaster Response – Teresa Adrian
  - Awards & Scholarship – Mike Beard
6. OTHER BUSINESS
  - Special Presentation by Kurt Kasson
7. ADJOURNMENT

SE

## BOAT ANNUAL CONFERENCE SCHEDULE AT A GLANCE

### TUESDAY, AUGUST 6, 2019

7:30–4:00 p.m. Registration Open

5:45 p.m.–6:10 p.m. Board Shuttle Bus for Texas Shoot-Out

6:30 p.m.–9:00 p.m.

Texas Shoot-Out

Dinner and bowling complimentary for all conference attendees and their family. Laser tag and arcade games are also available.

Main Event, 1911 N. Loop 1604 East, San Antonio, 210-305-5999

8:00 p.m./9:00 p.m. Bus Back to La Cantera

### WEDNESDAY, AUGUST 7, 2019

7:00 a.m.–5:00 p.m. Registration Open

Ballroom Foyer

7:30–8:35 a.m. Networking Breakfast with Exhibitors

Ballroom DEF

8:45 a.m. Nominating Committee Meeting

San Cristobal

#### CONCURRENT SESSIONS

8:45–10:00 a.m.

- Major Changes of the 2018 IBC
- Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance
- Medical Gas Endorsement for Inspectors (Day 3)

Ballroom H  
Ballroom I

Ballroom G

10:00 a.m.–10:30 a.m. Networking Break with Sponsors

Ballroom ABC

#### CONCURRENT SESSIONS

10:30–11:50 a.m.

- Major Changes of the 2018 IBC (Part 2)
- Impact of 2016 Preserved Treated Wood Changes on Building Codes, Industry Standards and Evaluation Reports
- Medical Gas Endorsement for Inspectors (Day 3-Continued)

Ballroom H  
Ballroom I

Ballroom G

Noon–1:00 p.m. Chow Time

Ballroom DEF

#### CONCURRENT SESSIONS

1:15–2:30 p.m.

- Major Changes between 2012 to 2018 IRC
- Fire Stop Products – What is Old and What is New
- Medical Gas Endorsement for Inspectors (Day 3-Continued)

Ballroom H  
Ballroom I  
Ballroom G

2:30–3:00 p.m. Networking Break with Sponsors

Ballroom ABC

#### CONCURRENT SESSIONS

3:15–4:15 p.m.

- Major Changes between 2012 to 2018 IRC (Part 2)
- Benefits of CSST Gas Piping Systems
- Medical Gas Endorsement for Inspectors (Day 3-Continued)

Ballroom H  
Ballroom I  
Ballroom G

BY



4:15–5:30 p.m. Networking Reception Ballroom Terrace

5:30 p.m. Free evening

**THURSDAY, AUGUST 8, 2019**

7:00 a.m.–4:00 p.m. Registration Open Ballroom Foyer

7:30–8:30 a.m. Networking Breakfast with Exhibitors Ballroom DEF

CONCURRENT SESSIONS

8:45–10:00 a.m.

- Post Disaster Damage Assessment Training Ballroom H
- • Understanding Active and Passive Floodproofing Options Ballroom I  
for Non-Residential Buildings in a Special Flood Hazard Area
- Medical Gas Endorsement for Inspectors (Day 4) Ballroom G

10:00 a.m.–10:30 a.m. Networking Break with Sponsors Ballroom ABC

CONCURRENT SESSIONS

10:30–11:50 a.m.

- Post Disaster Damage Assessment Training (Part 2) Ballroom H
- Safe Use on Modified Shipping Containers Ballroom I
- Medical Gas Endorsement for Inspectors (Day 4-continued) Ballroom G

✓ Noon–1:30 p.m. Chow Time and Annual Business Meeting Ballroom DEF

CONCURRENT SESSIONS

1:45–3:00 p.m.

- Post Disaster Damage Assessment Training (Part 3) Ballroom H
- Building Official 101 & Legislative Issues Ballroom I
- Medical Gas Endorsement for Inspectors (Day 4-continued) Ballroom G

3:00–3:30 p.m. Networking Break with Sponsors Ballroom ABC

CONCURRENT SESSIONS

3:30–4:45 p.m.

- Post Disaster Damage Assessment Training (Part 4) Ballroom H
- Building Official 101 & Legislative Issues (Part 2) Ballroom I
- Medical Gas Endorsement for Inspectors (Day 4-continued) Ballroom G

6:30–8:00 p.m. BOAT Awards Dinner Ballroom DEF

8:00–10:30 p.m. Casino Night Ballroom ABC

**FRIDAY, AUGUST 9, 2019**

8:00–9:30 a.m. Cracker Barrel and Continental Breakfast San Augustine

8:30 a.m. Jackson Plumlee Annual Golf Outing

8:00 a.m.–12:00 Noon

Medical Gas Endorsement for Inspectors-TSBPE Exam Ballroom G

BY

#### 6.4.5.6 State Agency Energy Advisory Group (SAEAG)

The following pages are meeting notes, agendas, and summaries from the SAEAG meetings from 2019.

### State Agency Energy Advisory Group

LBJ Office Building- 111 E. 17<sup>th</sup> Street, Austin

#### Agenda

April 17, 2019

- |        |  |
|--------|--|
| 9:00am | SECO & OAG Update  |
| 9:20am | Introductions  |
| 9:30am | <b>Cybersecurity and IoT Building Automation-</b> Presenter: Jerry Drew<br>Building Automation using Internet of Things (IoT) technology is being accepted by facility managers at a rapid rate. These highly flexible systems provide local and remote access to HVAC and other building controls at a much lower cost than traditional building automation systems. This session will explore IoT BAS in both cloud and local network configurations, and the network security implications with each deployment solution. |

### 6.4.5.7 Texas Energy Summit (Previously, Clean Air Through Energy Efficiency (CATEE))

The Texas Energy Summit 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. The Texas Energy Summit is hosted by the Energy Systems Laboratory (ESL) of the Texas A&M Engineering Experiment Station (TEES).

The following pages are conference program agendas from the Texas Energy Summit 2019.

## Texas Energy Summit 2019

Tue, Nov 12, 2019

10:30am

### WORKSHOP: Continuous Commissioning®

🕒 10:30am - 12:30pm, Nov 12

📍 Hearing Room E02.016

The trademarked Continuous Commissioning® (CC®) process, developed by the ESL, focuses on the optimization of public, commercial, and institutional building operations. This workshop will provide an overview of this extremely cost-effective process complemented by a series of case studies that illustrate several different situations where the process has been highly effective.

#### 🗣️ Speakers



**Saleem Khan** President, Texas Energy Engineering Services, Inc. (d/b/a TEESI Engineering)



**Victor Saeh** Principal, Smith Seckman Reid (SSR)



**Carlos Yagua** Assoc. Research Engineer, TEES Energy Systems Laboratory



**Greg Zeig** Principal, HHS Associates



**Mitchell Paulus** Energy Engineer, Command Commissioning

11:00am

### WORKSHOP: Texas Emissions Reduction Plan (TERP) 101

🕒 11:00am - 12:00pm, Nov 12

📍 Hearing Room E2.014

The Texas Emissions Reduction Plan (TERP) is our state's voluntary program to reduce mobile-sources emissions. This panel will discuss its programs, funding, health benefits and economic benefits. The Volkswagen settlement funding will be discussed, too.

#### 🗣️ Speakers



**Clay Pope** Principal, Capitol Access Partners



**Cyrus Reed** Interim Director & Conservation Director, Sierra Club, Lone Star Chapter



**Mike Wilson** Director, Air Grants Division, Office of Air, Texas Commission on Environmental Quality (TCEQ)

### 1:00pm

#### WORKSHOP: Future Directions for TERP

🕒 1:00pm - 3:00pm, Nov 12

📍 Hearing Room E2.014

The Texas Emissions Reduction Plan (TERP) has served Texas since 2001, reducing emissions and improving air quality in key areas around the state. As the program nears a 20-year milestone, what has gone well, what could be improved, and are there areas where the program should evolve? Hear observations and discussion from a panel ranging from researchers to grant recipients, and come prepared to provide your feedback!

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#### 🗣️ Speakers



**Mustapha Beydoun** Vice President, Houston Advanced Research Center (HARC)



**Glenn Choe** Regulatory Affairs/Principal Engineer, Toyota Motor North America



**Lori P. Clark** Program Manager, Clean Fleet and Energy Improvements, North Central Texas Council of Governments (NCTCoG)



**Ken Colburn** Principal and Director, U.S. Programs, The Regulatory Assistance Project



**Ken Gathright** Environmental Compliance Coordinator, Port Houston




**Ann Xu** Assistant Director of Technology, Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH), Texas Transportation Institute (TTI)

#### WORKSHOP: The ERCOT Grid - A Primer

🕒 1:00pm - 2:00pm, Nov 12

📍 Hearing Room E02.016

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 Speakers



Warren Lasher Sr. Director, System Planning, ERCOT



Carl Linvill RAP



Caitlin Smith Vice President, AB Power Advisors

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2:00pm

**WORKSHOP: The Evolution of the Grid - High Renewables and DERs, Low Cost**

🕒 2:00pm - 4:00pm, Nov 12

📍 Hearing Room E02.016

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 Speakers



Leia Guccione Managing Director, Electricity Program, Rocky Mountain Institute



Charlie Hemmeline Executive Director, Texas Solar Power Association



Ric Oconnell Executive Director, GridLab



Douglas Staker VP, Utility Business Development, ENEL X



Andrea Tosi Power System Specialist, Pecan Street Inc

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3:00pm

**WORKSHOP: Electric Buses**

🕒 3:00pm - 5:00pm, Nov 12

📍 Hearing Room E02.014

Several Texas transit agencies have taken industry leadership positions and adopted all-electric bus technology. Come and hear about projects already in place as well as near-term plans, and hear from industry representatives who provide the vehicle and infrastructure technologies needed to support the

electrification transition. The group will discuss the major obstacles and solutions needed to enable large-scale adoption of electric buses in Texas.

#### Speakers



**Alvin Blakes** Project Manager, Dallas Area Rapid Transit



**Rob Borowski** Sustainability Officer, Capital Metropolitan Transportation Authority



**Wayne Gensler** Vice President and COO of Bus and Paratransit, Trinity Metro



**John Hall** Director, Texas Energy Program, Environmental Defense Fund (EDF)



**Carl Holley** Regional Director of Sales - Southwest, Greenlots, a member of the Shell Group



**Marvin Hurt** Director, Fleet Engineering, Dallas Area Rapid Transit



**Lauren Cochran Scoville** Director of Sales, Proterra

#### 5:00pm

##### North American Renewables Operation Center Tour

🕒 5:00pm - 6:30pm, Nov 12

📍 Omni Austin Hotel Downtown

Tour the state-of-the-art North American Renewables Operation Center located in the Omni Hotel in downtown Austin. This center provides RWE Renewables with the ability to not only manage its own 3.8 gigawatt (GW) capacity portfolio but also in managing a further 2.9 GW of capacity for other owners. The team members within the center manage the day-to-day activities for the purposes of safe and reliable grid operations and commercial offtake matters within nearly all of the Independent System Operators (ISOs) 24 hours a day. The facility is fully compliant with the critical infrastructure protection (CIP) requirements governing electric generation facilities. Services provided by the center include scheduling and dispatching of power, remote management of power and voltage in accordance with NERC standards, and offtake arrangements under various contracts.

##### Cocktail Reception

🕒 5:00pm - 6:30pm, Nov 12

📍 Omni Austin Hotel Downtown

Network with other Summit attendees from 5:00-6:30pm in the Lonestar room at the Omni!

electrification transition. The group will discuss the major obstacles and solutions needed to enable large-scale adoption of electric buses in Texas.

**Speakers**



**Alvin Blakes** Project Manager, Dallas Area Rapid Transit



**Rob Borowski** Sustainability Officer, Capital Metropolitan Transportation Authority



**Wayne Gensler** Vice President and COO of Bus and Paratransit, Trinity Metro



**John Hall** Director, Texas Energy Program, Environmental Defense Fund (EDF)



**Carl Holley** Regional Director of Sales - Southwest, Greenlots, a member of the Shell Group



**Marvin Hurt** Director, Fleet Engineering, Dallas Area Rapid Transit



**Lauren Cochran Scoville** Director of Sales, Proterra

**5:00pm**

**North American Renewables Operation Center Tour**

🕒 5:00pm - 6:30pm, Nov 12

📍 Omni Austin Hotel Downtown

Tour the state-of-the-art North American Renewables Operation Center located in the Omni Hotel in downtown Austin. This center provides RWE Renewables with the ability to not only manage its own 3.8 gigawatt (GW) capacity portfolio but also in managing a further 2.9 GW of capacity for other owners. The team members within the center manage the day-to-day activities for the purposes of safe and reliable grid operations and commercial offtake matters within nearly all of the Independent System Operators (ISOs) 24 hours a day. The facility is fully compliant with the critical infrastructure protection (CIP) requirements governing electric generation facilities. Services provided by the center include scheduling and dispatching of power, remote management of power and voltage in accordance with NERC standards, and offtake arrangements under various contracts.

**Cocktail Reception**

🕒 5:00pm - 6:30pm, Nov 12

📍 Omni Austin Hotel Downtown

Network with other Summit attendees from 5:00-6:30pm in the Lonestar room at the Omni!

Wed, Nov 13, 2019

8:30am

**Welcome to the 2019 Texas Energy Summit**

🕒 8:30am - 9:00am, Nov 13

📍 Capitol Auditorium

👤 **Speakers**



**David Claridge** Director, TEES Energy Systems Laboratory



**Doug Lewin** Executive Director, Texas Energy Summit

9:00am

**Opening Keynote**

🕒 9:00am - 9:15am, Nov 13

👤 **Speaker**



**Mayor Steve Adler** Mayor, City of Austin

9:15am

**Keynote: Evan Smith, CEO Texas Tribune**

🕒 9:15am - 9:45am, Nov 13

📍 Capitol Auditorium

👤 **Speaker**



**Evan Smith** CEO & co-founder, The Texas Tribune

9:45am

**Clean Air and Clean Energy in Texas Today (with Commissioners Lindley (TCEQ) and D'Andrea (PUC), and ERCOT CEO Magness)**

🕒 9:45am - 10:45am, Nov 13

📍 Capitol Auditorium



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 Speakers



Arthur D'Andrea Commissioner, PUCT, Public Utility Commission of Texas (PUCT)



Emily Lindley Commissioner, Texas Commission on Environmental Quality (TCEQ)



Bill Magness President and Chief Executive Officer, ERCOT



Evan Smith CEO & co-founder, The Texas Tribune

**10:45am**

**BREAK**

🕒 10:45am - 11:00am, Nov 13

📍 Legislative Conference Center

**11:00am**

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**Increasing Grid Resiliency with Distributed Resources**

🕒 11:00am - 12:00pm, Nov 13

📍 Hearing Room E02.014

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 Speakers



Suzanne Bertin Managing Director, Texas Advanced Energy Business Alliance (TAEBA)



Christopher L. Brewster Principal, Lloyd Gosselink, Attorneys at Law



Robert Helton Director of Government & Regulatory Affairs, Engie North America



Lola Infante Senior Director, Clean Energy Technology and Policy, Edison Electric Institute



Valerie Von Schramm Strategic Research and Innovation Manager, CPS Energy

### Improving Public Health and Resilience in Energy Corridors

🕒 11:00am - 12:00pm, Nov 13

📍 Hearing Room E02.016

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#### 🗨️ Speakers



**DeVon Douglass** Director of Community Engagement, Harris County Judge Lina Hidalgo's office



**Rep. Jon Rosenthal** Representative, Texas House of Representatives



**Stephanie Thomas** Researcher & Organizer, Public Citizen



**Joe Zietsman** Assistant Agency Director and Strategic Advisor, Texas A&M Transportation Institute (TTI)

### State Agency Energy Leadership

🕒 11:00am - 12:00pm, Nov 13

📍 Hearing Room E02.010

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#### 🗨️ Speakers



**Darran Anderson** Director of Strategy & Innovation, Texas Department of Transportation (TxDOT)



**Sally Kachoris** Program Specialist, Texas Workforce Commission



**Doug Kirkley** Vice President Sales, E3 Entegral Solutions, Inc.



**Farshad Shahsavary** Energy and Engineering Manager, Office of Energy Management, Texas Facilities Commission



**William E. (Dub) Taylor** Director, State Energy Conservation Office (SECO)

12:00pm

**LUNCH**

🕒 12:00pm - 12:45pm, Nov 13

📍 Capitol Grill

12:45pm

**Keynote: The Permian Boom: Making High Production and Clean Air Coexist**

🕒 12:45pm - 1:45pm, Nov 13

📍 Capitol Auditorium

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🗨️ **Speakers**



**Al Collins** Vice President of Public Policy, Occidental Petroleum Corporation



**Russell Gold** Senior Reporter, The Wall Street Journal



**David Hudson** President, Xcel Energy



**McCall Johnson** Director, External Affairs, Recurrent Energy



**Sheila M. Olmstead** Professor, Lyndon B. Johnson School of Public Affairs, University of Texas at Austin (UT)

1:45pm

**BREAK**

🕒 1:45pm - 2:15pm, Nov 13

📍 Legislative Conference Center

2:15pm

**Clean Energy as an Economic Development Tool**

🕒 2:15pm - 3:15pm, Nov 13

📍 Hearing Room E02.014

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🗨️ **Speakers**



**John Clamp** Chief Financial Officer, Alamo Area Council of Governments



**John Davis** Former State Representative, Conservative Texans for Energy Innovation



**Charlene Heydinger** President, Texas PACE Authority



**Ginger Watkins** Executive Director / Economic Development, Cameron Industrial Foundation

### Electrifying Transportation

🕒 2:15pm - 3:15pm, Nov 13

📍 Hearing Room E02.016

#### 🗣️ Speakers



**Fernando Cazares** National Director, Chispa



**Alison Cochran** Product Planning Manager, Peterbilt Motors Company



**Chris George** Executive Director, EVOlve Houston



**Tom "Smitty" Smith** Executive Director, Texas Electric Transportation Alliance (TxETRA)



**David Treichler** Director Strategy and Technology, Oncor Electric Delivery

### Public Sector Energy Efficiency Requirements

🕒 2:15pm - 3:15pm, Nov 13

📍 Hearing Room E02.010

There are numerous energy efficiency requirements for public sector entities in Texas. The newest is requirement that state agencies have assessments performed to determine whether they should subsequently implement Continuous Commissioning or some other accepted form of existing building commissioning. This session will address these requirements and financing options with a discussion of the legislative intent of the commissioning assessments by the author of the legislation.



Cliff Braddock METCO Engineering



David Claridge Director, TEES Energy Systems Laboratory



Rep. John Raney Representative, Texas House of Representatives



Bahman Yazdani Associate Director, TEES Energy Systems Laboratory



Fred Yebra State Energy Conservation Office (SECO)

### 3:15pm

#### BREAK

🕒 3:15pm - 3:45pm, Nov 13

📍 Legislative Conference Center

### 3:45pm

#### Keynote: Benji Backer, American Conservation Coalition

🕒 3:45pm - 4:15pm, Nov 13

📍 Capitol Auditorium

#### 🗣️ Speaker



Benjamin Backer President & Founder, American Conservation Coalition

### 4:15pm

#### Political Movements and Climate Change

🕒 4:15pm - 5:15pm, Nov 13

📍 Capitol Auditorium

#### 🗣️ Speakers



Benjamin Backer President & Founder, American Conservation Coalition



Emma Galbraith Student Activist, Citizen Climate Lobby/ Austin Climate Coalition



Pamela M. Giblin Climate Leadership Council Senior Policy Advisor, Baker Botts, L.L.P.



Albert Morales Sr. Political Director, American Decisions



Phoebe Sweet Manager Director, Climate Nexus

### 5:15pm

#### Welcome Reception

🕒 5:15pm - 6:30pm, Nov 13

📍 Legislative Conference Center

## Thu, Nov 14, 2019

### 8:30am

#### What's Happening on the ERCOT Grid and How does it Impact Air Quality?

🕒 8:30am - 9:30am, Nov 14

📍 Capitol Auditorium

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#### 🗣️ Speakers



Jeff Haberl Professor and Assistant Director, Texas A&M University, Dept. of Architecture and Texas A&M Engineering Experiment Station's Energy Systems Laboratory



Joshua Rhodes Senior Energy Analyst, Vibrant Clean Energy

### 9:30am

#### Keynote Plenary: Utilities, Customers, and New Energy Technologies

🕒 9:30am - 10:30am, Nov 14

📍 Capitol Auditorium

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**Kevin Boudreaux** Vice President - Sustainable Solutions, MP2 Energy LLC, a Shell Energy North America Subsidiary



**Deborah Kimberly** Vice President, Customer Energy Solutions and Corporate Communications, Austin Energy



**Joseph Kopser** Executive in Residence, McCombs Business School



**Suzanne Russo** Chief Executive Officer, Pecan Street Inc.

### 10:30am

#### Break

🕒 10:30am - 11:00am, Nov 14

📍 Legislative Conference Center

### 10:45am

#### Being Resilient through the Pitfalls of Energy Management

🕒 10:45am - 11:45am, Nov 14

📍 Hearing Room E02.014

#### 🗣️ Speakers



**Jim Brown** Senior Principal, EAS Energy System Associates, Inc.



**Danny Helm** Energy Manager, Arlington Independent School District



**David Hoedebeck** Director of Maintenance, Round Rock ISD



**Ashley Williams** Director of Curriculum, Texas Energy Managers Association (TEMA)


### 11:00am

#### Innovation for Industrial Emissions Reductions

🕒 11:00am - 12:00pm, Nov 14

📍 Hearing Room E02.016

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 **Speakers**



**Marilu Hastings** Vice President, Sustainability Programs, Cynthia and George Mitchell Foundation



**Scott Martin** Principal and Engineering Manager, 8 Rivers Capital



**Jason Lankford** Energy Tech Center Director, Dow Chemical



**Alan Rossiter** Executive Director, External Relations/Educational Program Development, UH Energy, University of Houston



**Ken Medlock** Senior Director, Center for Energy Studies

**Poster Session**

🕒 11:00am - 12:00pm, Nov 14

📍 Extension, South Central Gallery

**11:45am**

**LUNCH**

🕒 11:45am - 12:30pm, Nov 14

📍 Capitol Grill

**12:30pm**

**Big Renewables: Procuring Cheap, Clean Energy**

🕒 12:30pm - 1:30pm, Nov 14

📍 Hearing Room E02.014

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 **Speakers**



**Mike Bendewald** Managing Partner, Texas Energy Aggregation



**Chris Hendrix** CEO & Co-Founder, Demand Control 2, LLC





James Hines SVP Government Affairs and General Counsel, Texas Association of Business



Beth O'Brien Sr. Manager, External Affairs and Government Relations, Pattern Energy

### Local Government Energy Leadership

🕒 12:30pm - 1:30pm, Nov 14

📍 Hearing Room E02.016

#### 🗣️ Speakers



Lara Cottingham Chief Sustainability Officer, City of Houston



Cassidy Ellis Local Government Program Manager, South-central Partnership for Energy Efficiency as a Resource (SPEER)



James McGuire Director of Environmental Quality & Sustainability, City of Dallas

### Poster Session

🕒 12:30pm - 1:30pm, Nov 14

📍 Extension, South Central Gallery

### 1:30pm

### 2019 Texas Energy Summit Awards Ceremony

🕒 1:30pm - 2:30pm, Nov 14

📍 Capitol Auditorium

### 2:30pm

### Closing Keynote Plenary: Policy Solutions for Clean Air and Clean Energy

🕒 2:30pm - 3:30pm, Nov 14

📍 Capitol Auditorium

#### 🗣️ Speakers



Rep. Cecil Bell Representative, Texas House of Representatives



Kiah Collier Reporter/Editor, The Texas Tribune



Rep. Brooks Landgraf Representative, Texas House of Representatives



Rep. Eddie Rodriguez Representative, Texas House of Representatives



Rep. Erin Zwiener Representative, Texas House of Representatives

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#### 6.4.6 Papers, Theses, etc.

##### 6.4.6.1 Theses and Dissertations.

The following theses and dissertations were published in 2019 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Azizkhani, M. “*Investigating the Level of Application/Education of Passive/Natural Systems in the Design of Sustainable Buildings in the US*”, PhD., Department of Architecture, April 2019.

The purpose of this research is to examine the degree of adoption and education of the concepts of natural systems for heating, cooling, and lighting (i.e., passive systems) versus artificial/mechanical systems (i.e., active systems) in the design of sustainable buildings by practitioners and educators. In addition, this research investigates the variables that may increase/reduce the application of these systems in architectural designs. Natural systems use renewable energies or ambient conditions, while mechanical systems often use non-renewable energies to heat, cool, ventilate, and illuminate buildings. Although an extensive list of publications about natural systems exist, there are very few studies about the approaches/tools used by professionals for the design of natural systems in sustainable buildings. This research seeks to fill this gap through three methodologies, including: a content analysis, a case study, and a survey questionnaire to practitioners/educators. The findings show that there is a low percentage of the application of passive/natural systems in architecture design in the US. To promote the application of passive systems, the clients’ desire/collaboration, building code/rating systems, and simulation tools for passive design are the most influential factors according to a survey of the practitioners in the US. The findings also indicate that the education of passive/natural systems in the US architecture schools are mainly focused on discussions at the conceptual level, which iii needs to be further developed to include the teaching of the simulation of these systems as well. Overall, the findings suggest that investment in several areas can facilitate the application of passive systems in the US, which include: better educational focus on the simulation/calculation of passive systems; stronger connection between academia and the building industry focused on passive design; providing user-friendly tools for the design of passive systems; better collaboration between architects, clients, and engineers; reducing the work experience gap between retiring faculty and new faculty; better focus on passive design in integrated design studios; and strong inclusion of passive systems in building codes/rating systems. The long term goal of this study is to pave the way for reducing a building’s energy consumption by shifting society’s dependency from non-renewable energies to renewable energies.

- Ahn, J, “*Origins of Whole-Building Energy Simulation Programs Used for High Performance Commercial Buildings: Contributions of the MATEUS, SHEP, TACS, CP-26, CP-33 and RESPTK Programs*”, MS., Department of Architecture, August 2019.

Today, there are many building energy simulation programs in use. Some programs are publicly available, while others are restricted to private use. However, currently, there are only a few large, public domain programs that are widely used, such as DOE-2.2/eQUEST, TRNSYS, EnergyPlus and proprietary programs, such as TRACE and HAP. All these programs have their roots in the development of the 1950s and 1960s.

Several previous papers have traced the origins of building energy simulation programs to the Post Office program. However, there were earlier programs that were not widely discussed in these previous papers, including the Mathematical Analysis of Thermal Environment in Underground Shelters (MATEUS) program, the SHelter Environmental Prediction (SHEP) program, the Thermodynamic Analysis Computer System (TACS) program and several miscellaneous computer programs that contributed significantly to the development of the Post Office program and the NBSLD program, which included: the FORTRAN IV program to calculate heat flux response factors for a multi-layer slab (i.e., the CP-26 program), the Response Factors Calculation program (RESPTK) and the FORTRAN IV program to calculate z-transfer functions for the calculation of transient heat transfer

through walls and roofs (i.e., the CP-33 program). In addition, contributions of the American Society of Heating, Refrigerating and Air conditioning Engineers (ASHRAE) Task Group on Energy Requirements (TGER) to the development of early computer programs were not widely discussed in detail in these previous studies. Therefore, this study revisits the importance of the earlier programs that contributed to the development of the Post Office program and the NBSLD program.

#### 6.4.6.2 Papers

##### 6.4.6.2.1 Published Papers in 2019

The following papers were published in 2019 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Farias, F., Kota, S., Jeong, W., Kim, J., Alcocer, J, Haberl, J.S., Clayton, M.J., Yan, W., 2019. “*Development of a Reference Building Information Model (BIM) for Thermal Model Compliance Testing - Part II: Test Cases and Analysis (RP-1468)*”, ASHRAE Transaction.

This paper is the second of two papers that report on the results of ASHRAE Research Project RP-1468. Accurate building performance analysis is necessary for designing high performance sustainable buildings. This paper discusses the analysis of selected test cases conducted to arrive at mapping rules. The test cases presented include alternative modeling of curved facades; alternative modeling of an arched window with shades; and the analysis of the alternative location of thermal surfaces with respect to the outside face, centerline, and inside face of an exterior wall. The test cases were modeled using Building Information Models (BIMs) and building energy simulation (BES) tools, and simulations were performed. A Rapid Analysis of Energy Simulation Results (RAESR) spreadsheet tool was developed to support the comparison of simulation results. The development process and tools used to conduct the analyses are provided in the final three-volume report so they may be of use to other researchers.

Link: [https://www.techstreet.com/standards/at-19-013-development-of-a-reference-building-information-model-bim-for-thermal-model-compliance-testing-part-ii-test-cases-and-analysis-rp-1468?product\\_id=2043942](https://www.techstreet.com/standards/at-19-013-development-of-a-reference-building-information-model-bim-for-thermal-model-compliance-testing-part-ii-test-cases-and-analysis-rp-1468?product_id=2043942)

- Shin, M., Haberl, J.S., 2019. “*Thermal Zoning for Building HVAC Design and Energy Simulation: A Literature Review*”, Energy and Buildings, Vol 203.

Building energy simulation programs can be useful tools in evaluating building energy performance during a building's lifecycle, both at the design and operation stages. In addition, simulating building energy usage has become a key strategy in designing high performance buildings that can better meet the needs of society without consuming excess resources. Therefore, it is important to provide accurate predictions of building energy performance in building design and construction projects. Although many previous studies have addressed the accuracy of building energy simulations, very few studies of this subject have mentioned the importance of Heating, Ventilation, and Air-Conditioning (HVAC) thermal zoning strategies to sustainable building design. This research provides a systematic literature review of building thermal zoning for building energy simulation. This work also reviews previous definitions of HVAC thermal zoning and its application in building energy simulation programs, including those appearing in earlier studies of the development of new thermal zoning methods for simulation modeling. The results indicate that future research is needed to develop a well-documented and accurate thermal zoning method capable of assisting designers with their building energy simulation needs.

Link: <https://www.sciencedirect.com/science/article/pii/S0378778819312769>

- Shajahan, A, Culp, C.H., Williamson, B., 2019. “*Effects of Indoor Environmental Parameters Related to Building Heating, Ventilation, and Air Conditioning Systems on Patients’ Medical Outcomes: A Review of Scientific Research on Hospital Buildings*”, *Indoor Air*, Vol 29, Issue 2, pp.161-176.

The indoor environment of a mechanically ventilated hospital building controls infection rates as well as influences patients’ healing processes and overall medical outcomes. This review covers the scientific research that has assessed patients’ medical outcomes concerning at least one indoor environmental parameter related to building heating, ventilation, and air conditioning (HVAC) systems, such as indoor air temperature, relative humidity, and indoor air ventilation parameters. Research related to the naturally ventilated hospital buildings was outside the scope of this review article. After 1998, a total of 899 papers were identified that fit the inclusion criteria of this study. Of these, 176 papers have been included in this review to understand the relationship between the health outcomes of a patient and the indoor environment of a mechanically ventilated hospital building. The purpose of this literature review was to summarize how indoor environmental parameters related to mechanical ventilation systems of a hospital building are impacting patients. This review suggests that there is a need for future interdisciplinary collaborative research to quantify the optimum range for HVAC parameters considering airborne exposures and patients’ positive medical outcomes.

Link: <https://onlinelibrary.wiley.com/doi/full/10.1111/ina.12531>

## 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 2019, and the activities summary is listed as follow:

- Regular maintenance
- Weekly report.

### 6.5.1 Solar Test Bench Setup

Figure 64 shows the exterior view of the STB. In addition, the whole STB setup comprises the sensors indicated in Table 34, which includes the sensor name, make, model and serial number along with the multiplier, offset and unit.



Figure 64. Exterior View of the Solar Test Bench

Table 34. List of the sensors updated to the end of 2019

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

6.5.2 2019 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 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 65 shows the example plots comparing the STB data with the NOAA data.

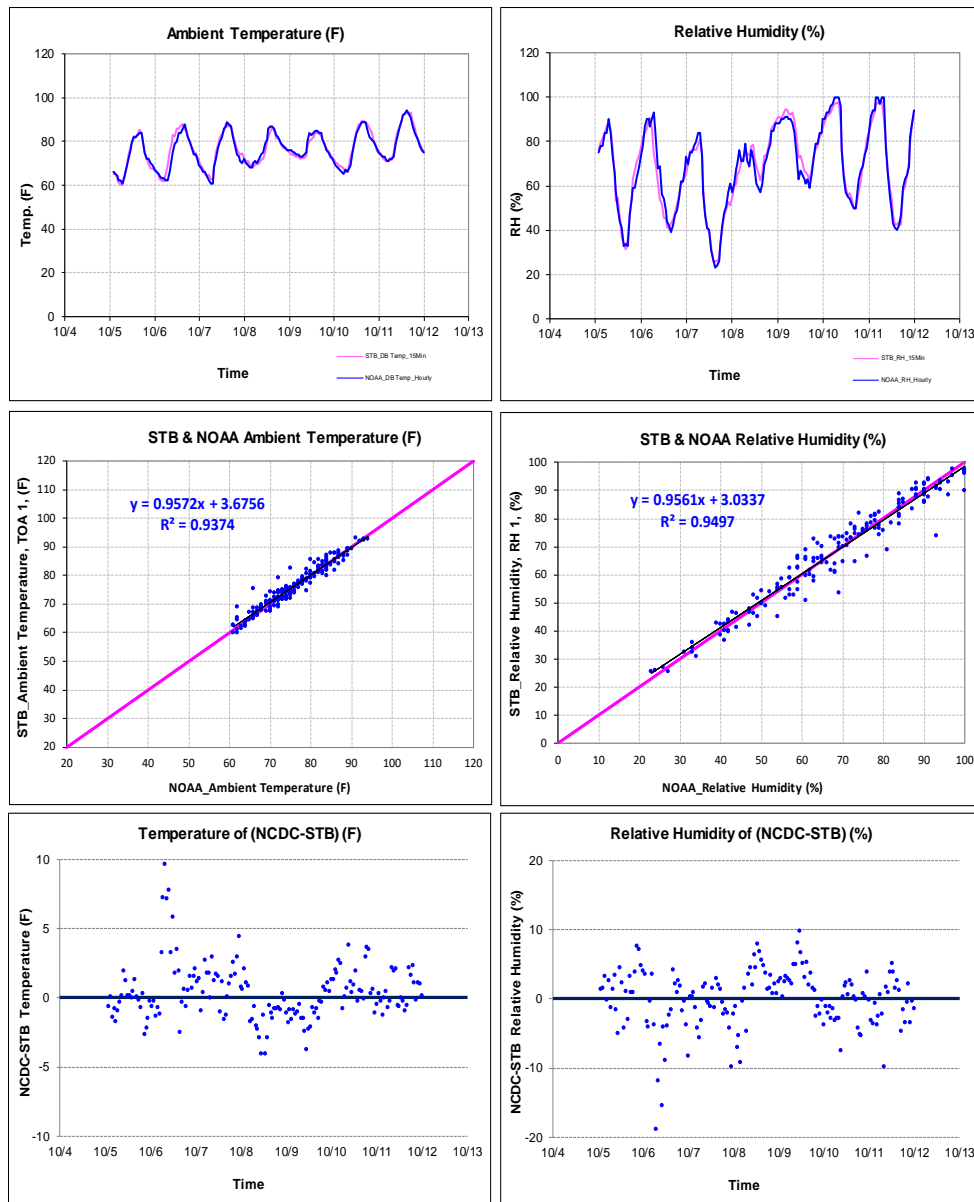


Figure 65: Comparisons of the STB Data with the NOAA Data

### 6.5.3 Future work Plan

- Datalogger firmware update
- New global solar radiation (the combination of direct and diffuse solar radiation) measurement instrument installation
- Remote weather station installation

### 6.5.4 Acknowledgements

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Appendix A: Presentations to Various Entities at Conferences and Workshops in 2019

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

- “Energy Efficiency and Renewable Energy Impacts on NOx Emission Reductions” Texas Energy Summit conference, Austin, TX, Nov 2019, presented by Jeff Haberl.

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## Energy Efficiency and Renewable Energy Impacts on NOx Emission Reductions in Texas

Jeff Haberl, Ph.D.  
Juan-Carlos Baltazar, Ph.D., P.E.  
Bahman Yazdani, P.E.

2019 TEXAS ENERGY SUMMIT  
Texas State Capitol in Austin, Texas  
November 12-14, 2019

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## ACKNOWLEDGEMENTS

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**TCEQ:** Bob Gifford, Vincent Meiller  
**PUC:** Katie Rich, Therese Harris  
**SECO:** Dub Taylor, Stephen Ross  
**ERCOT:** Paul Wattles, Connor Anderson

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## LEGISLATION

**Legislation to Reduce Energy/Emissions 2001 to Present**

**Senate Bill 5 (79th Legislature, 2001)**  
 CH 385 Texas Emissions Reduction Plan  
 CH 386 Texas Building Energy Performance Standards  
 CH 388.003 Adoption of Building Energy Efficiency Performance Standards  
 CH 388.004 Enhancement Of Energy Standards Outside Of Municipality  
 CH 388.007 Distribution Of Information And Technical Assistance  
 CH 388.008 Development Of Home Energy Ratings

**TERP Amended (79th Legislature, 2005)**  
 CH 386 Texas Building Energy Performance Standards  
 (HB 1365) Sec. 388.004 Enhancement Of Energy Standards Outside Of Municipality  
 (HB 1260) Sec. 388.005 Energy Efficient Building Program  
 CH 388 Texas Building Energy Performance Standards  
 (HB 3225) Sec. 388.009 Certification of Municipal Inspectors

**TERP Amended (79th Legislature, 2005)**  
 CH 382 Health and Safety Code  
 (HB 1212) Sec. 382.056 Development of Creditable Statewide emissions from wind and other renewable  
 (HB 3653) Sec. 382.0275 Commission Action Relating to Water Heaters

**TERP Amended (80th Legislature, 2007)**  
 CH 382 Health and Safety Code  
 (HB 3693) Sec. 388.003 add sub-section (b-1), (b-2), (b-3) that allows SECO to adopt new editions of the IECC based on written recommendations from the Laboratory  
 (HB 3693) Sec. 388.008 Development of Standardized report formats for newly constructed residences  
 CH 382 Health and Safety Code  
 (SB 12) Section 388.03 add sub-section (b-1), (b-2) allows SECO to adopt new editions of the IECC based on written recommendations from the Laboratory

**TERP Amended (81st Legislature, 2009)**  
 CH 382 Health and Safety Code  
 (HB 1786) Section 23 amends Sec. 388.252 (a) and (b) extends date of TERP to 2019 and requires Commission to contract with Laboratory for credible EE/RG emissions reductions

**TERP Amended (82nd Legislature, 2011)**  
 CH 477.004 Health and Safety Code  
 HB 51 Section 2, v-2, establishes advisory committee, which including the Laboratory  
 Section 3 & 4 amends review of municipal's amendments  
 CH 388.003 & 388.007 of Health and Safety Code  
 HB 51 Section 3 & 4 amends review of municipal's amendments

**CH 388.006 Health and Safety Code**  
 SB 896 Section 2, requires the Laboratory to calculate energy savings and emissions reductions for political subdivisions reporting to SECO

**CH 39.905 Utilities Code**  
 SB 924 Section 1(a) and Section 2(d) requires the Laboratory to calculate energy savings and emissions reductions for political subdivisions reporting to SECO

**NO new amendments were passed (82nd Legislature, 2012)**

**TERP Amended (84th Legislature, 2015)**  
 Section 388.003, Health and Safety Code  
 HB 1726 Section 1 Establishes the 2015 energy code as the TERP's effective date  
 1. 2015. The state may adopt new codes no sooner than every 6 years. The Section also adds Energy Rating Index as a voluntary compliance alternative

**NO new amendments were passed (83rd Legislature, 2017)**

**NO new amendments were passed (85th Legislature, 2019)**

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## EPA CRITERIA FOR SIP CREDITS (2004)

**Quantifiable:** The emission reductions generated by measures to reduce emissions *must be quantifiable* and include procedures to evaluate and verify over time the level of emission reductions actually achieved.

**Surplus:** Emission reductions are *surplus* as long as they are not otherwise relied on to meet air quality attainment requirements in air quality programs related to your SIP.

**Enforceability:** Measures that reduce emissions from electricity generation may be: (1) *Enforceable directly* against a source; (2) *Enforceable against another party* responsible for the energy efficiency or renewable energy activity; or (3) Included under our *voluntary measures* policy.

**Record Keeping:** The *measure should be permanent* throughout the term for which the credit is granted unless it is replaced by another measure or the State demonstrates in a SIP revision that the emission reductions from the measure are no longer needed to meet applicable requirements.

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## ENERGY SAVINGS & NOx EMISSION REDUCTION

**IC3 International** **ESL Calculates & Reports NOx Emissions Reductions for:**

- Code-Compliant Construction:** Energy savings from new construction
  - ESL Single-family construction
  - ESL Multi-family construction
  - ESL Commercial construction
- Green Power Production:** Wind and other renewables
- PUC SB7:** Energy efficiency programs implemented by electric utilities under the Public Utility Regulatory Act §39.905
- SECO:** Energy-efficiency programs towards school districts, government agencies, city and county governments, private industries and residential energy consumers
- A/C Retrofits:** Installation of SEER 13/14 replacement air conditioners in existing residences

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## ENERGY SAVINGS & NOx EMISSION REDUCTION

**IC3 International** **ESL Calculates & Reports NOx Emissions Reductions for:**

**Code-Compliant Construction:** Energy savings from new construction

**IC3 International** **ESL Calculates & Reports NOx Emissions Reductions for:**

**User Login**  
 (This is the publicly accessible energy code compliance software based on the Texas Building Energy Performance Standards Version 4.4 Jan 2015 release)  
 1. Requirement: Version 4.4 has drastically changed the ESL algorithm. The amount of calculations needed has more than doubled. An ESL calculation will now take up to 1 minute to complete

Username: \_\_\_\_\_ Please enter a username  
 Password: \_\_\_\_\_ Please enter a password  
 (Log In)  
 Register New User: [Energy Password](#)

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 Contains: HoloSAP Manual, IC3 v4.4.2, RESNET1 User Results, IC3 File

**Login Screen**

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**ENERGY SAVINGS & NOx EMISSION REDUCTION**

**IC3** International ENERGY CODE COMPLIANCE CALCULATOR

**ESL Calculates & Reports NOx Emissions Reductions for:**  
Code-Compliant Construction: Energy savings from new construction

**Main Page**

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**ENERGY SAVINGS & NOx EMISSION REDUCTION**

**IC3** International ENERGY CODE COMPLIANCE CALCULATOR

**ESL Calculates & Reports NOx Emissions Reductions for:**  
Code-Compliant Construction: Energy savings from new construction

**Prints Certificate for Electrical Panel**

- IC3 Prints Certificate for Posting on Electrical Panel
- Records Certificate in IC3 Registry

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**STATEWIDE SAVINGS FROM CODE COMPLIANCE**

How much electricity has been saved from residential code compliance for all single-family housing 2000-2019?

**Projects/Certificates in IC3 Registry**

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**STATEWIDE SAVINGS FROM CODE COMPLIANCE**

How much residential code compliances have saved in Austin, TX (Climate Zone 2A) from 1999 to 2019?

**2,500 ft2 SF House**

Wall: R-11 to R13  
Roof: R-26 to R-38  
Win Uval: 1.11 to 0.40  
Win SHGC: 0.71 to 0.25  
SEER: 10 to 14  
AFUE: 0.80 to 0.82  
HSPF: 6.8 to 8.2  
DHW EF: 0.86 to 0.95

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**STATEWIDE SAVINGS FROM CODE COMPLIANCE**  
2000 – 2018 (ESTIMATED)

**Savings (2002 to 2017)**  
Total: \$6,737 million

**Savings (2002 to 2018)**  
Electricity (Envelope): \$2,336 million (+9.2%)  
Electricity (HVAC Systems): \$2,258 million (+20.0%)  
Demand: \$3,078 million (+13.2%)  
Total: \$7,672 million (+13.9%)

**Increased Costs (2002 to 2018)**  
Costs: \$ 2,077 million

**NOx Emissions Reduction (2008 to 2018)**  
82.21 tons NOx / year

**Emissions Reduction in 2018**  
(Equivalent to about 62,500 cars)

**Total: \$7,672 million**  
**Demand: \$3,078 million**  
**Electricity (HVAC Systems): \$2,258 million**  
**Cost: \$2,077 million**  
**Electricity (Envelope): \$2,336 million**

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**STATEWIDE WATER SAVINGS AT POWER PLANTS**  
2000 – 2018

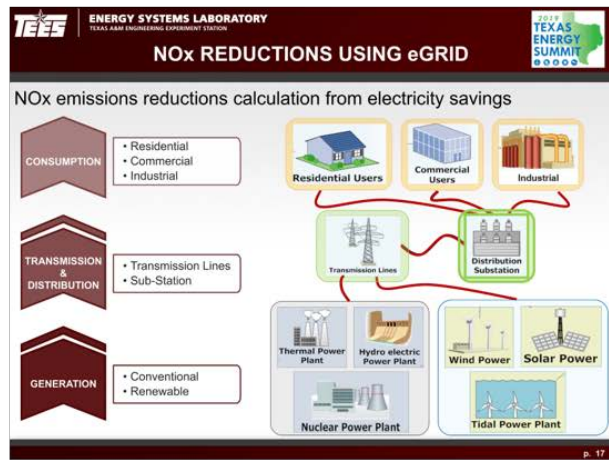
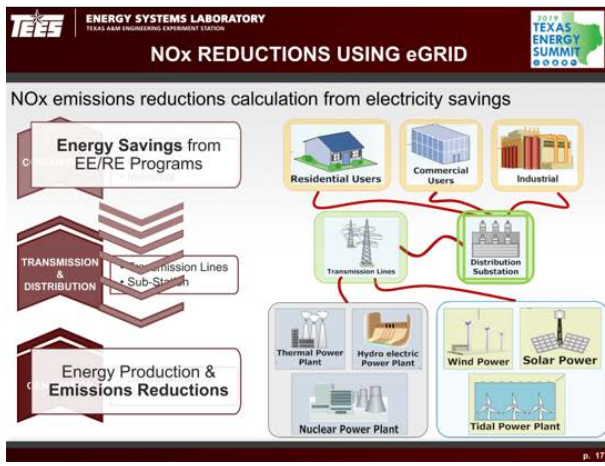
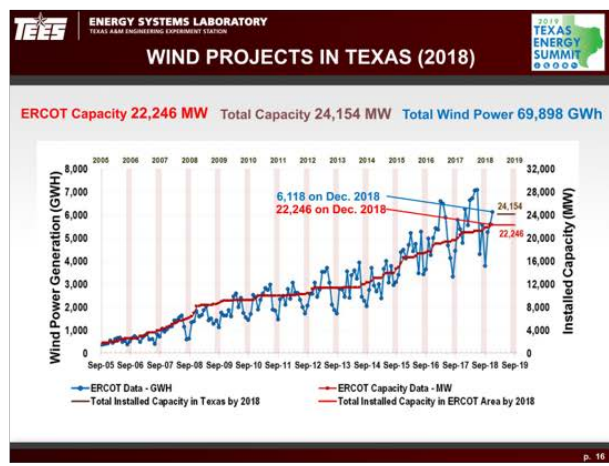
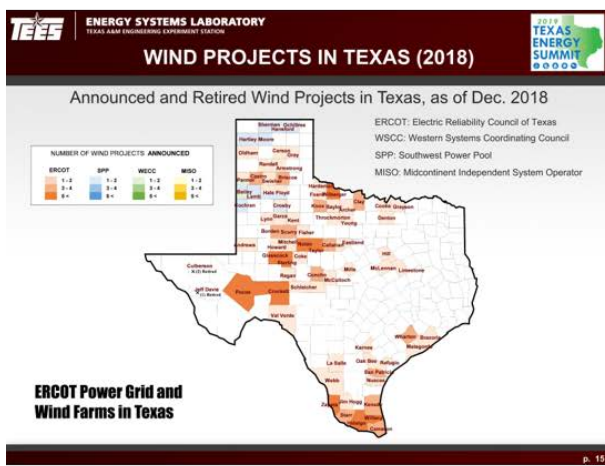
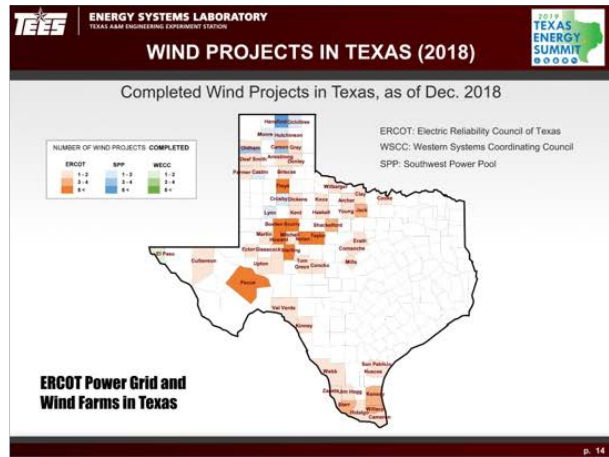
Electricity/Water Savings from SF (Code Compliance)

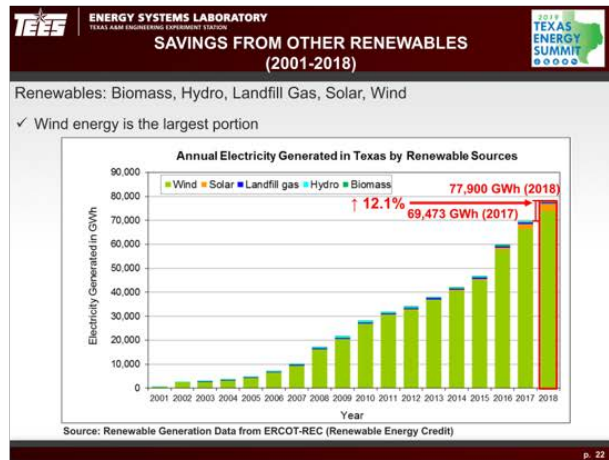
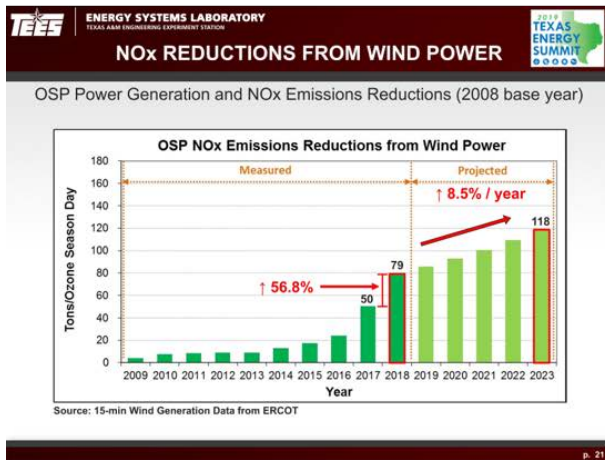
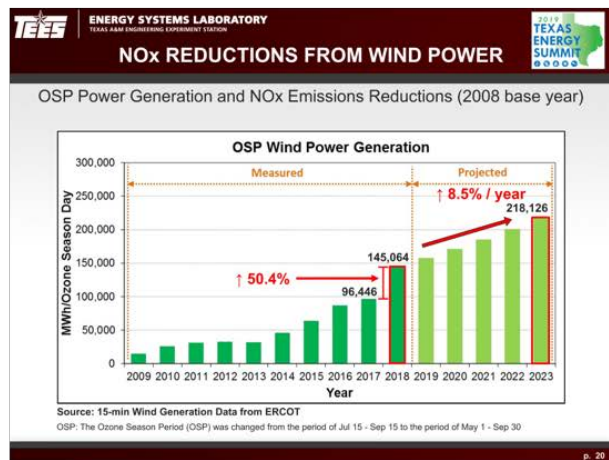
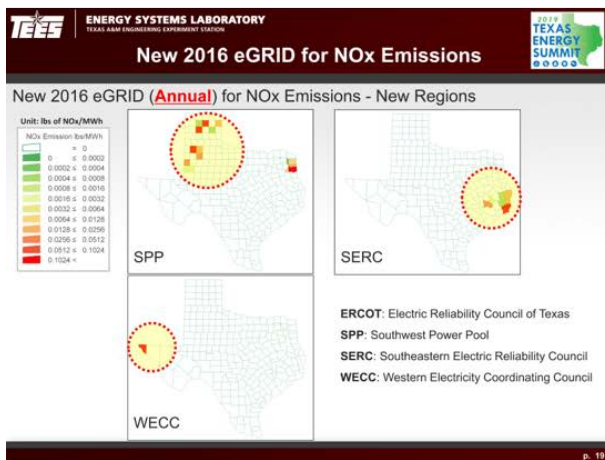
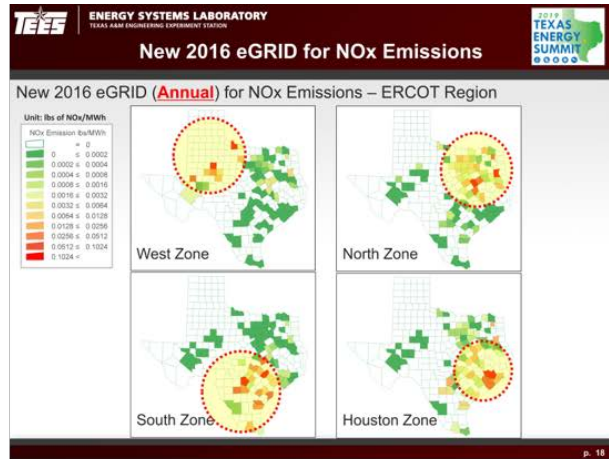
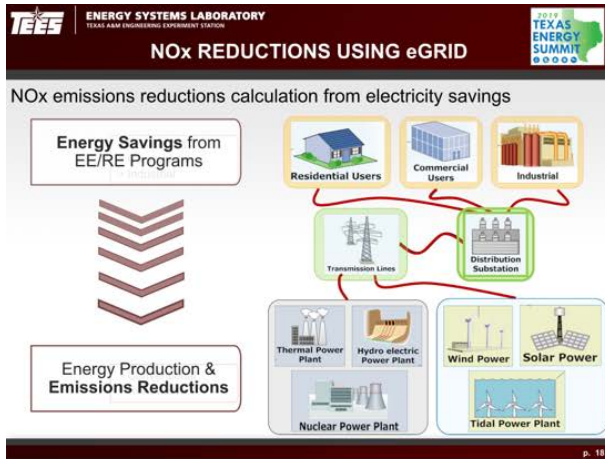
**2018 Total Electricity Savings (MWh/yr)**  
1,872,999

**2018 Total Water Savings (gal/yr) (acre-ft/yr)**  
805,389,366 (2,472)

Conversion Factors: 430 gal/MWh, 325,851 gal/acre-ft

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### SAVINGS FROM OTHER RENEWABLES (2001-2018)

Renewables: Biomass, Hydro, Landfill Gas, Solar, Wind

✓ Wind energy is the largest portion

**Excluding Wind**

Annual Electricity Generated in Texas by Renewable Source (Excluding Wind)

Year	Biomass (GWh)	Hydro (GWh)	Landfill gas (GWh)	Solar (GWh)
2001	~100	~100	~100	~100
2018	287	205	395	3,183

Source: Renewable Generation Data from ERCOT-REC (Renewable Energy Credit)

### RENEWABLE PROJECTS IN TEXAS (2018)

Renewables\*:

- Solar PV - non utility scale (4,794 projects) **+8 projects**
- Solar PV- utility scale (49 projects) **+18 projects**
- Biomass (14 projects)
- Hydro (29 projects)
- Geothermal (286 projects)
- Landfill Gas (37 projects)

Aspen Power plant in Lufkin, TX

### 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.

Integrated OSP MWh Savings

Year	MWh/OSP
2008	~1,000
2017	10,534
2018	11,532
2023	15,820

↑ 9.5% (2017 to 2018)    ↑ 6.5% / year

### 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

Integrated OSP MWh Savings

Year	MWh/OSP
2008	~200
2017	3,251
2018	3,841
2023	5,088

↑ 8.2% (2017 to 2018)    ↑ 5.8% / year

### 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

2018 Annual NOx eGRID (Proposed Emissions Reduction @ 2023)

Combined Energy and NOx Savings Summary: 88 Programs in the 104 ERCOT Counties. 863,448 kWh/year. 10,000 tons/year and 10,000 tons/year.

### INTEGRATED NOx EMISSIONS REDUCTION (2008 Baseyear)

2018 Integrated OSP NOx Emissions Reduction Using new 2016 eGRID

2018 Integrated OSP NOx Emissions Reduction

Year	NOx Emissions Reduction (tons/day)
2017	59
2018	90
2023	137

↑ 52.4% (2017 to 2018)    ↑ 8.8% / year

2018 Integrated OSP NOx Emissions Reduction

- ESL Code Compliance (4.85 tons/day)
- PUC SB7 programs (4.21 tons/day)
- SECO Political Sub.\* (1.30 tons/day)
- Green Power (Wind) (78.80 tons/day)
- Residential AC Retrofits (0.63 tons/day)
- Total (2018) (89.79 tons/day)**

2023 Integrated OSP NOx emissions reduction


- ESL Code Compliance (10.25 tons/day)
- PUC SB7 programs (5.78 tons/day)
- SECO Political Sub.\* (1.75 tons/day)
- Green Power (Wind) (118.49 tons/day)
- Residential AC Retrofits (0.49 tons/day)
- Total (2023) (136.77 tons/day)**

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### REPORTS AND PAPERS: TERP

**Reports: 2002 through 2018**

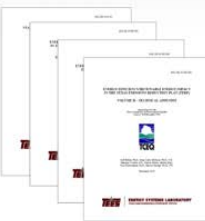


*A Growing Knowledge Base*

**Recent Reports:**

- Statewide 2018 Air Emission Calculations from Wind and Other Renewables (Vol I and Vol II)
- TCEQ 2018 Annual Preliminary Report: Integrated NOx Emissions Savings from EEIRE Programs Statewide
- TCEQ 2018 Annual Report Volume I: Technical Report
- TCEQ 2018 Annual Report Volume II: Technical Appendix

**Publications:**




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### REPORTS AND PAPERS: TERP

**Publications: 2018**



**Dissertation 2018:**

- Shao, W. "Development of a Procedure for Automating Thermal Zoning for Building Energy Simulation" PhD, Department of Architecture, August 2018.

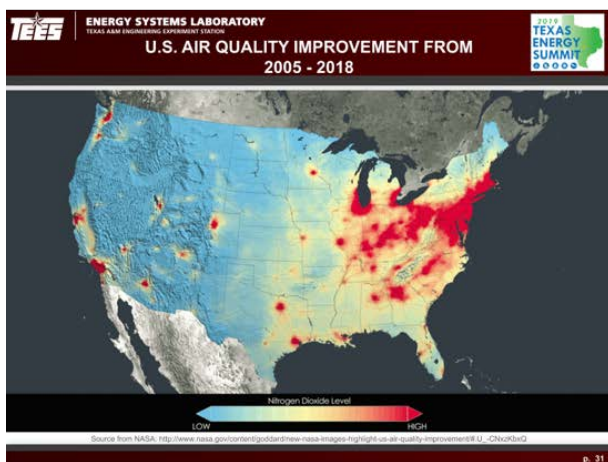
**Papers 2018:**

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**ENERGY SYSTEMS LABORATORY**  
TEXAS A&M ENGINEERING EXPERIMENT STATION

**2019 TEXAS ENERGY SUMMIT**

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## Appendix B: IC3 Parameter Reports

Tables between Table 35 and Table 64 show the yearly average parameter values by county. These tables show wall cavity insulation across Texas in 2019.

Table 35: Yearly Average Wall Cavity Insulation Distribution by County in 2019 (All Projects)

County	Avg Wall Insulation (R-value)	House Count	County	Avg Wall Insulation (R-value)	House Count
Anderson	13.0	1	Hopkins	13.6	13
Austin	0.0	1	Hunt	13.1	103
Bastrop	17.5	2	Jefferson	15.0	4
Bexar	13.2	101	Johnson	14.2	186
Blanco	16.0	1	Kaufman	13.2	267
Brazoria	13.0	1	Liberty	13.0	40
Brazos	2.1	149	Llano	15.2	3
Burnet	15.0	4	Mason	18.4	5
Caldwell	13.0	2	McLennan	10.5	8
Cameron	19.0	1	Medina	6.5	2
Coleman	15.0	1	Midland	16.5	2
Collin	16.4	774	Montague	13.2	4
Comal	13.1	17	Montgomery	16.9	5
Cooke	16.2	2	Navarro	13.0	1
Dallas	14.3	1417	Nueces	13.1	191
Denton	13.9	667	Palo pinto	13.0	4
Ellis	13.9	174	Parker	14.0	219
Erath	13.0	2	Potter	0.0	1
Fort bend	12.9	4	Rains	13.0	1
Freestone	13.0	1	Rockwall	13.3	87
Galveston	16.0	10	San patricio	13.0	11
Gillespie	13.0	1	Tarrant	14.0	1977
Grayson	14.2	145	Taylor	14.0	1
Gregg	13.0	5	Travis	15.1	1559
Guadalupe	13.4	13	Van zandt	16.8	3
Harris	15.8	831	Walker	13.0	1
Hays	11.1	7	Waller	8.7	3
Henderson	13.9	32	Williamson	13.0	1
Hidalgo	13.5	2	Wise	13.6	58
Hood	13.4	89			



Table 36: Yearly Average Wall Cavity Insulation Distribution by County in 2019 (Submitted Projects)

County	Avg Wall Insulation (R-value)	House Count
Anderson	13.0	1
Bastrop	17.5	2
Bexar	13.2	89
Brazoria	13.0	1
Brazos	13.4	16
Burnet	15.0	4
Caldwell	13.0	2
Coleman	15.0	1
Collin	16.5	750
Comal	13.1	15
Cooke	16.2	2
Dallas	14.6	1303
Denton	14.0	627
Ellis	14.1	163
Fort bend	12.9	4
Freestone	13.0	1
Galveston	15.7	9
Gillespie	13.0	1
Grayson	14.4	136
Gregg	13.0	3
Guadalupe	17.7	9
Harris	16.1	788
Hays	13.0	4
Henderson	13.9	32
Hidalgo	13.5	2
Hood	13.4	89
Hopkins	13.9	9

County	Avg Wall Insulation (R-value)	House Count
Hunt	13.2	100
Jefferson	15.7	3
Johnson	14.3	178
Kaufman	13.2	255
Liberty	13.0	31
Llano	15.2	3
Mason	18.4	5
Mclennan	14.0	6
Medina	13.0	1
Midland	16.5	2
Montague	13.2	4
Montgomery	17.4	4
Navarro	13.0	1
Nueces	13.1	189
Palo pinto	13.0	3
Parker	14.2	203
Rains	13.0	1
Rockwall	13.4	83
San patricio	13.0	11
Tarrant	14.4	1804
Travis	15.2	1455
Van zandt	16.5	2
Walker	13.0	1
Waller	13.0	1
Williamson	13.0	1
Wise	13.8	55

Table 37: Yearly Average Wall Cavity Insulation Distribution by County in 2019 (Passed Projects)

County	Avg Wall Insulation (R-value)	House Count	County	Avg Wall Insulation (R-value)	House Count
Anderson	13.0	1	Hunt	13.2	100
Bastrop	17.5	2	Jefferson	15.7	3
Bexar	13.2	89	Johnson	14.3	178
Brazoria	13.0	1	Kaufman	13.2	255
Brazos	13.4	16	Liberty	13.0	31
Burnet	15.0	4	Llano	15.2	3
Caldwell	13.0	2	Mason	18.4	5
Coleman	15.0	1	McLennan	14.0	6
Collin	16.5	750	Medina	13.0	1
Comal	13.1	15	Midland	16.5	2
Cooke	16.2	2	Montague	13.2	4
Dallas	14.6	1302	Montgomery	17.4	4
Denton	14.0	626	Navarro	13.0	1
Ellis	14.1	163	Nueces	13.1	189
Fort bend	12.9	4	Palo pinto	13.0	3
Freestone	13.0	1	Parker	14.2	203
Galveston	15.7	9	Rains	13.0	1
Grayson	14.4	136	Rockwall	13.4	83
Gregg	13.0	3	San patricio	13.0	11
Guadalupe	17.7	9	Tarrant	14.4	1801
Harris	16.1	788	Travis	15.2	1455
Hays	13.0	4	Van zandt	16.5	2
Henderson	13.9	32	Walker	13.0	1
Hidalgo	13.5	2	Waller	13.0	1
Hood	13.4	89	Williamson	13.0	1
Hopkins	13.9	9	Wise	13.8	55

These tables show water heater efficiencies across Texas in 2019

Table 38: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2019 (All Projects)

County	Avg Electric Energy Factor	House Count	County	Avg Electric Energy Factor	House Count
Anderson	0.9	1	Hopkins	0.9	13
Bastrop	1.0	1	Hunt	0.9	70
Bexar	0.9	11	Jefferson	0.9	1
Blanco	0.9	1	Johnson	0.9	164
Brazoria	0.9	1	Kaufman	0.9	133
Brazos	0.9	1	Liberty	0.9	1
Burnet	0.9	4	Llano	0.9	1
Caldwell	0.9	1	Mason	0.9	5
Collin	0.9	172	Mclennan	1.0	3
Cooke	0.9	2	Midland	0.9	1
Dallas	0.9	633	Montague	1.0	1
Denton	0.9	324	Montgomery	0.9	2
Ellis	0.9	110	Navarro	0.9	1
Erath	0.9	2	Nueces	1.0	102
Galveston	0.9	1	Palo pinto	0.9	4
Gillespie	0.9	1	Parker	0.9	160
Grayson	0.9	95	Rockwall	0.9	41
Gregg	0.9	2	San patricio	1.0	11
Guadalupe	1.0	9	Tarrant	0.9	1133
Harris	0.9	54	Travis	1.0	112
Hays	0.9	4	Van zandt	0.9	2
Henderson	0.9	29	Waller	0.9	2
Hidalgo	1.0	2	Wise	0.9	47
Hood	0.9	75			

Table 39: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2019 (Submitted Projects)

County	Avg Electric Energy Factor	House Count	County	Avg Electric Energy Factor	House Count
Anderson	0.9	1	Hunt	0.9	67
Bastrop	1.0	1	Jefferson	0.9	1
Bexar	0.9	8	Johnson	0.9	159
Brazoria	0.9	1	Kaufman	0.9	127
Brazos	0.9	1	Liberty	0.9	1
Burnet	0.9	4	Llano	0.9	1
Caldwell	0.9	1	Mason	0.9	5
Collin	0.9	165	Mclennan	1.0	3
Cooke	0.9	2	Midland	0.9	1
Dallas	0.9	598	Montague	1.0	1
Denton	0.9	314	Montgomery	0.9	1
Ellis	0.9	103	Navarro	0.9	1
Galveston	0.9	1	Nueces	1.0	101
Gillespie	0.9	1	Palo pinto	0.9	3
Grayson	0.9	91	Parker	0.9	148
Gregg	0.9	1	Rockwall	0.9	40
Guadalupe	1.0	9	San patricio	1.0	11
Harris	0.9	49	Tarrant	0.9	1078
Hays	0.9	4	Travis	1.0	106
Henderson	0.9	29	Van zandt	0.9	1
Hidalgo	1.0	2	Waller	0.9	1
Hood	0.9	75	Wise	0.9	47
Hopkins	0.9	9			

Table 40: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2019 (Passed Projects)

County	Avg Electric Energy Factor	House Count	County	Avg Electric Energy Factor	House Count
Anderson	0.9	1	Hunt	0.9	67
Bastrop	1.0	1	Jefferson	0.9	1
Bexar	0.9	8	Johnson	0.9	159
Brazoria	0.9	1	Kaufman	0.9	127
Brazos	0.9	1	Liberty	0.9	1
Burnet	0.9	4	Llano	0.9	1
Caldwell	0.9	1	Mason	0.9	5
Collin	0.9	165	Mclennan	1.0	3
Cooke	0.9	2	Midland	0.9	1
Dallas	0.9	597	Montague	1.0	1
Denton	0.9	314	Montgomery	0.9	1
Ellis	0.9	103	Navarro	0.9	1
Galveston	0.9	1	Nueces	1.0	101
Grayson	0.9	91	Palo pinto	0.9	3
Gregg	0.9	1	Parker	0.9	148
Guadalupe	1.0	9	Rockwall	0.9	40
Harris	0.9	49	San patricio	1.0	11
Hays	0.9	4	Tarrant	0.9	1076
Henderson	0.9	29	Travis	1.0	106
Hidalgo	1.0	2	Van zandt	0.9	1
Hood	0.9	75	Waller	0.9	1
Hopkins	0.9	9	Wise	0.9	47

Table 41: Yearly Average NGas Water Heater Energy Factor Distribution by County in 2019 (All Projects)

County	Avg NGas Energy Factor	House Count	County	Avg NGas Energy Factor	House Count
Bastrop	0.9	1	Jefferson	0.9	1
Bexar	0.6	86	Johnson	0.9	19
Brazos	0.7	16	Kaufman	0.7	134
Caldwell	0.9	1	Liberty	0.6	39
Coleman	0.9	1	Llano	0.8	2
Collin	0.8	534	Mclennan	1.0	3
Comal	0.6	17	Medina	0.9	1
Dallas	0.8	721	Midland	0.9	1
Denton	0.7	324	Montague	0.7	3
Ellis	0.8	61	Montgomery	0.7	2
Fort bend	0.8	4	Nueces	0.7	86
Freestone	0.8	1	Parker	0.8	57
Galveston	0.8	8	Rains	0.9	1
Grayson	0.7	48	Rockwall	0.7	45
Gregg	0.8	3	Tarrant	0.8	731
Harris	0.8	752	Travis	0.7	1346
Hays	0.6	2	Van zandt	0.9	1
Henderson	0.9	3	Walker	0.9	1
Hood	0.8	14	Williamson	1.0	1
Hunt	0.9	32	Wise	0.8	10

Table 42: Yearly Average NGas Water Heater Energy Factor Distribution by County in 2019 (Submitted Projects)

County	Avg NGas Energy Factor	House Count	County	Avg NGas Energy Factor	House Count
Bastrop	0.9	1	Johnson	0.9	18
Bexar	0.6	81	Kaufman	0.7	128
Brazos	0.7	15	Liberty	0.6	30
Caldwell	0.9	1	Llano	0.8	2
Coleman	0.9	1	Mclennan	1.0	3
Collin	0.8	519	Medina	0.9	1
Comal	0.6	15	Midland	0.9	1
Dallas	0.8	681	Montague	0.7	3
Denton	0.7	310	Montgomery	0.7	2
Ellis	0.8	58	Nueces	0.7	86
Fort bend	0.8	4	Parker	0.8	54
Freestone	0.8	1	Rains	0.9	1
Galveston	0.8	7	Rockwall	0.7	43
Grayson	0.7	45	Tarrant	0.8	705
Gregg	0.9	2	Travis	0.7	1276
Harris	0.8	737	Van zandt	0.9	1
Henderson	0.9	3	Walker	0.9	1
Hood	0.8	14	Williamson	1.0	1
Hunt	0.9	32	Wise	0.7	8
Jefferson	0.9	1			

Table 43: Yearly Average NGas Water Heater Energy Factor Distribution by County in 2019 (Passed Projects)

County	Avg NGas Energy Factor	House Count	County	Avg NGas Energy Factor	House Count
Bastrop	0.9	1	Johnson	0.9	18
Bexar	0.6	81	Kaufman	0.7	128
Brazos	0.7	15	Liberty	0.6	30
Caldwell	0.9	1	Llano	0.8	2
Coleman	0.9	1	Mclennan	1.0	3
Collin	0.8	519	Medina	0.9	1
Comal	0.6	15	Midland	0.9	1
Dallas	0.8	681	Montague	0.7	3
Denton	0.7	309	Montgomery	0.7	2
Ellis	0.8	58	Nueces	0.7	86
Fort bend	0.8	4	Parker	0.8	54
Freestone	0.8	1	Rains	0.9	1
Galveston	0.8	7	Rockwall	0.7	43
Grayson	0.7	45	Tarrant	0.8	704
Gregg	0.9	2	Travis	0.7	1276
Harris	0.8	737	Van zandt	0.9	1
Henderson	0.9	3	Walker	0.9	1
Hood	0.8	14	Williamson	1.0	1
Hunt	0.9	32	Wise	0.7	8
Jefferson	0.9	1			

Table 44: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2019 (All Projects)

County	Avg Heat Pump WH Energy Factor	House Count
Dallas	2.1	7
Galveston	2.3	1
Johnson	2.1	1
Parker	2.0	1
Tarrant	2.1	14
Travis	2.3	26

Table 45: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2019 (Submitted Projects)

County	Avg Heat Pump WH Energy Factor	House Count
Dallas	2.1	7
Galveston	2.3	1
Johnson	2.1	1
Parker	2.0	1
Tarrant	2.1	14
Travis	2.3	23

Table 46: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2019 (Passed Projects)

County	Avg Heat Pump WH Energy Factor	House Count
Dallas	2.1	7
Galveston	2.3	1
Johnson	2.1	1
Parker	2.0	1
Tarrant	2.1	14
Travis	2.3	23

These tables show the average A/C SEER across Texas in 2019.

Table 47: Average A/C SEER across Counties in 2019 (All Projects)

County	Avg A/C SEER	House Count	County	Avg A/C SEER	House Count
Anderson	14.0	1	Hood	14.7	89
Bastrop	17.0	2	Hopkins	14.0	13
Bexar	15.3	96	Hunt	14.1	103
Blanco	15.0	1	Jefferson	14.3	4
Brazoria	16.0	1	Johnson	14.8	184
Brazos	16.3	20	Kaufman	14.2	267
Burnet	14.0	4	Liberty	16.0	40
Caldwell	15.0	2	Llano	15.7	3
Cameron	16.0	1	Mason	16.6	5
Coleman	16.0	1	Mclennan	15.7	6
Collin	15.3	772	Medina	15.0	2
Comal	15.6	17	Midland	15.0	2
Cooke	14.0	2	Montague	15.0	4
Dallas	14.8	1382	Montgomery	15.2	5
Denton	14.8	656	Navarro	14.0	1
Ellis	14.9	173	Nueces	16.0	190
Erath	15.0	2	Palo pinto	15.8	4
Fort bend	15.0	4	Parker	15.1	217
Freestone	15.0	1	Rains	15.0	1
Galveston	16.4	10	Rockwall	14.7	86
Gillespie	16.0	1	San patricio	16.0	11
Grayson	15.0	143	Tarrant	14.8	1895
Gregg	14.0	5	Travis	16.1	1536
Guadalupe	16.2	10	Van zandt	15.3	3
Harris	15.3	810	Walker	14.0	1
Hays	15.2	7	Waller	14.0	2
Henderson	14.7	32	Williamson	14.0	1
Hidalgo	16.0	2	Wise	14.8	57

Table 48: Average A/C SEER across Counties in 2019 (Submitted Projects)

County	Avg A/C SEER	House Count
Anderson	14.0	1
Bastrop	17.0	2
Bexar	15.3	89
Brazoria	16.0	1
Brazos	15.9	16
Burnet	14.0	4
Caldwell	15.0	2
Coleman	16.0	1
Collin	15.3	750
Comal	15.5	15
Cooke	14.0	2
Dallas	14.8	1303
Denton	14.8	627
Ellis	15.0	163
Fort bend	15.0	4
Freeston	15.0	1
Galveston	16.1	9
Gillespie	16.0	1
Grayson	15.0	136
Gregg	14.0	3
Guadalupe	16.0	9
Harris	15.3	788
Hays	15.9	4
Henderson	14.7	32
Hidalgo	16.0	2
Hood	14.7	89
Hopkins	14.0	9

County	Avg A/C SEER	House Count
Hunt	14.1	100
Jefferson	14.3	3
Johnson	14.8	178
Kaufman	14.2	255
Liberty	16.0	31
Llano	15.7	3
Mason	16.6	5
Mclennan	15.7	6
Medina	14.0	1
Midland	15.0	2
Montague	15.0	4
Montgomery	15.0	4
Navarro	14.0	1
Nueces	16.1	189
Palo pinto	16.3	3
Parker	15.1	203
Rains	15.0	1
Rockwall	14.7	83
San patricio	16.0	11
Tarrant	14.8	1804
Travis	16.0	1455
Van zandt	15.0	2
Walker	14.0	1
Waller	14.0	1
Williamson	14.0	1
Wise	14.8	55



Table 49: Average A/C SEER across Counties in 2019 (Passed Projects)

County	Avg A/C SEER	House Count	County	Avg A/C SEER	House Count
Anderson	14.0	1	Hunt	14.1	100
Bastrop	17.0	2	Jefferson	14.3	3
Bexar	15.3	89	Johnson	14.8	178
Brazoria	16.0	1	Kaufman	14.2	255
Brazos	15.9	16	Liberty	16.0	31
Burnet	14.0	4	Llano	15.7	3
Caldwell	15.0	2	Mason	16.6	5
Coleman	16.0	1	Mclennan	15.7	6
Collin	15.3	750	Medina	14.0	1
Comal	15.5	15	Midland	15.0	2
Cooke	14.0	2	Montague	15.0	4
Dallas	14.8	1302	Montgomery	15.0	4
Denton	14.8	626	Navarro	14.0	1
Ellis	15.0	163	Nueces	16.1	189
Fort bend	15.0	4	Palo pinto	16.3	3
Freestone	15.0	1	Parker	15.1	203
Galveston	16.1	9	Rains	15.0	1
Grayson	15.0	136	Rockwall	14.7	83
Gregg	14.0	3	San patricio	16.0	11
Guadalupe	16.0	9	Tarrant	14.8	1801
Harris	15.3	788	Travis	16.0	1455
Hays	15.9	4	Van zandt	15.0	2
Henderson	14.7	32	Walker	14.0	1
Hidalgo	16.0	2	Waller	14.0	1
Hood	14.7	89	Williamson	14.0	1
Hopkins	14.0	9	Wise	14.8	55

These tables show the average ceiling insulation across Texas in 2019.

Table 50: Average Ceiling Insulation across Counties in 2019 (All Projects)

County	Avg Ceiling Insulation	House Count
Anderson	38.0	1
Bastrop	34.0	2
Bexar	31.4	96
Blanco	24.0	1
Brazoria	44.0	1
Brazos	36.9	20
Burnet	32.0	4
Caldwell	29.5	2
Cameron	23.0	1
Coleman	22.0	1
Collin	36.4	772
Comal	38.0	17
Cooke	19.5	2
Dallas	35.7	1382
Denton	34.5	656
Ellis	35.2	173
Erath	38.0	2
Fort bend	29.6	4
Freestone	23.0	1
Galveston	27.8	10
Gillespie	38.0	1
Grayson	36.3	143
Gregg	28.2	5
Guadalupe	29.8	9
Harris	31.9	811
Hays	34.0	6
Henderson	34.1	32
Hidalgo	22.2	2
Hood	23.1	89
Hopkins	41.8	13
Hunt	37.9	103
Jefferson	38.0	3
Johnson	33.6	185
Kaufman	33.2	267
Liberty	37.6	40
Llano	24.3	3
Mason	24.6	5
Mclennan	37.3	6
Medina	38.0	1
Midland	25.5	2
Montague	34.0	4
Montgomery	29.0	5
Navarro	38.0	1
Nueces	24.5	190
Palo pinto	29.3	4
Parker	35.7	217
Rains	38.0	1
Rockwall	38.3	86
San patricio	23.6	11
Tarrant	34.7	1902
Taylor	14.0	1
Travis	37.1	1541
Van zandt	28.5	3
Walker	20.0	1
Waller	30.0	2
Williamson	38.0	1
Wise	39.1	57

Table 51: Average Ceiling Insulation across Counties in 2019 (Submitted Projects)

County	Avg Ceiling Insulation	House Count	County	Avg Ceiling Insulation	House Count
Anderson	38.0	1	Hunt	37.9	100
Bastrop	34.0	2	Jefferson	38.0	3
Bexar	31.6	89	Johnson	33.5	178
Brazoria	44.0	1	Kaufman	33.1	255
Brazos	38.0	16	Liberty	37.5	31
Burnet	32.0	4	Llano	24.3	3
Caldwell	29.5	2	Mason	24.6	5
Coleman	22.0	1	McLennan	37.3	6
Collin	36.4	750	Medina	38.0	1
Comal	38.0	15	Midland	25.5	2
Cooke	19.5	2	Montague	34.0	4
Dallas	35.7	1303	Montgomery	31.0	4
Denton	34.3	627	Navarro	38.0	1
Ellis	35.2	163	Nueces	24.4	189
Fort bend	29.6	4	Palo pinto	26.3	3
Freestone	23.0	1	Parker	35.7	203
Galveston	28.6	9	Rains	38.0	1
Gillespie	38.0	1	Rockwall	38.3	83
Grayson	36.2	136	San patricio	23.6	11
Gregg	27.3	3	Tarrant	34.7	1804
Guadalupe	29.8	9	Travis	37.1	1455
Harris	31.9	788	Van zandt	34.0	2
Hays	36.0	4	Walker	20.0	1
Henderson	34.1	32	Waller	30.0	1
Hidalgo	22.2	2	Williamson	38.0	1
Hood	23.1	89	Wise	39.1	55
Hopkins	40.3	9			

Table 52: Average Ceiling Insulation across Counties in 2019 (Passed Projects)

County	Avg Ceiling Insulation	House Count	County	Avg Ceiling Insulation	House Count
Anderson	38.0	1	Hunt	37.9	100
Bastrop	34.0	2	Jefferson	38.0	3
Bexar	31.6	89	Johnson	33.5	178
Brazoria	44.0	1	Kaufman	33.1	255
Brazos	38.0	16	Liberty	37.5	31
Burnet	32.0	4	Llano	24.3	3
Caldwell	29.5	2	Mason	24.6	5
Coleman	22.0	1	Mclennan	37.3	6
Collin	36.4	750	Medina	38.0	1
Comal	38.0	15	Midland	25.5	2
Cooke	19.5	2	Montague	34.0	4
Dallas	35.7	1302	Montgomery	31.0	4
Denton	34.3	626	Navarro	38.0	1
Ellis	35.2	163	Nueces	24.4	189
Fort bend	29.6	4	Palo pinto	26.3	3
Freestone	23.0	1	Parker	35.7	203
Galveston	28.6	9	Rains	38.0	1
Grayson	36.2	136	Rockwall	38.3	83
Gregg	27.3	3	San patricio	23.6	11
Guadalupe	29.8	9	Tarrant	34.7	1801
Harris	31.9	788	Travis	37.1	1455
Hays	36.0	4	Van zandt	34.0	2
Henderson	34.1	32	Walker	20.0	1
Hidalgo	22.2	2	Waller	30.0	1
Hood	23.1	89	Williamson	38.0	1
Hopkins	40.3	9	Wise	39.1	55

These table show the average heating efficiency across Texas in 2019

Table 53: Average NGas Heating Efficiency across Counties in 2019 (All Projects)

County	Avg NGas Efficiency	House Count	County	Avg NGas Efficiency	House Count
Bexar	0.8	89	Hunt	0.8	36
Brazos	0.8	17	Jefferson	0.8	2
Burnet	0.8	1	Johnson	0.9	21
Caldwell	0.9	1	Kaufman	0.8	137
Collin	0.8	609	Liberty	0.8	39
Comal	0.8	17	Medina	0.9	1
Dallas	0.9	802	Midland	0.9	2
Denton	0.8	343	Montague	0.8	3
Ellis	0.8	66	Montgomery	0.8	4
Fort bend	0.8	4	Parker	0.8	94
Freestone	0.9	1	Rains	0.8	1
Galveston	0.8	5	Rockwall	0.8	49
Grayson	0.8	57	Tarrant	0.8	796
Gregg	1.0	3	Travis	0.8	1313
Harris	0.8	748	Van zandt	0.9	1
Hays	0.8	3	Walker	0.8	1
Henderson	0.8	2	Wise	0.8	9
Hood	0.9	7			

Table 54: Average NGas Heating Efficiency across Counties in 2019 (Submitted Projects)

County	Avg NGas Efficiency	House Count	County	Avg NGas Efficiency	House Count
Bexar	0.8	86	Hunt	0.8	36
Brazos	0.8	15	Jefferson	0.8	2
Burnet	0.8	1	Johnson	0.9	20
Caldwell	0.9	1	Kaufman	0.8	131
Collin	0.8	594	Liberty	0.8	30
Comal	0.8	15	Medina	0.9	1
Dallas	0.9	755	Midland	0.9	2
Denton	0.8	328	Montague	0.8	3
Ellis	0.8	63	Montgomery	0.8	3
Fort bend	0.8	4	Parker	0.8	90
Freestone	0.9	1	Rains	0.8	1
Galveston	0.8	5	Rockwall	0.8	46
Grayson	0.8	52	Tarrant	0.8	765
Gregg	0.9	2	Travis	0.8	1247
Harris	0.8	733	Van zandt	0.9	1
Hays	0.8	1	Walker	0.8	1
Henderson	0.8	2	Wise	0.8	8
Hood	0.9	7			

Table 55: Average NGas Heating Efficiency across Counties in 2019 (Passed Projects)

County	Avg NGas Efficiency	House Count	County	Avg NGas Efficiency	House Count
Bexar	0.8	86	Hunt	0.8	36
Brazos	0.8	15	Jefferson	0.8	2
Burnet	0.8	1	Johnson	0.9	20
Caldwell	0.9	1	Kaufman	0.8	131
Collin	0.8	594	Liberty	0.8	30
Comal	0.8	15	Medina	0.9	1
Dallas	0.9	755	Midland	0.9	2
Denton	0.8	327	Montague	0.8	3
Ellis	0.8	63	Montgomery	0.8	3
Fort bend	0.8	4	Parker	0.8	90
Freestone	0.9	1	Rains	0.8	1
Galveston	0.8	5	Rockwall	0.8	46
Grayson	0.8	52	Tarrant	0.8	763
Gregg	0.9	2	Travis	0.8	1247
Harris	0.8	733	Van zandt	0.9	1
Hays	0.8	1	Walker	0.8	1
Henderson	0.8	2	Wise	0.8	8
Hood	0.9	7			

Table 56: Average Heat Pump Heating Efficiency across Counties in 2019 (All Projects)

County	Avg Heat Pump Efficiency	House Count	County	Avg Heat Pump Efficiency	House Count
Anderson	10.0	1	Hopkins	8.5	13
Bastrop	8.8	2	Hunt	10.3	67
Bexar	9.6	7	Jefferson	9.8	1
Blanco	9.0	1	Johnson	9.3	161
Brazoria	13.0	1	Kaufman	8.5	130
Brazos	8.4	1	Liberty	8.2	1
Burnet	8.3	3	Llano	9.2	3
Caldwell	8.2	1	Mason	9.3	5
Coleman	8.5	1	Mclennan	8.6	6
Collin	8.6	162	Montague	8.2	1
Cooke	8.2	2	Montgomery	8.5	1
Dallas	8.9	579	Navarro	11.2	1
Denton	8.6	311	Nueces	8.7	189
Ellis	8.9	106	Palo pinto	8.2	4
Erath	8.5	2	Parker	8.7	123
Galveston	8.5	3	Rockwall	8.8	37
Gillespie	9.0	1	San patricio	8.7	11
Grayson	8.6	85	Tarrant	8.9	1080
Gregg	9.0	2	Taylor	13.0	1
Guadalupe	9.8	9	Travis	9.5	221
Harris	9.2	54	Van zandt	8.8	2
Hays	9.7	3	Waller	8.2	2
Henderson	8.2	30	Williamson	8.2	1
Hidalgo	12.0	1	Wise	8.7	48
Hood	8.7	82			

Table 57: Average Heat Pump Heating Efficiency across Counties in 2019 (Submitted Projects)

County	Avg Heat Pump Efficiency	House Count	County	Avg Heat Pump Efficiency	House Count
Anderson	10.0	1	Hopkins	8.5	9
Bastrop	8.8	2	Hunt	10.3	64
Bexar	9.7	3	Jefferson	9.8	1
Brazoria	13.0	1	Johnson	9.3	156
Brazos	8.4	1	Kaufman	8.5	124
Burnet	8.3	3	Liberty	8.2	1
Caldwell	8.2	1	Llano	9.2	3
Coleman	8.5	1	Mason	9.3	5
Collin	8.6	156	Mclennan	8.6	6
Cooke	8.2	2	Montague	8.2	1
Dallas	8.9	548	Montgomery	8.5	1
Denton	8.6	299	Navarro	11.2	1
Ellis	8.9	100	Nueces	8.7	189
Galveston	8.5	2	Palo pinto	8.2	3
Gillespie	9.0	1	Parker	8.6	113
Grayson	8.6	83	Rockwall	8.8	37
Gregg	9.0	1	San patricio	8.7	11
Guadalupe	9.8	9	Tarrant	8.8	1034
Harris	9.1	52	Travis	9.4	207
Hays	9.7	3	Van zandt	8.2	1
Henderson	8.2	30	Waller	8.2	1
Hidalgo	12.0	1	Williamson	8.2	1
Hood	8.7	82	Wise	8.7	47

Table 58: Average Heat Pump Heating Efficiency across Counties in 2019 (Passed Projects)

County	Avg Heat Pump Efficiency	House Count	County	Avg Heat Pump Efficiency	House Count
Anderson	10.0	1	Hunt	10.3	64
Bastrop	8.8	2	Jefferson	9.8	1
Bexar	9.7	3	Johnson	9.3	156
Brazoria	13.0	1	Kaufman	8.5	124
Brazos	8.4	1	Liberty	8.2	1
Burnet	8.3	3	Llano	9.2	3
Caldwell	8.2	1	Mason	9.3	5
Coleman	8.5	1	Mclennan	8.6	6
Collin	8.6	156	Montague	8.2	1
Cooke	8.2	2	Montgomery	8.5	1
Dallas	8.9	547	Navarro	11.2	1
Denton	8.6	299	Nueces	8.7	189
Ellis	8.9	100	Palo pinto	8.2	3
Galveston	8.5	2	Parker	8.6	113
Grayson	8.6	83	Rockwall	8.8	37
Gregg	9.0	1	San patricio	8.7	11
Guadalupe	9.8	9	Tarrant	8.8	1033
Harris	9.1	52	Travis	9.4	207
Hays	9.7	3	Van zandt	8.2	1
Henderson	8.2	30	Waller	8.2	1
Hidalgo	12.0	1	Williamson	8.2	1
Hood	8.7	82	Wise	8.7	47
Hopkins	8.5	9			

These tables show the average SHGC across Texas in 2019

Table 59: Average SHGC across Counties in 2019 (All Projects)

County	Avg SHGC	House Count	County	Avg SHGC	House Count
Anderson	0.22	1	Hopkins	0.21	13
Bastrop	0.27	2	Hunt	0.21	103
Bexar	0.22	98	Jefferson	0.22	4
Blanco	0.22	1	Johnson	0.24	185
Brazoria	0.20	1	Kaufman	0.24	267
Brazos	0.27	21	Liberty	0.23	40
Burnet	0.25	4	Llano	0.26	3
Caldwell	0.26	2	Mason	0.25	5
Coleman	0.25	1	Mclennan	0.26	6
Collin	0.23	772	Medina	0.25	1
Comal	0.22	17	Midland	0.25	2
Cooke	0.24	2	Montague	0.23	4
Dallas	0.24	1387	Montgomery	0.24	5
Denton	0.24	657	Navarro	0.20	1
Ellis	0.23	173	Nueces	0.27	191
Erath	0.23	2	Palo pinto	0.25	4
Fort bend	0.30	4	Parker	0.24	219
Freestone	0.30	1	Rains	0.21	1
Galveston	0.24	10	Rockwall	0.24	86
Gillespie	0.20	1	San patricio	0.26	11
Grayson	0.23	143	Tarrant	0.24	1914
Gregg	0.24	5	Taylor	0.27	1
Guadalupe	0.25	10	Travis	0.23	1545
Harris	0.27	817	Van zandt	0.27	3
Hays	0.25	6	Walker	0.25	1
Henderson	0.22	32	Waller	0.32	2
Hidalgo	0.23	2	Williamson	0.29	1
Hood	0.29	89	Wise	0.23	57



Table 60: Average SHGC across Counties in 2019 (Submitted Projects)

County	Avg SHGC	House Count	County	Avg SHGC	House Count
Anderson	0.22	1	Hunt	0.21	100
Bastrop	0.27	2	Jefferson	0.23	3
Bexar	0.21	89	Johnson	0.24	178
Brazoria	0.20	1	Kaufman	0.24	255
Brazos	0.25	16	Liberty	0.23	31
Burnet	0.25	4	Llano	0.26	3
Caldwell	0.26	2	Mason	0.25	5
Coleman	0.25	1	Mclennan	0.26	6
Collin	0.23	750	Medina	0.25	1
Comal	0.22	15	Midland	0.25	2
Cooke	0.24	2	Montague	0.23	4
Dallas	0.24	1300	Montgomery	0.24	4
Denton	0.23	626	Navarro	0.20	1
Ellis	0.23	163	Nueces	0.27	189
Fort bend	0.30	4	Palo pinto	0.25	3
Freestone	0.30	1	Parker	0.24	203
Galveston	0.25	9	Rains	0.21	1
Gillespie	0.20	1	Rockwall	0.25	83
Grayson	0.23	136	San patricio	0.26	11
Gregg	0.20	3	Tarrant	0.24	1801
Guadalupe	0.25	9	Travis	0.23	1455
Harris	0.27	787	Van zandt	0.25	2
Hays	0.27	4	Walker	0.25	1
Henderson	0.22	32	Waller	0.32	1
Hidalgo	0.23	2	Williamson	0.29	1
Hood	0.29	89	Wise	0.23	55
Hopkins	0.21	9			

Table 61: Average SHGC across Counties in 2019 (Passed Projects)

County	Avg SHGC	House Count	County	Avg SHGC	House Count
Anderson	0.22	1	Hunt	0.21	100
Bastrop	0.27	2	Jefferson	0.23	3
Bexar	0.21	89	Johnson	0.24	178
Brazoria	0.20	1	Kaufman	0.24	255
Brazos	0.25	16	Liberty	0.23	31
Burnet	0.25	4	Llano	0.26	3
Caldwell	0.26	2	Mason	0.25	5
Coleman	0.25	1	Mclennan	0.26	6
Collin	0.23	750	Medina	0.25	1
Comal	0.22	15	Midland	0.25	2
Cooke	0.24	2	Montague	0.23	4
Dallas	0.24	1299	Montgomery	0.24	4
Denton	0.23	625	Navarro	0.20	1
Ellis	0.23	163	Nueces	0.27	189
Fort bend	0.30	4	Palo pinto	0.25	3
Freestone	0.30	1	Parker	0.24	203
Galveston	0.25	9	Rains	0.21	1
Grayson	0.23	136	Rockwall	0.25	83
Gregg	0.20	3	San patricio	0.26	11
Guadalupe	0.25	9	Tarrant	0.24	1799
Harris	0.27	787	Travis	0.23	1455
Hays	0.27	4	Van zandt	0.25	2
Henderson	0.22	32	Walker	0.25	1
Hidalgo	0.23	2	Waller	0.32	1
Hood	0.29	89	Williamson	0.29	1
Hopkins	0.21	9	Wise	0.23	55

These tables show the average window U-Factor across Texas in 2019

Table 62: Average Window U-Factor across Counties in 2019 (All Projects)

County	Avg U-Factor	House Count
Anderson	0.3000	1
Bastrop	0.2600	2
Bexar	0.3322	99
Blanco	0.3200	1
Brazoria	0.3000	1
Brazos	0.3650	22
Burnet	0.2800	4
Caldwell	0.3800	2
Coleman	0.2100	1
Collin	0.3248	772
Comal	0.3500	17
Cooke	0.3400	2
Dallas	0.3170	1390
Denton	0.3283	660
Ellis	0.3253	173
Erath	0.3500	2
Fort bend	0.3775	4
Freestone	0.3000	1
Galveston	0.3260	10
Gillespie	0.3300	1
Grayson	0.3359	143
Gregg	0.2940	5
Guadalupe	0.4040	10
Harris	0.3379	818
Hays	0.3133	6
Henderson	0.3428	32
Hidalgo	0.3650	2
Hood	0.3390	89
Hopkins	0.2954	13

County	Avg U-Factor	House Count
Hunt	0.3094	103
Jefferson	0.3375	4
Johnson	0.3109	185
Kaufman	0.3384	267
Liberty	0.3278	40
Llano	0.2800	3
Mason	0.3560	5
Mclennan	0.3183	6
Medina	0.3600	1
Midland	0.3500	2
Montague	0.3150	4
Montgomery	0.3100	5
Navarro	0.3300	1
Nueces	0.3246	191
Palo pinto	0.3425	4
Parker	0.3258	219
Potter	0.1000	1
Rains	0.3200	1
Rockwall	0.3317	86
San patricio	0.3200	11
Tarrant	0.3220	1916
Taylor	0.3000	1
Travis	0.3355	1545
Van zandt	0.3867	3
Walker	0.3500	1
Waller	0.3500	2
Williamson	0.3500	1
Wise	0.3316	57

Table 63: Average Window U-Factor across Counties in 2019 (Submitted Projects)

County	Avg U-Factor	House Count	County	Avg U-Factor	House Count
Anderson	0.3000	1	Hunt	0.3099	100
Bastrop	0.2600	2	Jefferson	0.3367	3
Bexar	0.3331	89	Johnson	0.3112	178
Brazoria	0.3000	1	Kaufman	0.3380	255
Brazos	0.3856	16	Liberty	0.3271	31
Burnet	0.2800	4	Llano	0.2800	3
Caldwell	0.3800	2	Mason	0.3560	5
Coleman	0.2100	1	Mclennan	0.3183	6
Collin	0.3247	750	Medina	0.3600	1
Comal	0.3500	15	Midland	0.3500	2
Cooke	0.3400	2	Montague	0.3150	4
Dallas	0.3169	1303	Montgomery	0.3125	4
Denton	0.3274	627	Navarro	0.3300	1
Ellis	0.3250	163	Nueces	0.3208	189
Fort bend	0.3775	4	Palo pinto	0.3400	3
Freestone	0.3000	1	Parker	0.3255	203
Galveston	0.3267	9	Rains	0.3200	1
Gillespie	0.3300	1	Rockwall	0.3320	83
Grayson	0.3362	136	San patricio	0.3200	11
Gregg	0.3000	3	Tarrant	0.3206	1803
Guadalupe	0.4167	9	Travis	0.3353	1455
Harris	0.3375	788	Van zandt	0.3500	2
Hays	0.2950	4	Walker	0.3500	1
Henderson	0.3428	32	Waller	0.3500	1
Hidalgo	0.3650	2	Williamson	0.3500	1
Hood	0.3390	89	Wise	0.3278	55
Hopkins	0.2978	9			

Table 64: Average Window U-Factor across Counties in 2019 (Passed Projects)

County	Avg U-Factor	House Count	County	Avg U-Factor	House Count
Anderson	0.3000	1	Hunt	0.3099	100
Bastrop	0.2600	2	Jefferson	0.3367	3
Bexar	0.3331	89	Johnson	0.3112	178
Brazoria	0.3000	1	Kaufman	0.3380	255
Brazos	0.3856	16	Liberty	0.3271	31
Burnet	0.2800	4	Llano	0.2800	3
Caldwell	0.3800	2	Mason	0.3560	5
Coleman	0.2100	1	Mclennan	0.3183	6
Collin	0.3247	750	Medina	0.3600	1
Comal	0.3500	15	Midland	0.3500	2
Cooke	0.3400	2	Montague	0.3150	4
Dallas	0.3169	1302	Montgomery	0.3125	4
Denton	0.3274	626	Navarro	0.3300	1
Ellis	0.3250	163	Nueces	0.3208	189
Fort bend	0.3775	4	Palo pinto	0.3400	3
Freestone	0.3000	1	Parker	0.3255	203
Galveston	0.3267	9	Rains	0.3200	1
Grayson	0.3362	136	Rockwall	0.3320	83
Gregg	0.3000	3	San patricio	0.3200	11
Guadalupe	0.4167	9	Tarrant	0.3207	1800
Harris	0.3375	788	Travis	0.3353	1455
Hays	0.2950	4	Van zandt	0.3500	2
Henderson	0.3428	32	Walker	0.3500	1
Hidalgo	0.3650	2	Waller	0.3500	1
Hood	0.3390	89	Williamson	0.3500	1
Hopkins	0.2978	9	Wise	0.3278	55